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paleotronic

RETRO-TECHNOLOGY SCIENCE, HISTORY, ART AND CULTURE

The DSKY: Keeping Them Safe
IBM System/360: Doing the Math
Apollo Live from Tranquility Base
BASIC & Logo Lunar Landers
Arcade Games on the Moon
The Rise and Fall of Imagic

PLUS:
Freescape: The First FPSs?
Rob Fulop talks Atari 2600
Millennium Moon Mousing
Build your own Theremin
and much, much more!

How electronics, computers and human ingenuity led us to escape the shackles of Earth and travel TO THE MOON!

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T MINUS ZERO

Space... the final frontier.

Apollo 16 was the tenth manned mission of the Apollo space program, and the fifth to land on the surface of the Moon. Launched on April 16th 1972, the mission lasted 11 days, concluding on April 27th, splashing down 350km southeast of Kiritimati in the Pacific Ocean.

Some people believe the opposable thumb is the secret to humanity's success. But not me. For me, I think the knowledge of our mortality, of our limited existence, has played a far greater role in advancing us forward as a species. Otherwise, why try? It's all well and good to be able to use a rock as a tool, but if you're well fed and happy on a temperate savannah, the impetus to go anywhere else is likely to be rather muted. No, humanity craves legacy, and the best way to ensure true legacy (not just your standard all-too-short fifteen minutes) is to drive progress by inventing something useful or discovering something (or some place) of value.

Columbus thought he could revolutionise trade by finding a simple, direct route from Europe to Asia – by going the other way around. Of course, he didn't, but he ran into the New World, which was some consolation prize! It turns out the Norse had been there first, but they didn't stay long, and while their voyage was arguably much more difficult than Columbus's (and for that they certainly earn bonus points) staying power is everything.

The Spanish and the Portuguese took the South of these two new "Americas", and the British and French the North. Their subsequent pioneers and explorers made plenty of discoveries (and names) of their own.

But Columbus was by no means a special case – a millennia and a half before, the Romans built roads and marched to (and conquered) virtually every nook and cranny of Europe. The Vikings explored Iceland and Greenland. Marco Polo, while not the first European to get to China was the first to squawk about it, inspiring many other explorers – including Columbus. But none of them would've done any of that if those first restless souls hadn't left the comforts of the savannah.

It's not all about the destination though, as fantastical as some of those (the top of Everest, the South Pole, the depths of the Mariana Trench) may be, but how we got there is arguably of equal or greater import. Without the innovations which led to sailing vessels capable of crossing the Atlantic, of trains steaming across the plains of North America, or the aircraft which shrunk the travel time to exotic locales from weeks to hours, much of those accomplishments may not have happened.

Speaking of aircraft, it was a mere 66 years between Kitty Hawk and "one small step for man", from the first powered flight to leave the ground in any capacity to flying to the Moon. That's an extraordinary achievement – perhaps _the_ most extraordinary achievement – by any measure. But while those men who set foot on the lunar surface were perhaps the greatest of humanity's explorers, there's no way they could've got there without a vast amount of preceding innovation and ingenuity.

Firstly, the Earth doesn't generally want to let you leave. Gravity and a modest amount of thrust work together with an aircraft wing to cause lift and keep a plane in the air, but travelling straight up requires more thrust – much, much more. You need a rocket for that. But it's not a simple matter of filling a tube full of fuel and lighting a fuse - something of the size required to break free of the Earth's gravity has to be stable, especially during liftoff, or it's more likely to go where you don't want it to go (frequently the ground) than where you do.

All you end up with for all of that time and money spent is a very expensive debris field. Secondly, once you get out into space, you have to deal with the fact that it's space – no atmosphere, extremes of heat and cold, radiation, meteorites. Assuming you figure out how to survive all of those, you can romp around a bit, but don't think you can play hooky on old Mother Earth and walk back through that kitchen door for supper when you're done! No sir (or ma'am.) She don't want you back – she'll set you on fire if you try. Unless you do it just the right way.

So, once you've worked out how to get up there, take a spin around a few rotations, maybe take a walk outside and return safely back down, you begin to get designs on that disc that has a habit of dominating the night sky, taunting, beckoning to you like a mythical Siren.

And you start to believe that it's possible – after all, once you're up there, all you have to do is build up a head of steam and point yourself in the right direction. It's a simple matter, isn't it? Just engineer a tin can a few people can survive in for a few days and off we go! Easy-peasy.

Except it's not – especially not if you want your odds of survival to reach above the single digits. There's literally a million things that could go wrong, and millions of taxpayer dollars to be wasted if things don't go exactly as planned. Precise calculations need to be made, taking into account hundreds of

variables – if even a single one of those is incorrect you could end up taking a wrong turn in space and ending up someplace far less hospitable than Albuquerque. It's not a good look when your astronauts die slowly, running out of oxygen, or roasting or freezing to death!

"If you fail to plan, you plan to fail." A Moon shot requires one hell of a plan, and a significantly large part of that plan involves electronics – from getting off the ground, to getting where you want to go, surviving it and making it back, each stage is far more dependent on electrons than on human grit and determination (although those are still useful characteristics). While the bravery of the Apollo astronauts is not to be understated, without the assistance of technology their dream of walking on the Moon would still be just that – a dream.

This issue of Paleotronic is dedicated to that technology, and to those who developed it. From the computers needed to calculate trajectories and guide the spacecraft to the radio equipment that allowed them to communicate, and to the rockets and space suits and cameras that allowed it all to be broadcast live on TV, we'll take a look at the lot, diving into the electronic behind-the-scenes that allowed some of humanity to stand tall somewhere truly not-of-this-Earth, and the rest of us to witness it.

But don't worry, the pages that follow are not exclusively filled with the finer points of aerospace engineering – there's plenty of fun and games too, including an expose on the 1980s home computer Lunar Lander craze and a look at popular Moon-related arcade titles including Battlezone and Moon Patrol. We'll also revisit the dramatic rise and fall of Atari 2600 game developer Imagic, and Rob Fulop's breakout hit Demon Attack (set on the Moon, of course!) and have a chat with the man himself. And much, much more!

So sit back and relax and take a trip back through time with us, as we revisit all of those innovations which not only culminated in one particularly momentous event in mid-1969, but largely shaped the technological world we live in today. Because were it not for our need for advancement, our desire to grow humanity's legacy in the knowledge that we have only the briefest of chances of doing so, we might still be sitting on the savannah, admiring the Moon for its beauty but little else.

Now, to the Moon!

"Magnificient desolation" was how Buzz Aldrin described the lunar surface, an apt description of the wasteland that spread out before him upon his arrival there. Devoid of life or atmosphere, the Moon is little more than a rock, a big barren rock. But it's our big, barren rock, especially now that we've stood on it! How did we get there? More importantly, how did we get back? Let's find out!

Today's Paleotronic

Launch Schedule

DSKY

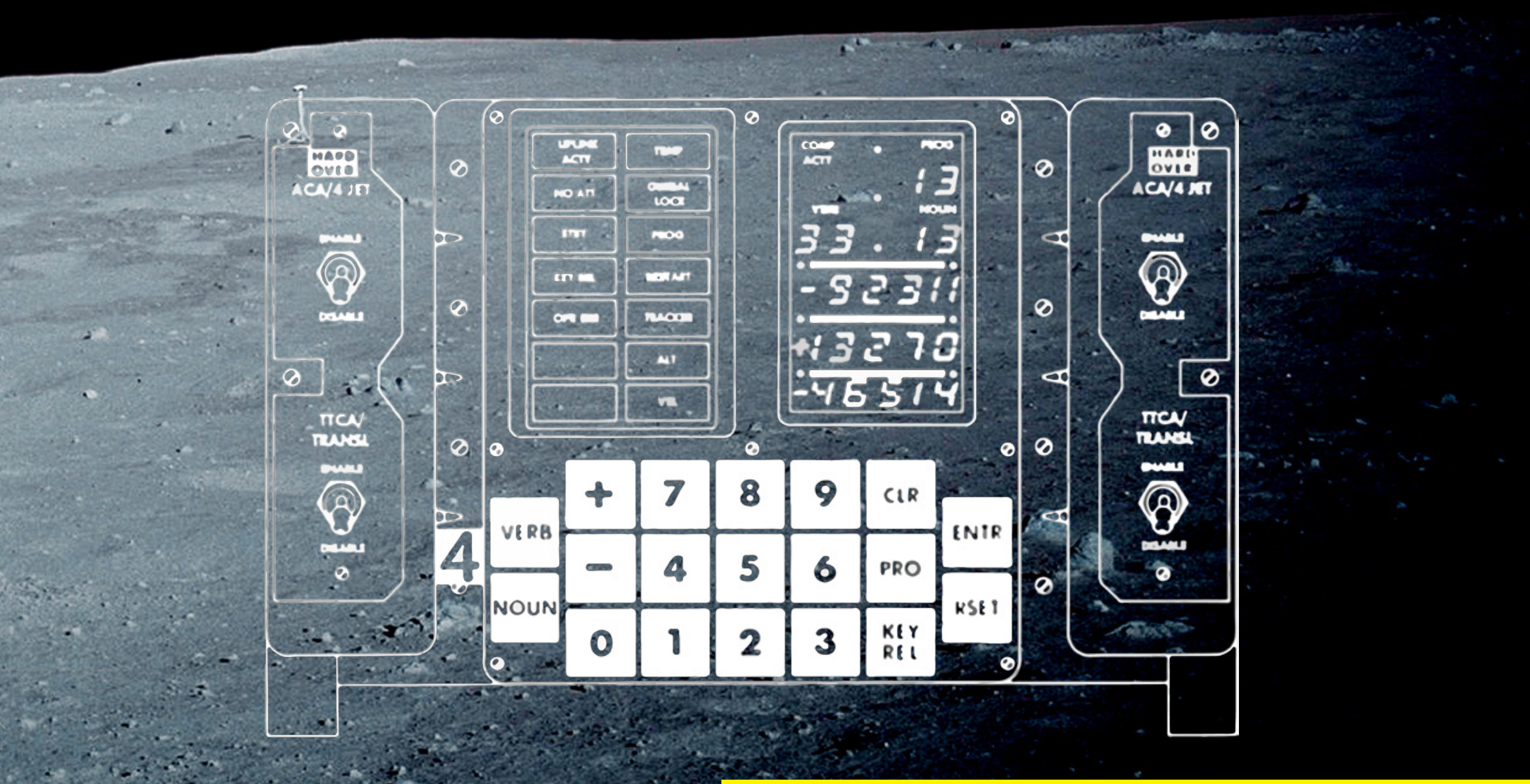
THE DISKEE

Apollo's most important crewmember

The DSKY (a quasi-acronym of DiSplay and KeYboard) was the user-interface to the Apollo Guidance Computer. Affectionally known by astronauts as the "Diskee", the term came to refer to both the interface and the computer, personified as their companion and friend.

The Diskee could take men to the moon.

More importantly, it would keep them safe.



FEATURE PRESENTATION

“Program alarm.”

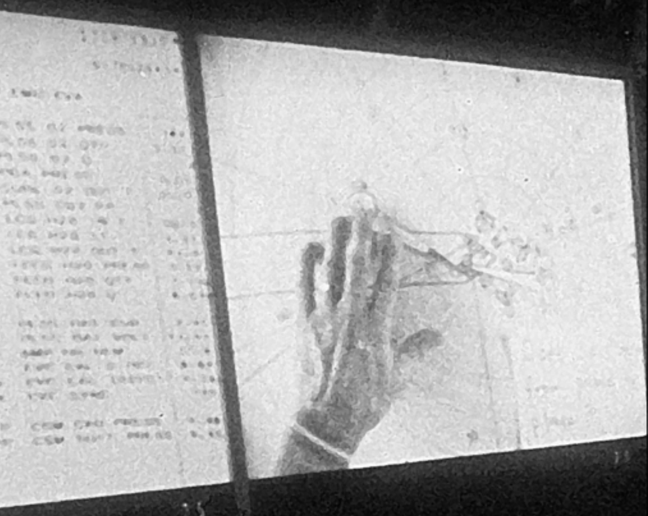
Apollo 11 commander Neil Armstrong’s tense two-word report came over the loudspeakers at NASA’s Mission Control in Houston, more of a question than a statement as he and and fellow astronaut Buzz Aldrin rapidly descended in the Lunar Excursion Module toward the surface of the Moon. What should they do now? Should they abort or trust the Apollo Guidance Computer to finish its job? They needed an answer, and quick!

Time stood still, then, for a moment in Mission Control, as those present weighed the ramifications of Armstrong’s report. After spending $16 billion dollars of American taxpayers hard-earned money, the efforts of over 400,000 engineers, scientists and technicians, and the deaths of three astronauts (including Gus Grissom, the second American to fly in space) in the tragic Apollo 1 fire, the idea of failure at such a pivotal moment caused the hearts of those in Mission Control to temporarily stop beating.

The Apollo 11 Lunar Lander was hurtling toward the surface of the Moon, and if the guidance computer had crashed so might the astronauts contained within it – not a scenario anyone would ever wish to see played out. “1202 alarm”, Aldrin clarified, reading the error number off of the DSKY, the keyboard and display that served as the astronaut’s interface into the Apollo Guidance Computer, and snapping Mission Control out of its momentary freeze, forcing its members into action. The fate of two astronauts, the Lunar Lander and the future of the entire Apollo program hanged in the balance, and this issue needed to be resolved pronto.

After the Apollo 1 fire NASA had been relentlesss about drilling its teams, including Mission Control, running simulations of a vast variety of scenarios, including ones involving various failures of the Apollo Guidance Computer.

Set in motion by US President John F. Kennedy’s famous declaration that Americans would walk on the Moon by the end of the 1960s, the Apollo program (also known as Project Apollo) was a human spaceflight program carried out by the National Aeronautics and Space Administration (NASA) to that end. Preceded by Project Mercury (the first human spaceflight program) and Project Gemini (which extended spaceflight capabilities in anticipation of a mission to the Moon), Apollo was NASA’s third manned spaceflight program, which ran from 1960-1972 and succeeded in landing twelve astronauts on the lunar surface.



Located in Building 30 at the Lyndon B. Johnson Space Center in Houston, Texas, the Mission Control Center was the heart of the Apollo missions, its staff managing almost every aspect of them after their respective Saturn V rockets had left the ground. Made up of two Mission Operation Control Rooms (MOCR), MOCR 2 was used for Apollo 11, and was designated a National Historic Landmark in 1985. Its final active use was in 1991 for space-shuttle mission STS-53, after which it was decommissioned, returned back to its Apollo-era configuration and is now preserved for posterity.

But perhaps NASA's aggressive efforts to avoid another disaster had overloaded the minds of its engineers as everyone seemed to be drawing a blank. 1202 alarm? What did that mean? Was it serious or not? What was the computer trying to say? Was the error code just advice or did it require human intervention?

Nobody present at that crucial moment seemed able to remember. No one, that is, except Jack Garman. Jack was hired by NASA in 1966 at the age of 21, and had elected to be assigned to the Apollo Guidance Program section where he worked closely with the Massachusetts Institute of Technology (MIT), overseeing the design of the Apollo Guidance Computer.

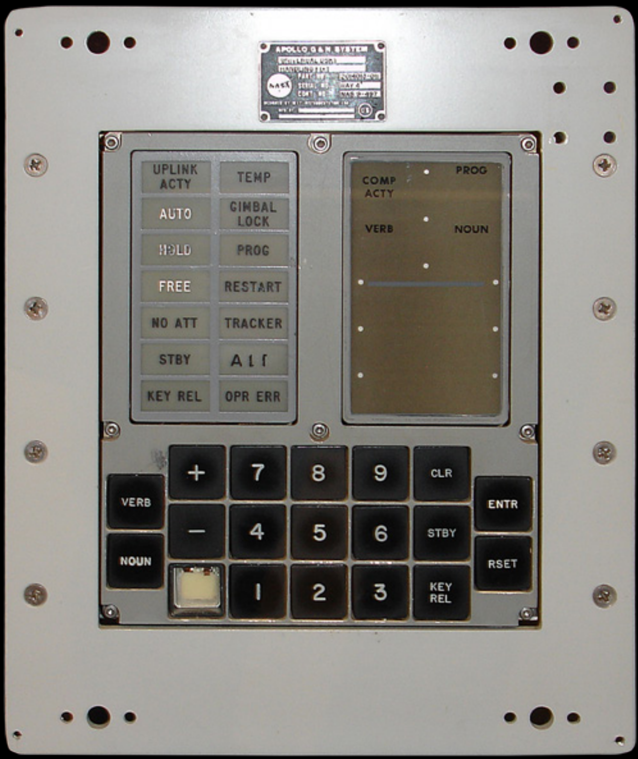
"Give us a reading of that 1202 alarm", came an increasingly anxious voice over the loudspeakers as Mission Control frantically searched its collective minds for an answer.

"That's okay," said Garman, and everyone heaved a tentative sigh of relief. But some started to remember that during a previous simulation of the 1202 alarm, Guidance officer (also known as GUIDO) Steve Bales – Garman's boss – had called for an abort. It was up to Bales now to decide whether to back Garman's call or contradict it.

Bales had already opted against calling for an abort earlier in the landing after learning the spacecraft was moving 6 m (20 ft) per second faster than it should have been, but the trajectory remained stable and Bales had decided to allow the mission to continue. But could he trust the opinion of his subordinate now?

He asked Garman for clarification, and Garman insisted that if the alarms weren't constant, the computer would continue functioning. Was he right? What if he wasn't? Two men could die! The clock was ticking and Bales had to decide.

FEATURE PRESENTATION



Manufactured by defense contractor Raytheon under the direction of the MIT Instrumentation Laboratory, the Apollo Guidance Computer (AGC) was installed on board each Apollo Command Module (CM) and Lunar Module (LM). The AGC provided computation and electronic interfaces for guidance, navigation and control of the spacecraft. The AGC was one of the first integrated circuit-based computers, providing similar perfomance to late 1970s home computers.

Bales mind pondered heavily, going back over the history of the guidance project, and Garman's role in it. One of the first integrated-circuit (IC)-based computers, design of the AGC began in early 1961. Despite traditionally contracting with defense companies, the MIT Instrumentation Laboratory was chosen by NASA to develop it, due to the storied reputation of laboratory founder Charles Stark Draper, known by some as the "father of intertial navigation." Draper's interest in flight instrumentation had been borne out of his experiences as a pilot in the 1930s – during the previous decade he had earned a number of degrees from Stanford and MIT including one in electrochemical engineering, and he put his knowledge to use searching for a solution to the problem of accurate aerial navigation.

By using a series of gyroscopes and accelerometers he devised a machine capable of sensing the direction and speed of an aircraft, and then adjusting the plane's heading appropriately. People were skepical of Draper's contraption's ability to navigate to a destination without using visual landmarks or radio transponders, but tests proved that his invention worked, and it became a critical component of US intercontinental ballistic missiles, submarines, military and later commercial aircraft.

NASA hoped that Draper's expertise would be useful in the design of a flight computer capable of navigating astronauts to –and landing on – the surface of the Moon. But Draper wouldn't be designing the AGC all on his own – he had an entire team ready to assist him.

One of those team members was Margaret Hamilton. Previous to her work on the AGC, From 1961 to 1963, Hamilton had written software for the giant AN/FSQ-7 computers at the heart of SAGE, the Semi-Automatic Ground Environment project that analyzed information from a large network of radar stations in order to construct a real-time view of North American airspace and use it to determine a potential response against Soviet attack. Despite questions regarding its reliability and the diminishing availability of the vacuum tubes that powered it, SAGE would remain a key component of NORAD's defense capabilities well into the 1980s, when it would inspire movies such as WarGames (1983).

Software development was a brand-new discipline in the early 1960s – previous computers had simply followed the directions of punch cards or control panels sequentially in real time and the idea of a resident program that monitored inputs and acted appropriately was cutting-edge at that stage. Hamilton was a pioneer in an emerging area – and the Apollo spacecraft was going to need a computer capable of doing nearly everything the 226 tonne (250 ton) AN/FSQ7 did in the space of a single cubic foot!

Margaret Hamilton stands next to printouts of Apollo Guidance Computer source code.

Margaret Hamilton sits inside an Apollo Command Module.

Born in Paoli, Indiana in 1936, Margaret Heafield graduated from Hancock High School in 1954. She earned a degree in mathematics in 1958, and briefly taught high-school math and French. She moved to Boston with the intention of doing graduate study in abstract mathematics, but instead took a position at MIT at Marvin Minsky's Project MAC to develop software for predicting weather on the LGP-30 and PDP-1 computers. From 1961 to 1963 she worked on the Semi-Automatic Ground Environment (SAGE) project at Lincoln Lab, where she wrote aircraft detection software for the first AN/FSQ-7 computer, known as the XD-1. Her success led her to join the Charles Stark Draper Laboratory at MIT, where she eventually managed a team credited with developing the software for Apollo and Skylab. Hamilton's team developed both the in-flight software and the system software to control it, building in advanced features such as error detection, process management, restart handling in the event of power or program failure, and human interaction via the DSKY (DiSplay and KeYboard) interface. During her time at MIT she coined the term 'software engineering' in an effort to engender more respect for computer programming, which by that point had developed into a more sophisticated discipline than previously.

In order to severely "downsize" a computer which had previously taken up the entire floor of an office building, the AGC's hardware designers turned to semiconductor technology. Integrated circuits, or "microchips" made of silicon were able to house tiny transistors, which had replaced the comparatively massive vacuum tubes that powered computers such as the AN/FSQ7. They were also lighter, cooler and used much less electricity.

Each chip had two logic gates, and there were 2800 chips in total. It had 2048 16-bit "words" (or 4096 8-bit bytes) of eraseable magnetic memory (which could be modified by programs or manually through the DSKY), and 36 kilowords (72 kilobytes) of read-only "rope" memory (see sidebar) that stored program code. It had a 2.048 MHz crystal clock that was divided in half to produce a 1.024 MHz timing reference (an equivalent to CPU speed).

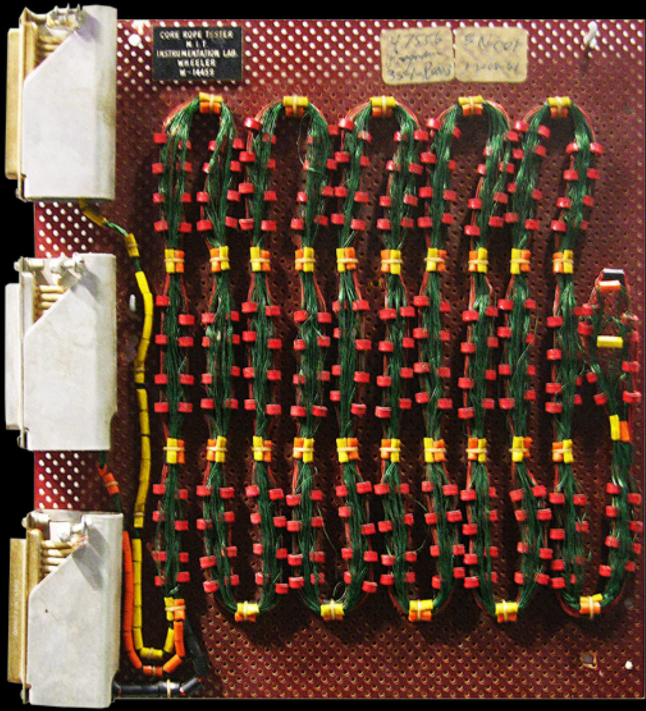
Hardware-wise the AGC was similar to home computers, such as the Atari 400 or Commodore VIC-20, which would be released over a decade later.

However, rather than using a QWERTY keyboard and a CRT-based monitor, astronauts communicated with the AGC via the DSKY (which they pronounced Diskee), a simple LED and button-based interface that allowd them to view memory locations, edit some of them and, perhaps most importantly, inform them of errors when things weren't working out the way they were supposed to.

This was especially important since the AGC would need to be able to run multiple programs simultaneously in order to co-ordinate and manage the various aspects of the Apollo spacecraft, and while it could determine which tasks had the highest priority in order to ensure critical functions continued to execute in the event there was too much on the AGC's plate – a concept that would come to be known as multitasking – sometimes human intervention would be required. Normally, the AGC used an "operating system" (at that time a new term) that consisted of two "god" programs – the first was known as the Exec, which co-operatively managed large applications which ran for extended periods of time, and the second was called the Waitlist, which scheduled shorter jobs that could re-schedule themselves or launch larger programs managed by the Exec.

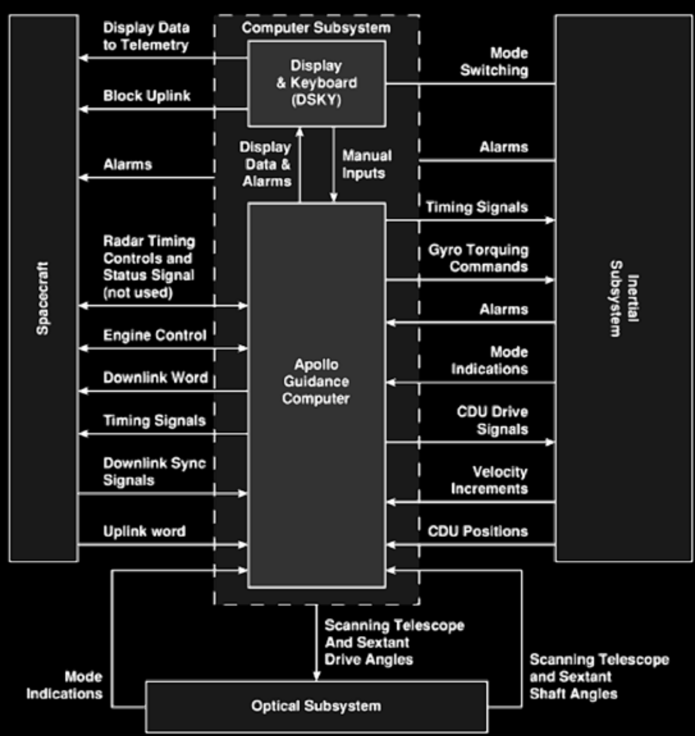
The computer also featured an interpreter which allowed for non-native, simplified instructions that represented more complex trigonometric, vector and scalar math functions needed for navigational programs, reducing their overall memory footprint. There were two AGCs – one in the command module, which ran software known as COLOSSUS, and one in the lunar excursion module (LEM) whose software was known as LUMINARY.

Understanding how the AGC's operating system functioned would be key to GUIDO Steve Bales' decision-making regarding whether the first lunar landing should be allowed to continue. The 1202 alarm displayed on the DSKY suggested that between the Exec and the Waitlist the workload was too high, and in order to ensure that critical functions operated in a timely fashion, some tasks needed to be terminated. However, which tasks the Waitlist had killed were not known to Mission Control – they had to trust that the software knew what was important at that exact moment.



The storage used by the AGC was known as 'core rope' memory, a form of read-only memory or ROM. Program code was encoded by physically passing wires through or around a number of ferrite cores. If the wire went through a core it was read as a one, if it bypassed the core then it was a zero. In the AGC up to 64 wires could be passed through a single core, which would be divided into 4 16-bit 'words'. Rope memory could store 72 kilobytes of memory per cubic foot, at the time a large amount of memory for the space used and ideal for something like Apollo, where volume and weight were both at a premium.

This block diagram of the Apollo Guidance Computer shows the various components that made up the system. Like most computers of today, it had a number of inputs and outputs for communications and user interface devices including the DSKY terminal, but unlike most computers of today it also had a number of Apollo spacecraft-specific inputs and outputs that led to various inertial sensors, sub-system alarms and engine controls. The AGC executed multiple programs simultaneously to deal with each of these inputs and acted accordingly.



Time was ticking away and a decision was needed – 386,000km (240,000 miles) away from Earth a fragile craft was rapidly approaching the surface of the Moon and they needed to know if they were going to land or potentially crash! Weighing all of his knowledge – the pedigree of the AGC, its design and designers, and the confidence of Garman, Bales concluded that it was safe for the mission to continue, so long as the alarm didn't continue to go off. Also, attempting to abort and return to the command module with a buggy computer could be just as risky.

And so, the landing continued.

Alan Shepard uses the DSKY in the Command Module. Shepard was the first American to travel into space (1961) and the first person to manually control the orientation of his spacecraft. In 1971 he commanded the Apollo 14 mission, and at age 47 became the oldest and earliest-born person to set foot on the Moon. During the mission, he famously hit two golf balls on the lunar surface.

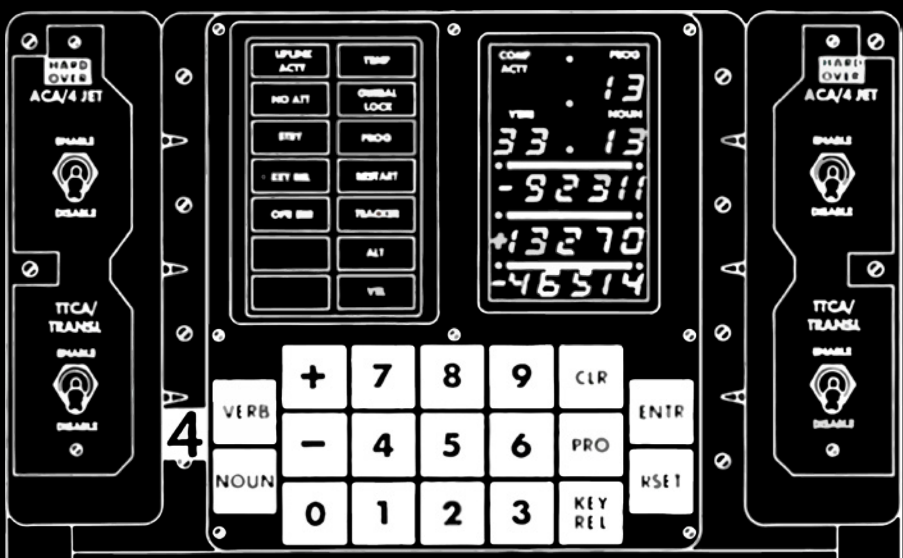
The journey to the Moon was not an easy one. After a noisy eleven-minute rocket-ride into orbit at three times the Earth's gravity (imagine weighing three times as much as you do now!) the combined spacecraft and third Saturn V stage orbits once or twice before burning for six more minutes in the direction of the Moon. Some complicated maneuvers then take place, to "unpack" the Lunar Module and dock it with the Command Module.

The third stage is then discarded and the combined Lunar and Command Modules then make their way to the Moon over the course of two to three days. The only way to return is by slingshotting around the Moon, so the astronauts are effectively stranded inside the spacecraft for the duration – not a pleasant situation to be in, especially during an emergency such as befell the ill-fated Apollo 13 mission.

However, the alarm went off again! Things became tense once more. But Buzz Aldrin soon realised that the alarm appeared to be directly related to his issuing of a 1668 command via the DSKY, which periodically returned DELTAH, the difference between the altitude as sensed by radar and the altitude calculated by the AGC (if this number became significant then presumably you were in trouble!)

After being given the "go" from Houston after the first alarm, Aldrin had entered 1668 again and another 1202 alarm occurred. The 1668 added an additional 10% to the processor's workload, which between the assorted programs involved in the landing and the radar tracking of the Command Module (needed in case of an abort) was already around 100%, and so the Waitlist was killing the 1668, considering it nonessential. The 1202 alarm was the AGC's way of informing the astronauts that it had done so.

But they needed the readout from the 1668 and so several more alarms occurred and several more "go" calls were issued. But the AGC continued to operate and the Lunar Module soon touched down on the Moon's surface. A post-mission analysis showed that the radar tracking the Command Module wasn't operating properly and was "stealing" more CPU cycles than it had been estimated to need. But thanks to the designers of the AGC, it had been able to cope, and humanity set foot on the Moon for the first time.



Astronauts interacted with the Apollo Guidance Computer via the DSKY.

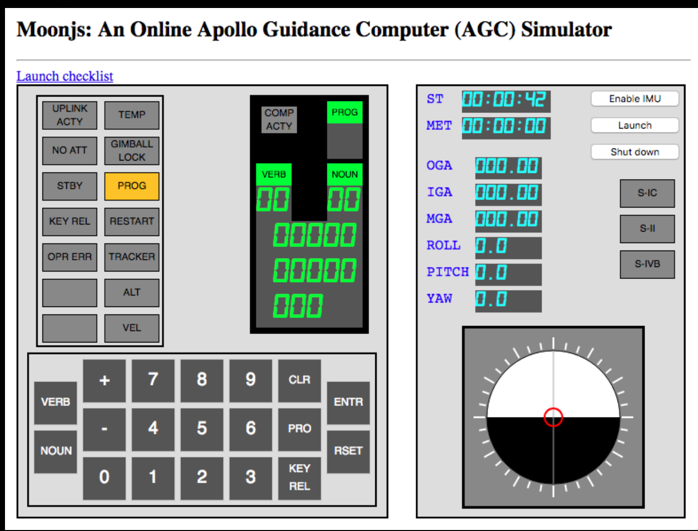
The DSKY had a fairly straightforward layout of indicator lights, including various warnings and statuses regarding AGC operation; five rows of numeric LEDs for data display; and a numeric keypad and control buttons for command and parameter entry. In the case of the latter, the DSKY used the concept of verbs and nouns; for example, Verb 06 can be used to display the value of a hundred different memory locations specified based on a given Noun.

EMULATION STATION

AGC Emulation

Would you like to see what it was like to use the DSKY and the Apollo Guidance Computer, and imagine that you're flying through space in the Command Module and/or landing on the Moon in the Lunar Module? Well, there are emulators for everything these days, and the AGC is no exception!

Moonjs is an online Apollo Guidance Computer simulator. It is a port of Virtual AGC, an application that runs on Windows and Linux. There's also a virtual machine that can run on MacOS X. Each of them runs a copy of the Colossus 249 flight control software that flew on the Apollo 9 command module. You can use these emulators to experience a simulated launch of a Saturn V rocket (at least from the guidance computer's point of view), or even a lunar landing!



http://svtsim.com/moonjs/agc.html

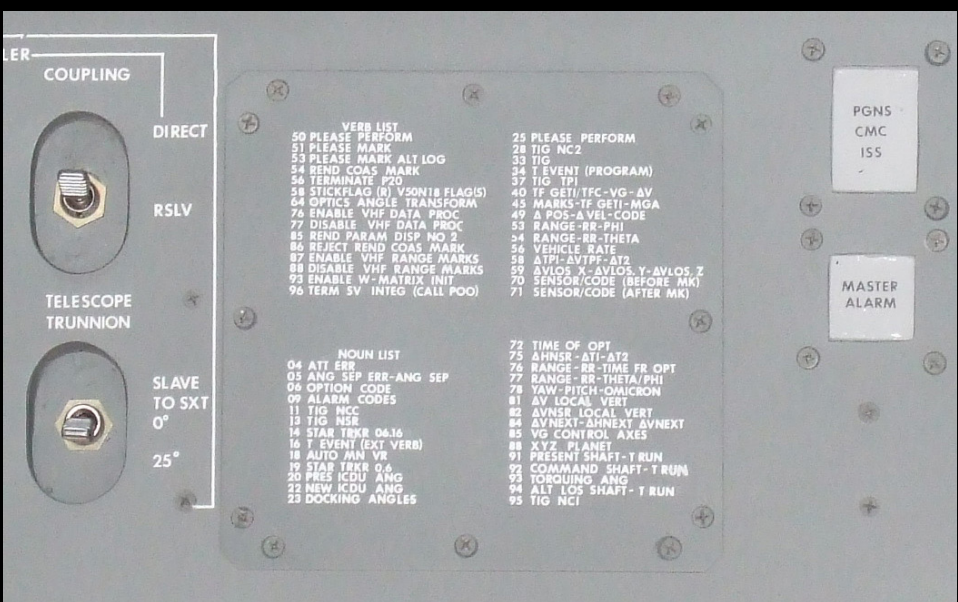
Browser-based Javascript DSKY Simulation

http://www.hotto.de/software/lm-simulator.html

Lunar landing simulator (needs AGC application)

http://www.ibiblio.org/apollo/

AGC VM, Linux or Windows Applications



Some of the nouns and verbs used by the DSKY, printed for quick reference on a side panel inside the Apollo Command Module. These include verbs such as "please perform" (used to execute specific computer programs specified by the following noun, such as "docking angles") and "enable VHF data processing". Some of these, such as the noun XYZ PLANET are mysterious, but probably made perfect sense to an Apollo astronaut!

Other unlisted commands included VERB 35, which tested the DSKY's digits and indicators, VERB 16 NOUN 65 which displayed the current time and VERB 91, which showed the checksum of the first bank of core rope memory. VERB 06 NOUN 62 showed the spacecraft's current velocity, altitude rate and altitude (assuming you were actually going somewhere.)

Back in the Day...

Newspapers around the world trumpeted the revelation that humanity had successfully landed on the moon, something that seemed like pure science fiction a mere decade earlier.

On the international stage it cemented the United States' place as the world leader in technological innovation, where it still remains today, although rising challengers such as China could soon threaten that supremacy.

NASA originally scheduled the moon walk for 2AM US EST Monday the 21st of July 1969 but wisely decided to move it to earlier Sunday evening, cancelling the astronauts' sleep period and blaming it on their pre-walk excitement. But had the original schedule stood, all three US TV networks had planned continuous coverage designed to keep their audiences awake and entertained up until the big moment. According to that week's TV Guide this included:

On ABC Steve Allen does a medley of songs spotlighting the moon in popular culture, Duke Ellington performs a concerto and James Dickey recites a poem, both in honor of the landing, and Rod Serling moderates a panel of science-fiction writers (including Isaac Asimov) discussing "Where do we go from here?"

Over on CBS, Walter Cronkite interviews former President Lyndon Johnson and 2001 author Arthur C. Clarke. Bob Hope does a monologue, and there are appearances by Orson Welles (War of the Worlds), Buster Crabbe (Buck Rogers and Flash Gordon) and Keir Dullea (2001).

Finally on NBC Gemini IX astronauts Gene Cernan and Tom Stafford co-anchor the coverage. Guests include Nobel Prize chemist Harold Urey, an expert on the origins of the solar system. They'll also go live to Denver and Atlanta where telescopes attempt to pick up images of the Apollo spacecraft while it orbits the moon.

The impact the live broadcast of the Moon walk had on the populace of Western countries cannot be overstated.

Witnessing such a momentus event live made people feel they were a part of it, and that sense of ownership and pride would power the Apollo program for several more missions. But how did they successfully broadcast a television signal at such low power from so far away, when many people had a hard time picking up their local VHF TV station from the other side of town?

There are two parts to this story, the transmission and the reception. This article deals with the transmission. We begin our tale all the way back in 1962, when the Apollo program was in its infancy. The Lincoln Laboratory at MIT in Lexington, Massachusetts, a research centre focussed on improving the US civil defense system through advanced electronics (and which developed the magnetic core memory used in the SAGE civil defense computer system), was tasked with developing an integrated communications system that would work with the proposed spacecraft design.

LINCOLN LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Their goal was to reduce the number of radio-based systems used in the Mercury space program (which put Americans in orbit). The Mercury spacecraft had used seven distinct frequencies widely separated from each other, including in the HF (3-30MHz), UHF (300MHz-3GHz), C-Band (4GHz-8GHz) and S-Band (2GHz-4GHz) ranges, which were used for voice, telemetry and tracking.

This meant a bit of a tricky dance to ensure that each one of these signals did not intefere with domestic or military signals (and vice-versa), but this was achievable at the relatively short-range of the Mercury spacecraft. Preferably, all of these transmissions needed to occur inside a single, narrow frequency range, and one that could be more easily received by ground stations from the much longer distances travelled by the Apollo spacecraft – a nice idea, but how could it be made to happen in reality?

RADIO WAVES

LUNAR TRANSMISSIONS

The television camera used on the lunar surface during Apollo 11 and also on the Apollo manned flights prior to Apollo 10, was a black and white (monochrome) RCA slow-scan camera with a 320 line horizontal, 10 frame per second vertical format.

73 Magazine, November 1969

APOLLO TV & RADIO (Nov. 73) Addenda: An adjustment should be made for Westinghouse Electric Corporation and Radio Corporation of America as follows. The monochrome TV camera used on the Apollo 7 and 8 space missions was made by RCA, as stated. However, the monochrome TV camera used on Apollo 11, which was left on the lunar surface, and the monochrome TV camera used on Apollo 9 was made by Westinghouse as well as the color TV cameras for Apollo 10 and 11. The statement to the effect that the RCA camera was utilized in Apollo 11 and 9 was based on incorrect information. I am thankful for being corrected.

Thomas Laffin W1FJE
Hillsboro NH 03244

As the clarification on the right indicates, the camera used to transmit the Apollo 11 moon walk was made by Westinghouse, not RCA – although it's not surprising the author initially thought that. RCA Chairman Richard Sarnoff battled Westinghous quite fiercely for the privilege of supplying cameras for the Apollo missions, which RCA finally did in 1971.

In mid-1962 the Lincoln Laboratory published an initial report titled "Interim Report on Development of an Internal On-Board RF Communications System for the Apollo Spacecraft." (whew!) NASA had demanded that the new system had to use one of the frequencies receivable by the existing ground stations set up for the Mercury program, so that they didn't have to install a large amount of new equipment, and the Apollo spacecraft also needed to have a transponder compatible with the receivers used by Deep Space Instrumentation Facility (DSIF) stations (a global network consisting of stations in California, Spain and Australia) established by the Jet Propulsion Laboratory (initially under contract by the US Army) to monitor satellites and other spacecraft.

The Lincoln Laboratory realised that they could use the DSIF transponder to transmit all of the requisite signals. In order to accurately determine the range of spacecraft (the DSIF transponder's primary function), it used a sophisticated modulation technique that generated pseudo-random binary code. This code was transmitted to the spacecraft and then retransmitted back, and by comparing the received data with the transmitted data it could be determined how far away the spacecraft was.

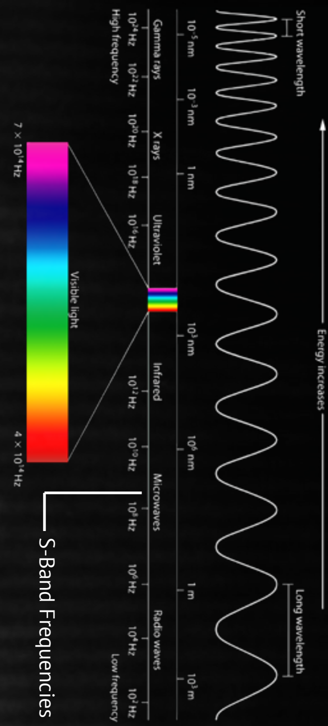
By using multiple ground stations to receive and compare the signal, the location of the spacecraft could also be triangulated. Further, if the spacecraft was too far away for the "round trip" method to be used, a signal could be generated using a crystal on the spacecraft that could then be compared with the same signal generated on the ground. Why so many ways of accomplishing the same thing? Because it's terribly embarrasing to lose a multi-million dollar spacecraft!

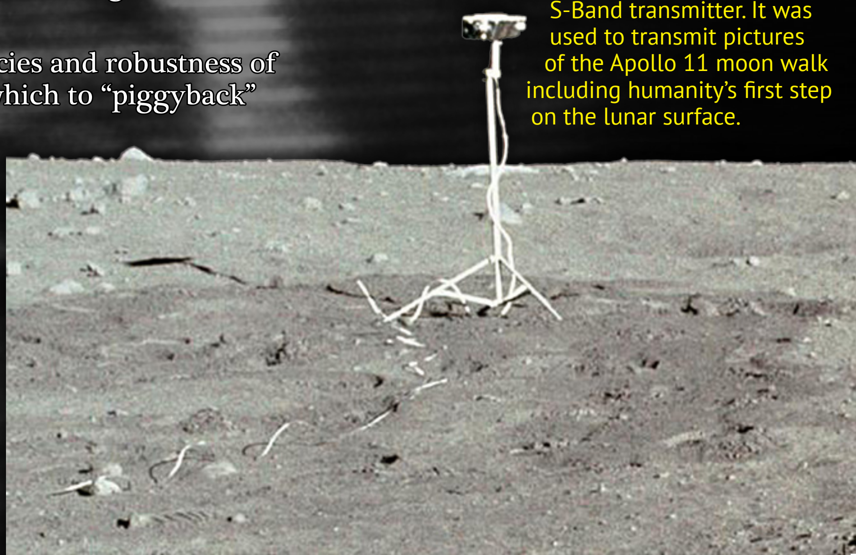
The Lincoln Laboratory decided the intricacies and robustness of the DSIF made it an ideal candidate upon which to "piggyback" the other signals.

On Apollo 10 and Apollo 11 the video signal was frequency modulated onto a 2272.5 mhz carrier from the Command Module. During the television transmissions no other signal was multiplexed on this particular carrier. However, the Command Module had another S-band carrier at 2287.5 which was frequency modulated with voice and telemetry, on sub-carriers at 1.25 and 1.024 mhz respectively.

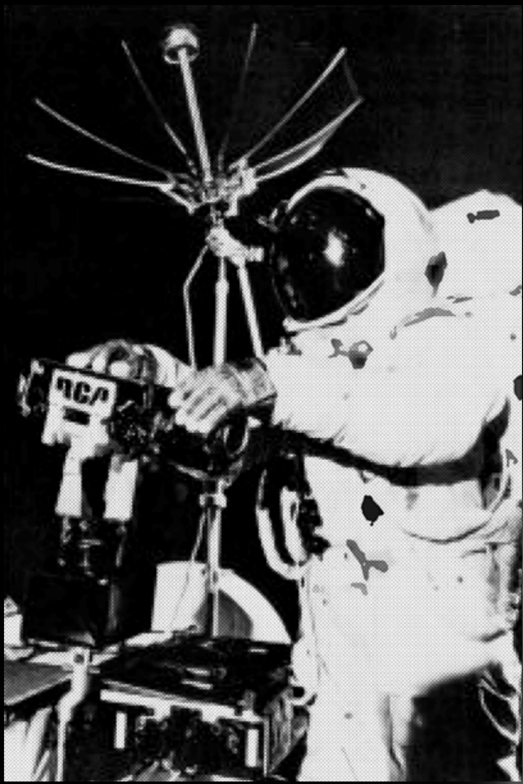
73 Magazine, November 1969

The Mercury space program used communications equipment that transmitted on seven discrete, widely separated frequencies, which presented great opportunities for disruption by other transmissions and natural sources of interference. By combining all of these transmissions together into a single multiplexed signal, its power could be boosted, and sources of interference in its band could be more easily mitigated.





The Westinghouse Apollo Lunar Television Camera was developed between 1964 and 1969. It had to operate at lunar temperatures ranging from -157°C (-251°F) to 121°C (250°F) – the difference between a flash freezer and an oven! It also needed to operate at low wattage while still providing a recognisable video signal – no small feat for the 1960s, when most TV cameras were large and required large amounts of light and power – and work with the Unified S-Band transmitter. It was used to transmit pictures of the Apollo 11 moon walk including humanity's first step on the lunar surface.



In early 1963 the Lincoln Laboratory demonstrated the "Unified Carrier" concept to NASA. The system used phase modulation (PM). Phase modulation is similar to frequency modulation (FM) in that the frequency of the carrier is changed, but instead of altering the frequency in a ratio to the signal being modulated (thus creating a sort of "mini"-representation of the original wide-band signal in a more narrow band), phase modulation modifies the carrier at a more granular level, modifying the curve (or "phase", roughly meaning the signal's position on the curve over time) of each of the carrier's individual cycles to encode the signal being modulated.

This substantially increases the "bandwidth" available to encode on the carrier and allows for a wide-variety of information to be modulated on a single carrier (usually on sub-carriers, some of which may have their own sub-carriers and... let's back out of that rabbit hole before we get lost!) Suffice it to say, due to its ability to convey large amounts of data, phase modulation is used for all sorts of modern radio-based technologies such as Wi-Fi and GSM.

However, in the case of the Unified S-Band system, to ensure the carrier signal could also be reliably used for precise distance tracking, the phase modulation was subtle enough that the signal could be mistaken for double-sideband amplitude modulation (AM), providing a certain amount of "security through obscurity".

[Above Left] An astronaut adjusts an RCA camera mounted on the Lunar Rover.

[Left] Due to the Lunar Module's low power transmitter, the Apollo 11 Moon walk transmission was received by the Parkes Radio Telescope in the state of New South Wales, Australia. It was scheduled to be received by a radio telescope in California but due to NASA's decision to change the time of the moon walk to coincide with evening television viewing in the United States it was left to the Aussies to capture the signal.

However, just before the Moon walk was set to begin a violent wind squall came up, and with the dish pointed just above the horizon it acted like a sail, causing the tower to sway. The staff nearly abandoned the telescope, but the wind subsided and the transmission went ahead. This was dramatised in the movie The Dish.

NASA was impressed by the demonstration and the technical qualities of the proposed system, and went ahead with its continued development. In practice, there were two signals, an "uplink" (using frequencies within the band from 2025-2120MHz) to the Apollo spacecraft, and a "downlink" (using frequencies from 2200-2290MHz) back to Earth.

The use of two separate frequency bands allowed for "full-duplex" operation, that is both the ground and the spacecraft could broadcast continuously, and consequently voice transmissions could not "walk over" each other.

Uplink voice and data transmissions were modulated on sub-carriers, at 30KHz and 70Khz respectively.

Stan Lebar, the project manager for Westinghouse's lunar cameras, with the monochrome camera model used in Apollo 11 on the right, and the later colour camera used on the Moon during the Apollo 12 and 14 missions on the left. Because contemporary colour video cameras using three camera tubes (one each for red, green and blue) were bulky and high in energy consumption, Westinghouse went back to an earlier method of recording colour video signals. CBS Laboratories' John Logie Baird-inspired 'colour wheel' system, used a spinning filter disc segmented into six semi-transparent coloured segments. The disc rotated at 9.99 revolutions per second between the lens and a single camera tube, providing an NTSC-standard 59.94 fields (or half-frames) per second of filtered monochrome images, each corresponding sequentially to red, blue or green. Once the signal was broadcast back to Earth, special equipment was used to translate the separate colour fields into an integrated NTSC signal, which was then sent to broadcasters.

The picture on the left was taken of a television monitor at the Honeysuckle Creek tracking station in Canberra, ACT Australia. Early images of the Moon walk (or EVA) were received, decoded and sent from there until Parkes came on-line, but as the image to the left indicates, Honeysuckle Creek continued to receive and decode the slow-scan television signal as a backup, in case Parkes went down. The SSTV signal was monochrome, at ten frames per second, each frame made up of 320 horizontal scanlines. The camera was stored upside-down in the Lunar Module, and as such the video had to be electronically rotated 180° for the first part of the EVA. The decoded SSTV video was sent to a communications exchange at Sydney which was then transmitted via satellite to Houston, Texas.

There is some dispute over which receiving station – Honeysuckle Creek or Parkes – provided which part of the EVA, in particular Neil Armstrong's first steps on the Moon. Honeysuckle Creek advocates argue Parkes was not ready until afterwards.

The downlink, on the other hand, had subcarriers at 1.25MHz (voice) and 1.024 MHz (telemetry data). The higher frequencies had larger bandwidth capabilities for the increased volume of downloaded data from the spacecraft – however this still wasn't enough for the television signal, at least not at the resolution and framerate that NASA wanted.

While video had been included as a slice of the original phase-modulated S-Band specification, NASA was concerned that the choppy, blocky image would be uninspiring to the American home audience, and felt that taxpayers might think they hadn't gotten value for money. The "solution" was to broadcast the video signal using FM instead of PM, but this meant telemetry data could not be sent and also invalidated the Doppler method of tracking the spacecraft. And so video could only be broadcast after the lunar module had safely landed on the surface of the Moon.

Even then, there was still only 700KHz of bandwidth available for video, which was nowhere near enough for a US standard NTSC television signal, which broadcast 525 scan lines at 30 frames per second. Some back-of-the-envelope math indicated that the best they could do was 320 scan lines at 10 frames per second – better than the original specification but still not exactly what the big US TV networks wanted.

This "slow scan" television signal couldn't be sent directly to the networks – first it needed to be converted, and at the time the only practical solution was to use a "telecine" device, essentially a slow-scan TV monitor displaying the received image, with a conventional NTSC TV camera pointed at it recording the monitor! Unfortunately this method introduced interference, blurring and ruined the sharp contrast the Westinghouse camera provided. But it was enough, and the greatest show not-on-Earth went live early on Monday, July 21, 1969 (UTC).

Well, Star Trek is gone except for the stations that still carry it in syndication. Perhaps it was killed off by the real thing; live television from space and from the moon. And, even more recently, those marvelous pictures sent back to old mother earth by NASA's Mariner Venus/Mercury probe. Amateur radio had its small part in the success of this mission; namely in those hams at the Jet Propulsion Laboratory here in Pasadena and at Boeing Aircraft in Renton WA who were part of the team of scientists, engineers and technicians working the project.

73 Magazine July 1974

In the 1960s most digital data transmissions were sent over wires. But how could data be exchanged with a spacecraft?

Before cathode-ray tube-based monitors were widely available, the solution for getting readable data in and out of a computer was the humble teletype, essentially an electric typewriter. This IBM 1052 “Printer-Keyboard” (an enhanced IBM Selectric), was part of the 1050 “Data Communications System” suite of I/O devices intended to interact with the IBM System/360 mainframe computer. They communicated using 7-bit ASCII at a blazing 75 or 150 bits-per-second (BPS), which translated to nearly 15 characters per second! But if the computer was sending data you had to be patient and wait your turn – no interrupting! (Well, that’s not exactly true, you could hammer seemingly helpful keys with names like “cancel” or “stop”, but sometimes all that effort provided was a bit of catharsis while reams of dead trees tattooed with redundant hieroglyphics spewed forth – ever so slowly. You could always turn the teletype off, but would you be able to reconnect? A risky gamble...

While the Apollo Guidance Computer was designed to be capable of doing the calculations needed for the entire flight, Mission Control was more comfortable doing what they could from the ground. For that to happen, the spacecraft needed to transmit relevant data back to Earth, where it was calculated using mainframe computers and the resulting course corrections sent back. Astronauts compared this information with the AGC and verified it using (of all things) a sextant!

The structure of the Unified S-Band signal was not fixed, and could be re-configured at any time to include any combination of data required. Each tracking station received a site configuration message (SCM) about one hour before the start of each tracking period, so that engineers at the station could configure their equipment for the corresponding “downlink mode” appropriately.

Signal flow paths were established using often untidy arrangements of patch cables, which linked each piece of decoding equipment in sequence – get one patch cable wrong and it could all go pear-shaped!

Other information included biomedical data on the astronauts’ health and scientific data from instruments installed on the spacecraft. All of this data was sent using the Unified S-Band radio system, and decoded using the Subcarrier Data Demodulation System (SDDS), which demodulated various phase (PM) and frequency modulated (FM) subcarriers that were further modulated using pulse-code modulation (PCM) and pulse amplitude modulation (PAM). That’s a lot of (de-)modulation!

Various USB configurations included:

1. astronaut voice primary, backup and emergency (morse) key;
2. real time and playback telemetry, both high and low bit rate;
3. ranging codes and a television signal;
4. scientific data in real time or playback;
5. hardline biomed data;
6. astronauts life support backpack telemetry;
7. lunar rover telemetry.

Named after Émile Baudot, the inventor of the Baudot code for telegraphy, "baud" refers to the number of pulses, bits or symbols per second sent by a telecommuncations device. 1200 baud was a common speed for home computer modems (MOdulator/DEModulators) used to connect to bulletin-board systems (BBSes) around 20 years after the Apollo missions, in the late 1980s.

> The average speed of the telemetry data is about 1200 bits per second, although the stations at Goldstone, California, Cape Kennedy, Florida, and Houston, Texas, have no upper speed limit.
> 73 Magazine November 1969

Once the data was decoded it was sent on to the relevant NASA departments. For example, the voice signals were relayed in real time to Mission Control via NASCOM (NASA Ground Communicartions System) undersea or satellite links. The voice signals were also recorded on magnetic tape, as was the master USB signal (more on that later).

Some of the most important data was biomedical information from the astronauts, which kept Mission Control apprised of the health of the astronauts and could potentially indicate dangerous faults with the spacecraft (or the astronaut!) in advance of their becoming fatal. Various devices hidden in the astronaut's suits monitored heart rhythm and rate, blood pressure, breathing and body temperature – the last one initially through the use of a rectal thermometer(!) but later via an oral sensor astronauts would insert into their mouths intermittently. This data would become crucial when irregularities were detected with Apollo 15 astronaut James Irwin's heart after leaving the Moon's surface and rendezvousing with the Command Module. He had been working with no sleep for 23 hours, and after transferring rock samples from the Lunar Module into the CM Irwin developed an issue with his heart rhythm. Doctors back at NASA were able to recognise the problem and order Irwin to rest for the remainder of the return to Earth, where he landed safely.

Ranging (or identifying the location of the spacecraft relative to the tracking station) was done by transmitting a stream of 'pseudo-random' digital code, which was echoed back by the spacecraft and then compared with what had already been sent in order to determine the elapsed time in between sending and receiving. Some simple mathematics then yielded the spacecraft's distance away from the tracking station. However, this didn't give you the complete location – for that you needed to triangulate it using the spacecraft's calculated distance away from multiple tracking stations. To that end the various tracking stations constantly exchanged their ranging data, ensuring that NASA had a clear idea where its spacecraft was at all times.

Our modern global-positioning system (GPS) works in a somewhat similar fashion – although rather than multiple ground stations triangulating a single object in space, multiple objects in space (GPS satellites) with known positions and sequences of numeric transmissions are used to triangulate the position of the receiver by identifying how long it takes to receive a signal from each satellite. This is done by comparing a 'time of transmission' (TOT) code embedded in the GPS signal with the receiver's time, which must be accurate.

NASA wasn't super-interested in developing all of its technologies in-house – it was the height of the Cold War and the US had several large 'defense' and aerospace companies well-versed in everything from rocketry to telecommunications, most of which had extremely generous government contracts and were more than eager to help NASA out in an on-going effort to please Congress and keep them. As these advertisements demonstrate, they weren't shy about trumpeting their involvement to the public either!

These companies included Raytheon, Boeing, North American Aviation and Pan Am, the latter's advertisement to the left highlighting the company's role in providing telemetry equipment, including for the transmission of astronaut's medical data.

on the road
parkes observatory

A desire to have the moon walk broadcast during prime-time US viewing hours, after the moon set there, meant that NASA would have to rely on a dish in a sheep paddock in Australia to get the feed (not livestock feed!)

Completed in 1961, the Parkes Radio Telescope was the brainchild of E.G. "Taffy" Brown, chief of the Radiophysics Laboratory at the CSIRO (Australian Commonwealth Scientific and Industrial Research Organisation). He had worked on radar development in the US during WWII and had made some powerful allies in the scientific community there.

Calling on this network, he obtained commitments from the Carnegie Corporation and the Rockerfeller Foundation to fund half the cost of the telescope. He then used those pledges to convince then-Australian prime minister Robert Menzies to fund the remainder of the project.

Parkes was one of the first large movable dish telescopes and is the second-largest in the Southern Hemisphere, at 64 metres (210ft) in diameter. The success of its design led NASA to copy it in their Deep Space Network, building matching dishes in Goldstone, California and Madrid, Spain.

Parkes is located in central New South Wales approximately 360km west of Sydney on the Newell Highway, which runs between the states of Victoria and Queensland. Originally founded as Currajong (a species of local tree) in 1853 and later called Bushman's (after Bushman's Lead, a local mine), it was renamed Parkes in 1873 after a visit from then-NSW premier Sir Henry Parkes.

Sir Henry is frequently referred to as the "Father of Federation" due to his early advocacy of a united country of Australia, and was an early critic of British convict transportation and a proponent of the Australian continental rail network. Unfortunately, he died in 1896, five years before the federation of Australia was completed, in 1901.

Several gold mines were established in the region around Parkes during the gold rush of the 1870s, and the town became a key transportation hub after the completion of the railroad through it in 1893. However, the use of rail declined in the 1980s and today Parkes' primary industries are the farming of wheat and wool.

Parkes was the setting of the 2000 movie "The Dish" which loosely chronicled the observatory's role in the broadcast of the 1969 Moon walk, although some scenes were shot in nearby town Forbes.

the mystery of the missing moon tapes

The role of the Parkes telescope in receiving the slow-scan television feed from the Moon is well known. But what is less known is that the original tapes, containing both the slow-scan video and telemetry data from the Apollo spacecraft, have been lost. NASA ground receiving stations (including Goldstone in Australia) performed real-time conversions of the SSTV images into more standard NTSC and PAL video formats, which were then broadcast around the world. The converted footage was widely recorded, and as it had become regarded and accepted as the de-facto record of the Moon walk, NASA felt there was no need to keep the original video and so they erased the tapes.

But the converted video was of substantially inferior quality to that of the original slow-scan feed, an issue that has provided fodder for Moon-landing conspiracy theorists, who commonly point to the video as evidence of an attempt to obfuscate flaws in the presentation of the moon walk "performance".

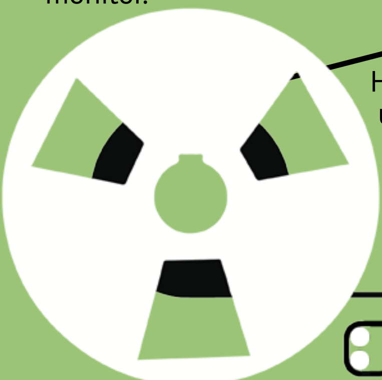
After several high-quality still images of the SSTV video feed surfaced in the 1990s, a team of former NASA employees and contractors began a search for copies of the telemetry tapes in the early 2000s. The video was multiplexed with other communications and other data channels when it was beamed from the Lunar Module back to Earth, where the signals were separated, and the video was displayed on a high-quality slow-scan monitor which was then recorded by an NTSC television camera. Although the SSTV feed was only 10 frames-per-second, the slow-scan monitor had persistent phosphors, which eliminated flicker and allowed the conventional video camera to record its screen. However, limitations in both the monitor and the camera significantly degraded the original signal's contrast, brightness and overall resolution. The NTSC video provided by Goldstone in the first few minutes of the Apollo 11 moonwalk are particularly subpar.

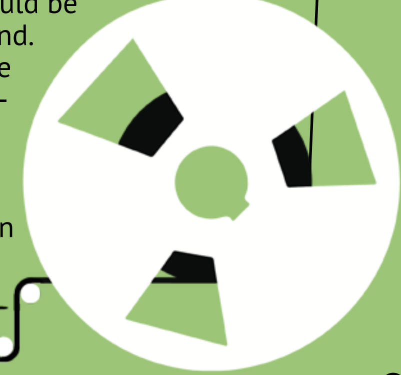
The already-poor signal was then transmitted up to a satellite and back down to Houston, Texas, where it was then sent by microwave relay to New York and then finally distributed to the televison networks which then sent it to affiliates – each one of these steps added additional noise and distortion to the images, and this was what was recorded and became the official record of one of the greatest moments in human history!

But if originals or copies of the one-inch data tapes with the raw, unprocessed signals could be found, then modern digital technology could create a flawless representation of the video information encoded within, similar to what a lucky few were able to witness at the ground receiving stations prior to conversion to NTSC. However, the informal search was unable to find any telemetry tapes. But it did locate an amateur Super 8 movie shot at the Honeysuckle Creek (Canberra, Australia) tracking station briefly showing the SSTV monitor.

After the Sydney Morning Herald published a story about the missing tapes in 2006, NASA launched an official search, suggesting that the tapes could be at the Goddard Space Flight Center in Maryland. However, no tapes were located there. Some tapes were unearthed at a university in Perth, but they didn't contain any video. Unfortunately, in 2009 NASA declared the search over. But some higher-quality recordings of the post-conversion feed were discovered. These have been digitally restored and can be viewed on NASA's website.

High-definition restorations of the moon walk can be viewed or downloaded at moonscape.info





The IBM System/360

It could walk and chew bubblegum!

In the early days of computing, all computers were in effect personal computers – only one person could use them at a time! In the beginning, it was like using a calculator: you entered in an instruction, the computer gave a response, you entered in another instruction, and so on. Tedious and time-consuming.

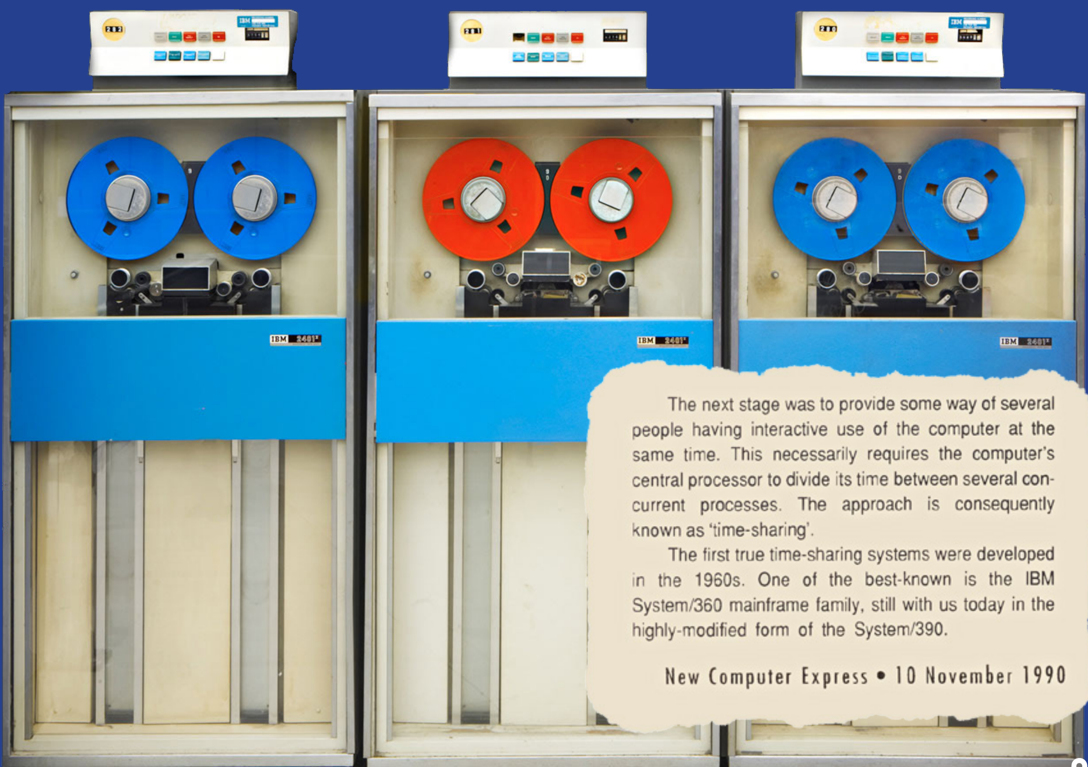
Later on, mechanical systems were developed to automate the entry of instructions using stacks of punch cards. Programmers would punch holes that corresponded to their required computer instructions in these cards, and then the computer would execute them when the cards were eventually read, often in the middle of the night! The computer could still only do one thing at a time, but at least people didn't have to physically wait in line.

However, while this was a practical solution for computer programs whose output wasn't time-sensitive, it became understood that aerospace applications in particular highlighted a need for not only real-time processing and computation, but for multiple computer programs to run at the same time, and even exchange data with each other while doing so. This would require a computer to divide its time amongst these programs, keeping track of where it was in each, executing an instruction and moving on, a process known as "time-sharing".

The IBM System/360 family was made up of some of the first time-sharing computer systems. Announced in 1964 and delivered in 1965, the System/360 mainframe came in a number of configurations, suitable for everything from small businesses to corporations, science labs to engineering firms, and from regional universities to NASA.

It was also one of the first "upgradeable" computer systems – customers could have confidence that as their needs expanded, they could grow their installation rather than replace it, which was an attractive selling point. Once an application was written, there was no need to write it again – most System/360 software can even still be used today (and some still is!) on IBM's Z servers, which maintain full backwards compatibility over five decades later!

Magnetic tape was the common data storage format during the 1950s and 60s. The tape drives pictured here are IBM 2401 System/360 9 track tape drives, released in 1964. They used half-inch (12.7mm) wide tape that stored 8-bits and one parity bit across its width (hence 9 tracks).



The next stage was to provide some way of several people having interactive use of the computer at the same time. This necessarily requires the computer's central processor to divide its time between several concurrent processes. The approach is consequently known as 'time-sharing'.

The first true time-sharing systems were developed in the 1960s. One of the best-known is the IBM System/360 mainframe family, still with us today in the highly-modified form of the System/390.

New Computer Express • 10 November 1990

by April Ayres-Griffiths

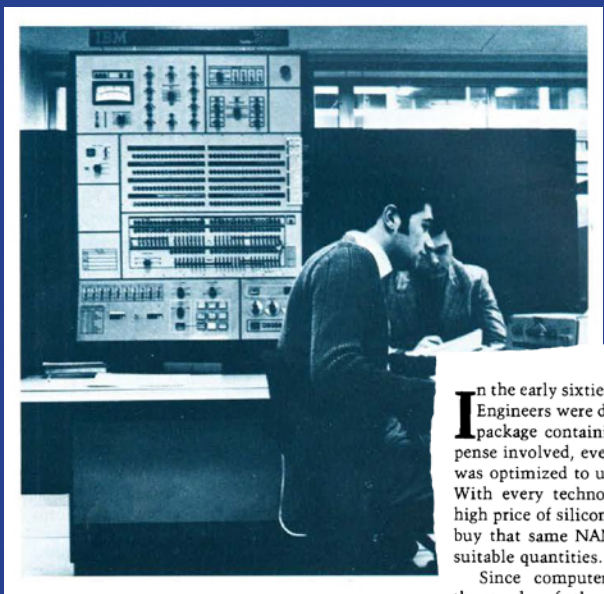
System Architecture

The CPU in System/360 was a clean room design implemented by IBM, with a Complex Instruction Set architecture, based around 24 bit addressing, with 16 general purpose 32 bit registers, and four 64 bit floating point registers.

Input and Output was provided by the concept of "Channels". A channel in the simplest sense is an IO processor that could act independently of the CPU. Channels had their own unique instructions (as opposed to those of the main CPU) and worked separately to the CPU. In higher end models of the 360, the channels were separate components in the system, living in their own cabinets. In the lower end models, such as the model 30, the channels were run in microcode (alongside the CPU), and processing of the CPU would be suspended whilst the channel performed IO.

This architecture supported sharing a channel across multiple tasks (a byte multiplexed channel), by means of subchannels which were interleaved into the single channel. These were utilized for low speed devices such as terminals and line printers, which would carry relatively infrequent data individually, thus allowing many tasks / operations to share the same channel. Higher speed devices such as storage, which needed continuous data transfer, used what were known as "selector" channels, which supported a single subchannel.

IBM published advertisements like these spruiking its involvement in the space program, including the Saturn V's on-board computer.



A third type of channel, called a block multiplexer channel, supported multiple tasks, however only one could be active at a given time. This was commonly used when the performing an operations which could be suspended and resumed, for example interacting with external storage such as tape devices or punched card systems.

Peripheral devices themselves are logically attached to the system via what are called control units, which themselves attach to the system via channels. In a physical sense, control units are connected together by what are known as channel cables. Peripherals were addressable via a 16 bit identifier, and a control unit can manage multiple peripherals, usually within an a particular numeric range.

> In the early sixties the integrated circuit was introduced. Engineers were delighted to pay $20.00 for a single DIP package containing four NAND gates. Due to the expense involved, every device designed using these devices was optimized to use as few of these devices as possible. With every technological advance that came along the high price of silicon dropped dramatically. Today you can buy that same NAND gate for less than fifteen cents in suitable quantities.
>
> Since computers designed in the sixties required thousands of those $20.00 NAND chips, computers (specifically CPU's) designed at that time were very expensive. Since CPU's were so expensive computer center administrators wanted to squeeze every bit of useful computational power out of their system as was possible. It was considered heresy to leave a computer idle. A million-dollar instrument sitting around idle was a very expensive waste of money.
>
> No. 68 · January 1984 MICRO

For example, if the system needed to interact with a particular device, it would request the needed address and the request would propagate out to the control units following their physical connections. Once a control unit recognised an address that it managed it would "claim" it and manage the request. Irregardless, a result would propagate back along the channel connection until it reached the CPU. If the address was unclaimed then an error condition would result.

The term "mainframe computer" originally referred to the large cabinets, called "main frames" that housed the central processing unit and main memory of early computers.

A key plank of the architecture was the standardization of the way that components of the system interconnected via the control units and channels. This meant IBM was able to release a plethora of devices for System/360 which could be used by all systems, and made extending the capabilities of an existing system as easy as connecting additional needed components.

Many standard peripherals for the time, were supported of course, such as magnetic tape, paper tape and punched card readers and writers (such as the IBM 2540 which could read 1000 punch cards per minute). Data communications devices were also supported, including teletype devices.

CRT displays were available for the system, including the IBM 2250 and 2260 models. The IBM 2250 was actually a vector graphics based CRT terminal which IBM released in conjunction with System/360 which was able to render an arbitrary display list of vectors, it supported a light pen, and was quite revolutionary, carrying a built in vector based character set to make it easier to display textual information to users. However, it was way out of the price range of many, at $280,000 USD in 1965. The IBM 2260 was an albeit cheaper alternative, as a monochrome, electro-mechanical video display terminal, which also included a keyboard, and could operate at 2400 baud.

Direct access storage was supported as well, such as the IBM 2311 Memory Unit which could store 7.25 megabytes of data on a removable six platter magnetic disk. An IBM 2321 Data Cell could store up to 400 megabytes of data with an access time between 100 and 600 milliseconds, and contained ten data cells. A data cell could be changed in or out, and contained 200 strips of magnetic tape which could be accessed in a random access fashion. If a maxi-

JCL *Some call it Despicable, Some call it Home*

"After you study it for six months, it makes perfect sense." – An IBM enthusiast.

JCL is a language with which you submit programs to an IBM 360 or 370 computer. "Submit" is right. Its complications, which many call unnecessary, symbolize the career of submission to IBM upon which the 360 programmer embarks. **Byte, April 1976**

PL/I (or Programming Language I) was meant to be an all-purpose language, but its broad scope meant its compiler was bloated and slow.

When IBM announced its System 360 back in 1964, there had been hope that they would support the international language committees and make ALGOL the basic language of their new computer line. No such luck. Instead they announced PL/I (Programming Language I), a computer language that was going to be all things to all men.

In programming style it resembled COBOL, but had facilities for varieties of "scientific" numbers and some good data structure systems. It is available for the 360 and for certain big Honeywell computers; indeed, the operating system for MULTICS at Massachusetts Institute of Technology was written in PL/I. Whether there are people who love the language I don't know; there are certainly people who hate it.
Byte, April 1976

Subscribers, please bear with us. If you have not received a response to a BYTE reader service inquiry, the delay rests squarely upon us, not the advertisers. We have quite frankly been inundated with requests since putting reader service on reply cards, and recently got a bit behind in processing. Each card must be keypunched and run through a (somewhat traditional) data processing operation currently implemented on an IBM/360 Model 25 with 16 K bytes of memory, 2311 disk drives and an archaic tape operating system. As this note is written (September 10) the current reader service requests total 24,000 individual cards with multiple requests per card, and are being mailed to advertisers as mailing label printouts.■

As the apology from Byte Magazine to its readers above notes, the System/360 would become entrenched in all sorts of industries and businesses, and used for all kinds of applications – including mailing lists! Its usefulness in automation contributed in no small way to the advancement of the contemporary economy.

Real-time systems and time-sharing make the power of the computer available to untold thousands at their desks and even in their homes.
Creative Computing, July 1977

mum of 8 devices were connected, the system could provide up to 3 gigabytes of storage. Memory (RAM) storage devices (such as an IBM 2361) could also be connected to the system to further extend system memory.

IBMs goal was to provide a flexible system

that could grow with an organisations needs, allowing them to match as many price points as possible. In this aspect, it could be said that they succeeded.

Time Sharing

Time sharing, or sharing the processing resources between multiple interactive users was a concept gaining interest in the mid 1960s as interactive processing often featured significant periods of idle time. Working with the University of Michigan, IBM developed a modified version of the System/360 model 65 (the model 65M), which added a virtual memory and address translation support, via a component called a DAT (Dynamic Address Translation) box. This had the benefit of allowing multiple programs to effectively run in their own isolated virtual address spaces.

The system was initially intended to be a one of a kind, but IBM soon recognised that time sharing could be lucrative to pursue, and announced the model 67, which would build on the work done with University of Michigan and commercialise it, offering a special operating system, TSS/360 (Time Sharing System), that supported multiple concurrent users. To each user, it was as if they had access to their very own System/360 system. Eventually, IBM cancelled the TSS project, but not before it's concepts had formed the basis of a multitude of other time sharing systems. *Continued on Page 48*

When Neil Armstrong stepped upon the surface of the moon in 1969, he knew exactly where he was, having followed a precisely planned journey, and the whole world was watching him in realtime! In less than five hundred years man's ability to communicate had advanced from its most primitive forms to an astonishing level of sophistication, made possible only by the nearly two-hundred computers that comprise the NASA Apollo System.
Creative Computing, July 1977

IBM marketed the System/360 to practically everybody, positioning it as the solution to almost every problem. But not only could it perform traditional business tasks, it also opened up an entire new field of customer data analysis, allowing companies to centralise and mine their own transaction records to identify new business and sales opportunities. However, it also allowed access to this information to be sold to third parties, leading to the rise of "direct mail" and telemarketing.

'Time sharing' operating systems allow the use of a single computer in real-time by multiple users, as opposed to earlier operating systems that could only manage a single, sequentially executed task at once. On older systems, each 'job' would be run one at a time, and then move on to the next. Large jobs could plug up systems for hours or even days.

Generations began simply enough. When transistor-based computers were introduced in the late fifties, a major change took place. Suddenly, the old vacuum-tube machines were obsolete and a new era had dawned. The old machines became the first generation, and the new machines the second.
In the mid-sixties transistors gave way to integrated circuits, and IBM's System/360 heralded the arrival of a third generation. The increased circuit integration of the IBM System/370 earned it the title of fourth generation.
Byte, Fall 1984

Getting the Apollo spacecraft all the way to the moon was going to take power – a lot of power.

And to build a rocket of such magnitude was going to take a great deal of expertise – German expertise. And the US had that expertise, rocket scientists taken as spoils of war by the Americans at the end of the Second World War, including, most notably, Wernher von Braun.

Von Braun had worked on the German's V-2 rocket program, the first long-range guided ballistic missile and the first man-made object to travel into space. Although V-2 attacks resulted in the deaths of over 9,000 Allied civilians and military personnel, the US government was willing to overlook that fact in its cold war against the USSR, which had also obtained V-2 technology and refined it to produce an ICBM it used to put the first man-made satellite, Sputnik, into space in 1957.

After coming to the US, von Braun worked for the Army on the Jupiter rocket program in competition with the Navy's Vanguard program. The Vanguard was initially chosen to launch the first American satellite into space, which angered von Braun, who predicted, "Vanguard will never make it." He was correct – in the wake of the Soviets' success with Sputnik, the rushed first launch of the Vanguard TV-3 rocket containing the first American "test" satellite exploded four feet (1.2 metres) off the launchpad, hurling the satellite from the top of the rocket into nearby bushes, and earning it the nickname "Kaputnik".

The predecessor to NASA, known as NACA (the National Advisory Committee for Aeronautics) turned to von Braun and the Jupiter program for a solution, desperate not to lose any more face to the Soviets. Von Braun and his team developed the Juno I rocket, a modified Jupiter-C with an additional fourth stage designed to propel a satellite to an orbital velocity of 8 kilometres per second. In early 1958 it was used to successfully place the first American satellite into orbit, Explorer 1.

However, the Americans were unsatisfied at earning second place in the satellite event and so declared a new one in which they felt certain they would place first – putting a man on the Moon. However, this was going to require a much bigger rocket – the Juno I carried at most a 29kg (64 lb) payload, while the Apollo spacecraft was estimated to weigh 41,000kg (90,000 lb!)

The single engine that had powered the Jupiter rockets' first stage was obviously not going to be sufficient to lift that much mass into orbit and while the Jupiter's additional stages had multiple engines, they needed to be physically spun to stabilise them – obviously not a viable solution for the first stage.

The first stage, known as S-IC, was built by Boeing at the Michoud Assembly Facility in New Orleans, LA. It used RP-1 (Rocket Propellant-1) as fuel, a highly refined form of kerosene similar to jet fuel. It is significantly more powerful than liquid hydrogen and is stable at room temperature. It is combined with liquid oxygen acting as an oxidiser, which causes the RP-1 to lose electrons and burn more intensely.

The 42m (138 ft) tall first stage provided over 34,000 kilonewtons (kN) of thrust and fully fueled had a weight of 2300 metric tonnes (5.1m pounds)! It was powered by five engines arranged in a quincunx (four at each corner of a square with one in the centre). It lifted the entire rocket to an altitude of 67km (38 nm).

The Saturn V Instrument Unit (IU)

Happily, while von Braun was perfecting his rocketry, computer science had also marched on, and offered a solution to the complex problem of ensuring the rocket remained stable during takeoff and in flight. By the late 1960s a digital computer sophisticated enough to manage rocket navigation and guidance in real time could be made small enough to be housed on the launch vehicle itself. Housed inside a ring-shaped structured fitted to the top of the Saturn V's third stage (highlighted in red on the model to the right), the Launch Vehicle Digital Computer (LVDC) monitored gyroscopes and accelerometers to determine the attitude and location of the rocket and corrected the rocket's direction accordingly by 'gimballing' or swiveling the exhaust nozzles of the current stage as appropriate. The LVDC was able to ensure that the rocket would remain both stable and on-course, regardless of the size of the payload and the resultant thrust required. The LVDC also managed general navigation, directing the rocket's various stages from liftoff and into orbit.

The Instrument Unit also contained environmental systems to ensure proper operating conditions for the LVDC and the analog flight computer were maintained, an emergency detection system that forced an abort if vehicle breakup became imminent, radio communication systems that relayed data to the ground and received commands. The IU was powered by four silver-zinc batteries providing 28 volts DC.

The various systems housed inside the Instrument Unit ring included (as numbered in diagram above):

1. Environmental Control System
2. Electrical Power System
3. Measuring System
4. Control Accelerometers
5. Control Computer System
6. EDS
7. Radar Altimeter
8. C-Band Radar
9. Azusa System
10. Minitrack System
11. ST-124-M Platform
12. Platform Air Supply
13. Platform Electronics
14. Guidance Command System
15. Telemetry System
16. Switch Selector
17. Guidance Computer
18. Data Adapter

The second stage, known as S-II, was built by North American Aviation at Seal Beach, California. Using liquid oxygen and hydrogen, it also had five rockets. The S-II was approximately 25m (82 ft) tall and had a diameter of 10m (33ft). Fully fueled it weighed over one million pounds (480,000kg)! Rather than having two fully-separated tanks the S-II saved on weight by having a common bulkhead between them made of aluminium and a resin designed to insulate against the 70°C (126°F) temperature difference between the two tanks.

The third stage, known as S-IVB, was built by the Douglas Aircraft Company at Huntington Beach, California. It had a single engine and used the same fuel as the S-II. It was approximately 18m (59ft) tall and had a diameter of 7m (22ft). It weighed 119,000kg (262,000lb) fully fueled. The S-IVB could be restarted once per mission, the second burn needed for trans-lunar injection.

ELECTRONS in motion

For a human to physically walk on the alien surface of the Moon, they were going to need a serious suit!

With surface temperatures at the equator ranging from -173°C (-280°F) to 116°C (240°F), the lunar landscape could serve as both a flash-freezer and an oven - not exactly hospitable conditions for soft, pink-skinned vertebrates like ourselves. There is also no oxygen, and to make matters more interesting for Apollo engineers, mission planners dictated the suit couldn't be physically tied to the Lunar Excursion Module – it had to be portable.

163 March 1970

THE APOLLO PROGRAMME MOON SUIT—described by Mike Rickett

EVERYONE WITH an interest in the exploits of the Apollo 11 and 12 missions will have regretted the failure of the colour television camera when Al Bean accidentally pointed it at the Sun a short while after the recent Apollo 12 EVA—extra vehicular activity—had be…

On … will wear two versions … garment assembly for use inside the space craft, worn by the Command Module Pilot, and a suit for extra-vehicular use by the Commander and Lunar Module Pilot. Together with a liquid cooling garment, portable life support system, oxygen purge system, and lunar extravehicular visor assembly, the suit provides an astronaut with life support for a four hour mission outside the lunar module.

Worn next to the skin is a liquid cooling garment, knitted in nylon-spandex with a network of plastic tubing used for circulating cooling water. More important still is the portable life support system in the backpack, which supplies oxygen at 3.9 lb. per square inch, and also cooling water for the cooling garment.

Used oxygen is cleansed of solid and gas contaminants and the back pack also includes communications and telemetry equipment, displays, controls, and a main power supply. On top of the PLSS is an oxygen purge system, which supplies a contingency 30-minute supply of gaseous oxygen in … pound bottles.

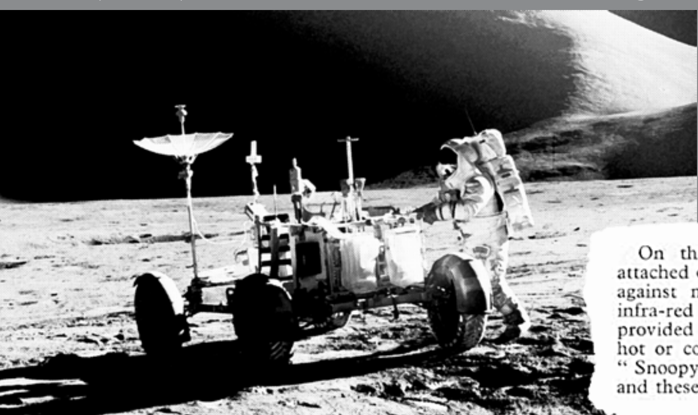
… Moon walk would be impossible, because even though the Moon has no air, moisture, or water, if the Sun's rays touched the unprotected human body during the two week long lunar day, they would kill instantly. Similarly, the two week long lunar night is cold enough to freeze even air, and in temperatures of minus 279 degrees below zero, no human life could exist without substantial protection. Added to these problems is that of micro-meteoroids—very small grains of rock—that constantly hurtle to the Moon's surface. On Earth, they are burnt up by the atmosphere, and the dea… radiation pouring out of the Sun is safely absorbed… these problems have been taken into account wh… highly efficient space suit was designed.

> Worn next to the skin is a liquid cooling garment, knitted in nylon-spandex with a network of plastic tubing used for circulating cooling water. More important still is the portable life support system in the backpack, which supplies oxygen at 3.9 lb. per square inch, and also cooling water for the cooling garment.

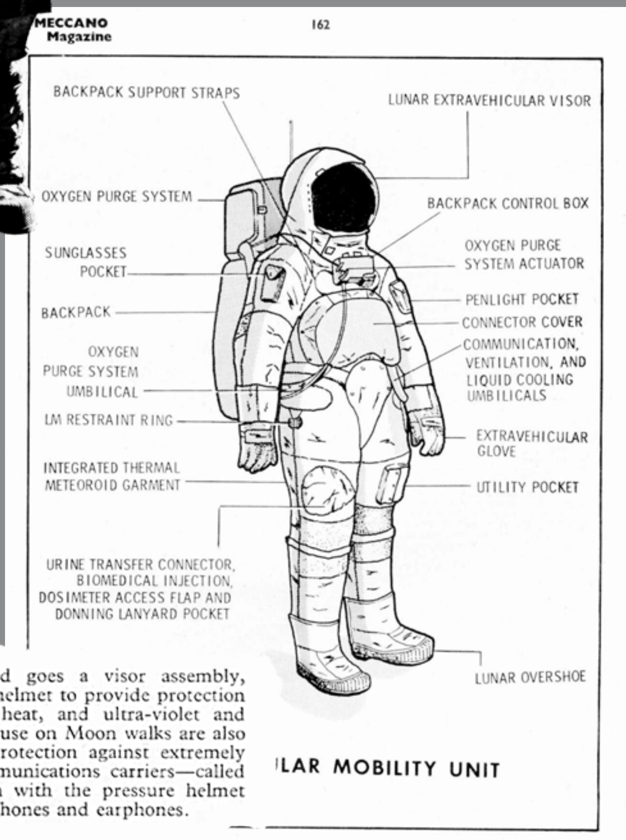
The solution NASA developed was a backpack-like device known as the Portable Life Support System. It provided two critical functions: first it removed carbon dioxide from the pressurised air inside the suit using lithium hydroxide, which combines with CO_2 producing lithium carbonate and water. Secondly, the PLSS circulated water through a Liquid Cooling and Ventilation Garment (LCVG) worn by the astronaut under the pressurised exterior suit. This garment contains a network of flexible tubes that make direct contact with the astronaut's skin. Water is circulated through the tubes, which draw heat away from the body and prevents the astronaut's core temperature from becoming unmanageably high while exposed to direct sunlight walking on the lunar surface.

The water made its way through the LCVG and returned to the PLSS, where it was cooled by passing it through an 'ice sublimator' which consists of porous nickel plates. The pores are sized sufficiently to allow water to freeze within them without damaging the plates. While the documentation available on this process is not completely clear, it appears that while coolant circulation was 'paused', water would be applied to the plates which, shielded from sunlight, would quickly freeze. The coolant would then circulate, passing through the sublimator. Due to the lack of atmosphere on the moon, the heated ice then sublimated directly to water vapour, which was then vented away from the suit. The cycle was then repeated.

During the Apollo 12 commander's first moon walk, 2.15kg (4.75lb) of water was sublimated, dissipating 262W of heat.



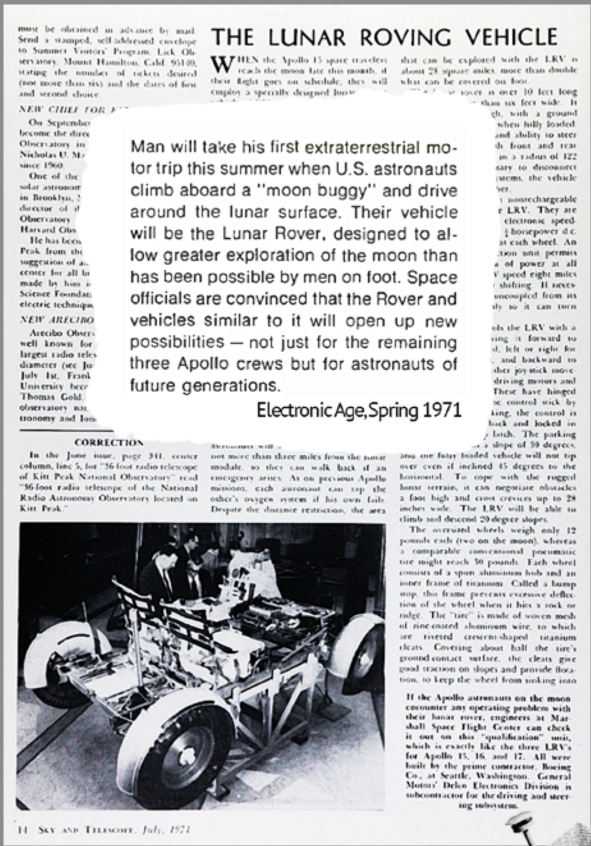
Pages from Meccano Magazine, a British publication



MECCANO Magazine 162

…LAR MOBILITY UNIT

On the astronaut's head goes a visor assembly, attached over the pressure helmet to provide protection against micro-meteoroids, heat, and ultra-violet and infra-red light. Gloves for use on Moon walks are also provided and these give protection against extremely hot or cold objects. Communications carriers—called "Snoopy hats"—are worn with the pressure helmet and these have both microphones and earphones.



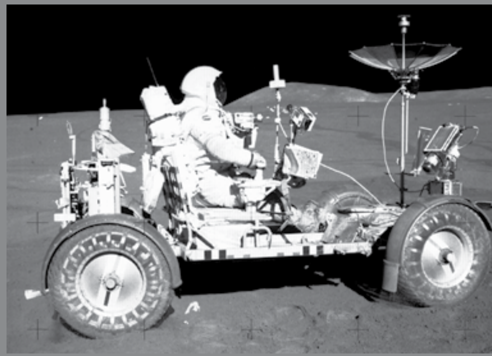
THE LUNAR ROVING VEHICLE

Man will take his first extraterrestrial motor trip this summer when U.S. astronauts climb aboard a "moon buggy" and drive around the lunar surface. Their vehicle will be the Lunar Rover, designed to allow greater exploration of the moon than has been possible by men on foot. Space officials are convinced that the Rover and vehicles similar to it will open up new possibilities — not just for the remaining three Apollo crews but for astronauts of future generations.

Electronic Age, Spring 1971

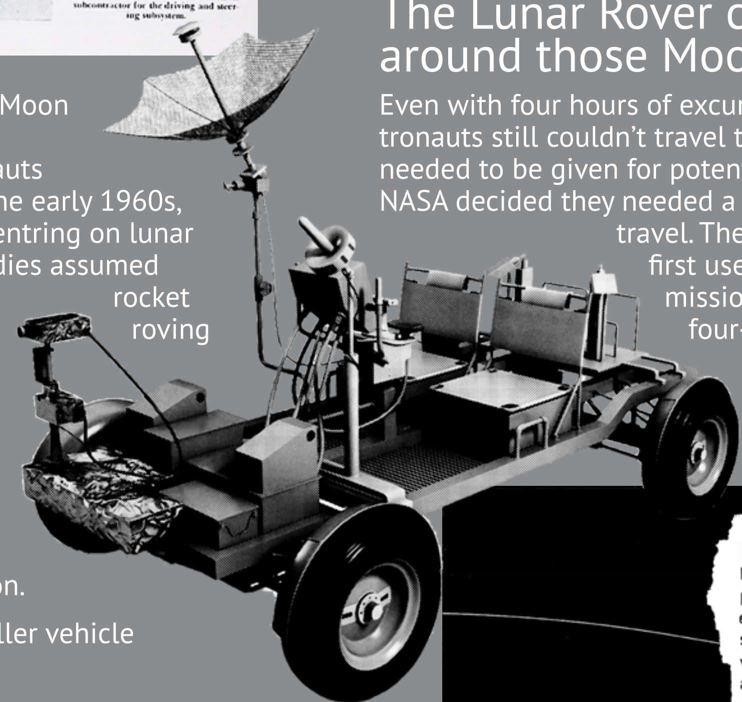
The PLSS used during Apollo 11 contained enough oxygen, lithium hydroxide and water for a four hour lunar excursion. It also had a 279 watt-hour battery. There was also an additional backup in case the PLSS failed known as the Oxygen Purge System (OPS). The OPS was essentially just an oxygen tank that provided a maximum of 30 minutes of emergency oxygen and cooling by venting the suit directly into space.

The PLSS weighed 38kg (84lb), which combined with the 19kg (7lb) OPS would've been quite a hefty load on Earth, but in the Moon's one-sixth gravity was only 10kg (22 pounds) – easy to carry!



But why walk when you can ride? The Lunar Rover could get you around those Moon craters in style!

Even with four hours of excursion time, the lunar astronauts still couldn't travel that far. Plenty of leeway needed to be given for potential emergencies. And so NASA decided they needed a vehicle for longer-distance travel. The Lunar Roving Vehicle (LRV), first used during the Apollo 15 mission, was a battery-powered four-wheeled cart carried on the Lunar Excursion Module. Once landed, astronauts would unpack the LRV, use it and leave it behind.

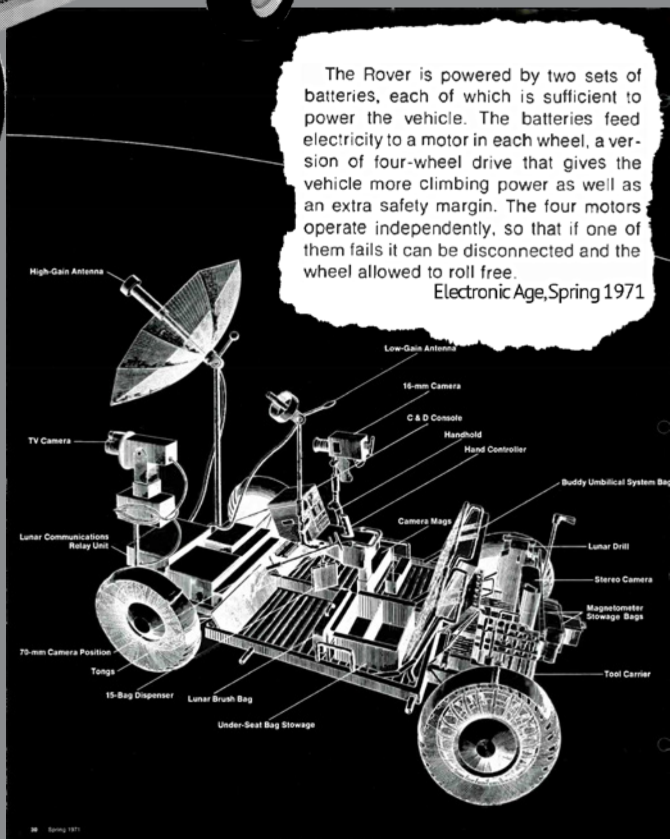


The history of the LRV (or 'Moon buggy' as it was popularly referred to by both astronauts and the public) began in the early 1960s, when a series of studies centring on lunar mobility. These earlier studies assumed that a second Saturn V rocket would carry a large roving vehicle and enough supplies for a two-week surface mission to the Moon in advance of the landing party, but the US Congress objected to the cost, insisting on only one Saturn V launch per mission.

Consequently a much smaller vehicle would be required.

In 1965 Wernher von Braun contracted Huntsville, Alabama-based Brown Engineering Company (BECO) to develop a two-man 'Local Scientific Surface Module'. BECO paid particular attention to the wheels and the suspension, noting the unknown composition of the Moon's surface and the reduced gravity. In 1969 the design was tentatively approved, and Boeing was contracted to build the final product. The first LRV was delivered in 1971 at a cost of US$38m ($236m in 2018!)

Weighing in at 210kg (460lb), the mostly-aluminium LRV had wheels consisting of a steel mesh overlaid with titanium chevron 'treads' used to provide traction. Each wheel was driven by an independent electric motor, and two additional motors steered each axle, allowing for a tight turning radius. These motors were powered by a 36-volt battery that provided a range of 92km (57mi) and a top speed of 13km/h (8mph). The LRV also contained a navigation computer which constantly kept track of the rover's location, radios and both film and television cameras.



Selected by NASA in 1959 to become part of the first large-scale spaceflight program, the seven men who would become well-known to the American public and the world-at-large as the 'Mercury 7' went on to make significant contributions to the history of human spaceflight, but what NASA did not similarly advertise was that thirteen women were also chosen, women who had passed all of the same tests and trials as their male counterparts, and who were deemed equally as qualified and capable of travelling in space.

While these women would never be given the opportunity to participate in the space program as mission astronauts, they proved conclusively that physically, mentally and psychologically, women and men were far less different than was commonly believed at the time. Notions that women were somehow cognitively inferior, emotionally fragile or physically too weak to undertake strenuous activities were roundly shown to be false and such attitudes subsequently antiquated – and rightly so. Were it not for the Mercury 13, those in positions of power may not have been convinced that women could succeed not only in the field of aeronautics but in other technical areas, and the feminist revolution of the late 20th century may not have happened.

After studying medicine at Harvard in the early 1930s, Randy Lovelace joined the Army Medical Corps Reserve where he began studying the problems associated with high-altitude flight, and developed an oxygen mask for use in aircraft. During this time he met Jacqueline Cochran, a female pilot who held three women's speed records, and formed what would become a lifelong friendship.

During WWII, Randy served in the Air Force, performing experiments in the use of parachutes at high altitude. This included him personally 'bailing out' of a plane flying at over 40,000 ft (12,192m), an exercise which rendered him unconsious but saw him awarded a Distinguished Flying Cross.

In 1958 he was appointed the chairman of the NASA Special Advisory Committee on Life Science. As such, he played a key role in the selection of astronauts for the first American human spaceflight program, Project Mercury. During this time, his old friend Jacqueline Cochran convinced Randy that he should also study the suitability of women for spaceflight. Randy agreed that women were generally smaller and lighter and could allow for smaller space vehicles.

Randy owned a private clinic and used it to test twenty-five women. The candidates had to be under the age of 35, in good health, hold a second class medical certificate, have a bachelor's degree, hold an FAA commercial pilot rating or better, and have over 2,000 hours of flying time.

Prior to even beginning astronaut testing, the candidates had to undergo thorough examinations, including numerous x-rays and lengthly eye exams. Their cardiovascular health was stress-tested with stationary bikes and their ability to recover from vertigo was

Myrtle Cagle
Jerrie Cobb
Janet Dietrich[3]
Marion Dietrich[3]
Wally Funk
Sarah Gorelick (later Ratley)
Jane "Janey" Hart (née Briggs)
Jean Hixson
Rhea Hurrle Woltman (later Allison, then Woltman)
Gene Nora Stumbough (later Jessen)
Irene Leverton
Jerri Sloan (née Hamilton, later Truhill)
Bernice Steadman (née Trimble)

The 13 women who passed the same physical examinations as the Mercury 7 astronauts.

[Top Left] Jerrie Cobb in a simulator.
[Top Right] Sarah Gorelick (in helmet) and others.

[Left] Seven surviving FLATS (First Lady Astronaut Trainees) attending the STS-63 launch.(from left): Gene Nora Jessen, Wally Funk, Jerrie Cobb, Jerri Truhill, Sarah Rutley, Myrtle Cagle and Bernice Steadman.

Women in Technology
The Mercury 13

determined by shooting ice-water into their ears! Those women who passed all of these trials were then advanced to the actual spaceflight suitability testing.

One of these women was Jerrie Cobb. Daughter of an Air Force Lt. Col., Jerrie was encouraged in her childhood to take up aviation, first flying in her father's 1936 biplane at age 12. By age 16 she was barnstorming around her native Oklahoma, dropping leaflets on towns announcing the arrival of circuses. She saved money by sleeping under her plane's wing, which she used to buy fuel so she could practice her flying more. The next year she earned her private pilot's license, and received her commercial pilot's license a year later.

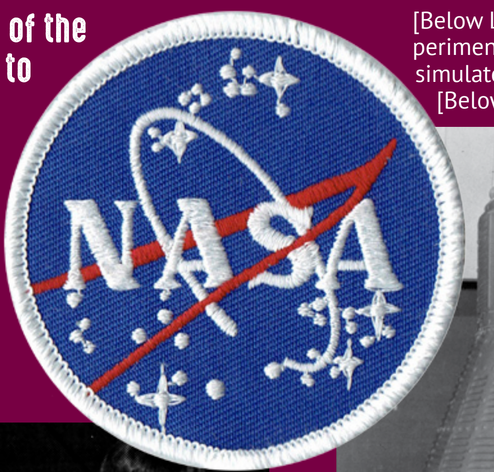
Facing discrimination, she struggled to make a career of flying, taking crop-dusting jobs among other less-desirable tasks. However, by her late 20s she had set new world records for speed, distance and altitude, and became the first woman to fly in the Paris Air Show, where she was named Pilot of the Year and awarded the Amelia Earhart Gold Medal of Achievement.

By 1960 Jerrie had over 7,000 hours of flying time, and her accomplishments did not escape the notice of Randy Lovelace, who invited her to be the first participant in his female spaceflight testing program. Jerrie (and the other 24 women) were subjected to a number of invasive tests, including swallowing a rubber tube so that their stomach acids could be withdrawn and tested, and being subjected to electric shocks to assess their reflexes.

Some of the women were disqualified due to brain or heart abnormalities, but 13, including Jerrie, passed all of the same physical tests as the seven male Mercury astronauts. Jerrie and two other women underwent the second phase of testing, consisting of psychological evaluations, and Jerrie alone underwent the third phase, advanced physical tests using jet aircraft. Jerrie ranked in the top 2% of all astronaut candidates of both genders – which seems to have caused some concern at NASA.

Before the other women could undergo third phase testing, NASA abruptly cancelled the project. Jerrie immediately flew to Washington D.C. lobbying to try to have the program resumed. After she wrote President John F. Kennedy, a House subcommittee was convened to invesigate the possibility of gender discrimination. Astronaut John Glenn testified that NASA policy required all astronauts to be former military test pilots – and women were not allowed to be test pilots. No action was taken.

Thanks in no small part to the efforts of the Mercury 7, the first American woman to venture into space, Sally Ride, went up on the Space Shuttle Challenger during the STS-7 mission launched on June 18th 1983. STS-7 was also the first mission to carry five people in a single spacecraft. Amongst other things, the mission deployed two communication satellites.



[Below Left] An all female crew of scientific experimenters at NASA. whose working conditions simulate those found in space.
[Below Right] Jerrie Cobb and Mercury capsule.

New for 1969: A Tale of 3 TVs...

What better to watch the Moon landing on than your brand-new 1969 television set?

RCA, Magnavox and Zenith all debuted new TV lines that year, each with their own unique selling point. Televisions themselves were no longer novel by 1969 (not even colour ones), and so manufacturers were forced to develop new features that could potentially entice people to part with even more of their hard-earned cash.

Luckily, they didn't have to look too far. Televisions of the day were utilitarian, with simple channel dials and volume knobs. The youngest child in the family usually served as the remote control! The TV repairman was a not-infrequent visitor. And colour was kind of meh. But there were new TVs with solutions for all these problems – for $$$.

> To the general public of 50 years ago, the idea of sending moving images through space seemed the impossible dream of over-optimistic engineers. Today Americans alone own as estimated 146 million television sets—more than the number of telephones, refrigerators, automobiles, or bathtubs. TV has moved from the impossible to the indispensable. A viewing audience, including some who once considered video communications as remote a notion as a spaceship to the moon, already looks back a full decade to the time when it watched, from the comfort of the living room sofa, that first human step on the moon.
>
> Radio Electronics, June 1980

RCA's Two Thousand was a high-end vision of what it was imagined televisions might look like in the year 2000. It was manufactured in a limited run of 2000, and cost US$2000 (or about US$14000 in today's terms). That bought you a 23-inch (58cm) screen that had such a "vivid, detailed picture" you could "even watch it in a brightly-lit room". It had an electronic tuner that could remember and recall your favourite channels, and you could change brightness, tint and other settings using the remote control – ooh la la. The advertisement proudly declared that "computers" made it all possible, and concluded: "Imagine. Once for $2000 all you could get was a trip around the world. Now you can travel to a whole new century." Not quite.

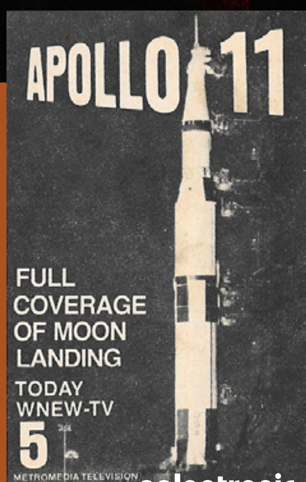
Happily to get a better colour picture you didn't need to re-mortgage your house and buy a Two Thousand.

Zenith's Chromacolor system reduced the size of the red, green and blue phosphor dots that were arrayed behind the front of the picture tube, surrounding them with a black pigment which soaked up ambient room light. This allowed them to in turn reduce the strength of the anti-reflective glass filter that sat in front of the picture tube, and resulted in a brighter, clearer image.

The new design was also easier to view in more brightly-lit environments (including outdoors), making portable television sets more practical. Not to be outdone, competitor Sony would introduce its Trinitron tube to the US market in 1970 – but we're talking '69.

American families and many other families from across the globe gathered in their lounge rooms to watch the wall-to-wall television coverage of the Apollo 11 Moon landing and subsequent walk, which saturated the airwaves for several days from launch until splashdown.

The event highlighted the public's newfound ability to engage visually with moments of historic importance in real-time, unlike in the past when one would only hear about them on the radio or read about them in the paper, often hours or days after the events had actually occurred.



Magnavox, meanwhile, was attempting to relieve a common customer complaint – the need for, complexity and cost of television adjustment and repair. Early TVs could be quite fussy: valves (vacuum tubes) were fragile and became quite hot, repeated heat expansion and subsequent contraction caused them to frequently 'burn out', necessitating replacement. While this was a relatively straightforward procedure, it meant navigating wires and components potentially containing lethal high-voltages, leading owners to leave it to TV repairmen. Also, over time component aging could lead to variations in voltages that affected the image and required adjustment.

By housing many of the more serviceable components in a separate 'drawer' behind of and including the control knobs and speaker, owners could perform simple repairs and adjustments themselves, forgoing the need to call out a repairman.

However, the benefits of Magnavox's 'innovation' were short-lived, as more reliable transistor-based 'solid-state' televisions would soon become prevalent.

Owing to an increase in the import of Japanese electronics made by companies such as JVC and Sony, these TVs were also typically smaller and lighter, with cabinets made of molded plastic instead of wood, allowing consumers to more easily carry their sets into repair centres – which they needed to do less often. But don't worry, the rise of the temperamental VCR would keep electronics repair-people and their shops busy for many more years to come.

Soon, the era of the console TV would come to an end entirely – which was a good thing because wooden cabinets were heavy!

The Magnavox Quasar TV with "the works in the drawer".

In 1965 color television reached the elite billion-dollar category as an industry. Hand-held minicams appears at the 1969 political conventions; and the Trinitron gun was developed, reducing aberrations with its three in-line electron beams from once source and single large-diameter lens. In 1969 came the shadow-mask tube with a black-matrix faceplate, reducing back-scattered light by 50 percent. Radio Electronics, June 1980

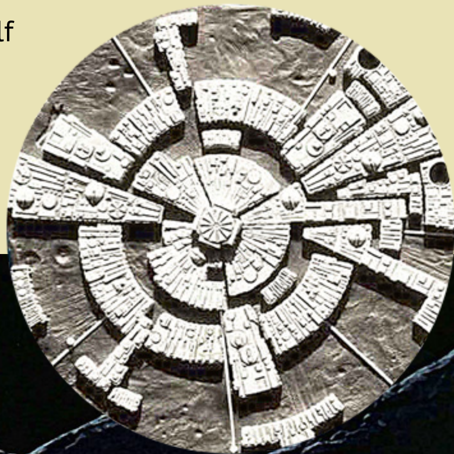
The Entertainment Centre

POPPED Culture
Lunar Edition

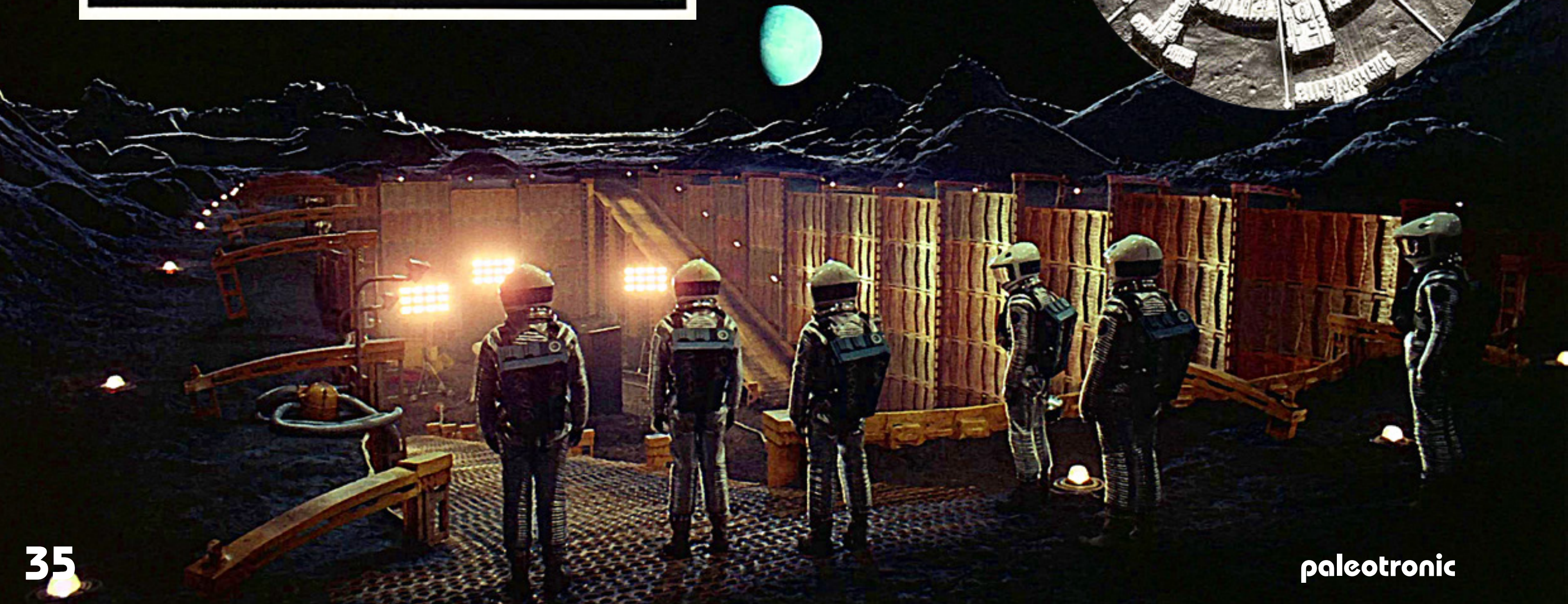
2001: A Space Odyssey is a 1968 motion picture written by director Stanley Kubrick and science-fiction novelist Arthur C. Clarke. In the film, a featureless black monolith is uncovered near Clavius Base, an American outpost on the Moon. Once the monolith is exposed to sunlight, it emits a powerful radio signal in the direction of Jupiter. The US sends spacecraft Discovery One to investigate, but along the way its artificially-intelligent computer, HAL-9000, appears to malfunction, and in response to the possibility he might be shut down, attempts to kill the crew.

The protagonist (and remaining survivor) Dr. David Bowman manages to deactivate Hal, and the ship arrives at Jupiter, discovering another monolith in orbit around the planet. When Bowman leaves the ship in a pod and approaches the monolith, a vortex appears and the pod is sucked into it, traveling across vast distances of space where Bowman observes strange cosmological phenomena and oddly-coloured landscapes.

Eventually, he finds himself in a bedroom where he sees and becomes progressively older versions of himself, eventually being reborn as a new space-native being.



[Right] Clavius Lunar Base
[Below] Uncovering the monolith



SPACE: 1999

In the British science-fiction television program Space: 1999 (1974-77), nuclear waste stored on the far side of the Moon explodes, knocking it out of Earth's orbit and sending it off into space – along with the 311 inhabitants of Moonbase Alpha, a scientific base four kilometres wide and one kilometre deep.

Located in the Moon crater Plato, Moonbase Alpha is the setting for much of the program. Built between 1983 and 1997, the complex extends outward from the central 'main mission' tower similarly to 2001's Clauvius Base. It is completely self-sustaining, powered by a combination of nuclear reactors and solar energy. Water is obtained from ice deposits under the lunar surface.

High-speed 'travel tubes' connect each part of the base, including buildings devoted to astronomy, geology, chemistry, biology and astrophysics; residence and recreation sections; and spacecraft hangers.

The show starred American actors Martin Landau and Barbara Bain.

Five Space: 1999 'Annuals' were published between 1975 and 1979, each edition containing a fan-friendly mixture of comics, text stories and features on the show's production and cast.

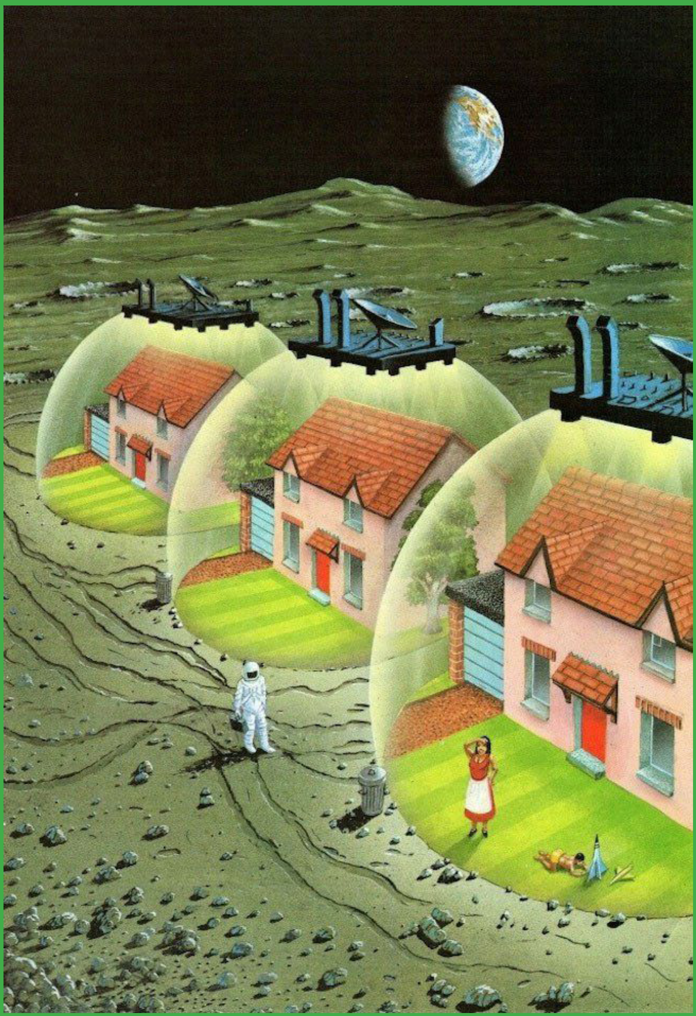
Two series of the program, each comprised of 24 episodes, were produced, chronicling the experiences of Moonbase Alpha's residents as the Moon hurtled through space. During their adventures, they visit a number of exoplanets, travel to other star systems via wormholes, and meet (and come into conflict with) various alien species and spacecraft.

The program explores a number of typical science-fiction themes including the possible extraterrestrial origin of humanity, the nature of God, time travel and plots involving astronomical phenomena. And aliens! Plenty of aliens.

The series was criticised for its lack of realism, with science-fiction author Isaac Asimov noting that any explosion capable of knocking the Moon out of orbit would almost certainly blow it apart, and even if it survived it would take thousands of years for it to reach the nearest star. He did, however, praise it for its portrayal of movement in the low-gravity environment of the Moon.

Creators Gerry and Sylvia Anderson were surprised at the criticism, disappointed that the show was not granted the same suspension of disbelief given to other science-fiction programs such as Doctor Who or Star Trek. Despite the criticism, the show was popular, and currently has a 7.4/10 rating on the Internet Movie Database.

The writers of 2001: A Space Odyssey and Space: 1999 weren't intentionally being fantastical. In the 1960s and 70s the idea of a moon colony wasn't just science-fiction – it was widely predicted as an eventual certainty!



You can't blame them of course. From their perspective, why wouldn't we colonise the Moon? We 'd managed to survive virtually everywhere on Earth: in deserts, the deep-sea – even in the Antarctic (people in the 1960s thought we'd establish large colonies in all of those places in short order as well).

Surely it was just a simple matter of technology catching up with the desire, and there wouldn't be long to wait. After all, publicly-available electricity wasn't even a thing a hundred years earlier, and prior to 1903 human flight had only been achieved by hot-air balloon! The people of the 1960s had jet planes, long-distance telephones, colour televisions and electronic calculators – many people alive then had been born before any of these had been invented. And the rocket-age meant that not even the sky was the limit anymore – first the Moon, then Mars, then the moons of Jupiter and Saturn… humanity was going all kinds of places, and fast! Of course there were going to be Moon colonies – lots of them.

Obviously not like this comic though. That would be silly. Grass on the Moon? Please. If you wanted vegetation (as a species weren't we over plants, anyway?) you would have to visit the flora dome. Your house would have a rock garden. Like in Coober Pedy or Arizona.

Seriously though, people have been proposing lunar colonies for a while. In 1638, Bishop John Wilkins wrote *A Discourse Concerning a New World and Another Planet*, in which he predicted a human colony on the Moon. Konstantin Tsiolkovsky (1857–1935), among others, also suggested such a step. But things would really heat up in the 1950s when just about everyone got a bit of Moon dust in their eyes.

In 1954 science-fiction writer Arthur C. Clarke proposed a lunar base made up of inflatable igloo-like modules that would then be covered with actual – rather than metaphorical – Moon dust for insulation! Subsequent steps would include the establishment of a larger, permanent dome; a nuclear reactor for the provision of power; an algae-based air purifier; and electromagnetic cannons to launch cargo and fuel to interplanetary vessels in space.

MOON COLONIES

Clarke wasn't the only one. In 1959, John S. Rinehart suggested that the safest design would be a structure that could "[float] in a stationary ocean of dust", since there were, at the time this idea was… erm…floated, theories that there could be mile-deep dust oceans on the Moon (a concern that was shared by some at Project Apollo but allayed by the Ranger probes, see The Pro Shop). But it wasn't just science-fiction authors that had these ideas – the US government had them as well.

Project Horizon was the US Army's plan to establish a fort on the Moon by 1967. Led by Heinz-Hermann Koelle, a German rocket engineer of rhe Army Ballistic Missile Agency (ABMA), it proposed that the first landing would be carried out by two 'soldier-astronauts' in 1965 and that more construction workers would soon follow. It was posited that 140 rocket launches would then transport 245 tons of cargo to the lunar outpost by 1966 – that's a lot of rockets! Since it turned out you needed a Saturn V to get anything of substance away from Earth's gravity, obviously this wasn't feasible.

But the Army wasn't alone in its ambitions. The US Air Force had it's own plans – the Lunex Project wanted to have one of their own on the Moon by 1961, and envisioned a 21-airman underground base on-line by 1968 at an esimated cost of US$7.5 billion (in 1958 dollars!) But those visionaries were wrong, regardless of how much money you could throw at them, their proposals just weren't viable.

At least yet. In 2017 the Moon Village Association was created to promote the implentation of an international human settlement near the lunar south pole. Will it happen? Perhaps. Someday…

SPACE NOTES

LIVING ON THE MOON

A domed lunar city of the future.

AN appreciable proportion of the current N.A.S.A. spending is devoted to the development of a manned lunar landing craft to be operational during the period 1965–70. Some of the military organisations have even more ambitious ideas—the Army Corps of Engineers has announced plans for a lunar base in the late '60's and the U.S. Air Force is also thinking of bases at about the same period.

The first Moon landings, whether they are carried out by N.A.S.A. or by military organisations, will be a national project—cost no object. But after the first few shots economics will certainly become important. This issue of Space Notes is devoted to looking at the problems involved in setting up lunar bases.

First of all, how will a lunar base differ from the usual type of community found on Earth? The greatest difference will be that of isolation. On Earth it is not possible to get more than about 12,000 miles away from any given point and one is still bound by the same gravitational force. In theory it is always possible to get home "under one's own steam". The Moon, however, is 240,000 miles away, and a highly-specialised vehicle, launching and landing complex is required to return to Earth.

The effect of looking up at the Earth in the sky is certain to be profound on the inhabitants of a lunar colony. The practical effects of isolation will be just as great. If an item is forgotten it will not be possible to obtain it very easily—in principle it would be possible to have a small supply vessel sent under remote control from Earth, but the cost would be so exceptionally high (thousands of dollars per pound delivered at the moment) that such a procedure would be reserved for dire emergencies. Thus all items required (and this includes water, food and air) must be either taken to the Moon or produced there.

The other important factor is environment. The big difference from Earth is the lack of an atmosphere. Wherever one is on Earth the easiest and cheapest thing to obtain is air. Not so on the Moon, as its gravity is so small that any atmosphere that was there disappeared into space many ages ago.

By J. HUMPHRIES, B.Sc. (Eng.), A.M.I.Mech.E., A.F.R.Ae.S.

On Earth, both extreme of heat and cold are encountered—sufficient to kill on comparatively short exposures, but nothing so bad as on the Moon. The lack of an atmosphere means that there is no protection from the Sun during the long day and temperatures rise to about 99 degrees Centigrade (near boiling point). The surface cools very quickly at sunset falling to almost minus 115 degrees C. in half an hour. Fortunately the low gravity (the third major environmental difference) will enable quite massive and complex suits containing heating and cooling apparatus to be worn, but at best it will not be possible to exist for more than a few hours in a suit.

The low gravity will be a tremendous help in many ways—it is only one-sixth of that on Earth. This means that surface transport will be far easier and it will be possible to build structures which, on the Earth, would collapse under their own weight.

Before any manned landings take place,

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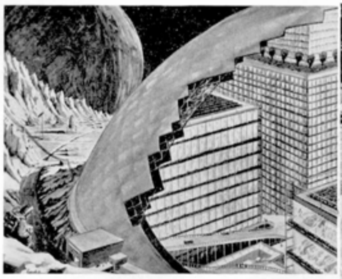


Above: A sectional view of a domed city showing maximum use of internal space. This and the previous picture are by courtesy of the Martin Company. Right: Nuclear-propelled lunar freighter. Photograph, Frank Tinsley and American Bosch Arma.

the solar system are now thought to have been formed by an agglomeration of space debris; if this is so, then the Moon should have a chemical composition approximating to that of the Earth. In other words, there should, somewhere, be quite a lot of water.

It has been calculated that the radioactive elements in the Moon will have heated the central core to over 1,000 degrees Centigrade. This will have driven all the water into the outer layers of the Moon. There probably exist fissures, perhaps arising from past volcanic activity, and some water will have been forced up these, freezing as it nears the surface. Some astronomers now think that the small domes which are a feature of certain parts of the Moon's surface are, in fact, the ends of sub-surface glaciers covered by dust and other debris.

Solar power will be continuously available on the day side of the Moon and can be used to split up the water into oxygen and hydrogen. These gases can be stored and used for fuel or the oxygen can be used for breathing purposes. During the night, the gases could be used to generate power. Alternatively, an atomic power plant could be used at night, and the design of small stations for use in the early stages of lunar exploration is already well advanced.

TRANSPORT COSTS

Protection will be needed not only against heat and cold but also against meteors, ultra-violet radiation and possibly other solar radiations. This may best be achieved by building underground, although domed cities such as those shown in two of our illustrations may be practical. It all depends on the conditions we find.

Undoubtedly a major aim in space flight will be to cut the costs as much as possible. This will have two effects. First it will enable larger expeditions and more equipment to be sent, thus rapidly accelerating the colonisation of the Moon; secondly it will make it economic to send some of the rarer metals, if found, back to Earth. Possible improvements in conventional chemical rockets are limited and nuclear power is the most promising propulsion source for future space-ships.

The ship shown in the top right illustration on this page utilises a nuclear fission plant to supply the heat and hydrogen is used as the working fluid. It carries sufficient hydrogen for the Earth-Moon trip and is refuelled on the Moon with hydrogen produced from the electrolysis of water.

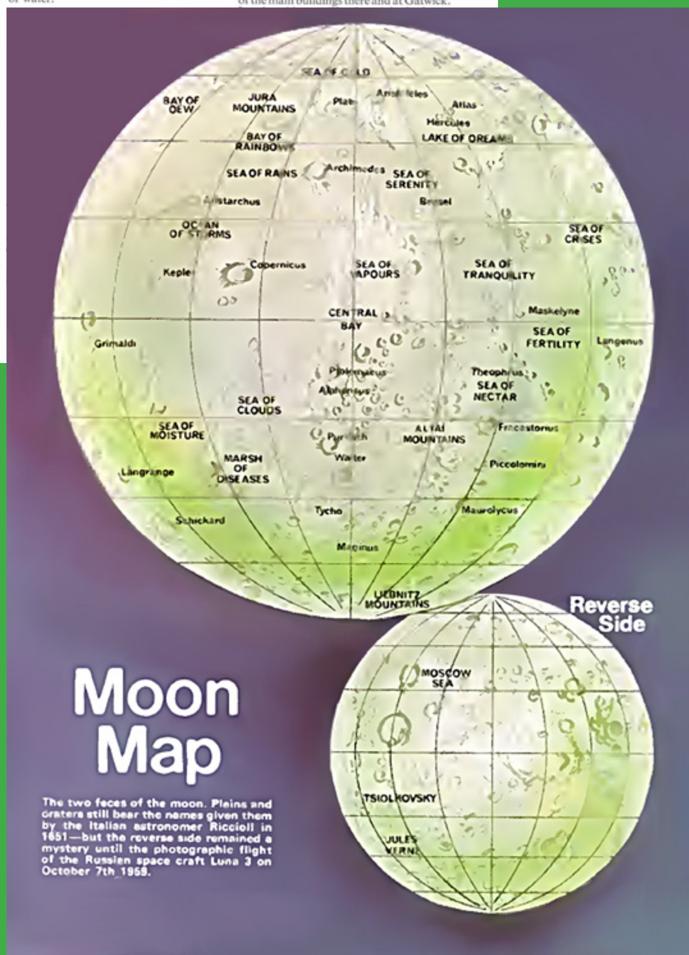
many excellent half-tone illustrations and line drawings.

Useful appendices at the end of the book include check list of camping "gear" for two, list of some recommended camps, and a glossary of camping words and phrases in French, German and Italian.

• • • •

The new edition of *London's Airports (Heathrow and Gatwick)*, published by Ian Allan, price 2/6, will delight *M.M.* readers who are interested in civil aircraft and live in the London area or will be able to visit either of these London airports during their holiday travels. It describes the work of the various Air Traffic Controllers at Heathrow, and the features and functions of the main buildings there and at Gatwick.

The September 1962 edition of Britain's Meccano Magazine speculated on colonising the Moon, suggesting that it should have a large water supply (an idea previously dismissed but recently determined to likely be correct). However, the author also thought a lunar base would likely be impractical without the invention of nuclear-powered rocketry, which never happened.



ARCADE RATS ON THE MOON!

LUNAR ESCAPES

During the 1960s the world was experiencing space fever. It was an ailment for which there was no cure, nor did anybody want one. During the 1950s the United States and Soviet Union had sent vehicles into space, though this was only the beginning. In May 1961, John F Kennedy announced to the nation they would land a man on the moon 'before this decade is out.'

In 1969 the Apollo 11 mission succeeded in this promise, just months shy of the decade's end. Though John F Kennedy had been assassinated years earlier, he had kept his promise in the minds of the public. Though other missions to the moon have taken place, it is this first event that is seen as one of man's greatest accomplishments. It also continues to be a goldmine for conspiracy theorists who claim the moon landing was faked.

Spacewar, the first ever computer game was developed using a space theme. This trend would continue throughout the 1960s and 1970s with Computer Space and other Spacewar clones being released to an increasingly uninterested public. 1969 saw the first 'lunar landing' type of game developed on the PDP-8/E Minicomputer. The idea behind the game was to take control of a lunar landing module. It would start at the top of the screen and the player would gently guide it down to the surface on an allocated landing platform.

Initially using a text interface, asking the player to enter numbers to determine how much fuel to use on each turn. Numbers would range between 0 and 200, with 0 being free fall and 200 the maximum burn. The author never followed up with the game, though it was later redesigned to work with a light pen.

Ten years later, in 1979, Atari decided to release a commercial version of the game. Indeed, this would be similar to Computer Space, which was a commercialised version of Spacewar, a game developed at an institution. This was in an era before lawsuits prevented such displays of plagiarism from being allowed to happen. Like the original Atari intended their version to feature vector graphics, but there was a problem. Cinematronics had already created the first vector based arcade game, so Atari were playing catchup in the technology game. However, one of the projects Atari's Cyan Engineering was working on involved vector graphics, so with the idea in place it was time to get started.

It was Howard Delman who came to Atari with the idea of creating a remake of the original lunar landing game. Rich Moore was bought on board after it was determined that he had played the original game. Presumably he could use this insight to help them create a replica of the original. Rich admitted to Retro Gamer magazine that he had become a space enthusiast after seeing the Apollo 11 moon landing in 1969. He even indulged himself by purchasing and building model kits of the lunar lander after the event.

With the team in place, supported by Rick Moncrief and Atari legend Ed Logg, it was time to plan the layout of the game. Graph paper was used to plot out the the landscape; something Rich was able to do purely based on his memory of the original game. Ed Logg created the font for the game on similar graph paper. This font would be used for later Atari vector games, most notably Star Wars.

Paul Monopoli looks back on three popular arcade games set on the Moon: Lunar Lander, Battlezone and Moon Patrol.

From the drawings, Howard and Rich wrote the course code for the game which was typed up by two fast typists. As the game developed, Howard and Rich fell into specific roles. Howard would work on the hardware while Rich would explore the code and discover new ways in which to tweak it. The work flowed between the two men who continued in their individual roles, though they came together when it was time to discuss elements of gameplay.

Howard wanted a realistic simulator, though realised that even real lunar modules had a version of an 'auto pilot.' He also realised that to attract player an arcade game needs to be simple. Much of the development time was spent getting the four difficulty levels just right. The physics used are far from perfect, though they were actually designed to aid the player in landing the craft. Though the difficulty shoots up rather quickly the game allows you to get through the first level with relative ease.

The controls comprised of a thrust lever with two buttons to tilt the module left and right. A "save your ass" button was included that would straighten the module and increase the thrust. The pay off was that it cost a significant amount of fuel to use. However, if you were in a perilous position then you may not have a choice but to try it and see what happens.

Super-Tank Shoot-Out

Deftly employing the vector graphics Quadrascan monitor to create extremely high resolution images, *Battlezone* puts the gamer behind the dual-joystick controls and assists him with an on-board tracking computer.

The setting for this high-tech battle is the surface of the moon.

Electronic Games, May 1982

ATARI COIN CONNECTION

ATARI INC., 1265 BORREGAS AVENUE, SUNNYVALE, CALIFORNIA 94086

Introducing Battlezone.™ Combat-Ready for High Profit Scoring

The radar screen display shows the location of enemy tanks... "Enemy in range" appears on the screen... the player positions his tank, aims, fires and the enemy tank is blown away!

This is Battlezone™, over a year in development, the latest in Atari's line of ultra-exciting combat video games. It's a battle of wits and skill between the player and computer-controlled enemy tanks and missiles. It's competition in a world beyond the stars.

Battlezone is a totally new, one-player, first person game, with the player in control of a supertank. The player must maneuver his tank to dodge enemy tank fire. Enemy missiles and saucers also appear to be shot down for added points.

This game features Atari's exclusive Quadra-Scan™ display system, along with spectacular "3-D" screen graphics and exciting sound effects. The 1812 Overture is played at special bonus levels. There are four operator-adjustable game times, four operator-adjustable bonus levels, and over one hundred coin options.

continued on last page

VOLUME 4 NUMBER 10 © ATARI INC., 1980 OCTOBER 1980

Though the game was released shortly after the 10th anniversary of the moon landing, Atari neglected to mention this point in any promotion for the game. Sadly the success of Lunar Lander was short lived, as the action packed Asteroids stole any thunder it was likely to receive. Though it wasn't as successful as other Atari projects of the era, Lunar Lander developed a cult following with fan made versions of the game being created across almost every platform that has ever been developed.

Continuing to make use of its new vector graphics engine, Atari released Battlezone in 1980. There is conflicting information about where exactly this game is based, with an early issue of Electronic Games Monthly claiming that it takes place on the moon, but a recent issue of Retro Gamer Magazine states that the game is set in a cyber world. With that said, later revisions of the game take place on the lunar surface, so one could assume that the original does as well.

Atari developers would participate in brainstorming meetings where new ideas could be introduced and worked over. Battlezone was the result of one of these meetings. It was suggested that the vector technology could be used to create a first person game, quite possibly the first of its kind. Indeed, the idea was such a draw for Atari employees that designer, Ed Rotberg, would have to kick people off the machine while it was being debugged.

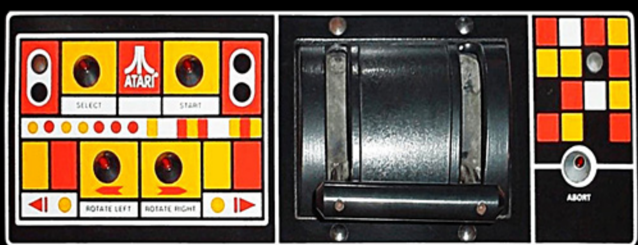
Many of the in game effects came down to some tricky coding. In an interview with Retro Gamer magazine Ed Rotberg claims that explosions were actually rotated in 2D, while appearing like parts of the tank were exploding in all directions in 3D. Coding this part of the game was one of Ed's fondest memories of the game.

While Ed claims that the game hardly broke new ground, it was the implementation of the design that keeps Battlezone in the minds and hearts of gamers today. It also attracted the attention of the military who requested that Atari use the game engine to develop a training simulator. This simulation focused on the firing of weapons and the use of targeting systems. Ed Rotberg was completely against working on a military project, but completed work on what is known as 'the Bradley Trainer' under the proviso that he be exempt from any further military projects.

Ed and co-designer Jed Margolin were also against the idea of using a viewfinder scope, something he felt the game wasn't really designed for. In the end his superiors had their way and Atari released Battlezone with the iconic viewfinder. A monitor would allow those not playing to view the action. The way the cabinet is setup is similar to Space Invaders, with the player actually looking at a mirror which angles the image from the monitor. Twin sticks were used to control the tank.

The big problem with the viewfinder was the height, which was fixed in place. If you were below a certain height you would be unable to play the game, and this included children. A revision of the cabinet was released which removed the viewfinder, instead opting for a standard monitor. This is known as the "full face" version of the game.

Jed Margolin claims that the removal of the viewfinder would have doubled as a cost saving measure, considering that adding any extras of that nature to an arcade machine would increase its cost by a considerable amount. This also meant that the mirror did not need to be included inside the cabinet, and while those not playing were still able to see the action it was much easier without the scope in the way.



The controls for Lunar Lander were a simplistic affair, comprised of a variable throttle lever and two buttons that tilted the module left and right.


ON THE ROAD TO RUIN ON THE MOON

MOON PATROL

The moon's surface is an inhospitable place, pitted with craters and also boasting an atmosphere heaving with aliens.

In Moon Patrol a moon buggy is your responsibility as it traverses a lunar landscape across the screen.

You are armed with a fire button and a jump stick to overcome most of the hazards that come your way.

The aliens hovering above your craft are the main source of danger in this game.

Computer and Video Games Jan 1983

Many players have commented on how immersive the game is with the inclusion of the viewscope, though it's sadly something that has been lost in all home ports of the game. While most of the home ports featured wireframe vector-style graphics, it is Atari's own 2600 version that differs the most. Most likely the result of hardware limitations, the 2600 version does not use wireframe graphics, nor is it a first person shooter. Instead the game shows the outside of the tank in a semi third person perspective with basic, blocky full colour action.

The arcade cabinet holds another secret that arcade enthusiasts on klov.com managed to uncover. On official Atari cabinets with specific serial numbers (ranging from 997 - 2250 out of 13000 cabinets) there are holes drilled into the sides which have been plugged by plastic lugs. Jed claims that this was supposed to be for an external, mounted monitor that would mean those who were unable to crowd around the cabinet could see the gameplay from the distance. This was an idea that was implemented by rival Bally Midway for a short time. The Bally Midway 'auxiliary monitor' sat on top of the cabinets, and the promotional flyer shows passers-by checking out the action on the upper visual rather than crowding around the player.

Battlezone is a game that has endured over the decades, with sequels and 'inspired by...' games being developed for various platforms. Battlezone 98 is an official sequel released by former Atari breakaway company Activision in 1998. The game expanded on the original first person concept by allowing the player to not only control the tank, but construct other vehicles and bases. The game received high praise from the gaming press though was not the big seller Activision were hoping it would be.

On the flip side, one such 'Battlezone inspired' game known as Vector tanks was pulled from the Apple App Store in 2011 after Atari started to clamp down on its intellectual property. The developer, Black Powder Media, claims that they were not alone in having their app pulled from the store as Atari were clamping down on titles that infringed on their IP in the lead to re-releasing their games for the umpteenth time.

While Lunar Lander was the first vector based arcade game for Atari and Battlezone was the first vector based first person shooter, Moon Patrol introduced the world to another arcade first. Parallax scrolling was alleged to be first used in the game by Japanese developer Irem. While this is a generally piece of history, others would argue that the Eugene Jarvis developed Defender was the first game to do so.

Released by Williams, Defender uses a form of scrolling but video game enthusiasts online can be found arguing over the method used to generate the movement in the game, and whether it can be classified as parallax scrolling. It's a moot point for the crew at Williams, who ended up licensing Moon Patrol for release in the West.

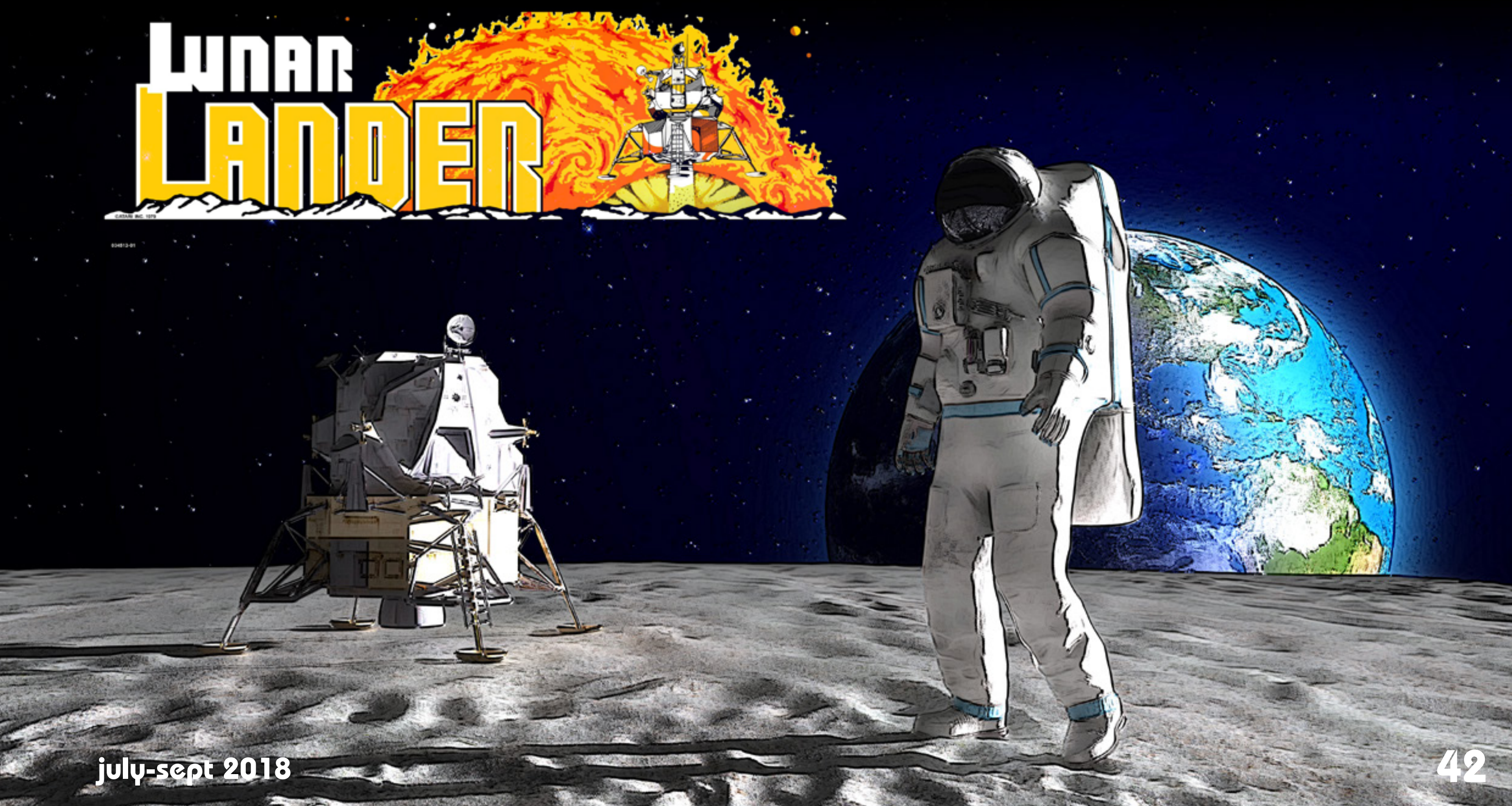
The story of Moon Patrol involves the player working for the Luna City police, though as a youngster this writer was not privy to that storyline, nor was anyone else he knew. The game generated pre conceived notions in the minds of players who created their own stories about the buggy that jumped over craters and shot tanks and UFOs. The game only became successful after its Western release and the game about a buggy on the moon was picked up by Atari to be converted for home computers and consoles.

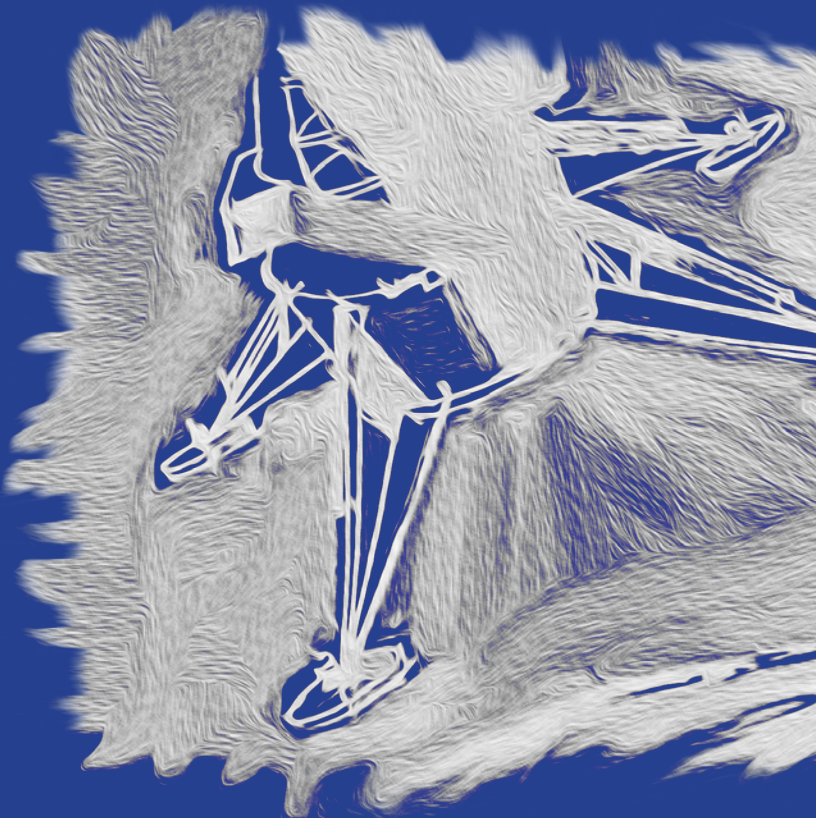
The game was released on a plethora of systems, and though people can recall playing the game on the Amstrad CPC, ZX Spectrum, Dragon32 and others the game never actually appeared on any of these systems. As was the case with many popular games in the 80s, Moon Patrol was cloned by other developers. These clones filled the void for systems that never received an official release but, strangely enough, they also came out for systems that did have a port of Moon Patrol.

Each of the ports features a buggy jumping over holes in the ground and attacking other vehicles, though not all of them take place on the moon. Desert Patrol for the TRS80 takes place in... well... a desert, though the gameplay is pretty much identical. Overlander on the Amiga (the 1993 Scorpius release) shows the moon in the background, though it is unclear where the game takes place.

The parallax scrolling technique used by the game could be seen in just about every arcade game released during the 1980s and 1990s, though even today many independent developers will release games using the technique. What was a technical achievement at the time can now be replicated with tools and a little bit of coding. Though people are argue as to the origin of the technique it definitely left its mark on the arcade landscape.

Video games featuring the moon, or based on the moon, can be found in just about very genre. From Duke Nukem 3D to Command and Conquer to Super Mario Odyssey, both gamers and developers have demonstrated a keen interest in the celestial body. Though there seems to be a keen interest in Mars and other planets in and around the solar system, video games featuring the moon will be finding their way onto our devices for as long as video games are made.





In late 1972, as Apollo Space Missions were winding down a burgeoning virtual space race was busily preparing for launch. A subgenre of simulation games soon to be known as Lunar Landers was taking to the skies on every early micro computer imaginable. These armchair moon mission would capture the imagination and precious clock cycles of many early home computer owners.

Although there were variations, at the core all early Lunar Lander games placed the player at the command of a Lunar Excursion Module on its final descent out of orbit. The primary mission was to guide the humble craft to the surface of the the moon (or other celestial bodies) without killing the crew in a fiery explosion. The earliest Lunar Lander games and simulations were turn based, text only, question and answer affairs. Players would input rocket thrust settings and the burn times required to combat a moon's gravity. A simple enough premises, but complicated enough to be addictive.

The most obvious way to learn about a Lander game would have been through a type-in programs listing, either from a magazine article or a book on the BASIC computer language. Complexity levels of the early type-in microcomputer implementations varied from the absurdly simple, to wildly complicated. Adaptations stuck as closely as possible to real world physics, including such elements as spacecrafts orientation (both horizontal and vertical), velocities and fuel consumption. Though perhaps it was the relative simplicity of programing a simple BASIC Lunar Lander game that propelled the simulation subgenre to absolute stardom.

Lunar Lander

A new game for 16K Spectrum and 1K ZX81 by Gordon Cooper

This program runs on a 16K Spectrum. It uses the colour and high resolution plotting facility of the Spectrum to show the spaceship landing on a rugged lunar surface. To land safely will require all your skill. You must angle and fire your rocket to counteract gravity, the downwards fall and sideways drift. For experienced pilots there is an option to have a solar wind, making landing even harder.

To help you land, there is a constantly updated plot of your angle and position on the screen. You also have digital instruments showing your height, speed, drift and remaining fuel. You control the craft by rolling left or right and deciding the amount of rocket thrust.

To start the game, load the program and issue the Run command. There is an option to display instructions on the screen. Once past these you will find a solar wind blowing. To begin with, use your plasma bomb to stop this. As you become more experienced, you can omit the bomb and have a sidewind to counteract as well.

At this point, the radar scanner will start with sound and colour effects. Once working, it will display the craft at the top left of the screen, above a rugged surface. Enter l or r to roll left or right, and h to hold your angle once you are happy with it. Now enter the number of gallons of fuel you wish to burn this cycle. Start with a number between five and 10. Carry on in this way until you have landed.

Happy landings. If you are not perfect your craft will topple over, or disintegrate while a funeral march plays. A perfect landing needs a speed of less than 4 and a drift of less than 2. You will find it slightly easier to land on level high ground.

To speed the execution of commonly used routines, three subroutines are placed at the beginning of the listing. To pass over these, Line 2 passes control straight to Line 80. Between Lines 80 and 110 is the code to display the instructions.

Lines 110 to 120 determine whether you want a wind to harrass your landing. Lines 122 to 130 start up the radar, with colour and sound effects. Control then passes to the subroutine at Line 13 to plot the moon surface.

The plotting subroutine plots vertical lines of alternate pixels from the bottom of the screen to the randomly varying moon surface held as v(x). This is done by both Lines 20 and 25. The two lines start plotting one pixel apart, at z — 0 or 1. This prevents the appearance of horizontal lines over the moon's surface.

Once the surface is plotted, which takes quite a time, control passes to Line 200, where the variables are set up with initial values. Line 235 adjusts the amount of fuel to compensate for the wind and drift. These values are then printed by the subroutine at Line 4. This is at the beginning of the program to speed its execution. It is called 10 times in each fuel burn cycle.

The main loop, which handles each descent and fuel burning cycle, begins at Line 260. It begins by adjusting the pitch of the craft in response to the left or right commands. While doing this it updates the screen picture by calling the subroutine twice, once with Over 1 to rubout, then with Over 0 to plot the new angles. Line 410 determines how much fuel is to be burnt, with the lines up to 620 adjusting the variables accordingly. These simulate the effects of rocket thrust, gravity and wind.

Lines 650 to 870 handle the landing. Dependent on speed, you get three victory roll sounds, the craft topples over, or disintegrates. If it breaks up, a funeral march starts at Line 5000, and a cross is placed at the grave by Lines 1050 to 1084.

ZX81 lander

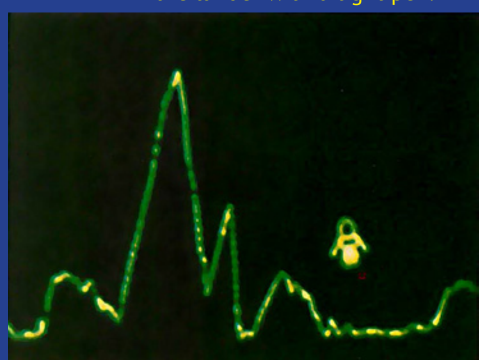
This program is designed to run on a standard 1K ZX81 in Slow mode. It produces a moving graphic image of a lunar module descending to the moon surface. The altitude, speed and remaining fuel are also displayed on the capsule's digital instruments.

To start off try entering 5, which will leave the speed the same while using 5 of your precious gallons of fuel. To slow down further enter a larger number, but watch your fuel. If you burn more than 9 in a given period you will see the jet/rocket exhaust.

POPULAR COMPUTING WEEKLY

LOADING... READY... RUN... CRASH!

[Below] Screenshot from Jack Burness' 1973 'Moonlander' for the PDP-11 minicomputer. Players controlled the lander with a light pen.



While there was an endless supply of Lander clones, one of the most popular sources of the game was released by Creative Computing magazine. It was David H. Ahl's book 'BASIC Computer Games Microcomputer Edition', a popular early BASIC listing type-in source, that was available on shelves in 1978. The book contained 101 BASIC type in programs, and of these, three listings were dedicated to Lunar Lander variants.

The program listings in 'BASIC Computer Games Microcomputer Edition' were targeted at a generic Microsoft BASIC implementation. They were easy enough to adapt to other BASIC flavors. The book was a re-coding of Ahl's earlier work, '101 BASIC Computer Games' which was originally published in 1973 targeting the BASIC dialect found on Digital Equipment Corporation's minicomputers.

David H. Ahl got his ideas for the Lunar Landers through his prior job at Digital Equipment Corporation. While working there he was exposed to a version of the game written by a high school student, Jim Storer. Jim had written the very first documented incarnation of Lunar Lander in the FOCAL programing language back in 1969. Jim submitted his game to Digital where it was incorporated into education and promotional materials for the companies PDP-8 minicomputers. It was Jim's version that David H. Ahl would translate into BASIC and help popularise in '101 BASIC Computer Games'.

Text based Lunar Landers got the ball rolling, and it wasn't long before the simulation entered the graphical world. In 1973 Jack Burness, a consultant to Digital Equipment Corporation, produced possibly the first real-time graphical Lunar Lander for the DEC GT40. The DEC GT40 was a graphical computer terminal addition for the PDP-11 minicomputer. It ensured Burness's new realistic simulation 'Moonlander' was not only novel for its use of a vector graphics display but also for its incorporation of a light pen as the main control mechanism.

In 1978, when home microcomputers and text based Lunar Landers were making their way into people's homes, Engineers Rich Moore and Howard Delman were busy preparing Atari's corporations seminal arcade version of the game. Based on the vector graphics hardware designed for Atari's earlier 'Space Wars', Atari's Lunar Lander contained all the game play of Burness's simulation. To make the game fun for an arcade audience the hardcore physics were removed. Despite this simplification the game met with limited success in the arcades. However it was this Atari Lunar Lander that created the template for the later graphic clones and game variants.

Article and game by
David Stephenson

Another new game from Creative Computing . . .

LUNAR

by David Ahl

LUNAR, also known as ROCKET, APOLLO, LEM, etc. is, next to STAR TREK and SPACE WAR, the most popular computer game. It is certainly the most popular on smaller machines. (I remember a milestone of sorts when I managed to compress LUNAR to run on 4K PDP-8 BASIC while retaining full instructions and landing messages. I used every single character available.)

The version of LUNAR presented here was originally written in FOCAL by Jim Storer, a student at Lexington (Mass.) High School in the mid 60's. While everyone claims to be the original program author of LUNAR, I'm reasonably sure that Jim predates the others and therefore qualifies as the original, original author. I converted the program to BASIC in early 1970. It's a straight-forward version without side stabilization rockets or other goodies but, nevertheless, is quite a challenge to land successfully.

PLAYING THE GAME

Your mission is to achieve a soft landing of your LEM on the moon. You separate from the command ship 200 miles above the surface of the moon and, every 10 seconds, set the burn rate of your retro rockets to slow your craft. You may free fall (0 lbs./sec.) or burn at any rate between 8 lbs./sec. and 200 lbs./sec. Since ignition occurs at 8 lbs./sec., burn rates between 1 and 7 lbs./sec. may not be used. A negative burn rate automatically aborts your mission.

There are three popular ways to land:

1. Constant burn rate all the way down.
2. Free fall for a while, then maximum burn rate tapering off as you get close.
3. Gradually increase burn rate to a maximum, then taper off as you get close.

Recall from physics that Newton found the force of attraction (gravity) between two bodies varies directly with the mass of the bodies and inversely with the square of the distance between their centers. This may help you land successfully. Then again, it may not.

COMPUTER NOTES

Convert the program to your version of BASIC. Multiple statements on one line are separated by a colon (:). Everything else is standard.

Some computers produce an error calculating the expansions (Statements 910 and 920) when you get close to the moon and the numbers get very small. If yours does, substitute the expanded form. Here it is for Statement 910:

−Q*(1+Q*(1/2+Q*(1/3+Q*(1/4+Q/5))))

You should be able to figure out the other one yourself.

Would you like us to print the other versions of LUNAR in *Creative Computing*? If so, write and let me know—DHA.

MAPPING THE MOON

This photograph pictures Mare Crisium, the large "flat" area near the eastern edge of the moon as seen from Earth. In the foreground is the mountainous terrain that forms the southern rim of Mare Crisium. Visible near the horizon, 285 miles across the mare, is its northern rim. Prominent at above right in the mare is the 24-mile-wide crater Picard. Photo was made from Apollo 10, the last flight before the lunar landing. (Photo Kodak)

SAMPLE RUN

```
RUNNH
LUNAR LANDING SIMULATION

CONTROL CALLING LUNAR MODULE.

YOU MAY SET THE FUEL RATE (K) TO ZERO OR ANY VALUE
BETWEEN 8 AND 200 LBS PER SECOND.  A NEGATIVE FUEL
RATE WILL ABORT THE MISSION.

YOU HAVE 16000 LBS OF FUEL.
ESTIMATED FREE FALL IMPACT TIME IS 120 SECONDS.
CAPSULE WEIGHT IS 32,500 LBS.

FIRST RADAR CHECK COMING UP...
BEGIN LANDING PROCEDURE

TIME(SECS)   HEIGHT(MI)   VELOCITY(MPH) FUEL(LBS)   FUEL RATE
 0            120          3600          16000       K? 0
 10           109.95       3636          16000       K? 0
 20           99.9         3672          16000       K? 0
 30           89.85        3708          16000       K? 0
 40           79.8         3744          16000       K? 0
 50           69.75        3780          16000       K? 0
 60           59.7         3816          16000       K? 0
 70           49.65        3852          16000       K? 200
 80           37.3656      3476.43       14000       K? 200
 90           26.2623      3072.94       12000       K? 200
 100          20.3232      2637.46       10000       K? 200
 110          13.644       2164.97       8000        K? 200
 120          8.33572      1649.14       6000        K? 200
 130          4.52958      1081.92       4000        K? 100
 140          2.2667       522.396       2200        K? 90
 150          1.22796      238.772       1300        K? 40
 160          .718389      127.493       900         K? 20
 170          .418089      80.5798       700         K? 22
 180          .237646      41.1685       400         K? 14
 190          .147722      22.5114       340         K? 10
 200          .859622E-1   20.9163       240         K? 10
 210          .317304E-1   18.8912       140         K? 12
ON THE MOON AT  210.451 SECS.
IMPACT VELOCITY OF  8.98172 M.P.H.
FUEL LEFT  38.5879 LBS.
VERY GOOD LANDING. NOT PERFECT YET.

TRY AGAIN (1 FOR YES, 0 FOR NO)? 0

CONTROL OUT

READY
```

26 CREATIVE COMPUTING

[Above Right] David H Ahl's 'Lunar" program was published in Creative Computing's fourth issue, May 1975.

Back in the old days, before Space Invaders, Player/Missiles, Asteroids and Moon Unit Zappa, there were Lunar Landers. Perhaps the oldest form of computer game, Lunar Landers deserve a place on computer memory lane right next to Eliza, Life and Pong.

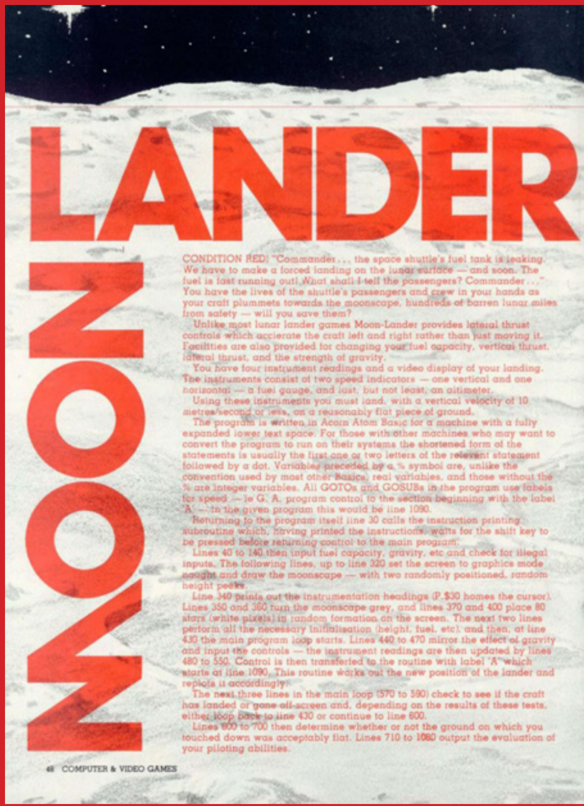
Antic, March 1986

More arcade focused games and the move away from BASIC to faster machine code programing would see the end of the Lunar Lander as a gaming force. By the mid to late 80's some elements of gameplay could still be found in games such as Superior Software's 'Thrust'. In this game it was the challenge to not land but rather pick up pods from a Lunar Surface while avoiding missiles fired from gun turrets. Thrust' might be long way from the original simulation but it's heritage is still clear.

It is now close to 50 years since the first Lunar Landers emerged on home computer screens, but it's direct legacy can still be found. Detailed simulations such as the 'Orbiter Space Flight Simulator' continue to have momentum with ideas that originate from the first Lander games. Modern day gamers, not challenged with the limitations of the 1970's and 80's home computers, are no longer limited to moon landings. Pilots now have the entire solar system at their disposal, flying historical and fictional spacecraft on untold missions at the edges of space.

Examples of light hearted contemporary gameplay can be found in games such as the 'Kerbal Space Program'. This game is only as complex as you choose it to be, possibly best representing the continued development of the lighter side of the Lander subgenre over the years. In the game you can run an entire space program or simply land on the moon with or without restrictive physics getting in the way.

In 1969 Lunar Lander took one small step into the future, but helped ensure giant leaps forward in the games and simulations being written today.



MOON LANDER

CONDITION RED! "Commander . . . the space shuttle's fuel tank is leaking. We have to make a forced landing on the lunar surface — and soon. The fuel is fast running out! What shall I tell the passengers? Commander . . ." You have the lives of the shuttle's passengers and crew in your hands as your craft plummets towards the moonscape, hundreds of barren lunar miles from safety — will you save them?

Unlike most lunar lander games Moon-Lander provides lateral thrust controls which accelerate the craft left and right rather than just moving it. Facilities are also provided for changing your fuel capacity, vertical thrust, lateral thrust, and the strength of gravity.

You have four instrument readings and a video display of your landing. The instruments consist of two speed indicators — one vertical and one horizontal — a fuel gauge, and last, but not least, an altimeter.

Using these instruments you must land, with a vertical velocity of 10 metres/second or less, on a reasonably flat piece of ground.

The program is written in Acorn Atom Basic for a machine with a fully expanded lower text space. For those with other machines who may want to convert the program to run on their systems the shortened form of the statements is usually the first one or two letters of the relevent statement followed by a dot. Variables preceded by a % symbol are, unlike the convention used by most other Basics, real variables, and those without the % are integer variables. All GOTOs and GOSUBs in the program use labels for speed — ie G. A. program control to the section beginning with the label 'A' — in the given program this would be line 1090.

Returning to the program itself line 30 calls the instruction printing subroutine which, having printed the instructions, waits for the shift key to be pressed before returning control to the main program.

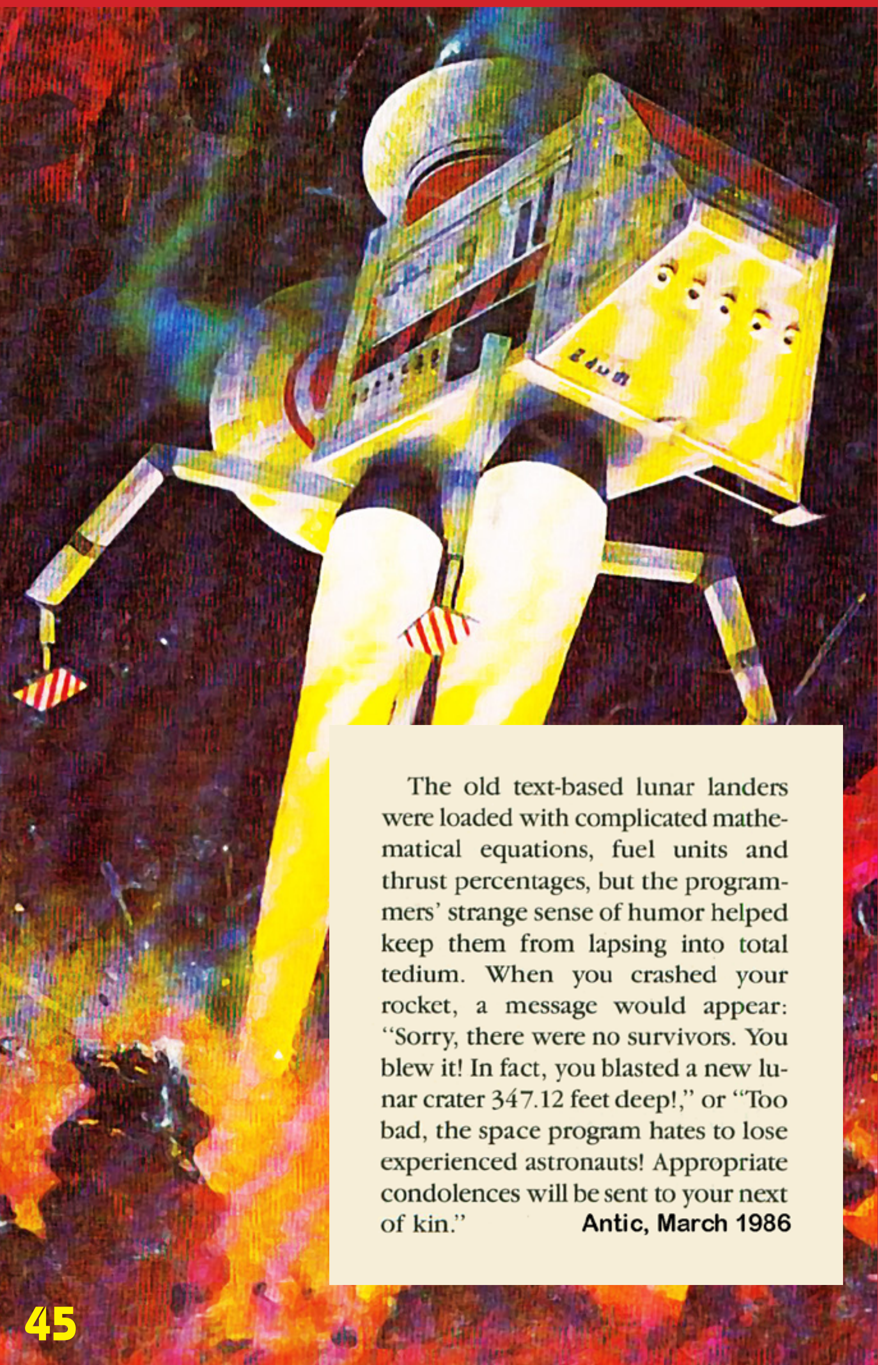
Lines 40 to 140 then input fuel capacity, gravity, etc and check for illegal inputs. The following lines, up to line 320 set the screen to graphics mode nought and draw the moonscape — with two randomly positioned, random height peaks.

Line 340 prints out the instrumentation headings (P.$30 homes the cursor). Lines 350 and 360 turn the moonscape grey, and lines 370 and 400 place 80 stars (white pixels) in random formation on the screen. The next two lines perform all the necessary initialisation (height, fuel, etc), and then, at line 430 the main program loop starts. Lines 440 to 470 mirror the effect of gravity and input the controls — the instrument readings are then updated by lines 480 to 550. Control is then transferred to the routine with label 'A' which starts at line 1090. This routine works out the new position of the lander and replots it accordingly.

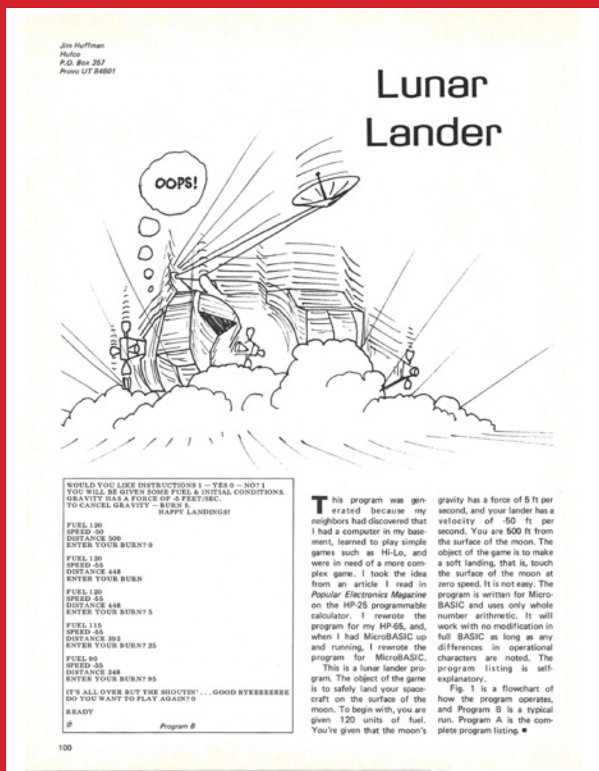
The next three lines in the main loop (570 to 590) check to see if the craft has landed or gone off-screen and, depending on the results of these tests, either loop back to line 430 or continue to line 600.

Lines 600 to 700 then determine whether or not the ground on which you touched down was acceptably flat. Lines 710 to 1080 output the evaluation of your piloting abilities.

48 COMPUTER & VIDEO GAMES



The old text-based lunar landers were loaded with complicated mathematical equations, fuel units and thrust percentages, but the programmers' strange sense of humor helped keep them from lapsing into total tedium. When you crashed your rocket, a message would appear: "Sorry, there were no survivors. You blew it! In fact, you blasted a new lunar crater 347.12 feet deep!," or "Too bad, the space program hates to lose experienced astronauts! Appropriate condolences will be sent to your next of kin." **Antic, March 1986**



Jim Huffman
Hufco
P.O. Box 357
Provo UT 84601

Lunar Lander


```
WOULD YOU LIKE INSTRUCTIONS 1 — YES 0 — NO? 1
YOU WILL BE GIVEN SOME FUEL & INITIAL CONDITIONS.
GRAVITY HAS A FORCE OF -5 FEET/SEC.
TO CANCEL GRAVITY — BURN 5.
                    HAPPY LANDINGS!

FUEL 120
SPEED -50
DISTANCE 500
ENTER YOUR BURN? 0

FUEL 120
SPEED -55
DISTANCE 448
ENTER YOUR BURN

FUEL 120
SPEED -55
DISTANCE 448
ENTER YOUR BURN? 5

FUEL 115
SPEED -55
DISTANCE 393
ENTER YOUR BURN? 25

FUEL 90
SPEED -35
DISTANCE 348
ENTER YOUR BURN? 95

IT'S ALL OVER BUT THE SHOUTIN' . . . GOOD BYEEEEEEEE
DO YOU WANT TO PLAY AGAIN? 0

READY

#
```

Program B

This program was generated because my neighbors had discovered that I had a computer in my basement, learned to play simple games such as Hi-Lo, and were in need of a more complex game. I took the idea from an article I read in *Popular Electronics Magazine* on the HP-25 programmable calculator. I rewrote the program for my HP-65, and, when I had MicroBASIC up and running, I rewrote the program for MicroBASIC.

This is a lunar lander program. The object of the game is to safely land your spacecraft on the surface of the moon. To begin with, you are given 120 units of fuel. You're given that the moon's gravity has a force of 5 ft per second, and your lander has a velocity of -50 ft per second. You are 500 ft from the surface of the moon. The object of the game is to make a soft landing, that is, touch the surface of the moon at zero speed. It is not easy. The program is written for MicroBASIC and uses only whole number arithmetic. It will work with no modification in full BASIC as long as any differences in operational characters are noted. The program listing is self-explanatory.

Fig. 1 is a flowchart of how the program operates, and Program B is a typical run. Program A is the complete program listing. ■

100

Lunar Lander games tended to come in two different flavours, either a simple text-based program that allowed the user to specify the amount of fuel to burn during a specific period of time, calculating thrust and fuel usage and determining if the user landed, crashed or ran out of fuel, or 'real-time' graphical versions controlled by keyboard keys or a joystick.

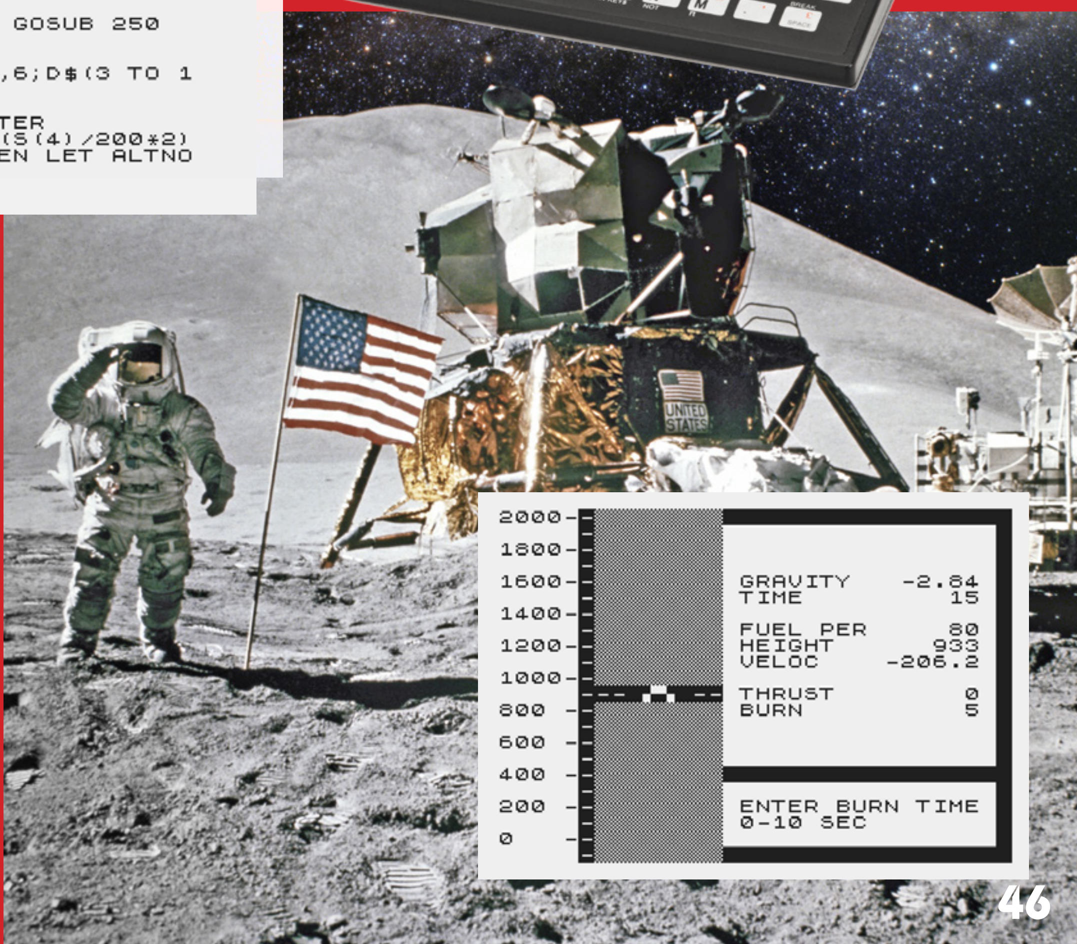
```
  10 REM ZX81 LANDER CLASSIC
  12 REM DAVID STEPHENSON 2018
  14 REM ----------------------
  16 REM S(X) LANDER VARIABLES
  18 REM 1=GRAV 2=TIME 3=FUEL
  20 REM 4=HEIGHT 5=VELOC
  22 REM  6=THRUT 7=BURN
  24 DIM S(7)
  26 RAND 0
  28 FAST
  30 GOSUB 188
  32 SLOW
  34 REM STARTING MENU
  36 PRINT AT 4,16;"LUNAR MODULE
",TAB 15;"---------------"
  38 PRINT AT 7,16;"SYSTEMS ERRO
R",TAB 16;"0028:C003CC2F"
  40 PRINT AT 10,15;"AUTOMATIC P
ILOT",TAB 18;"DISABLED"
  42 PRINT AT 13,15;" PRESS  KEY
PAD "
  44 GOSUB 256
  46 IF INKEY$="" THEN GOTO 46
  48 GOSUB 228
  50 REM START GAME
  52 LET S(1)=INT (RND*-3.5*100)
/100-0.5
  54 LET S(2)=0
  56 LET S(3)=100
  58 LET S(4)=2000
  60 LET S(5)=-90-INT (RND*110)
  62 LET S(6)=0
  64 LET S(7)=0
  66 LET ALT=INT (S(4)/200*2)
  68 GOSUB 222
  70 GOSUB 168
  72 REM MAIN LOOP
  74 IF S(3)>0 THEN GOTO 82
  76 LET S(6)=0
  78 LET S(7)=0
  80 GOTO 104
  82 PRINT AT 18,15;"ENTER THRUS
T    ";TAB 15;"0-10 M/S SQR    "
  84 INPUT S(6)
  86 IF S(6)<=10 AND S(6)>=0 THE
N GOTO 92
  88 GOSUB 238
  90 GOTO 82
  92 PRINT AT 18,15;"ENTER BURN
TIME";TAB 15;"0-10 SEC        "
  94 INPUT S(7)
  96 IF S(7)<=10 AND S(7)>=0 THE
N GOTO 104
  98 GOSUB 238
 100 GOTO 92
 102 REM UPDATE MODULE POSITION
 104 LET S(2)=S(2)+S(7)
 106 LET TDELTA=S(7)
 108 LET ACCEL=S(1)+S(6)
 110 LET S(5)=S(5)+ACCEL*TDELTA
 112 LET S(4)=INT (S(4)+S(5)*TDE
LTA+.5*ACCEL*TDELTA*TDELTA)
 114 LET S(3)=S(3)-S(6)*TDELTA/5
 116 IF S(3)<=0 THEN LET S(3)=0
 118 IF S(4)<=0 THEN LET S(4)=0
 120 GOSUB 168
 122 REM CHECK END CONDITIONS
 124 IF S(4)>0 THEN GOTO 74
 126 IF S(5)>=-2 THEN GOSUB 242
 128 IF S(5)>=-5 AND S(5)<-2 THE
N GOSUB 246
 130 IF S(5)<-5 THEN GOSUB 250
 132 REM GAME ENDED
 134 GOSUB 228
 136 PRINT AT 20-ALT,6;D$(3 TO 1
0);
 138 GOTO 36
 140 REM DRAW ALTIMETER
 142 LET ALTNOW=INT (S(4)/200*2)
 144 IF ALTNOW>20 THEN LET ALTNO
W=20
```

This 2018 Lunar Lander is based on the early examples of the game. After what seems like months in space your crew is on a final descent onto the planet's moon. The autopilot should have no problem handling a nice easy landing. But what's this? The module is coming in way to fast. Warnings start blaring from the flight computer, the mission is in trouble. At 2000 meters the autopilot fails and you're handed manual controls. The safety of the crew is in your hands. Have you got what it takes to land a Lunar Module?

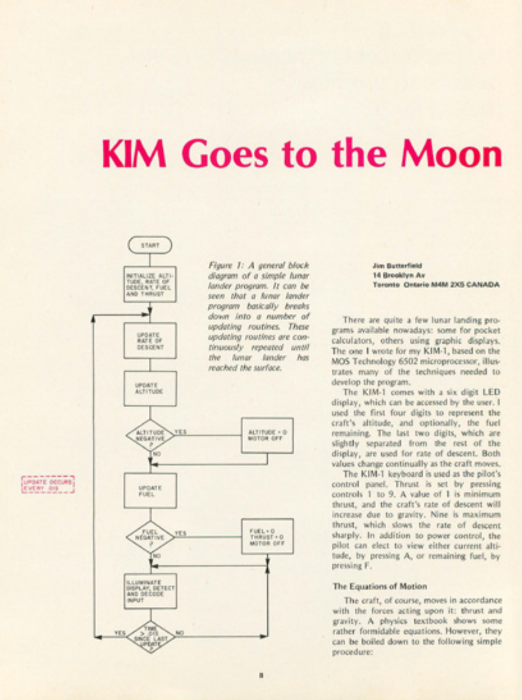
Control the module by setting the rockets thrust (acceleration) from 0 to 10 metre per second squared. The greater the thrust the more fuel you'll burn. Set the burn time, from 0 to 10 seconds. With some practice and a little luck you'll be able to guide the Module safely to the surface.

This program listing is for the Sinclair ZX81 computer (also known as the Times Sinclair 1000 in North America) released in 1981.

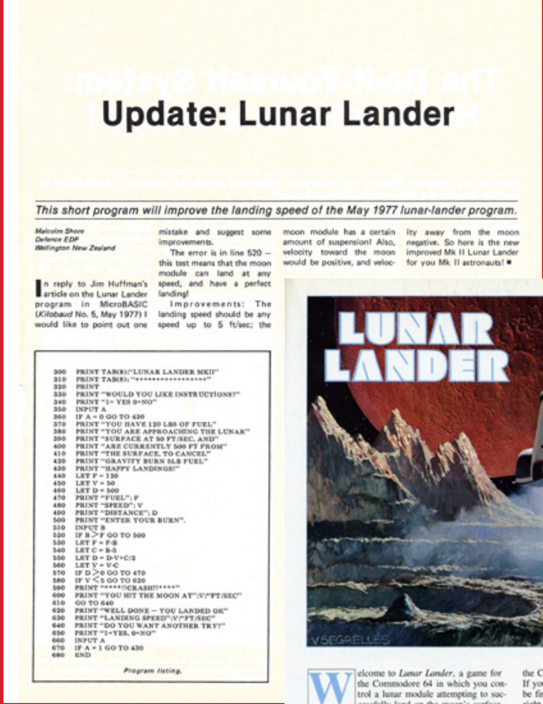
If you're not game to type it in, you can download an emulator file from paleotronic.com/landers.zip



The successor to Sir Clive Sinclair's ZX80, the first commercially-available completely assembled computer for under £100, the ZX81 was the first inexpensive mass-market computer that could be bought from non-specialist retailers, launchingcomputing in Britain as an activity for the general public, and not just businesspeople or hobbyists. Sir Clive's business strategy was to manufacture stripped-down versions of more expensive electronics to cater to a segment of the market ordinarily 'priced-out' of owning such devices, and the ZX81 was no exception – it lacked colour and sound, traded a mechanical keyboard for a pressure-sensitive 'membrane' one, had a very limited amount of memory (1 kilobyte) and used a standard cassette player for storage – but in general it worked, and with over 1.5 million units eventually sold, that seems to have been enough.

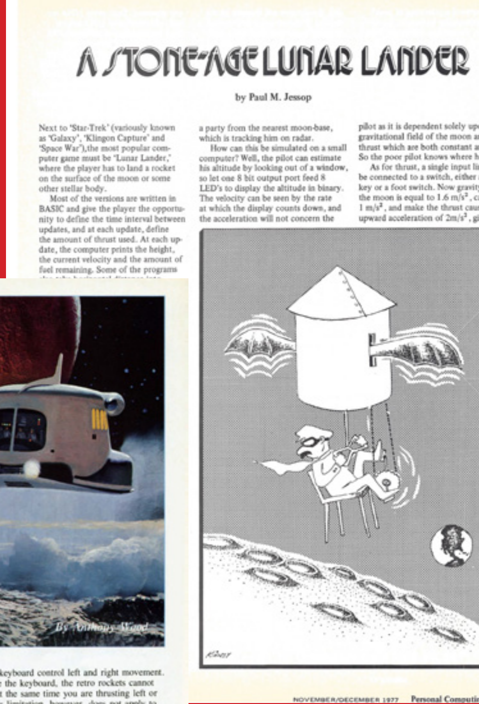


KIM Goes to the Moon



Update: Lunar Lander

This short program will improve the landing speed of the May 1977 lunar-lander program.



A STONE-AGE LUNAR LANDER

by Paul M. Jessop

LUNAR LANDER

AHOY! 35

There were many different implementations of the Lunar Lander concept for many different 1970s and 1980s-era computers.

```
146 FOR Z=ALT TO ALTNOW STEP (S(5)*10)/ABS (S(5)*10)
148 PRINT AT 20-Z,6;D$(29 TO 36)
149 IF 19-Z>=0 THEN PRINT AT 19-Z,6;D$(3 TO 10)
150 IF S(6)>1 AND S(6)<7 THEN PRINT AT 21-Z,9;D$(41 TO 42)
152 IF S(6)>3 THEN PRINT AT 21-Z,9;D$(37 TO 38)
154 IF S(6)>6 THEN PRINT AT 21-Z,9;D$(39 TO 40)
156 PRINT AT 21-Z,6;D$(3 TO 10)
158 IF Z<>ALTNOW THEN PRINT AT 20-Z,6;D$(3 TO 10);TAB 6;D$(3 TO 10)
160 NEXT Z
162 LET ALT=ALTNOW
164 RETURN
166 REM UPDATE HUD VALS
168 LET X=3
170 FOR Y=1 TO 7
172 LET R=INT (S(Y)*100)/100
174 LET R$=STR$ R
176 PRINT AT X+Y,23;D$(52 TO 58-LEN R$);R$
178 LET X=X+.34
180 NEXT Y
182 GOSUB 142
184 RETURN
186 REM SETUP GAME SCREEN
188 LET D$="-█▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒"
190 FOR X=1 TO 18
192 LET D$=D$+CHR$ 128
194 NEXT X
196 LET D$=D$+"▀▀ ▄▄▀ ▄▀ --<>()**"
198 FOR X=1 TO 15
200 LET D$=D$+CHR$ 0
202 NEXT X
204 FOR X=0 TO 21
206 IF (INT (11-X/2)-1)<>(11-X/2)-1 THEN GOTO 210
208 PRINT AT X,0;(INT (21-X)-1)*10*10;TAB 4;D$(1)
210 PRINT AT X,5;D$(2 TO 10);
212 IF X=0 OR X=16 OR X=21 THEN PRINT ;D$(11 TO 27);
214 PRINT TAB 31;D$(28)
216 NEXT X
218 RETURN
220 REM MAIN HUD SETUP
222 PRINT AT 4,15;"GRAVITY";TAB 15;"TIME";AT 7,15;"FUEL PER";TAB 15;"HEIGHT",TAB 15;"VELOC";AT 11,15;"THRUST",TAB 15;"BURN"
224 RETURN
226 REM CLEAR HUD
228 FOR X=2 TO 14
230 PRINT AT X,15;D$(43 TO 57);
232 NEXT X
234 RETURN
236 REM PRINT MESSAGE PANEL ALERTS
238 LET M$=" INPUT ERROR "
240 GOTO 260
242 LET M$=" SOFT  LANDING "
244 GOTO 260
246 LET M$=" HARD  LANDING "
248 GOTO 260
250 LET M$=" CRASH LANDING "
252 PRINT AT 20-ALT,9;D$(41 TO 42)
254 GOTO 260
256 LET M$="MANUAL  OVERIDE"
258 GOTO 260
260 FOR X=1 TO 5
262 PRINT AT 18,15;D$(43 TO 57);TAB 15;D$(43 TO 57)
264 PRINT AT 18,15;M$;TAB 15;M$
266 NEXT X
268 RETURN
```

With its tiny membrane keyboard, typing on the ZX81 was awkward for anyone older than 8, and so its designers devised a method of entry that reduced the number of required keystrokes. Unlike other computers such as the Commodore 64 or Apple II where you typed BASIC programs in 'freeform', entering every character and only learning if you had made a mistake after you typed RUN, the ZX81 had a very structured procedure for entering in lines of BASIC code.

When you turned the computer on, you saw a white-on-black K at the bottom of the screen. This was the cursor. The letter on the cursor changed to let you know what entry mode it was in. Each key on the keyboard had an associated command, function, operator and graphics character.

For example, when the K cursor was present, you could press P and the command PRINT would appear. K stands for 'Keyword'. Aftter PRINT appears the cursor changes into an L. Now you can type in a variable name or a number using the keyboard one character at a time, or use SHIFT or FUNCTION (SHIFT-NEWLINE) keys to use functions.

If you type a quotation mark, you can enter arbitrary text, including graphics characters, as shown in the listing. To enter graphics characters, you press SHIFT-9 to turn on graphics mode (the cursor will change to G). In this mode, unshifted letters are displayed in their inverse, white on black. Shifted letters display the graphics character noted on their keycap. Space is rendered as a black square.

The IBM System/360

Continued from page 26

Languages

A number of languages were available over the years for the venerable System/360.

The first of course was Basic Assembly Language (BAL), which allowed the systems programmer to work the closest to the machine. Mnemonics were used to represent the wealth of CPU operations and the assembler would translate these to object code. The assembler was actually quite powerful, supporting relative addressing, named constants and storage and labels. It even supported programmer comments, of course these were stripped out of the final object code. In a lot of ways, it would set the standard for assemblers for future generations of systems, including for example the 6502.

Fortran IV was also available for the System/360 as a language which was a little easier to work with than the lower level assembly language. It was less machine specific than previous versions of the language, aiming to strive for standards compliance. The name itself was derived from the words "Formula Translation", and it had its main applications in data processing and scientific computing. It was developed by IBM in the 1950's and made its way to System/360 as a matter of course. Fortran is still employed to this day, for many scientific and mathematical applications, and went to spawn more commonly recognised languages, one of which was BASIC.

Around 1965, IBM started work on APL/360, bringing the APL language to the System/360 platform. APL was very powerful for data processing as it was an incredibly concise language and used arrays of data as its main data type, rather than individual values. Each operation had its own graphic symbol, which made for incredibly concise code. For example, all prime numbers between 1 and R (an arbitrary value) could be computed with the following program:

$$(\sim R \in R \circ . \times R)/R \leftarrow 1 \downarrow \iota R$$

Early versions of APL/360 on the platform supported the concept of multiple concurrent users, making them in a sense their own time-sharing systems without the need for DAT hardware, as the abstractions could be handled by the APL environment itself.

LOGO LUNARCY!

Play Lunar Lander in Apple Logo

Lunarcy is a fun and simple lunar lander game written in Apple Logo and compatible with microM8's microLogo. You control a lander with a joystick (or the keyboard's arrow keys) and you can increase / decrease fuel to the main engine, and thrusters on the side of the craft as you try to land on the flat part of the moons surface. You need to avoid the hills or you will crash, but be careful – if you run out of fuel you will drop like a stone.

a game by April Ayres-Griffiths

LOGO LANDER

```
TO game
cs
setheading 0
make "SAFE 20
start.level
game.loop
END
```

start.level[7] is called to generate the terrain by calling generate.terrain, then calls draw.terrain to draw the terrain.

generate.terrain[5] creates a terrain by generating random terrain heights across the screen, including a consecutive safe zone for landing. It builds a list of y values in the variable :tlevels, calling calc.terrain to calculate the level of the terrain in a given segment.

draw.terrain[2] is called at the start of the level, and uses the data in the :tlevels variable to draw the moon surface. It does this by using setpos with the turtles pen in the down position which draws lines as it moves from point to point on the screen.

Type LOAD "LUNACY to load Lunacy from the disk image available at paleotronic.com/lunacy.dsk or enter the listing by hand.

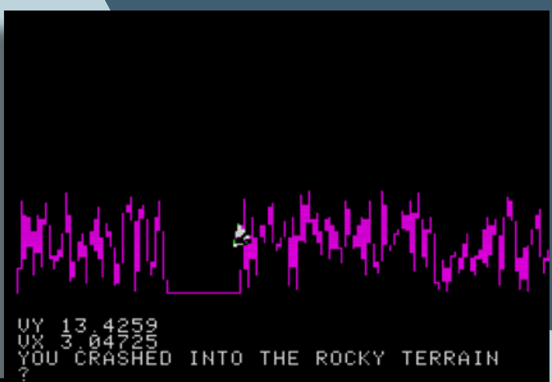
Type game to start [1].

```
TO draw.terrain :segments
ht
local "idx
make "idx 1
pu
setx -139
sety -64
pd
local "x
local "y
make "y -64
make "x -139
setpc 3
repeat :segments [make "y item
:idx :tlevels make "x :x + 279 /
:segments setpos list :x :y make
"idx :idx + 1]
setpc 1
st
END
```

```
TO setup
make "totalFuel 2000
make "fuelEngine 0
make "fuelAttitudeThruster 0
make "fuelThrustRatio 0.09
make "shipX 0
make "shipY 94
make "thrustY 0
make "thrustX 0
make "speedX 0
make "speedY 0
make "moonGAccel 1.62
make "landMaxSafeV 1
make "hDelta 1
make "vDelta 10
make "angle 0
make "segments 40
END
```

```
TO test.segment :segments
local "x
local "y
make "x xcor
make "y ycor
local "ssize
make "ssize 280 / :segments
local "seg
make "seg ( :x + 140 ) / :ssize + 1
local "rseg
make "rseg round :seg
if :rseg > :segments [make "rseg
:segments]
local "fl
make "fl item :rseg :tlevels
if :y > :fl [output 0]
if :fl = -64 [output 0]
output 1
END
```

check.keys[6] checks to see if an arrow key has been pressed and if so calls the appropriate thrust procedure.



5

```
TO generate.terrain :segments :safe
local "safestart
local "av
make "av :segments - :safe
make "safestart random :av
local "idx
make "idx 1
local "rval
make "tlevels []
repeat :segments [make "rval calc.
terrain :idx :safestart :safe
make "tlevels lput :rval :tlevels
make "idx :idx + 1]
END
```

yellow or green indicates a single, long line.

6

```
TO check.keys
if not keyp [stop]
local "CODE
make "CODE ascii readchar
if :CODE = 21 [thrust.right stop]
if :CODE = 8 [thrust.left stop]
if :CODE = 10 [thrust.down stop]
if :CODE = 11 [thrust.up stop]
if :code = 27 [throw "toplevel]
END
```

`eval.landing[16]` checks to make sure the craft is not too tilted, and that the horizontal and vertical speeds of the craft are below the safety threshold (1 m/s). If a safe landing is achieved, it reduces the width of the safe zone, and calls `start.level` to start a new level with a new terrain.

`setup[3]` defines various game parameters, including the amount of fuel available and the starting conditions. Play around with these and see how they affect the game!

`draw.ship[11]` moves the turtle (acting as our ship) to the correct position on the screen, and sets the "tilt" of the ship if it is moving horizontally.

`test.segment[4]` checks the landers horizontal and vertical position to determine if the lander is below the tip of the rocks. If so, the function returns 1, or 0 if the lander is safe. This function is called once per game.loop

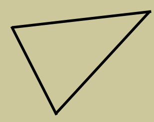
`game.loop[8]` is the main loop for the lander game. it draws the ship, waits for half a second (for the video to show), then checks the keyboard and the paddles for changes that will affect the crafts thrusters. It applies those changes by calling `apply.forces`, and updates the text display at the bottom of the screen with the remaining fuel, vertical velocity and horizontal velocity. It then calls `test.segment`, and if the craft has hit the mountains, it will call `crash.terrain`, otherwise it checks if the lander has reached the surface, and if so it calls `eval.landing` to test if the landing was safe. If none of those conditions were met, it calls itself (`game.loop`) again recursively to continue.

ANCIENT TONGUES

7

```
TO start.level
cs
setup
TEXTSCREEN
CLEARTEXT
pr [GENERATING THE MOON]
generate.terrain :segments :safe
draw.terrain :segments
END
```

abs[10] returns the 'absolute value' of a number by changing a negative number into a positive one.



8

```
TO game.loop
draw.ship
wait 30
check.keys
check.paddles
apply.forces
local "ay
local "ax
make "ay abs :speedY
make "ax abs :speedX
setcursor [0 20]
pr sentence "FUEL :totalFuel
setcursor [0 21]
pr sentence "VY :ay
setcursor [0 22]
pr sentence "VX :ax
local "crash
make "crash test.segment :segments
if :crash = 1 [crash.terrain stop]
if :shipY < -64 [eval.landing]
if :shipY > 100 [pr [FLUNG INTO
SPACE] stop]
game.loop
END
```

The four thrust[14] procedures increase or decrease the fuel usage, or change the thrust balance between the two rockets as appropriate.

9

```
TO apply.forces
local "fe
make "fe :fuelEngine
make "fa :fuelAttitudeThruster
if :fe > :totalFuel [make "fe
:totalFuel make "fa 0]
make "thrustX :fuelThrustRatio * :fa
make "thrustY :fuelThrustRatio * :fe
make "totalFuel :totalFuel - :fe - abs
:fa
make "speedY :speedY - :moonGAccel +
:thrustY
make "speedX :speedX + :thrustX
make "shipX :shipX + :speedX
make "shipY :shipY + :speedY
END
```

check.paddles[15] checks the joystick/paddle controls. horizontal motion puts fuel to the side thrusters, vertical motion increases or decreases fuel to the main engine. check keys does the same, except rather than checking the stick, reads the state of the arrow keys. It calls one of thrust.up, thrust.down, thrust.left or thrust.right to alter the burn parameters.

BY APRIL AYRES-GRIFFITHS

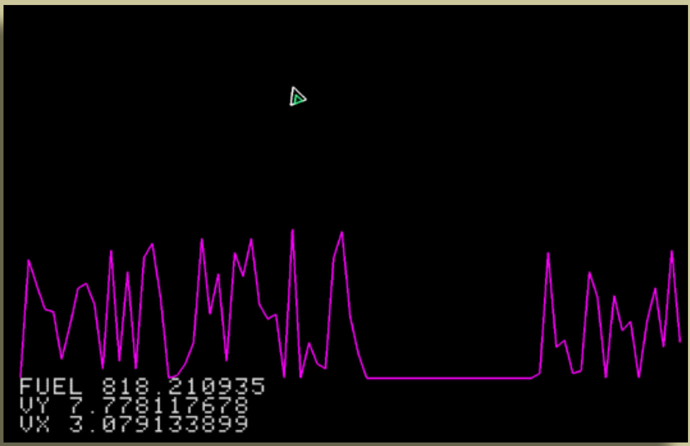
```
TO abs :number
if :number <
0 [output 0 -
:number]
output :number
END
```

10

```
TO draw.ship
pu
setx :shipX
sety :shipY
make "angle
:fuelAttitudeThruster
* 5
setheading :angle
pd
END
```

11

apply.forces[9] applies the current fuel settings, and adjusts the thrust levels and speed of the craft in the horizontal and vertical directions. It handles acceleration due to the moon's gravity as well. To keep things fast, approximations are used.



12

```
TO calc.terrain :idx
:safestart :safe
if :idx < :safestart [output
-64 + random 64 stop]
if :idx > :safestart + :safe
[output -64 + random 64 stop]
output -64
END
```

13

```
TO crash.terrain
pr [YOU CRASHED INTO
THE ROCKY TERRAIN]
END
```

calc.terrain [12] calculates the height of a segment in the terrain for generate.terrain.

crash.terrain[13] outputs a message to let the player know they have crashed.

14

```
TO thrust.up
make “fuelEngine :fuelEngine + :vDelta
END
TO thrust.down
make “fuelEngine :fuelEngine - :vDelta
if :fuelEngine < 0 [make “fuelEngine
0]
END
TO thrust.left
make “fuelAttitudeThruster
:fuelAttitudeThruster - :hDelta
END
TO thrust.right
make “fuelAttitudeThruster
:fuelAttitudeThruster + :hDelta
END
```

15

```
TO check.paddles
local “v
make “v 255 - paddle 1
local “f
make “f :v / 255
if :f < 0.167 [make “f 0]
make “fuelEngine 24 * :f
local “h
make “h paddle 0
local “a
make “a :h - 127
local “fa
make “fa :a / 127
make “fuelAttitudeThruster :fa * 5
END
```

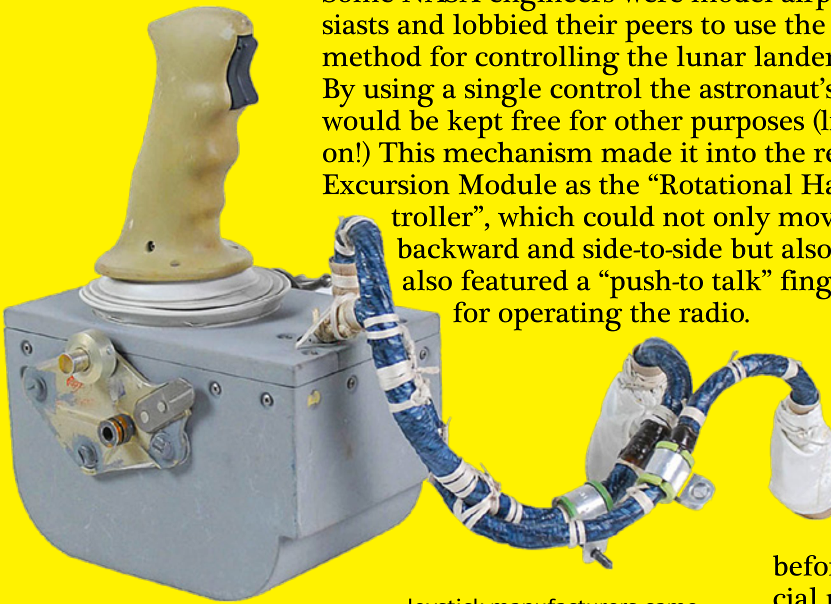
16

```
TO eval.landing
local “aa
make “aa abs :angle
local “ay
make “ay abs :speedY
local “ax
make “ax abs :speedX
if :ay > :landMaxSafeV [make “shipY -64 lt 80 draw.ship pr
[CRASHED INTO SURFACE - UNSAFE DESCENT] throw “toplevel]
if :ax > :landMaxSafeV [make “shipY -64 lt 45 draw.ship pr
[CRASHED INTO SURFACE - UNSAFE DESCENT] throw “toplevel]
if :aa > 10 [make “shipY -64 draw.ship pr [CRASHED INTO
SURFACE - UNSAFE ANGLE] throw “toplevel]
pr [HOORAY YOU LANDED SAFELY]
wait 180
make “safe :safe - 2
if :safe < 4 [pr [NICE WORK - ACE LANDER] throw “toplevel]
pr [LETS MAKE IT A BIT HARDER]
wait 60
start.level
END
```

The Apollo Lunar Lander did more for computer and arcade gaming than merely inspire programs based on its physics, it was also the first passenger vehicle to be controlled by means of an electronic joystick – later influencing the design of game controllers used by home computers and video-game consoles, many of which initially used simple potentiometer-based paddles.

Model aircraft first used single stick controllers in "Galloping Ghost" remote transmitters made in the early 1960s. These controllers provided an intuitive way of directing the aircraft while allowing for one hand to manage the throttle and and maintain a firm grip on the bulky transmitter. A derivative of this design would later be adopted by model race-car (RC) manufacturers as well.

Some NASA engineers were model airplane enthusiasts and lobbied their peers to use the single-stick method for controlling the lunar lander simulator. By using a single control the astronaut's other hand would be kept free for other purposes (like holding on!) This mechanism made it into the real Lunar Excursion Module as the "Rotational Hand Controller", which could not only move forward, backward and side-to-side but also rotate. It also featured a "push-to talk" finger trigger for operating the radio.



While the original joysticks that shipped with consoles such as the Atari 2600 and home computers such as the Apple II and Commodore VIC-20 were more reminiscient of the model aircraft controllers, it wasn't long before third-party manufacturers saw a commercial market for joysticks inspired by the Rotational Hand Controller. While they generally didn't rotate (although the author does remember at least one model that did, incorporating a paddle control), the hand grip and finger trigger were common features. Sometimes a thumb trigger was included in addition or in lieu of a finger trigger, and some models had trigger buttons on the base.

Models ranged in price from around US$20 for cheaper "budget" models all the way up to US$90 for fancier ones, such as wireless joysticks.

Joystick manufacturers came out with a variety of variations on the theme, adding thumb triggers and suction cups. Some console versions even had numeric keypads!

Wico joysticks were fairly well constructed, while the Galloping Ghost-inspired Supr Stick used micro-switches that were much more responsive than the bubble-contacts used by cheaper controllers. The Cynex Game-Mate provided a cable-free solution.

moon sticks

However, many of the less-expensive joysticks did not do justice to the lunar flight-stick they mimicked. They almost universally used “bubble” contacts, which made a connection signalling their corresponding direction when squashed by a plastic pin driven by the stick. Over time, these contacts became less sensitive, until frequently they would stop working entirely, leaving you with a three-way joystick, and introducing a whole new (but unwanted) element of challenge to games!

To encourage the player not to hold the joystick in their hands and put undue stress on the contacts, many models placed suction cups on the bottom, with the intention that you could ‘stick’ the stick to a desk or table and use it that way, but these suction cups never worked well on wood, which was what most desks and tables were made of!

Mid-range joysticks such as the Wico Boss used two metal prongs that were made to contact by pushing them together. This worked better than the bubbles but the prongs could get bent and permanently stuck on. However, bending them apart was an easy fix.

More expensive joysticks, like arcade controllers, used ‘microswitches’ that clicked when you moved a joystick in a particular direction. These switches were much more robust than the bubbles or the prongs, and models such as the Australian-made Star Cursor and the D-Zyne Supr Stick remain popular with retro-gamers and vintage computer collectors today.

PIXEL PLAYAS

Flying to the Moon and crashing back to Earth: the meteoric rise and fall of Imagic

BY PAUL MONOPOLI

For the Atari Video Game System and Sears Video Arcade

Image rendered from Imagic's "Moonsweeper" box artwork

Dennis Koble (left) and Bill Grubb (right) co-founded Imagic along with fellow former Atari employees Bob Smith, Mark Bradley and Rob Fulop; former Mattel employees Jim Goldberger, Dave Durran and Brian Dougherty; Pat Ransil from Intel and Gary Kato from Versatec.

Upon viewing Moonsweeper for the first time the word 'wow' just doesn't seem to do it justice, yet it's the first word to form in most people's brains.

It just seems to trite, so simple, yet your mind is unable to figure out another phrase that justifies what you are seeing before the word has already made its way to your mouth and the exclamation has been uttered.

While most games from the early 80s were simple, 2D affairs, Moonsweeper featured a semi-3D playing field and fast paced action. It broke rules by not having a scoring system, instead having the player build up energy or fuel reserves. In 1982 games most games were designed to played endlessly, with the gamer attempting to improve their high score with each play. However, Moonsweeper was able to be completed, though the game is difficult to get through.

According to the manual, your mission is 'to reach and rescue miners stranded on hostile moons in Star Quadrant Jupiter!' You are warned to be cautious as you venture across the hostile moons of Jupiter, rescuing miners who have been left stranded for reasons the manual fails to explain. Whatever the reason, Jupiter's surrounding lunar bodies have become mini war zones and the lives of those miners are at risk.

As you start the game you find yourself flying through space, with objects coming at you from all directions. It can be a little confusing to know what you need to do if you haven't read the manual. Luckily in the information age that can be found online and reading it is recommended if you want to know how to progress through the levels. The idea is to destroy or avoid everything except the moons, you want to head for them. Upon reaching one the game area will change you flying across the lunar surface, attempting to find and rescue miners. Once this is done you head back out into space to find the next moon. The game ends when you die or complete all of the moons.

Released in 1983, Moonsweeper wasn't the first successful title by developer Imagic. Classic titles such as Atlantis and Demon Attack could already be found on store shelves, though at the time it was unusual to see games released by a third party developer.

It was David Crane, Larry Miller and Bob Whitehead who set up Activision in 1979, the world's first company for creating games. Frustrated at the lack of recognition developers were given, he decided to set up a new company where coders were credited for the games they made. Prior to this the hardware manufacturers would handle the development and marketing of any games that were to be released on the system. After what they felt to be poor treatment from Atari, the men left the company but continued to do what they did best, make games, as Activision. Another Atari alum, Larry Kaplan, joined the trio shortly after, just as the lawsuit was about to hit. Atari decided to flex its corporate muscle and take the men to court.

The legal struggles between Atari and Activision would continue until 1982, but in the meantime other Atari employees found themselves facing the same situation as David Crane and co. Rob Fulop was one such employee, and he, like the Activision coders, liked the idea of creating a brand new third party development company. 21 months after the founding of Activision, Rob, along with other disgruntled Atari and Mattel employees, set up the world's second third party developer, Imagic.

Bill Grubb provided the Mattel connection, having worked on licensing for Mattel as well as Atari. During one of his visits in Mattel, Jim Goldberger, who Bill had previously attempted to bring over to Atari, approached him about starting up an 'Activision-type company.' Bill took this proposal seriously and discussed the idea with Jim until 2AM the following morning. From there he created a business plan and sought funding to get Imagic started.

The video game boom was in full swing in the early 80s, and there was plenty of money around for people who wanted to become a part of this new industry. Atari games were selling at an alarming rate, so much so that in Christmas 1981 there was a shortage of cartridges. Most likely due to the success of the industry, Rob claims that setting up Imagic was not a difficult process. The men started work on their first release, Demon Attack, a game based on the highly successful Galaga. The game was a best seller, netting the company a 'Game of the Year' award from Billboard. Fulop was finally starting to receive the recognition he was deprived of at Atari.

Demon Attack was not Imagic's only success story in its first year. Dennis Koble's Atlantis was another monster hit, though was eclipsed by Fulop's monster hit. One of the earliest examples of a tower defence game, Atlantis saw you controlling the defensive canons to fend off attacking Gorgon invaders. Dennis Koble was not a fan of licensing existing games and was always looking for new ideas to work on. He felt that Imagic should be licensing its games to other companies rather than just taking on existing properties. However, Bill Grubb, ever the businessman, was not too concerned about how they made money, as long as they continued to do so.

While Atari appeared to be too distracted by Activision to take on a second third party developer, they did take issue with Demon Attack's resemblance to Phoenix. Imagic was taken to court over the similarities between the games, though the case was settled out of court.

Fulop produced another space faring adventure with Cosmic Ark for the Atari 2600. Perhaps taking inspiration from Star Wars, this futuristic game was set in the distant past. Like Moonsweeper, the game is a rescue mission set on various planets "a long time ago in a galaxy far far away...". Sales were half that of Demon Attack, though the game was still highly successful. After developing the Atari 2600 port of Missile Command, Demon Attack and Cosmic Ark, he decided that he wanted a change of pace. Space was a fun environment to play around in, but a creative mind needs to expand beyond the familiar to grow.

The result of these changes became Cubicolor, a puzzle game that could not be further removed from Demon Attack if he tried. Rob took inspiration from the Rubik's Cube when developing the game, which ended up as a colour matching game. The game was too far removed from the heavy titles Imagic was currently churning out and Cubicolor's prospects were deemed to be poor. While the game was completed it was never released, leaving Rob with around 100 copies of the game sitting on EPROM chips.

While Imagic were becoming a success and its developers were receiving the recognition that eluded them at Atari, the employees remained grounded. Activision were known for treating their coders like super stars, though according to Bill Grubb and Dennis Koble the culture of Imagic was rather subdued in comparison. According to Grubb, while the coders wanted to be recognised for the games they were making they had no desire to become the dictionary definition of famous. Recognition and fame are two different things, and while the line can be fine at times, the Imagic employees had private lives outside of their work.

Imagic was moments away from going public when the video game crash of 1983 bought down the entire video game industry.

By January 1983, Imagic had grown from its original 9 founding members to over 80 employees. The company had also set up offices in a larger office building in Los Gatos. In the January 1983 issue of 'Video Games' magazine, fellow founding member and Imagic president Bill Grubb discussed the differences between themselves and Activision. In his words Imagic were doing things "more aggressively" and were focusing on releases for multiple systems, whereas Activision had narrowed their market to the Atari 2600 and Mattel Intellivision.

This rapid growth drew the attention of the New York Times, who predicted sales in excess of $75 million. They credited Fulop's Demon Attack as being one of the leading contributors to the success of the business, which was set to become the world's first public video game company. Their arrival on Wall Street was set to be a huge success. Imagic had talented coders and a well put together management team. Arnie Katz of the trade publication Electronic Games claimed that "they have everything going for them". The wheels were to be set in motion in the following 12 months.

The problem with success is that it comes with its own set of problems. Maintaining consistency at a high level can be tricky, and it doesn't take much to bring it all crashing down. In 1982 Imagic struck a deal with Texas Instruments do develop games for the TI series of computers. What could be seen as a coup for Imagic quickly became a pressing concern as the stock prices for Texas Instruments dropped by over 40% in a single week and the company started to report huge losses. Within the company this was seen as a significant setback, though it was one they felt they could recover from. They may have been able to do so, though another significant event was about to happen that would impact not only Imagic, but the entire industry.

Imagic was moments away from going public when the video game crash of 1983 bought down the entire video game industry. While Howard Warsaw's E.T. is seen as the main catalyst for the crash, history shows that complacency was the biggest problem. People couldn't get enough of video games, as evidenced by the huge sales of 1981. While the disappointing E.T. can definitely be seen as a contributor, the quality of games in general was on the decline. The Atari 2600 port of Pacman is seen by many as unnecessarily lazy and dull.

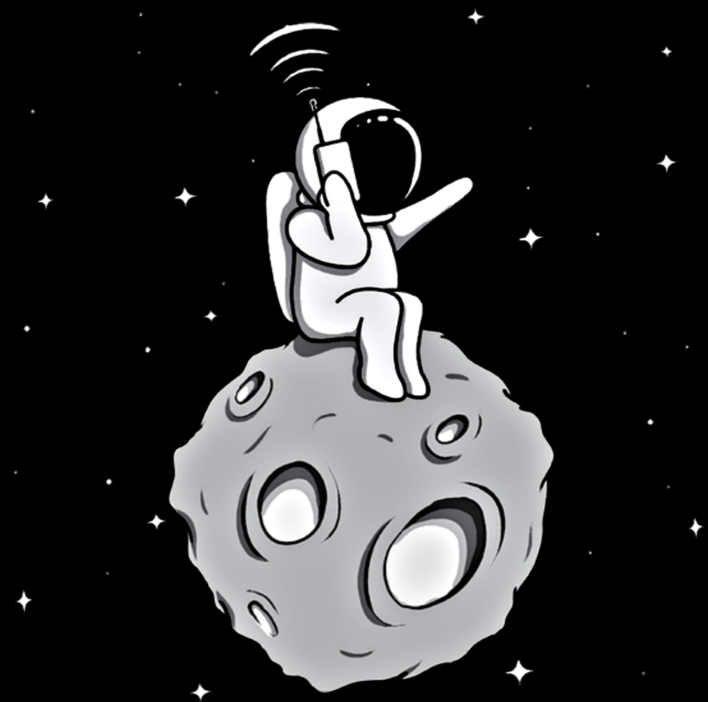
While Imagic was forced to withdraw its IPO the crash was something it could recover from. The company had made some smart decisions in the past year, including providing support for the home computer market, specifically the Commodore 64, VIC 20 and IBM PCjr, and ignoring some of the more questionable machines that hit the already over-saturated console market. Bill Grubb was always hesitant to support the Atari 5200 and decided to sit on that decision until the console had proven itself. He felt that if Atari were doing as well as they claimed then they would not have to release a new home console.

Despite this Rob Fulop claims that the crash had a significant impact on the management team at Imagic and the place was never the same after it happened. By the time the crash happened the company had in excess of 100 employees, over a quarter of which were laid off. Video game retailers were starting to push for changes to the inventory policies, allowing them to purchase less games and hold the developers liable for some of the losses they may incur.

Imagic made deals with retailers, allowing them to buy back old stock to make room for new stock. While this may sound like a good idea these cartridges need to be put somewhere, so storage costs were added on top of the buy back scheme. Imagic were forced to sell over $10 million of its own private stock to cover the costs. Meanwhile, the less aggressive Activision continued to do well, despite taking a hit along with the rest of the industry. The philosophy of Activision was to focus on the quality of the games rather than expansion. In the end it was a simple case of, they had less to lose.

While the end was fast approaching, the management of Imagic attempted to continue developing games for the home computer market. The 1984 CES saw Imagic debut four new titles for the IBMjr. The new president, Bruce Davis, declared that Imagic would only be focusing its development on home computers. Unfortunately this move came too late and the company was forced to fold shortly after.

Today the back catalogue of the world's second ever third party company sits with Activision, the world's first ever third party company. Along with their own back catalogue, Activision will occasionally release various titles from the Imagic back catalogue for modern systems, keeping the spirit of the aggressive group of third party developers alive and well.



DIAL-UP CHAT

Paleotronic had the great fortune to chat with Imagic co-founder Rob Fulop about life as a rock-star videogame developer in the early 1980s, and what came after.

We've read in other interviews that you were first exposed to computers in high school. Where was that? What did your class use them for? What did your classmates think of them? Did you learn BASIC programming or some other language? Did you design your first game on them?

The first computer I ever saw was a teletype machine linked via modem to a local museum. It was 1974, at Skyline High School in Oakland, CA, in the makeshift "computer lab" - basically the storage room of our math class. One could write simple programs using the BASIC language - I was instantly hooked and joined the small group of geeks who signed up each day for 15 minute blocks of time on the machine.

The very first program I wrote flipped a coin 100 times and tabulated the results. After that, I was only interested in writing programs that "played" with the user somehow. The second program I wrote played the game of Takeaway - a simple pile game similar to NIM. I programmed the game so that the computer could "cheat" and thus never lose. The third program I wrote was an attempt to attract girls into the computer lab - a "Boy Analyzer" - the user could enter the first name of any boy - and the computer would write out what sort of boyfriend he would be. Of course the program was rigged to give high ratings to the names of me and my friends, and thumbs down ratings to the names of guys we didn't like. Unfortunately this was before we figured out that labeling a guy as "bad news" was basically giving him an A+ rating - but the program did succeed at filling up the computer lab with girls.

Was that experience what led you to pursue a computer science degree at university? Which university did you go to? What was it like taking computer science in the late 1970s? Did you have a university mainframe? Which model? What did you do with it?

Yes, the experience in my 11th grade math class led directly to my choice of a major "EECS" as well as school "University of CA, Berkeley". At that time, we wrote our programs in FORTRAN, had each line of code put onto a punched card - then we would submit our "decks" of cards to the basement of the Engineering Building, and pick up the results of our output a few hours later. It wasn't until my junior year that I got to sit in front of a screen and learned about the UNIX environment.

When you got that first summer job with Atari, designing sound on the Superman pinball game, what was it like working with other technically-oriented people? Were you excited to be there? How did you design and generate the sounds? What hardware was used to do that?

Atari was very challenging in that I had never programmed the 6502 microprocessor, and the environment was quite unforgiving. We would hand write our code on paper, turn it into the data processing window, where typists would type the code into the machine and generate a paper tape.

We then took the paper tape to our development stations and fed it through the reader - then we could see if the program worked. Usually it did not, after which we had the option of hand "patching" the assembly code to try to work out the glitch - or if it was to much data to hand patch, we would hand rewrite the errant section of code, and turn it in again for another try.

The system had the advantage though of teaching us to really THINK through one's code before just hacking it in there. But it was a slow process, nonetheless. The sounds themselves played on a simple sound chip - I don't recall the specific one but it was used in virtually ALL the pinball machines of the time.

After you graduated, you returned to Atari and they put you to work in the consumer division, initially creating an Atari 800 version of Space Invaders. Could you please outline a bit about the technical processes you used? Was everything written from scratch in Assembler or did you use another programming language? Did you have any help or were you on your own? How did you feel about the game when you were finished?

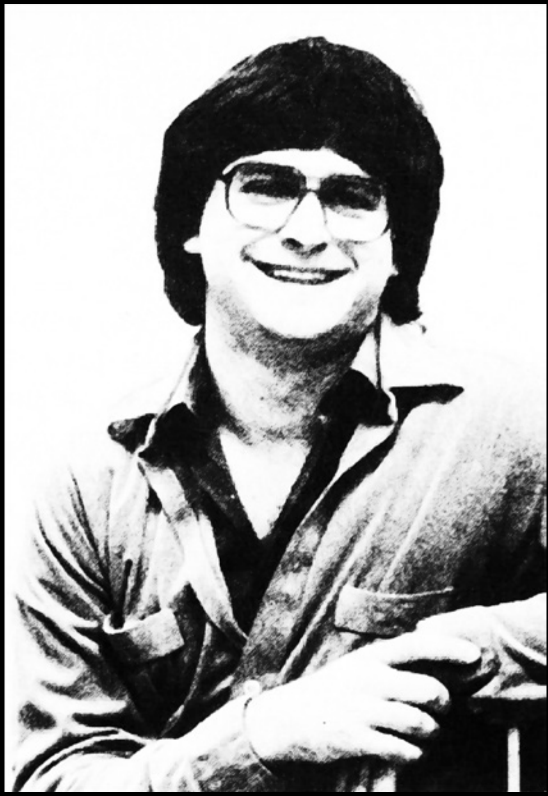
We were given a bare bones hardware manual for the TIA chip set - the hardware that is inside the Atari 2600. I was told to make a game. I spent the first six weeks visiting the Atari coin-op demo room every day, where I could play all the Atari games - as well as playing all of the existing 2600 games. I finally decided that I possibly could get a version of "Night Driver" to work on the 2600 chipset. Everything was written in 6502 Assembly. I received a bare bones lesson on how to write the display system from Larry Kaplan, a senior programmer at the time.

When the game was almost ready, we had a big meeting with "Marketing" where the executives came over and saw the game and seemed to like it - Ray Kassar, the CEO asked me "where did you get the idea for this?", which blew me away given Night Driver was one of their most popular Coin Operated games at the time! Apparently he had never seen it. I was happy to be done with it - it shipped with an ugly bug that nobody seems to be bothered by but me.

Moving from the comparatively luxurious Atari 800 to the Atari 2600 must have been tough, from a programming perspective. Could you go a little into the process of programming an Atari 2600 game at that time? What did you write the code on? How did you execute it on the 2600? Did you write algorithms on paper first? You developed a sprite generator for the 2600 on the Atari 800, could you talk a little about how that worked?

After Night Driver for the 2600, I moved over to the Atari 800 to do a version of "Space Invaders" - in retrospect it is remarkable that it was just up to me - nobody told me to port Space Invaders, even though Atari had purchased the license. Also, I decided on my own that I would not "copy" the original game - as I was far "too creative" to simply copy an existing game like I did with Night Driver. So I changed Space Invaders all around- I added a big dorky spaceship on the left of the screen - I did my own character designs - the top two rows make an "R" and an "F" when they march - I made up my own scoring system. The finished game looked and played totally different than the actual coin op Space Invaders by Taito. Marketing came to look at it and said "it's ok, but why didn't you just make Space Invaders, I mean, that's what people will expect when they buy it". And in that instant I felt like a total moron. They ended up shipping the game anyway.

Born in 1959, Rob Fulop graduated from college with an electrical engineering degree in 1979, after which he went to work for Atari. During his time there he ported Missile Command to the Atari 2600 (which became one of its most popular games). He later wrote Demon Attack, another of the 2600's biggest hits, while at Imagic, the company he co-founded.



The technical process of game development became a lot easier at this point because programmers could each have their own TERMINAL to write their own code - thus short cutting the need to turn one's code into the dreaded paper tape queue. This meant one could turn their next version of the game around MUCH faster, sometimes several times per hour as opposed to several times per day. So the games got a lot better since we could try more things. The sprite generator wasn't developed until I was at Imagic - at the time of Space Invaders I did all the graphics myself on graph paper, and then converted each line of dots into corresponding hex data which I would hand enter into the program.

How did you end up with the task of translating Missile Command to the 2600? What were some of the personal and technical challenges you faced doing that? Why did you hide your initials in it? Was that a result of the anonymous corporate culture Warners had implemented at Atari? Did that culture hinder your ability to develop games? How did your co-workers get along with your corporate overlords?

Missile Command was my favorite coin op game at the time - Brad Stewart and I were at lunch one day talking about if it would be possible to convert Asteroids and Missile Command to the 2600. He had an idea for how he could get the display engine to display a blocky asteroids playfield - it involved "flickering" frames so that essentially you use the hardware "twice" and every frame it goes back and forth displaying one set of graphics, or another. I thought the idea may also work to allow the 2600 to generate the many graphics needed to do MIssile Command - we both left lunch that day determined to see who could be the first to have a working display up on their system.

MEET THE DEAN OF DEMONS

ROB FULOP

They swoop, scream, puls[illegible] and fla[illegible]. They test you, exhaust you, m[illegible]e the [illegible] flow. Video games. How do designers make them so challenging? We went to Rob Fulop, creator of Imagic's Demon Attack, to find out.

At age 25, Fulop is one of the top video game designers in the country. But his job [illegible]n't all fun and games. It takes a lot of dedica[illegible]n and stamina.

"I usually start with an image in my head of the finished game. But it takes a lot of work to make it a reality. For Demon Attack, I knew all along that there would be colorful demons, lots of movement and plenty of surprises. I [illegible]ven knew what the demons would look like. But it's a long way from conception to finished produc[illegible]

It takes about six months in fact. About 90% of the game is completed in the first [illegible]ur months, "but the last two months are reall[illegible] tough," he says. "You have to scrunch the program to make it short enough. It takes a lot of discipline to complete a game."

Fulop paces himself carefully so that he doesn't burn out. If he gets frustrated with a game, he just goes home for the day. "I know some [illegible]ple work [illegible] night, and go home in the morn-ing [illegible] their program completed," he says, "but I can only work four or five hours at a time.

Fulop doesn't play games at home. "After being surrounded by 20 monitors all day at work, that's the last thing I want to see at home," he [illegible]ays. "Besides, I'm not really a very good player. [illegible]y reflexes are too slow."

Though he doesn't play video games, Fulop k[illegible]ows the secret to designing them. His games s[illegible]m simple in the beginning, bu[illegible] become more and more difficult as the play[illegible]r progresses. He relies on a special corps of yo[illegible]g video game players to test his new gam[illegible]s before they're released. "You can never make a game too hard," he says. "When I play Demon Attack, I score about 40,000 points. An experienced player should make 20,000 points a game the first week he plays. But there's always some young kid with incredible reflexes out there, someone who can practically ra[illegible] up points in his sleep. That kid is always o[illegible] my mind when I design a game, daring me to [illegible] game he can't crack. It's a real challenge to try to challenge him."

He won - but I was close behind, about a week later. The working displays inspired us to push forward and get the game logic working - both Asteroids and Missile Command were completed about the same time. At the time, the lessons of my prior "less than original" Space Invaders game were burning in my soul - so I was determined that Missile Command would be as EXACT a replica of the coin op version as I could possibly get - down to the very last sound effect - EVERYTHING would look and feel like the original Missile Command. And i think that's exactly why it has remained as popular as it has.

The initials were just simple Easter Eggs - at the time it was just "fashion" for us to hide some sort of message inside the game - mostly for our amusement. The challenge was to do the Easter Eggs so that they didn't consume too much memory space, which at 4K, was at a total premium. Missile Command was at about 4,500 bytes when it was done - I had to "squeeze" over 10% of the code down and still try to get it to do the same thing - crunching, or squeezing code was the bane of a game programmer's life - it was dreadful work since nothing looks any different, everything must remain the same, it just takes less memory. The last 100 or so bytes are the worst, we would do all sorts of ugly things in the code to save a byte here and there.

I never had a problem with anybody at Corporate Atari. I just thought it so weird that they knew absolutely nothing about video games. Zero. Like one there was a brainstorming session where all the marketing people came over, and we went to lunch at a pizza place where they had a bunch of games, and we walked thru and I overhead one of the women say "Wow, this is so fun, we should visit arcades sometimes!" Stuff like that, I just couldn't figure out how they could have jobs there and not be really into games. But there were almost proud of the fact that they knew nothing about the games, had never played them, etc.

Once your version of Missile Command took off, you understandably wanted to stop working like a studio musician and live the life of a rock star instead. Some of your other co-workers seem to have had similar desires. Did you collectively approach Atari first about renegotiating your arrangement, or did you simply decide one day to jump ship and form your own company? Did you give notice, or one day did you all just not turn up? Did Atari try to talk you out of it?

A few months after Missile Command shipped, we received Xmas bonuses, and I thought maybe I'd get like $5,000 or something - and was thinking I would probably purchase a better used than my grandma's old Dodge Dart. Instead I received a coupon for a free turkey at Safeway - I remember thinking "boy these guys are dumb - I'm 23 - I'd be thrilled with $5,000 and happily do another three games here". Instead I decided at that moment to pack up my Dart and leave. My boss, Dennis Koble was planning to leave as well, along with William Grubb (marketing) and Mark Bradley (Sales). So I asked to join the team and they said yes right away. We all gave notice with very little ceremony - it was only after we left that Atari panicked and thru crazy bonuses at the remaining programmers.

What were the early days at Imagic like? Any interesting anecdotes about startup culture, and the comparison with Atari's culture? What was it like competing with Activision?

Startups are fun - it's like Us against The World. My primary motivation was to make Atari cry when they saw my next game. That's it. Just break down in tears. I was motivated to do the very best I possibly could. Activision was our main competitor - and they had the A list talent - David Crane, Bob Whitehead, Al Miller, Larry Kaplan. These guys were the Belles of the Atari Ball when I was there. The guys to beat. But at first, I was singularly focused on making Atari regret how they mistreated me with the Turkey Bonus. We didn't think we could even touch Activision.

How did you come up with the idea behind Demon Attack? What was your creative process? Was it your first wholly-original Atari 2600 project? How long did it take to develop? Did you run into any road-blocks? How did you test it? Who came up with the marketing? What was your "90% rule"? How did you feel once Demon Attack was released? How did Atari's lawsuit over Demon Attack affect Imagic?

Demon Attack was derived from the popular game "Galaga" where hoards of attacking flying thingies "peeled off" and came right at the player - it had a particular panic-inducing moment where the player realizes that they are going to be facing off directly with an alien mind - and it was this panic-inducing moment that I wanted to capture in a game. I also wanted to make a game that featured MANY levels of play and have as many different looking enemies as I could fit. Actually, Demon Attack was my second original game, the first original was at Atari after Missile Command, but I never finished it and the prototype unfortunately is long gone. I did Demon Attack in about 8 months, and it was a very clean vision - just one play pattern that repeated over and over.

I worked on the swooping motion for a long time, never was happy with it, then moved on to finish the game, then I went BACK to the primary motion and tweaked the hell out of the motion routines to end up with the organic motion that gives the game it's distinctive feel. I had to fight to keep the game in the lab for the last month, my mistake in finishing everything before polishing the motion - marketing was eager to ship it - I insisted on holding it back. It got quite heated.

Finally I resorted to removing the backup copy of the source code from the company backup disks that were kept offsite, so that they had no choice but to wait for me to give them a final releasable version. It was not pretty. But the game did great - we were awarded VIDEOGAME OF THE YEAR by Billboard Magazine - which we used in all of our marketing. It was my first lesson in the life lesson that as long as a game is GOOD, despite all the screaming, nobody is going to remember that it was LATE! It's always at the end of a project that a GOOD GAME becomes GREAT - but it takes a dedication to polish and a willingness to hold steady despite the shrieking of Sales and Marketing. Many a games marketing manager at the time would say something like "The game itself doesn't matter. I could put dog pooh in a box and sell it". And sadly, they typically did just that. Thus the big game crash of 1982.

Shortly after Demon Attack hit the market you arguably did become a video-game rock star – how did that affect your personal life? Did that success create any friction between you and other game designers? Were there any rivalries? Was there a lot of pressure placed on you to one-up yourself? Where did you go from there?

My name was on the back of Demon Attack, plus I received royalties. There is nothing like handing six figure checks to an insecure 25 year old to change his worldview. I upgraded my car, house, girlfriend, pot dealer, everything. There was definitely a noticeable change in my long term friendships - many of my long time pals were still living the post-collegiate bum lifestyle and now their friend Rob hit the "big time" and doing so lit a fire under their butt - they moved out of mom's basement - got themselves into law school, etc. I never felt professional rivalries at Imagic . I remember going to a CES party and talking to a woman who told me "I heard that Rob Fulop may be here later" ... I thought that quite amusing and think maybe that moment was the peak of my rock stardom - but for the most part I never took any of it seriously since basically I was the same geeky guy who just happened to like computers and games. I knew at work that my next game wasn't going to be as strong as Demon Attack - I wasn't hungry in the same way - wasn't as into "Making them cry" - Cosmic Ark was based on an unusual graphic glitch that I had stumbled into that filled the screen with stars - I was eager to use to to stump Activision - I'm still not sure why it worked.

Did you see any signs of the video-game crash before it happened? How did you feel once it became apparent the bottom had fallen out of the market? Why do you think it happened? After the video-game crash set in, how did Imagic try to cope? When was the decision reached to effectively pull the plug? How did that affect you personally? How were you able to move on?

The video-game crash caught all of us by surprise. In retrospect, all the signs were there - at the 1982 June CES, many retailers complained about inventory that wasn't moving - but our optimistic sales team was pret-

ty much looking the other way, attributing the problems to poor quality product flooding the shelves. There was no discussion that Imagic games would be affected, since we had a reputation of top quality games.

It was a very difficult thing to deal with, and took me a long time to fully wrap my head around - particularly how CLOSE we had come to going public (literally Imagic was on track to offer our stock to the public market a few days after Atari let out the bombshell that they had the worst quarter ever). I left the company soon after, there was an effort to keep things going, but the spirit of the company was gone. Personally I went from very much believing the New York Times article that listed my net worth after the public offering at $8MM - to calculating I had about a two year cash window in the bank before I would need another job.

Still not fully believing the crash was real, I found some freelance development work doing a few games for Parker Brothers, but soon after they bailed out of the market. I started an independent game based on Robots called Actionauts, had a working prototype before realizing that the game had better potential on the Commodore 64, so I got a development deal from Simon Schuster to publis≠h the game. Six months later, Simon Schuster also bailed out of the software business leaving me to market the C64 version of Actionauts myself. I ended up giving the game away as "Freeware" and sign people up to a Commodore based bulletin board for updates - Commodore was excited about this idea (of using electronic distribution to release a software title) so they ran an article about the game, and PUBLISHED the bulletin board phone number so people could connect directly with me and download the game. I upgraded my "server" and waited patiently for the article to be published - but no calls came - not ONE. When I actually received my hard copy of the magazine, I found to my horror that Commodore hand published the WRONG PHONE NUMBER of my bulletin board - thousands of calls had been placed to the wrong number! I was devastated.

I ended up doing an online casino game for Q-Link, the predecessor to America On-Line. Rabbit Jack's Casino would become the first online casino, and the game earned royalties for years, ported to the IBM and Apple platforms. It was a difficult three-four year transition. Soon afterwards, I hooked up with Nolan Bushnell's company Axlon and started working on the NEMO Interactive Movie project with led to Night Trap.

Do you have any other creative hobbies, such as playing a musical instrument? Do you feel that they helped your ability to design games? Would you recommend budding game designers take up other creative pursuits as well?

I've been an amateur jazz and ragtime pianist for many years - my musical background definitely helped with the sound design in my work - as well as the inherent sense of craftsmanship that comes along with basic musicianship. I've also been an aspiring writer on and off at various stages of my life. I imagine any modern

Thanks in no small part to Rob's games, Imagic quickly rocketed into the videogame stratosphere, even starting its own fan club, the Numb Thumb Club, which published an annual newsletter trumpeting Imagic's latest titles. It even sold clothing emblazoned with box artwork from various Imagic games. Unfortunately the party was short-lived.

SHOWCASE

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The 1983 'video-game crash' caused sales to dry up, and retailers panicked, setting off a rapid race to the bottom that saw cartridges sell for as little as a dollar. Soon after the crash, Imagic laid off a quarter of its staff, but despite efforts to pivot toward the home computer market it never recovered, and by 1986 was out of business.

game designer needs to immerse themselves in at LEAST two other creative mediums - writing - music - graphics - animation - and basic design sense. Games and stories have essentially intertwingled at this point - there is no point where the story stops, and the game begins - as far as I'm concerned, the game design role is AUTHORSHIP, plain and simple. If it's not on the page - it won't be on the stage - so it all stems from the design documents. And who creates the design documents? The game designer.

New games written for classic consoles are all the rage these days. if someone wanted to create a new Atari 2600 (or Atari 8-bit) game, what would be some of your top tips? Do you have any advice about programming or game design in general? What about on the business side?

Obviously one needs a strong VERTICALLY moving game playfield for a game to be 2600-worthy. I think several mobile games meet this criteria - particularly a game like Doodle Jump which in my opinion would make a beautiful 2600 game. Anything where the action flows from the top of the screen down to the bottom, and not too many game objects are needed for any particular horizontal plane. That's why Doodle Jump would work well.

My basic theory of game design is there is very little reason to invent new games - the good ones already have been invented and we don't really need any more. The trick is to know where to look for the good games that already work, that have proven the test of time, that have been played and replayed countless times by people. The best game I ever made was DOGZ and CATZ - modeled after puppy dogs and kitty cats. People like puppy dogs, it's not surprise they also like the digital versions. Rabbit Jack's Casino simply took four basic casino games and made them work online. An adventure game is simply the game of TREASURE HUNT, always fun. Most multiplayer shooters are simply versions of an age old playground game called TAG that we all played as kids. Etc. There is little reason to try to dream up a brand new game. Sports offer tons of good game design ideas. As do card games. As do countless good board games. We really don't need new play patterns, kids are just as happy playing the same play patterns that they have always enjoyed.

Your story would make a great movie! Has anyone ever approached you about that?

No, but thank you - that's very funny! Like who would the hero and villain be? Or would I be both? How would the movie end? Would people cry or laugh ? I've toyed with doing a book, I probably have enough content for a book, just not convinced enough people would want to read it.

the toy store

One of the hottest Christmas toys of 1979 was a lunar-inspired tank that taught rudimentary computer programming!

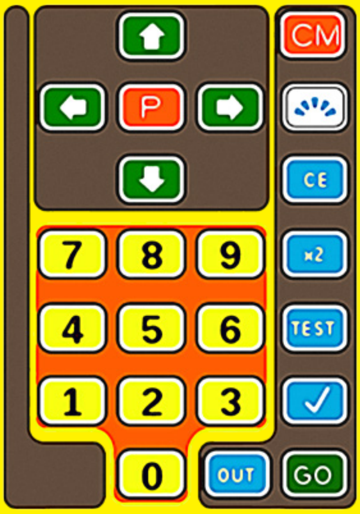
The Milton Bradley Big Trak (also stylised as bigtrak) is a programmable toy resembling a futuristic utility vehicle that could have been used by Moon astronauts or colonists. It has six wheels (two drive wheels), a "photon beam" headlamp and a keypad on top.

Users could program in a sequence of up to 16 commands, with multiple presses of the movement and directional directives combining into single commands, such as "move forward 10" or "turn right 90 degrees".

Big Trak is a stylish tractor and trailer which responds to eight programming commands which can be chained together into a 16-step program. (For those of you who know LOGO, in my mind, this is the ultimate representation of a LOGO-type language in a responsive, neat, tough "toy.")

Forward! **Big Trak** advances for as many as 99 units, each unit being the measure of its own 13-inch length. Push the "Repeat" button, and it travels twice as far. It gives the same performance in reverse. It pivots either right or left in a full circle, or even beyond a full circle. It also pivots in tiny fractions of a circle, for **Big Trak** possesses 60 swiveling positions. It can make a turn, proceed in a straight line, turn again, and continue travelling on whatever course its young navigator has set. (Even oldish Publishers have been known to program **Big Trak**!)

Creative Computing, May 1979



Forward/Backwards: Move forward or backwards in units of body length
Left/Right: Turn left or right in units of roughly 1/60th of a full rotation
HOLD: Pause in 1/10 of second time units (U.K. version; P: Pause)
FIRE: Fire the light bulb "laser" (U.K.; Photon Symbol)
CLR: Clear the program (U.K.; CM: Clear Memory)
CLS: Clear Last Step (U.K.; CE: Clear Entry)
RPT: Repeat a number of steps (primitive loop) (U.K.; x2: Repeat key)
TEST: Run short test program
CK: Check last instruction (U.K.; Tick symbol)
Out: Dump optional trailer accessory.

Using the Big Trak keypad, users could program in a sequence of commands the toy would then execute. However, with a limited memory of 16 commands, while it could navigate around an average bedroom or lounge room the restriction curtailed more complex journeys. It also 'forgot' when turned off.

The Big Trak was innovative for its time, when "programmability" was cutting-edge in consumer electronics such as VCRs, calculators and even microwaves, and the personal computer revolution was invading small businesses, homes and schools. It was marketed as the toy of the future, the sort of thing children would play with on space stations or inside Moon colonies, and the public responded favourably, buying over two million of them priced at around US$40 (US$120 or AU$165 in 2018).

"Not only is Big Trak fun to play with, it is also believed to be educationally good for children..."

MAKING TRAKS

A good toy for children who have heard about microprocessors, is Big Trak, a programmable model lorry.

It came into the UK shops last year amid a splash of publicity because of its programmable capacity. You can enter in up to 16 different commands simply by pressing calculator type keys. The truck will go forwards, backwards, turn at any angle and complete a whole circle.

Another special feature is that it can fire single or rapid shots from its laser cannon. It looks a bit like a moon buggy with big tank tracks on the wheels and is made of heavy duty plastic so it will withstand any unsuspected crashes into furniture if the programmer miscalculates his instructions.

Big Trak can be made to negotiate courses that you set by estimating distances for the toy to cover by multiplying the lengths of Big Trak — it measures 14". It's a test of skill and accuracy on the programmer's part to get Big Trak safely round a course.

A transporter is also available at extra cost to tack onto the end of Big Trak. Not only is Big Trak fun to play with it is also believed to be educationally good for children in learning how to program and amend the program after seeing the result, without the child realising what he is doing.

Made by Milton Bradley, Big Trak costs between £27 and £35 but make sure your furniture is as robust as the toy before you buy one.

Computers and Video Games, December 1981

Not just a toy, the Big Trak also made it in the classroom, and the university!

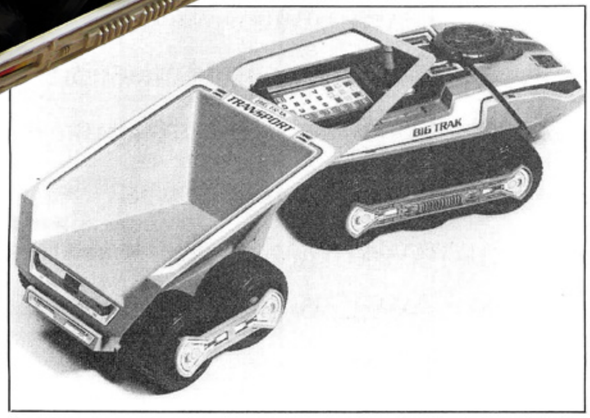
US$40 was much cheaper than the US$1195 an Apple II Plus cost, or even the US$595 for a Commodore PET 2001, and so educators also took a shining to the Big Trak, seeing it as a much more affordable alternative for teaching young children introductory computer programming. By laying out a simple obstacle course and tasking their pupils with convincing the Big Trak to navigate it, teachers could foster a basic understanding of programming in their students with relative ease, even before they were old enough to use an actual computer.

Students could then go on to learn the Logo programming language with a real-world reference in their minds, making the concept of the Logo turtle easier to grasp and the computer seem less foreign.

A number of products in recent years have attempted to replicate the success of the BigTrak in education, but no one offering has caught on the way the BigTrak did.

Happily the BigTrak has been reintroduced (see lower-right corner) so today's kids can have the same fun with it as 80s kids.

nance Toy Vehicle



Milton Bradley's Big Trak is a toy vehicle which is programmed to follow an extremely complex route. Big Trak advances for as many as 99 units, each unit being the measure of its own 13-inch length. By pushing the Repeat button, it travels twice as far. It gives the same performance in reverse. The vehicle pivots either right or left in a full circle or more. It also pivots in tiny fractions of a circle, for Big Trak possesses 60 swiveling positions. It can make a turn, proceed in a straight line, turn again, and continue traveling on whatever course has been set.

Big Trak has a total of 16 programming steps which direct its functions. By estimating the distances and punching in commands, the user may send it around tables, chairs, and other obstacles, and have it return. The user may input a command which will call up its arsenal of weaponry, firing a single shot, or short or long bursts of sound and light laser-cannon fire.

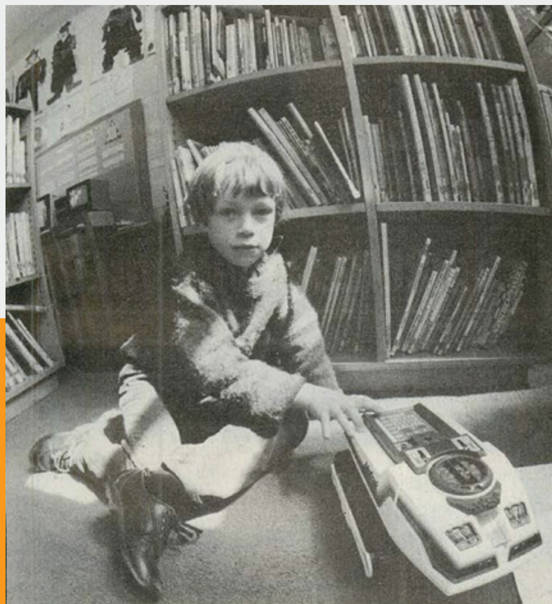
Byte Magazine, November 1979

The press was impressed with the Big Trak, and it made frequent appearances in technology magazines from its launch in 1979 through to the mid-1980s. Writers hailed its ability to get kids (and adults) to engage with technology in a fun but educational way.

One interesting by-product of the Logo idea in the classroom is an electronic toy called Bigtrak. Made by Milton Bradley, an international toy manufacturer, Bigtrak is a tank controlled by a microprocessor. It can be programmed in a Logo-like way to go forwards or backwards and to turn through a preset angle. It is not as precise or as versatile as the Logo floor turtle, but it costs only 1/10th as much, about £30.

Bigtrak workshops are now a standard feature of conferences and seminars to introduce primary-school teachers to the uses of computers in the classroom. It is a fine sight to see them wrestling with the problem of getting Bigtrak to drive around an obstacle course.

Practical Computing, September 1983



Milton Bradley's Bigtrak

Computer and Video Games Dec 1982

Bigtrak by Milton Bradley must be the best known of all electronic vehicles, having appeared on many television programmes that are concerned with the famous chip.

It can be programmed to travel forwards, backwards, left, right, turn, spin or fire it's photon cannon.

Bought separately, the Bigtrak Transporter can be linked to the vehicle and programmed to haul loads and dump them on command.

Bigtrak is priced between £27 and £40 and the transporter costs from £14 to £20.

In 2010 the BigTrak was relaunched under license by Zeon Ltd. which has since released two additional models, the smaller BigTrak Jr. and the redesigned smartphone or computer-controlled BigTrak XTR.

Learn more at www.bigtrakxtr.co.uk

“We choose to go the Moon in this decade and do the other things not because the are easy, but because they are hard; because that goal will serve to organise and measure the best of our energies and skills.” - John F. Kennedy.

It would not be unreasonable for NASA to assume that along with Kennedy’s 1961 commitment to reach the moon by the end of that decade came all of the resources required to make it happen. However, an American president is not a king, and despite his decree, in 1963 the US Congress slashed NASA’s budget by $600 million dollars.

Rumours were also flying fast and furious about potential, expensive setbacks NASA faced in its mission, including the mistaken notion that the Moon was covered in a 30-metre layer of dust and would be almost impossible to land on, and that astronauts would be killed in transit by radiation without thick lead shielding too heavy to get off the ground. NASA’s administration was in turmoil, and its head of manned space flight, responsible for the Apollo program, was fired.

His replacement, Dr. George Mueller, former vice-president of Space Technology Laboratories, a company that had worked on ballistic missile programs for the US government in the 1950s, quickly realised that in order to meet the goal of putting a man on the moon by 1970 amid increasingly tightening purse-strings, he was going to need more than engineering savvy – he would also need business savvy. He formed the Apollo Executive Group, sending invitations to the CEOs of all the corporations that provided equipment, software and services to the Apollo program – and he insisted that only the CEO of a company could turn up, or that company would not be represented at all.

A Roster of Service

The National Aeronautics and Space Administration lists these men from outside government as having served on the Apollo Executive Group:

William M. Allen
Chairman of the Board
The Boeing Co.

J. A. Anderson
Formerly with AC Spark Plug Division
General Motors Corp

J. L. Atwood
President (Retired)
North American Rockwell Corp.

C. E. Beck
President and
Chief Executive Officer
AMBAC Industries, Inc
Formerly with Philco-Ford

Dr. B. Paul Blasingame
General Manager, Milwaukee,
AC Electronic Division
General Motors Corp

George M. Bunker
Chairman of the Board
Martin Marietta Corp

Donald W. Douglas Jr
Corporate Vice President —
Administration
McDonnell Douglas Corp.

L. J. Evans
President
Grumman Aerospace Corp

Henry Ford II
Chairman of the Board and
Chief Executive Officer
Ford Motor Co.

William P. Gwinn
Chairman of the Board
United Aircraft Corp

William C. Hittinger
President
General Instrument Corp
Formerly with Bellcomm, Inc
an American Telephone &
Telegraph Co. subsidiary

Dr. John A. Hornbeck
President
Sandia Laboratories
Formerly, President, Bellcomm, Inc

H. M. Horner
Chairman, Emeritus
United Aircraft Corp

Richard Hough
Vice President
Long Lines Department
American Telephone & Telegraph Co.

Robert E. Hunter
Chairman of the Board and President
Philco-Ford Corp.

Dr. Howard Johnson
President
Massachusetts Institute
of Technology

Frederick R. Kappel
Chairman of the Board (Retired)
American Telephone & Telegraph Co

Roger M. Kyes
Executive Vice President
General Motors Corp.

T. Vincent Learson
President
International Business
Machines Corp.

James S. McDonnell
Chairman of the Board and
Chief Executive Officer
McDonnell Douglas Corp.

Kenneth McKay
Vice President—Engineering
American Telephone & Telegraph Co

Eugene J. McNeely
President (Retired)
American Telephone & Telegraph Co.

T. F. Morrow
Vice President
Defense-Space and Diversified
Products Group
Chrysler Corp

Mark Morton
Vice President and Group Executive
Aerospace Group
Valley Forge Space
Technology Center
General Electric Co

Hilliard Paige
Vice President and Group Executive
Information Systems Group
Valley Forge Space
Technology Center
General Electric Co.

Jack S. Parker
Vice Chairman and
Executive Vice President
General Electric Co.

J. Donald Rauth
President
Harvey Aluminum, Inc.

Dr. Ian M. Ross
President
Bellcomm, Inc.

Dr. J. A. Stratton
Chairman of the Board
Ford Foundation
Formerly with MIT

E. C. Towl
Chairman of the Board
Grumman Aerospace Corp

Dr. Charles H. Townes
Department of Physics
University of California
at Berkeley

Lynn A. Townsend
Chairman of the Board
Chrysler Corp.

Thomas J. Watson Jr
Chairman of the Board and
Chief Executive Officer
International Business
Machines Corp

A. L. Williams
Chairman of the Executive Committee
International Business
Machines Corp.

Lysle A. Wood
Vice President, Customer
Requirements
The Boeing Co

Dr. George Mueller

Afraid that their lack of presence could affect their companies’ abilities to obtain future NASA contracts, they came – including the likes of Henry Ford. Once Mueller determined who in each company was directly responsible for its part in the Apollo program (and had a commitment from the CEO that the Group could influence their direction), he allowed that person to come in the CEO’s place, but often the CEO still came anyway. Mueller added a few scientists and NASA engineers who could answer questions, and the work of the group nicknamed NASA’s “Board of Directors” began in earnest.

The Apollo Executive Group wasn’t a decision-making body – at least not officially – but its value lay in forcing fierce competitors to exchange sensitive information about their internal operations and intellectual property that they would have typically kept closely guarded. But by taking down those walls and communicating freely with other Apollo contractors, they ensured that each component involved in the rockets and spacecraft interacted with each other properly the first time – and because, despite their transparency, they were still competing, they did their utmost to deliver their parts more quickly than the other group members, and on budget.

After four years of extraordinary cooperation, disaster struck when a fire inside the Apollo 1 command module during a launch rehearsal in January, 1967, killed all three astronauts trapped inside. The inward-opening design of the pressurised command module's door was roundly criticised for hindering the effort to rescue the astronauts after the fire started. The Group met to conduct a post-mortem of the accident and discuss potential solutions, operating as Mueller had intended, and their efforts contributed to a renewed faith in the eventual success of the Apollo program.

Meanwhile, the first 36-story Saturn 5 rocket flew its first, and a successful, mission. Things were, once again, looking up. However, the second launch did not do as well – two engines shut down prematurely, exposing a number of flaws in the Saturn 5's machinery. The lack of confidence NASA subsequently had in the quality of the rocket, easily shaken in the wake of the Apollo 1 tragedy, jeopardised its aim of a manned third launch, and the Group was again called together to sort out the mess.

During what has been called the "ten days that shook Apollo", the associated companies faced intense pressure to resolve the issues discovered by the second Saturn 5 launch. After two weekend-long meetings and several conference calls, the Group was confident the issues had or would be resolved, and they recommended that the third launch proceed as scheduled, and on December 21st, 1968 the astronauts of Apollo 8 became the first humans to travel beyond low-Earth orbit, traveling around the moon.

Soon after, the Group was disbanded, its services no longer required since its goal of putting a man on the Moon was certain to soon be met. But Mueller would not soon forget its integral part in Apollo's eventual triumph. Discussing the Group in 1970, he reflected on its success.

"Without the Group, there is no doubt in my mind that we would never have succeeded in getting to the Moon within the budget, and almost certainly we would not have gotten it done on time."

"It was nothing but motivating people", he concluded, "that caused these apparent miracles."

Members of the Apollo Executive Group mingle. Second from the left in the foreground is aerospace engineer Dr. Wernher von Braun, while Dr. Mueller stands beside him to the right.

THE BUSINESS
Apollo Executive Group

THE TECH

Schookids today may all have tablets, but in the early 1980s you were lucky if your classroom had its own computer!

More likely, there was only one (or maybe two) for the entire school. Often, due to a lack of computer-savvy (or even remotely curious) teachers, it would be kept largely locked away in a repurposed closet, only opened if a child was eager enough (on their own terms and without assistance) to use it.

However, this thankfully wasn't universal, and some teachers (schools and even countries, such as Great Britain with the BBC Microcomputer) made an effort to provide their students with an introduction to personal computing, understanding that it was the future and the future was coming, fast. Smart teachers even enlisted the aid of their more tech-minded pupils to help!

There were a few programs that were staples of early computing curriculum in North America, many of which were distributed by the Minnesota Educational Computing Consortium, or MECC. Founded in 1973, MECC initially ran a UNIVAC mainframe serving 2000 terminals in schools around Minnesota, but in the early 1980s replaced the terminals with Apple IIs. MECC also developed and maintained a library of software, some of which had its origins in its mainframe days, such as The Oregon Trail.

When the class was too large for everyone to gather around the computer, I tried another approach. While a few students were at the monitor, the rest listened and watched as I explained the meaning of computer output.

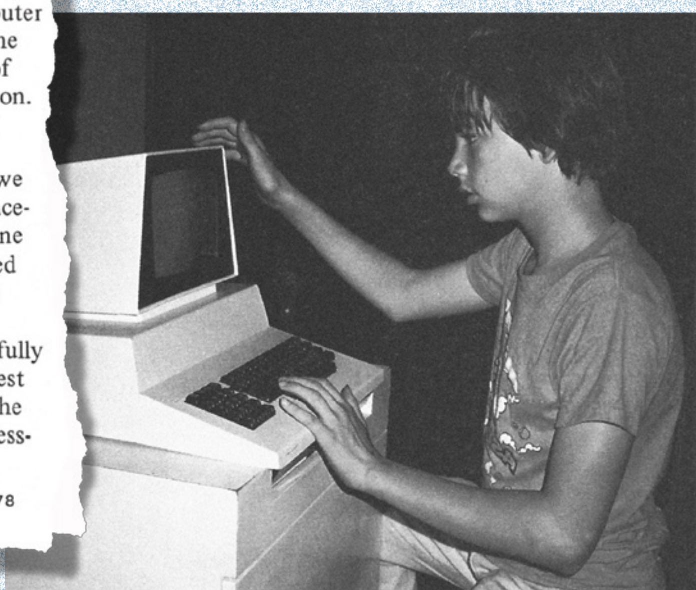
We did this several times with a simple game, "Lunar Lander". A day before the computer session, the physics teacher reviewed with the students the basic concepts of velocity, gravity, acceleration and free-fall. When the computer session started, I divided the class into teams of three. The computer displayed the altitude, velocity and quantity of fuel aboard a make-believe spaceship heading for the moon. I wrote this information on the board so the whole class could see and follow the game.

Usually the game is played with just one person, but we decided it should be played by three. After all, a real spacecraft would have a three-man crew. And this way everyone got to sit at the computer at least once during the allotted class time. Choose one of the more outgoing students as captain and two quieter students as his assistants.

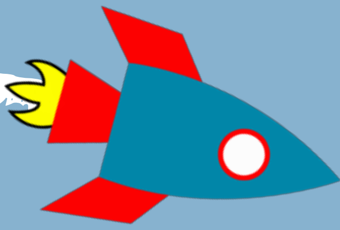
More often than not there will be "failures". By carefully studying the computer data, the students can see how best to land a simulated rocket on the moon. Explaining to the rest of the class why the simulation was or was not successful helps the remaining students to pay attention.

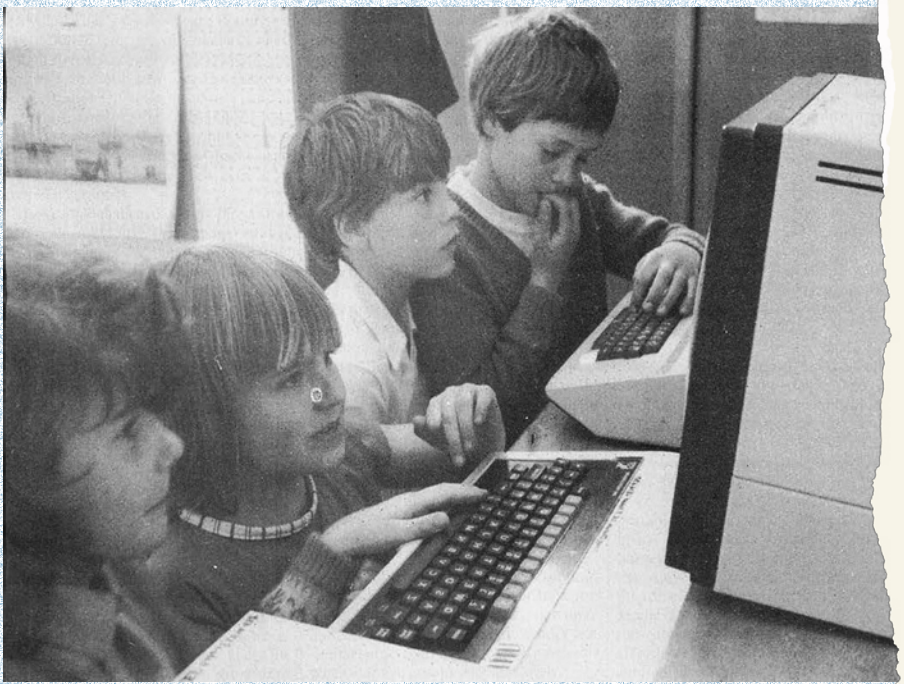
Personal Computing SEPTEMBER 1978

When you spent your days reading beat-up old textbooks and writing using pencil (or pen) and paper, there was something magical about using a computer, which was far more dynamic and interactive. In particular, educational programs with a game element, such as Number Munchers or Oregon Trail, were well-received by students otherwise accustomed to a curriculum utterly devoid of any entertainment value.



CLASS





Across the bay from the Exploratorium is the Lawrence Hall of Science, a modernistic, concrete building perched high in the green hills above the University of California at Berkeley. There, personal computers have spawned a similar interest in simulation. Perhaps the most spectacular will open this spring, when visitors will be able to stand in front of a 20-square-foot video screen and land, in real time, a lunar module on the surface of the moon. Then they'll be able to vary the situation: landing the craft with more fuel on board or taking off carrying an extra thousand pounds of rock specimens.

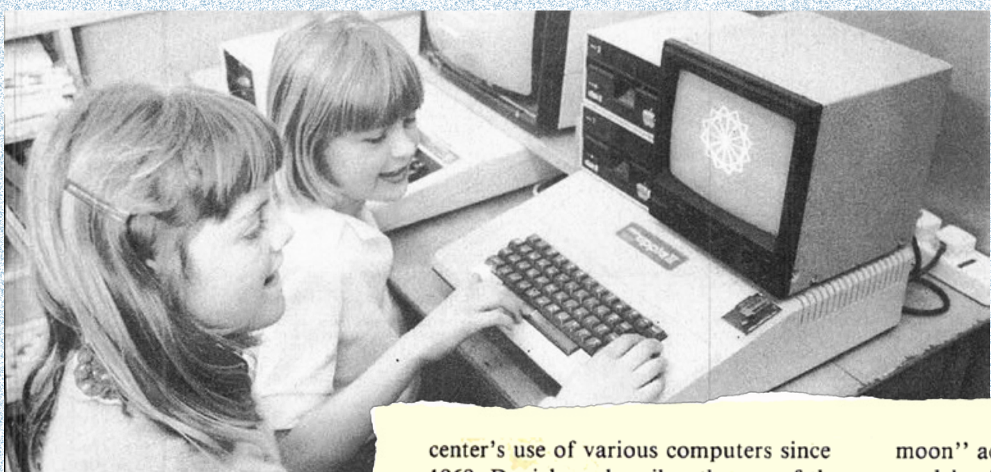
Ultimately, visitors at the Hall should be able to "land" a spacecraft on every planet in the solar system—actually experiencing the gravity and atmospheric conditions of each planet—in what will be a truly graphic astronomy lesson.

January 1983 PERSONAL COMPUTING

MECC adapted many existing educational titles to the Apple II, adding graphics and sound, as well as creating new titles, and sold them outside of Minnesota, encouraging the adoption of the Apple II as the computer of choice for schools all around the US and Canada.

In Australia, meanwhile, the locally produced, Z80-based MicroBee was released in 1982. At AU$399 the MicroBee was much more affordable than computers imported from overseas, and its manufacturer, Applied Technology, won a contract to provide the MicroBee to New South Wales schools. The computers remained in use until the late 1980s, and many Australians of that generation are familiar with them. No matter if you used an Apple II, BBC Micro or MicroBee, you were lucky if your class had a computer!

Understanding the otherwise humdrum educational standard of the time is critical to comprehending why these simplistic computers were so successful in getting children to engage with them – rather than writing out multiplication tables over and over, chanting them with your class or even using flash cards, the computer could provide an unpredictable and 'fun' experience, one that was more memorable and hence whose content – the times tables – was more likely to be remembered.



Of course, beyond maths, history and language was the topic of the computer itself, the technology that was certain to eventually insert itself into almost every facet of our daily lives – and to get ahead, you had better be in front of it. And so BBC BASIC and Apple Logo became study subjects in and of themselves, providing a window into how the computer worked and fostering some understanding of how all that other software – education and games – came to be on the screen.

center's use of various computers since 1969. Danielson describes the use of the lunar landing program: "Before they play ASTRO, many of the students have seen our videotapes of the Apollo flights, they've observed the moon through our telescopes, they've done a "lost on the moon" activity, and they've created models of lunar craters in the classroom. Then they finish with their own lunar landing. It's a very exciting thing; they really are piloting the lunar module at that point. The visual images are important to help the computer's printout come alive."

onComputing Winter 1979

This 'meta' nature of the 1980s computer – where its use couldn't help but impart some understanding of its inner workings – provided the students of the era with an educational advantage lamentably absent from modern classrooms.

George Bachaelor looks at Freescape, one of the first filled-polygon 3D gaming engines.

Last issue of Paleotronic, my article on RPG games focused on the birth of RPG games on home computers. It looked at how they were heavily turn based text adventures, inspired by the likes of Dungeons & Dragons board games. This issue of Paleotronic is all about the moon, so to tie in to the moon theme, I jump ahead to 1987, the launch of the Freescape 3D "being there" RPG home computer gaming experience.

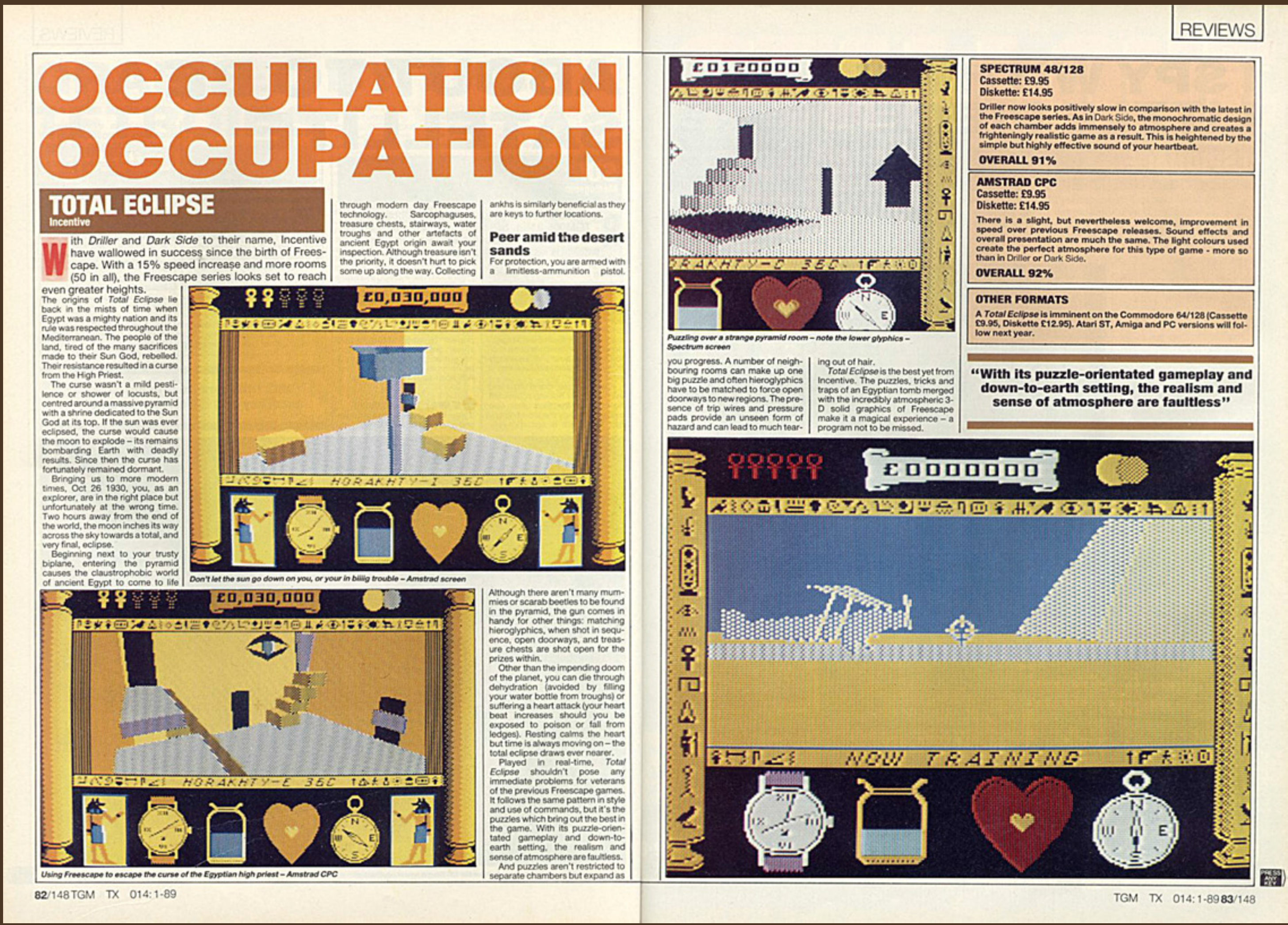
Freescape - what was all this about? It sounds a bit odd. I mean it's the middle of the 1980's, arcade machines are top of the video game industry money tree, this was the era of legendary beat em ups like Yie Ar Kung Fu, legendary football games like Tehkan World Cup, legendary run n jump platformers like Ghosts N Goblins and legendary space shoot em ups like Space Harrier. What the hell was a Freescape? That's exactly the question i was asking myself as i saw the advertisements while flicking through the pages of my Amastrad Action magazines.

At the time i took little notice, i was too enthralled and captivated in playing arcade and action games on my CPC. Classic games such as Spindizzy, Glider Rider and Arkanoid. These were the games that i loved and would play all day and night. Little did i know at that time the incredible impact the Freescape three dimensional engine would play in gaming history.

Taken from the words freedom and landscape to create 'Freescape', Ian and Chris Andrew of Incentive software were the brains behind the idea, an idea formed in 1985. Incentive had already been very busy in gaming circles for a number of years releasing original home computer games like Splat and Back Track in 1983. However it was their 3D RPG idea in 1985 that made them to coin a better phrase 'absolutely famous' within the home computer games industry. The idea soon became a working concept during 1986 and from there it took another 12 – 14 months to bring to life the Freescape 3D engine in a game, that could be released for sale for the home computer market.

An ambitious and very unlikely concept is an understatement. Nobody else was looking into such a difficult gaming concept, it was one that went completely against the gaming status quo. Even more intriguing was the project had been conceived on one of the most unlikely of machines.

You would have thought a 3D games engine would have been developed on the most powerful of machines at the time, the truth is that it wasn't, it was the complete opposite. Probably most looked over about the story, even though the story gets told a million times, is that the Freescape engine and first game released with it – Driller was coded on an Amstrad CPC6128 (128kb). The Amstrad



REVIEWS

OCCULATION OCCUPATION

TOTAL ECLIPSE
Incentive

With *Driller* and *Dark Side* to their name, Incentive have wallowed in success since the birth of Freescape. With a 15% speed increase and more rooms (50 in all), the Freescape series looks set to reach even greater heights.

The origins of *Total Eclipse* lie back in the mists of time when Egypt was a mighty nation and its rule was respected throughout the Mediterranean. The people of the land, tired of the many sacrifices made to their Sun God, rebelled. Their resistance resulted in a curse from the High Priest.

The curse wasn't a mild pestilence or shower of locusts, but centred around a massive pyramid with a shrine dedicated to the Sun God at its top. If the sun was ever eclipsed, the curse would cause the moon to explode – its remains bombarding Earth with deadly results. Since then the curse has fortunately remained dormant.

Bringing us to more modern times, Oct 26 1930, you, as an explorer, are in the right place but unfortunately at the wrong time. Two hours away from the end of the world, the moon inches its way across the sky towards a total, and very final, eclipse.

Beginning next to your trusty biplane, entering the pyramid causes the claustrophobic world of ancient Egypt to come to life through modern day Freescape technology. Sarcophaguses, treasure chests, stairways, water troughs and other artefacts of ancient Egypt origin await your inspection. Although treasure isn't the priority, it doesn't hurt to pick some up along the way. Collecting ankhs is similarly beneficial as they are keys to further locations.

Peer amid the desert sands

For protection, you are armed with a limitless-ammunition pistol. Although there aren't many mummies or scarab beetles to be found in the pyramid, the gun comes in handy for other things: matching hieroglyphics, when shot in sequence, open doorways, and treasure chests are shot open for the prizes within.

Other than the impending doom of the planet, you can die through dehydration (avoided by filling your water bottle from troughs) or suffering a heart attack (your heart beat increases should you be exposed to poison or fall from ledges). Resting calms the heart but time is always moving on – the total eclipse draws ever nearer.

Played in real-time, *Total Eclipse* shouldn't pose any immediate problems for veterans of the previous Freescape games. It follows the same pattern in style and use of commands, but it's the puzzles which bring out the best in the game. With its puzzle-orientated gameplay and down-to-earth setting, the realism and sense of atmosphere are faultless.

And puzzles aren't restricted to separate chambers but expand as you progress. A number of neighbouring rooms can make up one big puzzle and often hieroglyphics have to be matched to force open doorways to new regions. The presence of trip wires and pressure pads provide an unseen form of hazard and can lead to much tearing out of hair.

Total Eclipse is the best yet from Incentive. The puzzles, tricks and traps of an Egyptian tomb merged with the incredibly atmospheric 3-D solid graphics of Freescape make it a magical experience – a program not to be missed.

Don't let the sun go down on you, or your in biiig trouble – Amstrad screen

Using Freescape to escape the curse of the Egyptian high priest – Amstrad CPC

Puzzling over a strange pyramid room – note the lower glyphics – Spectrum screen

SPECTRUM 48/128
Cassette: £9.95
Diskette: £14.95

Driller now looks positively slow in comparison with the latest in the Freescape series. As in Dark Side, the monochromatic design of each chamber adds immensely to atmosphere and creates a frighteningly realistic game as a result. This is heightened by the simple but highly effective sound of your heartbeat.

OVERALL 91%

AMSTRAD CPC
Cassette: £9.95
Diskette: £14.95

There is a slight, but nevertheless welcome, improvement in speed over previous Freescape releases. Sound effects and overall presentation are much the same. The light colours used create the perfect atmosphere for this type of game - more so than in Driller or Dark Side.

OVERALL 92%

OTHER FORMATS

A *Total Eclipse* is imminent on the Commodore 64/128 (Cassette £9.95, Diskette £12.95). Atari ST, Amiga and PC versions will follow next year.

"With its puzzle-orientated gameplay and down-to-earth setting, the realism and sense of atmosphere are faultless"

82/148 TGM TX 014:1-89

TGM TX 014:1-89 83/148

CPC needs credit where it's due, to me, the CPC6128 is the best 128kb machine ever made. More often than not, the Amstrad CPC was playing second fiddle to the likes of the C64 and Spectrum's as games were normally released on a C64 or Spectrum first. It was quite unusual for such a progressive new tech being launched on an Amstrad CPC.

I mean who in their right minds would have thought that an 8-bit machine could produce such an incredible solid looking 3D world as a first person RPG game at that time. Sure it had already been somewhat done with Elite on the BBC micro and on other systems with such titles like The Sentinel, but that was just wire frame graphics, no one had ventured to the next logical step. This was time when 16-bit machines the likes of the Commodore Amiga and Atari ST were demonstrating their much vaunted power and memory over their 8-bit cousins.

So my humble CPC was at the forefront of this new gaming development that allowed solid 3D polygon graphics to showcase a 3D world in much more detail than previously had been done and with a more real life feel of exploration. Extraordinary feat by creator Chris Andrew to get so much out of a machine with such little power by today's standards.

Driller and the Freescape engine had finally brought to life a proper 3D, first person, RPG game to home computers. It was a massive leap forward not only in RPG games, but for gaming in general and should be recognized as possibly the birth of solid graphical first person gaming.

The origins of how Freescape came to be is just as fascinating because the story has roots in those RPG gaming text adventures that I mentioned in the last issue of Paleotronic. Around 1984, at a local computer club meet, Ian Andrew met Sean Ellis, a first year university student. Sean had showed Ian his ideas for an adventure gaming system he had developed with his Amstrad CPC. From there, that meeting lead to The Graphic Adventure Creator or GAC being developed. Remember adventure games were part of the gaming landscape back then, so

Total Eclipse (top of page) was a 1988 video game released for the Amiga, Atari ST, Amstrad CPC, Commodore 64, MS-DOS and ZX Spectrum computers. The player has to navigate around a pyramid and solve puzzles in order to lift an ancient Egyptian curse before it causes the Moon to explode, devastating the Earth with its debris. The game was the third to the Freescape system, which allowed for relatively fluid first-person navigation of the game environments.

3D ADVENTURES WITH FREESCAPE

Dark Side was another 1988 Freescape-driven game and the sequel to Driller (see bottom of page). Like Total Eclipse it was available for a number of different 8- and 16-bit platforms. The game is set on the alien moon Tricuspid orbiting the planet Evath. The terrorist Ketars have hijacked the moon's facilities and built an immense beam weapon on the moon's dark side with the intention of destroying Evath.

The player is a government agent secretly sent to the moon tasked with deactivating the weapon before it becomes fully charged. This is accomplished by destroying a power network of Energy Collecting Devices (ECDs) that are positioned around the moon's surface. However, a number of enemies in the form of tanks and flying turrets attempt to stop the player.

While Dark Side is more of an action game than other adventure-oriented Freescape games such as Total Eclipse or Castle Master, it did employ a number of concepts that would make their way into many more-modern 'first-person shooter' games, such as the use of beam weapons, jet packs and shields; and elements such as crosshairs and an HUD.

GAC was another success story for Incentive even at double the price of full price commercial game on cassette. It meant anybody could put together a graphic text adventure and they did,'t require any programming knowledge. To emphasize this point, Incentive released GAC homebrew games on their Medallion label, to not only make profits from, but to also demonstrate what could be possible with the software. It is believed over 117 titles were released with GAC on different computer systems, some were good and others not so good, the whole point about GAC was about the user being involved in creating their own type of RPG game.

Looking back, perhaps this thinking led to Ian and Chris Andrew's original ideas of where they wanted to see home computer gaming. Adventure games were still very limited in what you could experience as an RPG. This experience though, may have brought forward their thoughts for greater realism in games. If it was to be done it had to be created by themselves. The norm of creating 3D games was to use z-buffering to order objects and viewpoints, its very heavy on processor requirements and just wouldn't be able to do what they wanted. Chris's efforts in finding a solution paid off.

Working in assembly rather than another computer language, he was able to devise the box sorting method, allowing each individual element to be held in a bounding box, meaning the z-buffer was capable of being completed with one click instead of many. With some other coding tricks, the Freescape engine was now possible for solid 3D RPG gaming to be played and enjoyed in real time, it was an innovation that was just so far advanced of where the rest of the home computer gaming market was positioned.

What I find interesting about Freescape, is the setting of the first game using the new gaming tech. An alien moon that orbits another world called Evath, in a region of our galaxy 20th century mankind has yet to explore, this moon is called Mitral. Science fiction and being a moon explorer were chosen to be the first location of the new gaming experience. Perhaps this was just coincidence, maybe it was Incentive's way of recognizing the giant leap they had taken in computer games just as humanity had taken that giant leap in history by landing on the moon in 1969. Space travel and moon journeys remained very much part of popular culture in the 1980's just as they are today.

The first Freescape game, **Driller** (1987), was more of a puzzle game than either action or adventure. Driller is set on Evath's other moon, Mitral, which has been left in an unstable state by the Ketars and is going to explode due to a build-up of flammable gases in four hours, destroying Evath with it – unless the player can stop it first.

One does this by navigating a 'probe' around the moon and deploying a number of drilling rigs on its surface, to subsequently drill into it and let the gases escape. There are eighteen regions that must each have their gas levels reduced below 50% to avoid the explosion. Sometimes this requires multiple attempts at positioning each rig. The player must also fend off attacks from security systems by destroying or disabling them.

Driller received many positive reviews from videogaming magazines, including 97% from **CRASH**, which declared it "one of the best games CRASH has ever seen." Its readers also voted it the best game of 1987. **Your Sinclair** gave it 9/10 calling it "superb", and **Zzap!64** and **Amstrad Action** both awarded it 96%.

COMPETITION

BE TOTALLY DAZZLED BY incentive

SOLVE the puzzle . . .
WIN a £1,000 trip for two to Finland . . .
PLUS £200 spending money . . .
SEE a real-life total eclipse!

Once in your lifetime, you just might see a total solar eclipse – a uniquely impressive experience which seems, for a few amazing minutes, to blot out the mighty sun. And to celebrate the release of their stunning Freescape game *Total Eclipse*, which earned over 90% on 8-bit formats last issue and is soon out on 16-bit, Incentive are offering an opportunity to visit Finland in July 1990 and witness a total eclipse.

The five-day trip for you and a friend, worth about £1,000, includes return flights from London, four nights luxury hotel accommodation, tours around the cities of Helsinki and Joensuu, and of course an unforgettable dawn trip to see the total eclipse. Incentive are also throwing in £100 spending money per person, to cover any extra expenses you have.

Totally baffling

To win this once-in-a-lifetime prize, for which you're competing with readers of our sister magazines CRASH and ZZAP!, you'll have to solve the wordsquare.

And to make it extradifficult, we're not going to tell you what all the ten words are. Oh yes, 'Incentive' and 'total' and 'eclipse' are in there, and you'll have to find them. But we'll only give you clues for the others . . .

1 and 2 The two heavenly bodies involved in a total solar eclipse (4 letters, 3 letters).

3 The revolutionary solid 3-D technique which Incentive first used in *Driller* (9 letters).

4 TGM014 described *Total Eclipse* as 'a ??????? experience – a program not to be missed' (7 letters).

5 The country in which Incentive's game *Total Eclipse* is set (5 letters).

6 The capital of Finland (8 letters).

7 The country's second biggest city, located about 100 miles north and just west of the capital (7 letters).

Send your entries to **TOTALLY DAZZLED BY INCENTIVE COMP, TGM, *PO Box 10, Ludlow, Shropshire SY8 1DB* to arrive by February 16**. Usual rules as printed on the contents page apply. All the correct answers will be put into a hat with the correct answers from the ZZAP! and CRASH competitions, which are no easier than this, and one lucky name will be drawn – winning a terrific *Total Eclipse* trip for two.

THE WORDSQUARE

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T A M P E R E S A F
O L O M J K O I I R
T A O V F A K E N E
A I N C E N T I V E
L U W E I G U L B S
S I T S O S Y E A C
A D L O E R F P C A
M E C L I P S E T P
H A H K E T Y R V E
A S N M A G I C A L
```

The words can run up, down, across, or diagonally. When you find one, circle it or put a line through it. If you don't want to damage what Mel Croucher reckons will be a yuppie antique in a few years, send a photocopy of the page.

FUN IN THE SUN

Darkness at dawn: the total eclipse only occurs on a small part of the earth, where the moon blocks the sun's rays. In 1990, it's visible from Finland – where Incentive's prize trip coud take you.

Incentive's *Total Eclipse* may be in every software shop in the land, but real-life total solar eclipses are about as rare as Egyptian pyramids.

The reason? A total solar eclipse (also called a total eclipse of the sun) depends on the moon happening to be right in front of the sun, as we see it from earth. And even then, the eclipse is only visible very briefly (for less than eight minutes) and from a small area.'

Often that's a remote, inaccessible part of the world – most of the world is remote from Britain and inaccessible, after all – which is why very few people will ever see a total solar eclipse in their lives.

For instance, the last one sun took place over the Pacific Ocean around midnight on March 17-18 1988, lasting less than four minutes.

Partial eclipses of the sun, in which the moon only conceals part of the light, are more common – up to five of these can happen in any given year. One will be visible from Cornwall on August 11 1999 (yes, *ninety-nine*).

And then there are total eclipses of the moon, which happen when the earth stops sunlight reaching the moon and it seems to disappear. These are long and quite common – each year there can be up to three of 100 minutes each.

Readers interested in pursuing further the principles of ecliptic astronomy are referred to the work of Irving Berlin, who summed it all up as 'I got the sun in the mornin' and the moon at night'.

22/124 TGM TX 015:2-89

The background story of the Driller game is ideal not only for the Freescape engine but for giving realism to the gaming experience. Evath has two moons, Mitral and Tricuspid. Mitral has been heavily mined by an outlawed people, the Ketars, who have now fled the moon. A vast amount of gas has built up underneath Mitral's surface and should Mitral explode, thousands of Evathians will be wiped out as Evath is thrown out of orbit. This resulting freeze will wipe out your planet's entire population. Scientists have calculated a meteor is due to strike Mitral in a matter of hours and this alone will cause this disaster.

Your overall mission in Driller is to make safe each of the 18 sectors of Mitral by positioning a drilling rig over the gas pockets in each sector before the meteor strikes. In order to achieve this you will need to: (i) Gain access to and enter each ot the 18 sectors. (ii) Determine the gas centre and place the drilling rig on each sector to release at least 50% ot the gas below. (Use geological clues, intuition and trial and error for this). (iii) Locate and absorb sufficient Rubicon crystals for your continuing survival. (iv) Avoid and/or destroy the laser beacons, and scanners. As a sub mission: Amass as high a success rating as possible!

When playing the game now, the Freescape engine may not appear to be anything special in today's gaming terms, but back in 1987, it blew away home computer gamers, original, unique, mesmerizing, it was an instant success story, receiving high acclaim from all the magazines for every home computer it was released on.

Concept and game designer of Driller, Ian Andrew wrote in the Amstrad CPC game manual "Freescape represents many thousands ot man hours committed to bringing this great advancement in realism to your computer screen. For the first time, your can explore a solid, three dimensional environment with complete freedom of movement. You can move to any point in 3 dimensional space and then look in any direction and see the view as if you were actually there. The full perspective of the alien environment, complex gameplay and vast detailed landscape contribute to the uniquely absorbing atmosphere of Driller."

While the first game in the Freescape series took about a year or more of development, the second and sequel to Driller, Dark Side was released around 6-9 months later in the middle of 1988. Even quicker, a third game in the Freescape series, Total Eclipse was launched at the end of 1988. Both games again having settings or themes based on or about moons.

Dark Side is set 200 years on from Driller, however this time the action takes place on the dark side of Evath's other moon, Tricuspid. The Ketars who had set up Mitral to explode are back for their revenge, this time though they have constructed a massive weapon called the Zephyr One and they plan to blow up the planet Evath once and for all. Your mission is to destroy the Electronic Collection Devices (ECD's) that will be used to power up the Zephyr one within a time limit. If successful you will make it inoperable if not, then the Zephyr One will arm and blow the planet to rocks and dust. Dark Side introduces more elements than Driller, with much improved speed of movement and a lot more puzzles to solve.

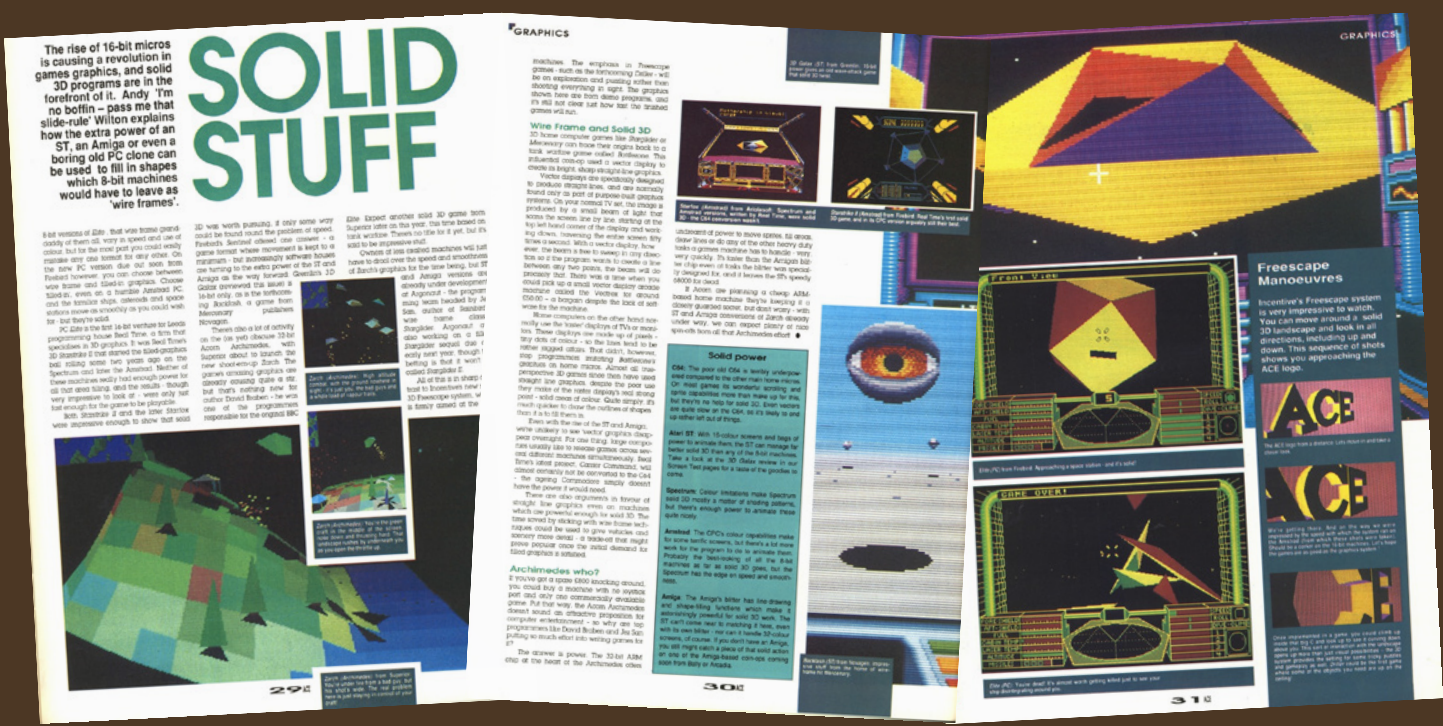
Total Eclipse, the third game in the Freescape series sees your mission take place in Egypt. In ancient Egypt times a high priest had set a curse on the people as they had stopped worshiping and providing sacrifices to the sun god Ra. A great pyramid had been erected, at the top most chamber a shrine was built for Ra the Sun God. The curse was set, should anything ever block the sun's rays during daylight hours it would be destroyed. Now it is 26th October, 1930 and in just two hours the moon will totally eclipse the sun, triggering the curse of Ra. The offending moon will explode showering the Earth with colossal meteorites and upsetting the ecological balance plunging civilization into a dark age of starvation and conflict. It is 8 o'clock, you have just landed your b-plane next to the great pyramid. Your mission is to reach and destroy the shrine of the Sun-God Ra which is located at the apex of the pyramid.

The graphics of the Freescape games mentioned above, may have been geometry based, looking rather pointed and edged shaped but it was truly realistic for the era. The reader must remember we are going back in time, some 31 years ago, as mentioned above, Freescape was designed with very limited hardware and memory, however it proved to be very adaptable. You could use the Freescape engine to create different 3D environments consisting of as many extras as the machines memory and processor speed would realistically perform. Extras may have been cuboids, four-sided frustums (called pyramids by Freescape), triangles, rectangles, quadrilaterals, pentagons, hexagons and line segments. A "sensor", was used for gaming purposes to detect the position of the camera relative to the sensor in the game world. Actual gameplay may seem inexplicably slow-moving by today's standards, patience was essential as you were for the first time moving in a game as if you were there yourself, walking about exploring, going through doorways, shooting at laser beacons – you know the usual stuff you would find while exploring a new world.

With each new game that was released utilizing the Freescape engine and there were six in total (Driller, Dark Side, Total Eclipse, Total Eclipse II, Castle Master and Castle Master II), improvements were made in overall speed and playability as well as some form of enhancement on the previous game.

Driller was basically exploring and getting to grips with a first person RPG. Dark Side was more involved. You had a jet pack from the beginning of play and now the gameplay involved a blend of arcade, strategy and adventure. The speed of movement had increased about five per cent on Driller. While the first two games were wide open, roaming experiences, the third game in the Freescape series, Total Eclipse saw your character entrenched inside a tomb of a pyramid and to get to the top chamber felt like trying to find the exit out of my local Ikea store. Once again an increase in speed of about five per cent in comparison to Dark Side. The game's appearance looked much more simplified with larger sprites and less instruments on the head up display.

While Freescape was a successful venture for Incentive software, it really took everybody by surprise, as if gamers, the home computing gaming industry and the 1980's just weren't ready for this type of gaming to be the norm. It didn't kill off RPG graphic and text based adventure games and it sure didn't see the big players the likes of Ocean Software, Codemasters, Gremlin, Virgin et al changing what they had already been doing. Other software houses just did not jump on board with this new gaming tech nor did they decide to make clones of copying Incentive's style of first person 3D RPG gaming – that was to come to ahead in the 1990's


GRAPHICS

SOLID STUFF

The rise of 16-bit micros is causing a revolution in games graphics, and solid 3D programs are in the forefront of it. Andy 'I'm no boffin – pass me that slide-rule' Wilton explains how the extra power of an ST, an Amiga or even a boring old PC clone can be used to fill in shapes which 8-bit machines would have to leave as 'wire frames'.

[illegible]

Wire Frame and Solid 3D

[illegible]

Solid power

[illegible]

Archimedes who?

[illegible]

Freescape Manoeuvres

Incentive's Freescape system is very impressive to watch. You can move around a solid 3D landscape and look in all directions, including up and down. This sequence of shots shows you approaching the ACE logo.

29 30 31

POINT + CLICK

Exploring space as a means to an end, to re-colonize your population, with the hope of one day returning to a habitable Earth is your only objective. This may sound extremely dire, but humanity has always lived in hope. Almost 30 Earth years have passed that brought Millennium 2.2: Return To Earth to prominence as one of the most classic mouse-driven, point and click adventure / strategy games.

Four years before the release of Millennium 2.2 , game designer and programmer, Ian Bird, had previous experience in strategy gaming working on the graphics of 1985 war simulator, Theatre Europe (by Personal Software Services or PSS). In between 1985 and 1989 information on whether Ian worked on any other games appears scarce. Perhaps he was working on Millennium 2.2 during those years? It would make a great deal of sense as i am sure the development time would have been extensive.

What you get with Millennium 2.2 is at its core, is a resource management computer game. Only released on Atari ST, Amiga and MS-DOS, I say only because its a shame that the 8-bit systems didn't get to enjoy this game as well. As a point and click graphics adventure strategy game it certainly would be possible. While the Atari ST and Amiga versions were of the same name, the MS-DOS version of the game was released as Millennium: Return to Earth, dropping the 2.2 from its title.

You just don't see good old space simulators like this one for computers nowadays. If you have not heard of or played Millennium 2.2 before, it's everything that's good about being stuck on a lonely moon base - if that's possible!

MILLENNIUM

The year is 2200. An asteroid has decided it would be fun to crash its way onto the Earth, which has now obviously made Earth uninhabitable. This is depicted at the start where you see the colour of the Earth change from blue to grey, strange that you don't see the destruction of the asteroid destroying the Earth, it would have been the proper game opening. All but two colonies remain after the cataclysmic event. One colony is based on the Moon, the other is based on Mars.

You play as the Moon based colony, needing to explore the solar system to achieve the end goal of getting back to your original home on Earth. As it happens not all humans are the same. The colony based on Mars happen to have taken a turn for the worse, no longer human, instead they have become mutant humans. They are not friendly by any stretch of the imagination, in fact they are completely ugly in every sense of the word, they let the humans on the Moon base know that if there is any exploration by them outside of the Moon it will be considered as an act of aggression and they will attack the human Moon base colony with deadly force.

■ REVIEWS ■

MILLENNIUM 2.2

Get in shape for Armageddon

ONCE I attended a lecture by a well known professor of astronomy who prophesised that hellfire and brimstone will soon be upon us. The Solar System is surrounded by a shell of material known as the Oort Cloud from which comets probably come.

Every 30 million years this cloud is perturbed by something massive, with the result that a great hail of debris rains down on the Sun. Some hits Earth, which explains the Ice Age and the extinction of the dinosaurs.

To compound the danger there are no less than 40,000 asteroids whose orbits cross our planet's path. The learned gentleman concluded that Earth was due to be done in within the next 30,000 years and that all nations should forget such trivia as defence spending and the International Monetary Fund and instead club together to build a filthy great laser to zap any lumps of rock that come too close.

And you thought computer games were abstract and had nothing to do with real life.

According to Electric Dreams, the end of the world will be rather earlier than expected: 2,200 AD. Some people, including yourself, will have escaped to the Moon where your task will be to colonise the Solar System.

The ultimate aim is re-colonising Earth, using various pieces of equipment to extract useful material from the Moon's crust. With this you will make craft which can be sent to the asteroid belt for more materials with which to build the ships that can colonise worlds.

The main screen shows a grandiose 3D view of the planets moving around the Sun. Clicking on a planet zooms in and shows its moons. Clicking again shows whether the planet is colonised and, if it isn't, whether it is worth doing so.

There is a row of icons across the top of the screen, the most important being the Moon base. Here you start with nothing save a small stock of minerals and a little power from a generator. You begin by researching and building a larger generator, which allows you to produce more power and thus turn on your mining equipment, which allows you to dig for the raw materials which you need to produce even bigger generators, which give you enough power to build craft that can leave the Moon's surface and report on other planets, which allows you to build life support systems....

Pretty soon, you have a beehive of activity, with all sorts of things being built and several expeditions to other planets going on at the same time. There is a save option, which is welcome, because a single game can easily take days.

Needless to say, everything doesn't go smoothly. If you build too many generators too quickly they will explode and you will have to start again. You have Martians as enemies and will often have to defend against them. But no two games are the same, and you may well manage to get probes off the ground before threats are sent over the electronic bulletin board.

As a games reviewer you quickly learn to detect an ST port with your eyes closed and fur on your tongue. Millennium 2.2 is yet another. Basically, it is is an infinitely expanded variant of Kingdom, the golden oldie which had you balancing the books of an ancient dynasty while ensuring that the population didn't get too restless and depose you. But the good presentation and huge variety of options brings it bang up to date.

Despite the could-do-better graphics and sound, plus the extremely terse instructions, Millennium 2.2 is a surprisingly addictive game. It grows on you, provided you stick with it. It should keep you frustrated for months.

Alastair Scott

The asteroid belt is a good source of new materials

Millennium 2.2
£24.99
Electric Dreams

Sound
Graphics
Gameplay
Value

Overall – 72%

The graphics are good, but they could have been so much better on the Amiga

32 AMIGA COMPUTING September 1989

No, its not a fighting shoot me up, but it does have those elements, perhaps to add realism and to keep you on your toes that you just can't forget about building spacecraft to attack the Martian mutants. Unfortunately you are starting life on the Moon base 'bare to the bones', so to speak. You don't start with any great weapons and to get them you will need to mine for uranium to produce orbital lasers that will help you repel the Martian attacks.

Combat is represented with a space ship fighting mini-game, probably the most awful part of the game as its basic 3D graphics representation of warfare are not exactly what makes this game a classic. While you are aware of the clock ticking away in real time, I couldn't feel any sense of being in a race against time. You do need to be proactive in your efforts but you are given the opportunity to ease in and learn the game if you have not played it before.

As the commander of the Moonbase you have to make decisions if you are to ensure the survival of mankind. Making those decisions are all about how well you manage all of your exploration, resource collection and daily activities. It's imperative to start with research. Then deal with your energy consumption as you need power to maintain a consistent production line while maintaining the refinery. A bunker is essential for stockpiling important items. Most critical to your success of all is colonization of other Planets and Moons.

To do this will require building and sending out probes, not just one but lots of them. You can send them out to Planets, Moons and asteroid belts. Probes can be lost while hurtling their way to a destination, so if you are going to find out the information you need, make sure you are probing the galaxy as much as possible. Successful probes will provide you with the information you need to make the decisions on whether to undertake mining for resources or if you are able to colonize and take over Planets and Moons.

At first it is possible only to mine asteroids before a suitable planetary colony can be discovered and established. Out of fifteen ingame resources, only silver, uranium, and chromium cannot be obtained by mining the Moon or Asteroid Belt. Amiga and Atari ST versions are predictably the same, in the DOS / PC version, resources are largely randomized for different planets, as is atmosphere determining if mutations occur, with notable exceptions of Earth, Mars and Moon.

2.2 GEORGE BACHAELOR

Depending on planetary orbits, colony ships and probes can take longer to reach their destinations. As time progresses, colonists will adapt to different atmospheres and after Earth is terraformed, secede from the player's control (this event will also strand any of player's ships that may be docked on those planets). The game operates in a realistic manner, so moving from one Planet to the other can take several days, usually a month or two. So it's best to plan ahead rather than just haphazardly hop from Planet to Planet. Once you build up other colonies in the solar system, the game really starts to come into its own as you try to keep your bases alive with supplies and other equipment.

Point and click play allows you to operate all functions necessary providing a more enhanced, thorough gaming experience. Sure it has its limitations, more so on when you are under attack (better use the joystick for this part), yet for the majority of the game, the control system ensures smoothness of gameplay, quick decision making and increases the amount of tasks you can perform. With it makes the learning curve tremendously fast, without it, I can only imagine how annoying and frustrating learning and progression would be.

With just once click you can point the cursor to zoom in on the solar system, zoom out of the solar system, you can forward time by an hour or by a day, you can open up a message bank bulletin board if you need to, you can see how many spaceships you have built, you can open up the data base to see what Planets and Moons you have explored and you can also find out much, much, more; including your life support, your energy, your research, your defence, your resources and your production levels. Millennium is as much a classic for the use of it's point and click as it is for its strategy and adventure.

Graphically it depicts space exploration, images of probes, your Moon Base, its essential equipment and all other items in an extremely life like manner. If I am going to want to be on a Moon Base then I sure want to be here, the graphics aren't stupendously insanely cool, but I am not disappointed either as it's recreation is very admirable and the gameplay and playability of the point and click more than make up for it.

I have read commentary that Millennium 2.2 is not very challenging, but the narrative and general management is very absorbing. I would disagree with the first part, especially as a first time player, because the game came with little detail in the instruction booklet, which was deliberately designed, so there was the first challenge ☒- you really didn't know what some equipment was designed for, or could actually do. Atmosphere of the game has retained its appeal, especially with the terrific music by David Whittaker, which just happens to be Gustav Mahler's Adagietto from Symphony no. 5.

THE VERDICT:

Millennium 2.2 is one of those great strategy games, very progressive for its time and often overlooked at its release at just how good the game and its point and click design was.

Perhaps people found it rather too easy to play and complete, that's not a negative to me. Games like this, you need to feel the exploration of space. Be able to venture forth to other Planets, settle colonies, mine the resources and that's what Millennium 2.2 does so very well. A sequel was released two years later by Ian Bird, in 1991, called Deuteros: The Next Millennium. Deuteros is set 800 years after the first game, once again a resource management game, much larger and harder than Millennium 2.2. So play this first before you play the sequel. In 2006 Rick Blackwell and Steve Demuth only had three months to develop their very own Millennium 2.2 remake for the 2006 Retro Remakes competition, which is also worth checking out.

Developed by Ian Bird, Millennium 2.2 was released in 1989 for the Atari ST, Amiga and MS-DOS by software publisher Electric Dreams. In the game, an asteroid has hit the Earth and rendered it uninhabitable. As commander of a small colony on the Moon it is your job to ensure the survival of humanity by exploring the Solar System for other habitable planets and moons, and ultimately re-establish life on Earth. But a race of mutant former-human colonists on Mars also wants Earth for themselves, making war inevitable.

MILLENNIUM 2.2

NEW COMPUTER EXPRESS • 10 JUNE 1989

ELECTRIC DREAMS
Amiga £24.99dk
Also on ST
Out soon on PC

Possibly the most eagerly awaited strategy game ever, *Millennium 2.2* has finally blasted off.

● GAMEPLAY

If you're bored with controlling mundane Earthly forces, then *Millennium 2.2* may just appeal to your megalomania, as it throws you into the hectic task of rebuilding civilisation after the entire population gets wiped out in a planetary collision. All that's left is you and 100 colonists on the moon, so you'll not only have to survive but also pick up the shattered pieces of humanity.

In game controls are via icons and selection screens, as you strive to balance life support, production and research with energy and defence – while keeping an eye on your resources.

● GRAPHICS AND SOUND

Visuals are subtle rather than stunning, but are well above the norm for a strat game. Audio is a little disappointing but not as much as the appalling intro sequence – we doubt whether this will attract many punters in the stores.

● OTHER VERSIONS

ST *Millennium 2.2* differs from the Amiga version only in audio quality – luckily it's the gameplay that counts in this one. We haven't seen the PC version yet – watch out for an update.

● EXPRESS VERDICT

Millennium 2.2 offers a lasting challenge backed up with atmospheric visuals and more than a touch of originality, thanks to its workable blend of adventure and strategy.

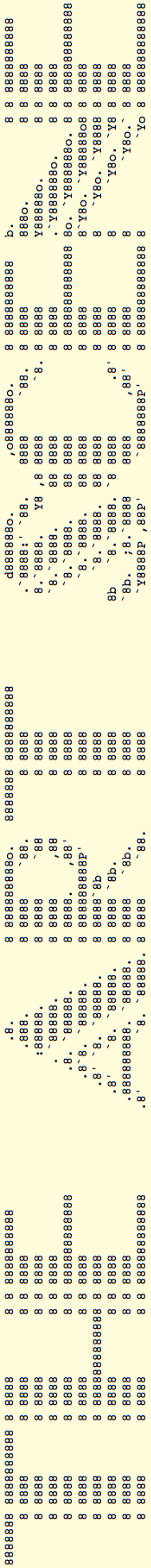
5 GAME

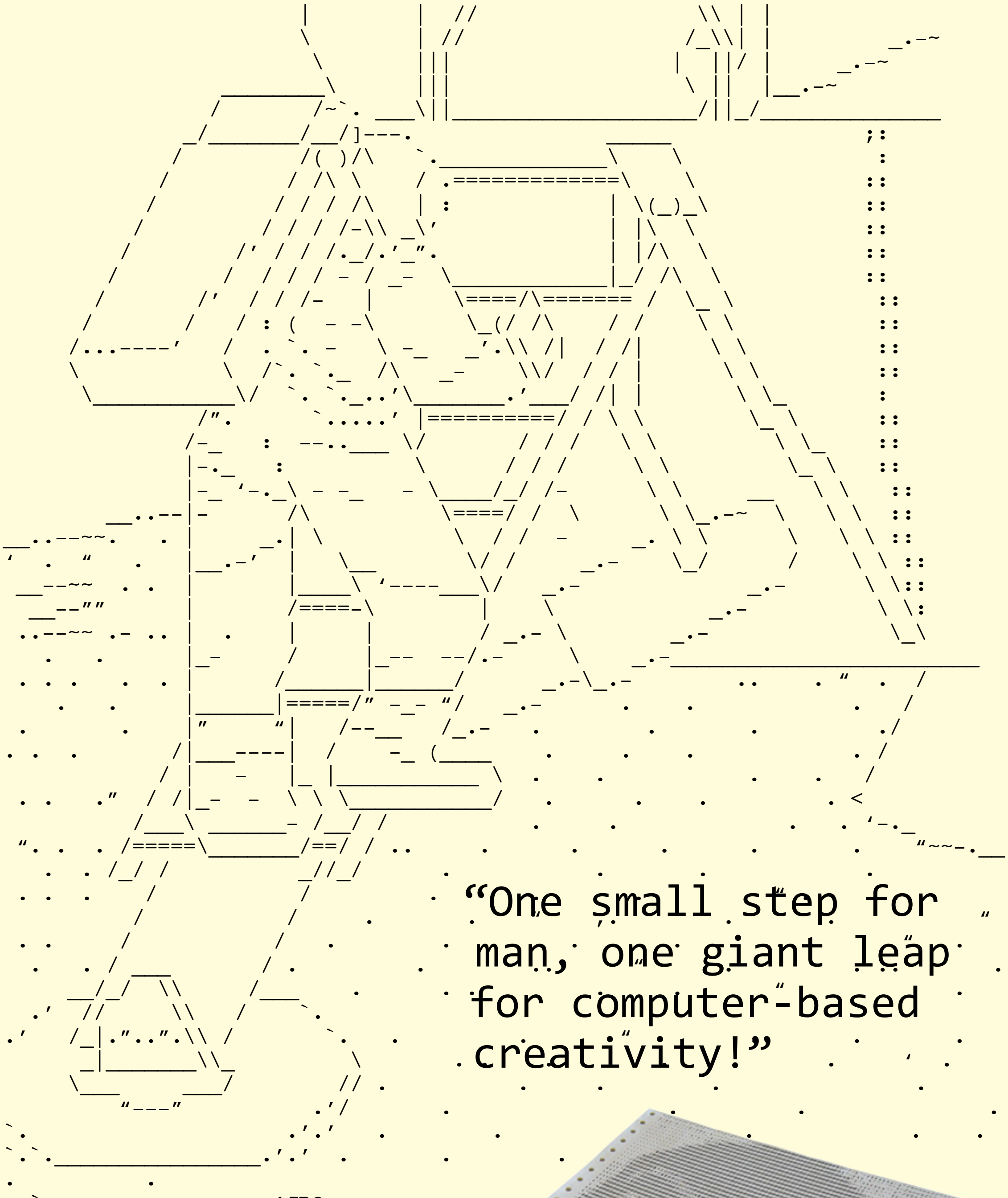
Rik Haynes

• All I need is the air that I breathe...and there's not much

• Checking on the batteries – let's hope they're Duracells

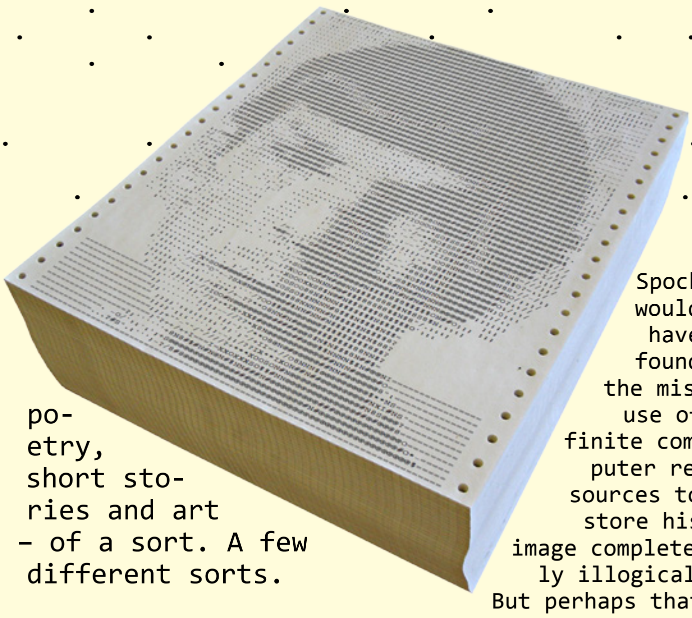
• The green, green grass of home. Well, grey dust, actually





JRO

“One small step for man, one giant leap for computer-based creativity!”



Spock would have found the misuse of finite computer resources to store his image completely illogical. But perhaps that was the point – a demonstration of human frivolity in the cold face of the wholly logical computer. Whatever the reason, Spock’s mugshot was a common resident of university mainframes’ hard disks.

Around the time of the first moon landing, graphical CRT-based displays were only just becoming available – up until then (and in many cases well into the 1970s) text-only printers were your only way of communicating with a computer. Now, while mailing lists, statistics and scientific analysis were all things that commonly found their way to paper, as the storage available to mainframes grew so did the variety of data on them. This data soon included works of human expression, including poetry, short stories and art – of a sort. A few different sorts.

The first sort of art consisted of simple alphanumeric conversions of photographs. A scanning beam would sequentially determine the darkness of each coordinate on a grid. An algorithm was then used to

Art finds a home in any medium, and the monospaced ASCII computer text standard was no exception.

The first widespread computer-facilitated copyright infringement was this guy.

translate each "spot" into an ASCII character, based on the density (or the amount of paper they blackened) of each letter. At a distance the human mind ignores the characters themselves and instead "sees" the larger monochrome image they collectively form. This is why we see images of Kirk and Spock on the top of the two stacks of fanfold paper gracing this spread, rather than the jumble of letters, numbers and symbols that they (also) are.

These pictures were quite popular with computer users (read: nerds) in the 1960s and 70s, but they would become more mainstream in the late 70s and early 1980s when some enterprising individuals utilised more portable minicomputers to translate video images on the fly, touring shopping malls around North America and offering shoppers "computer photographs". These folks would shoot a perfectly good full-colour TV image of you and yours and turn it into a low-resolution, black-and-white printout, then erase the video frame and sell you the sheet of fanfold paper, tractor holes and all – and people loved it! There really is no accounting for taste. ;)

Not surprisingly, the novelty quickly wore off. But a new technical phenom was soon on the rise – computer telecommunications. On-line services such as CompuServe and local 'bulletin-board systems' run by computing enthusiasts allowed people to exchange text-based messages across their city (country, or the world). The need for more emotional context gave rise to the emoticon, the now familiar B) >:(=/ of on-line discourse which morphed into the modern-day emoji, but these simple two or three character pictographs also had multi-line variants such as:

```
\|/          (__)
     `\------(oo)
       ||    (__)
       ||w--||     \|/
       bb   bb
```

These sorts of artworks could be quite sophisticated, such as the lunar astronaut at the top of the previous page.

The next page contains a few examples of ASCII art in various styles. Try to make some of your own!

FEBRUARY 1979 Personal Computing

A Success Story: Computer Photography

Technology has inspired development of several small businesses, but few of those can match the business — and success — of a little known enterprise generated by NASA when it transmitted the first pictures of the moon to the earth.

That breakthrough, which enabled the world to see close-ups of the moon for the first time, was a computer photograph. Since then, computer photography has become one of the fastest growing small businesses in the country.

In computer photography, a TV camera takes your image (the image can be live or on a photograph), freezes it and quickly prints it out (55 seconds) on computer paper. This same system was used in the space program to transmit TV images from the moon to earth via computer.

Computer photographs are sold primarily at fairs, malls and shopping centers where the business has become a big traffic builder and moneymaker. One of the companies in this business is Computer Amusement Svstems Inc. (CASI) of New York.

CASI's founder, Sam Kendes, first saw the potential of computer photographs more than two years ago. Kendes was captivated by a computer photograph machine and the crowds it attracted in New York's Times Square in early 1977. The more he investigated the budding young business, the more intrigued he became. Within a few months, he founded CASI.

According to the company, CASI's photographs have generated the following:

— $640 in sales in less than two hours at an amusement park in Los Angeles.

— $3000 in sales in less than 10 10 days at a department store in an Illinois suburb.

— $5000 a week for 38 weeks at a tourist attraction in southern California.

The CASI unit, which ranges in price from $7900 to $12,500, produces a picture that costs 10¢ and is sold for anywhere from $2.50 to $4. It can be transferred to T-shirts, handbags, calendars and even dartboards. The computer photo has attracted everyone from kids who want their favorite rock star's photo on a T-shirt to mothers who want a picture of their kids on a canvas handbag, calendar or T-shirt.

What makes the photo so appealing? Theorizes Kendes, "It combines three elements in society today — instant pictures (the Polaroid concept), television (which shoots the picture) and computers.

Another form of ASCII art used text characters to form not pictograms but instead larger text characters, such as in the titles for this department. This allowed for the representation of different typefaces on devices that were constrained to a single font, such as a line printer, mainframe terminal or DOS-based computer.

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      .o.        .oooooo..o   .oooooo.   ooooo ooooo            .o.                     .
     .888.      d8P'    `Y8  d8P'  `Y8b  `888' `888'           .888.                  .o8
    .8"888.     Y88bo.      888           888   888           .8"888.     oooo d8b .o888oo
   .8' `888.     `"Y8888o.  888           888   888          .8' `888.    `888""8P   888
  .88ooo8888.        `"Y88b 888           888   888         .88ooo8888.    888       888
 .8'     `888.  oo     .d8P `88b    ooo   888   888        .8'     `888.   888       888 .
o88o     o8888o 8""88888P'   `Y8bood8P'  o888o o888o      o88o     o8888o d888b      "888"
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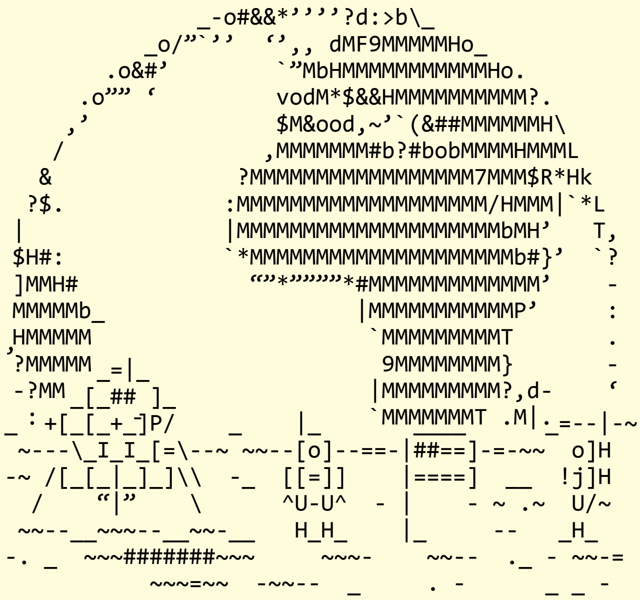

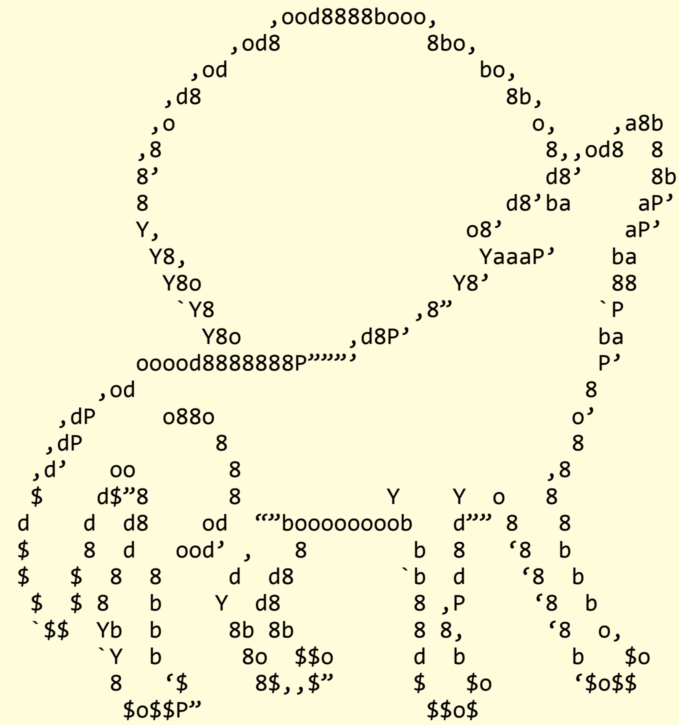

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 ----------------------------------
|        June, 20th, 1969          |
|  Here Men from the Planet Earth  |
|   First set Foot upon the Moon   |
| We came in Peace for all Mankind |
 ----------------------------=apx=--
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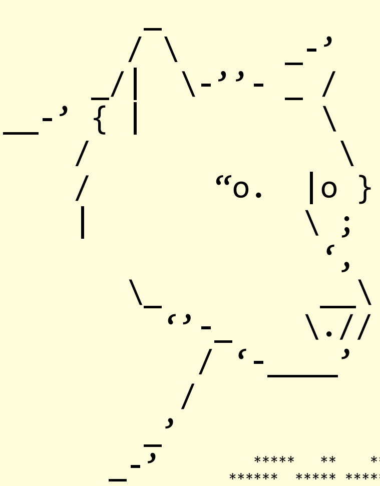
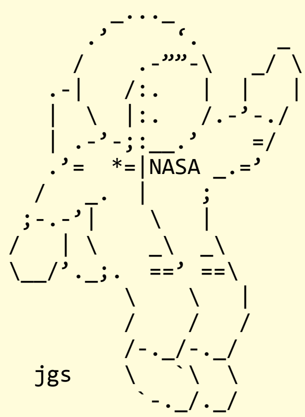
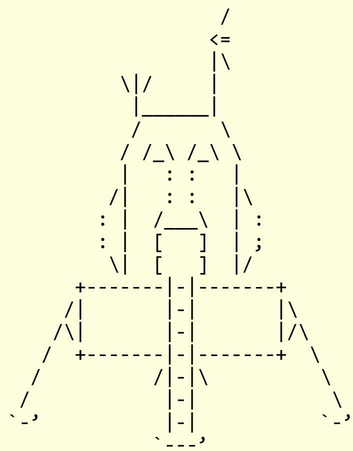
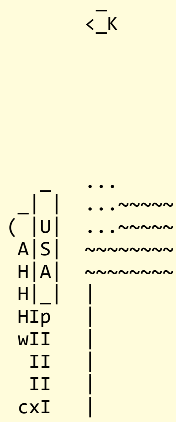
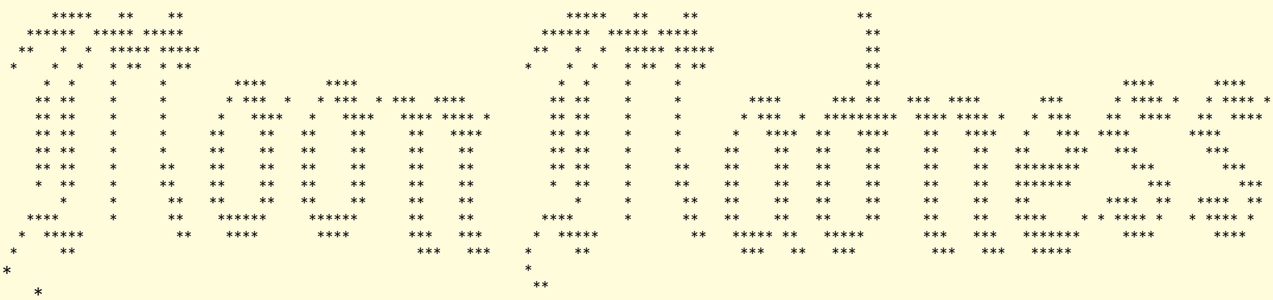
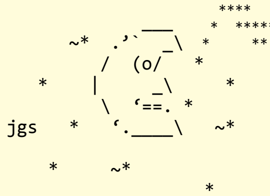


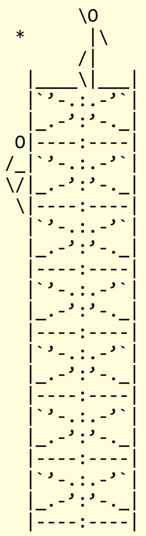


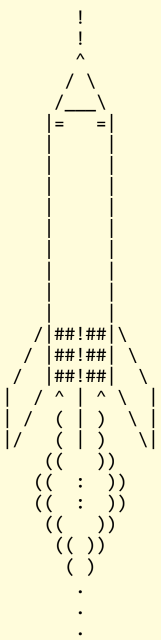










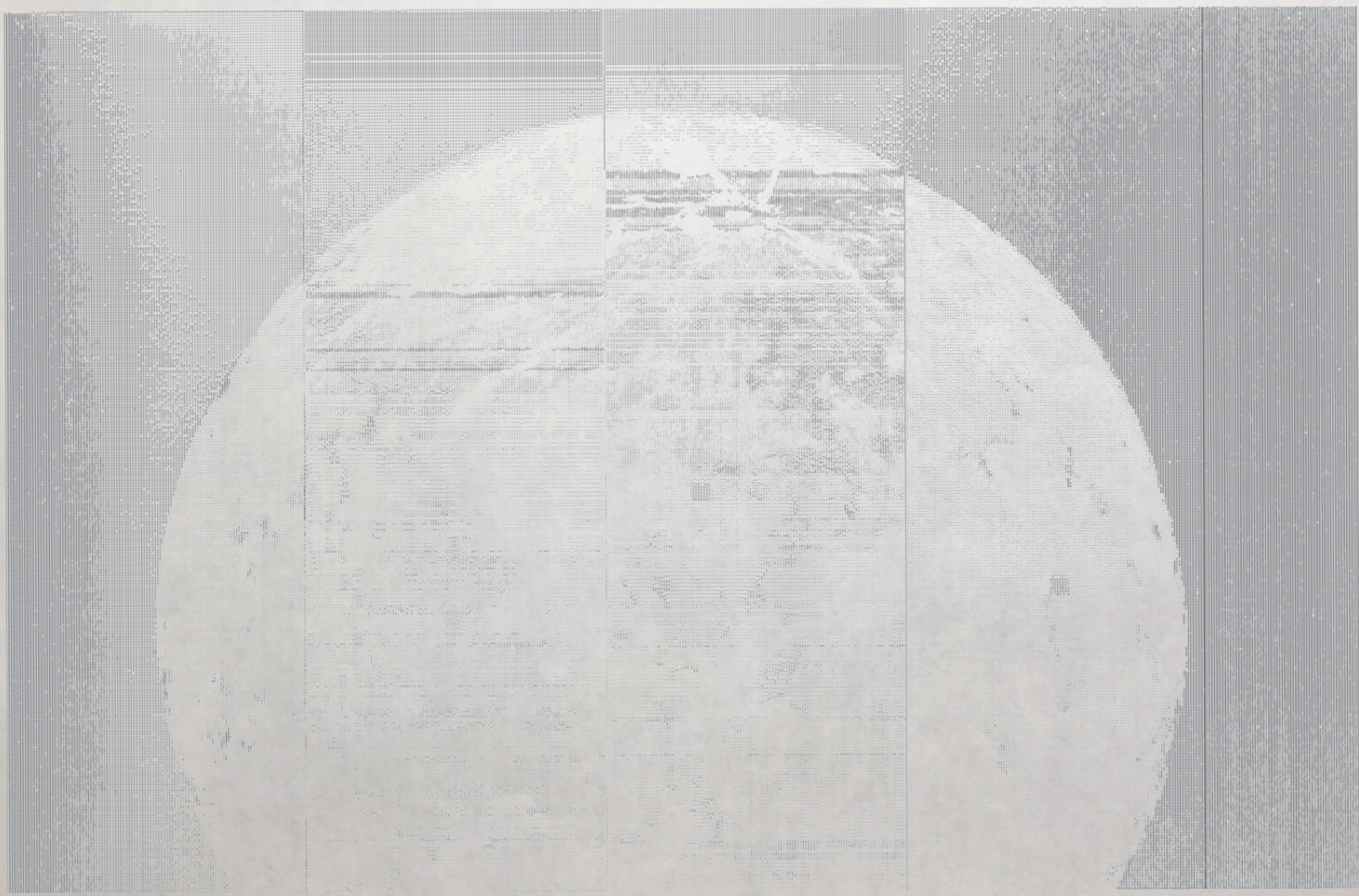


See www.asciiart.eu for more ASCII art!

Samuel Harbison was an undergraduate computer science student at Princeton university in 1973, where he worked part-time in the computer graphics laboratory of the Department of Biochemistry. The department had a digital densitometer it used to scan X-ray films of crystals in order to create 3D models of them.

Samuel had seen pictures created using text characters, and realised he could use the densitometer to scan negatives of 35mm photographs and then convert the 8-bit grayscale data the machine produced into text. He wrote a FORTRAN program on the university's IBM System/360 that inverted the negative image and then assembled it from a selection of 16 different character patterns.

Each picture was segmented into strips of 132-character wide line printer output (the image of Buzz Aldrin to the left is made up of three strips, but unfortunately the third in the file we located was corrupted.)



the PR shop

Before one could land on the Moon, one needed to learn more about it.

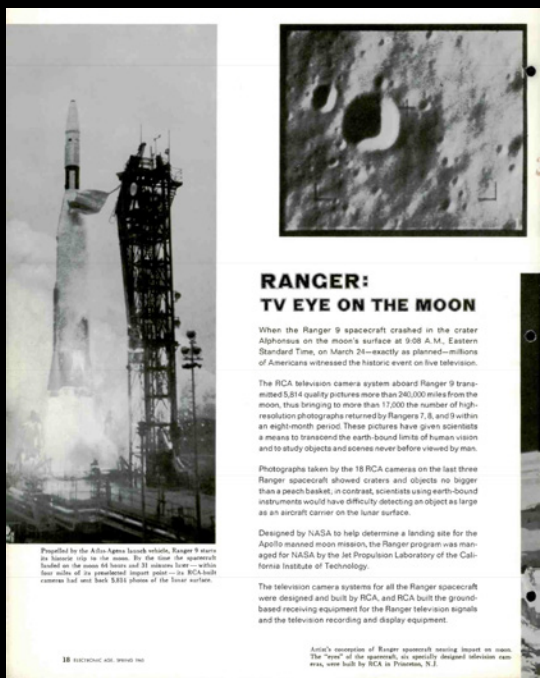
What was the surface made of? What was the terrain like? Where would we land? The Ranger missions hoped to assist in answering all of these questions.

But while it should be relatively simple to send a space-craft to snap photos of the Moon, how would you get them back?

The answer was to not take photographs at all.

But before resolving the photography question, NASA first had to get a probe to the Moon – which turned out to be more difficult than previously thought. A number of attempts made during the Pioneer space probe program of the late 1950s ended in various – and at times catastrophic – failures. Spurred on by the success of the Soviet's Luna 1 lunar probe earlier that year, in March 1959 the Pioneer 4 mission finally managed to escape Earth's gravity and make a lunar flyby – while it didn't return any images, it did transmit back radiation data, and proved the viability of deep space radio communications and the ability to track spacecraft.

Pioneer 4's success helped to embolden the Americans in their aspirations for a manned lunar mission, in part to get one up on the Soviets. But they would need to get more information about lunar conditions before sending people there. Which would mean more probes.



Propelled by the Atlas-Agena launch vehicle, Ranger 9 starts its historic trip to the moon. By the time the spacecraft landed on the moon 64 hours and 31 minutes later — within four miles of its preselected impact point — its RCA-built cameras had sent back 5,814 photos of the lunar surface.

RANGER:
TV EYE ON THE MOON

When the Ranger 9 spacecraft crashed in the crater Alphonsus on the moon's surface at 9:08 A.M., Eastern Standard Time, on March 24—exactly as planned—millions of Americans witnessed the historic event on live television.

The RCA television camera system aboard Ranger 9 transmitted 5,814 quality pictures more than 240,000 miles from the moon, thus bringing to more than 17,000 the number of high-resolution photographs returned by Rangers 7, 8, and 9 within an eight-month period. These pictures have given scientists a means to transcend the earth-bound limits of human vision and to study objects and scenes never before viewed by man.

Photographs taken by the 18 RCA cameras on the last three Ranger spacecraft showed craters and objects no bigger than a peach basket; in contrast, scientists using earth-bound instruments would have difficulty detecting an object as large as an aircraft carrier on the lunar surface.

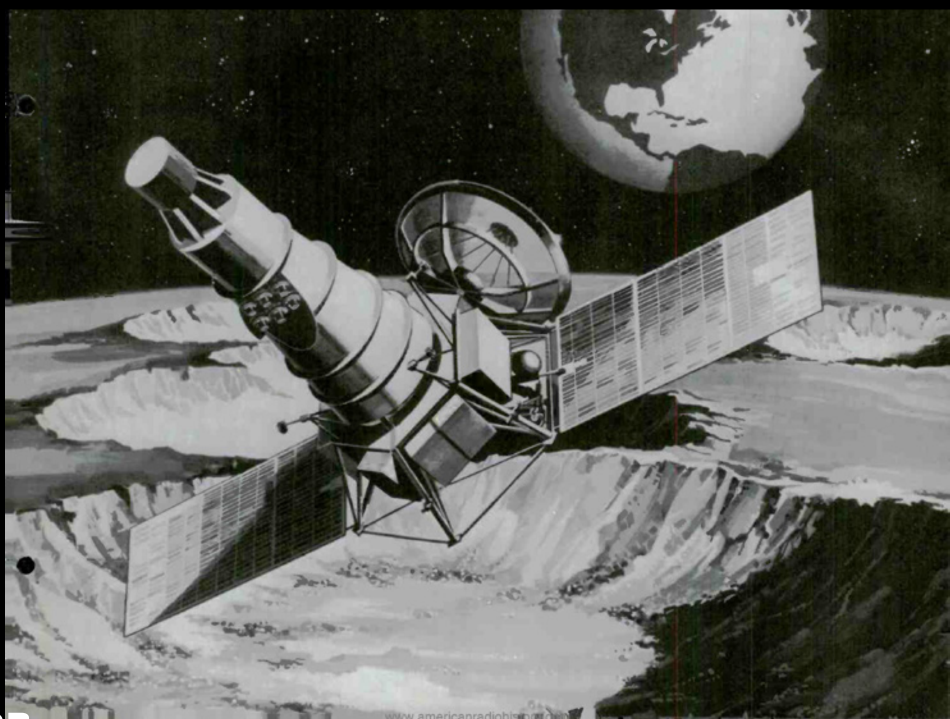
Designed by NASA to help determine a landing site for the Apollo manned moon mission, the Ranger program was managed for NASA by the Jet Propulsion Laboratory of the California Institute of Technology.

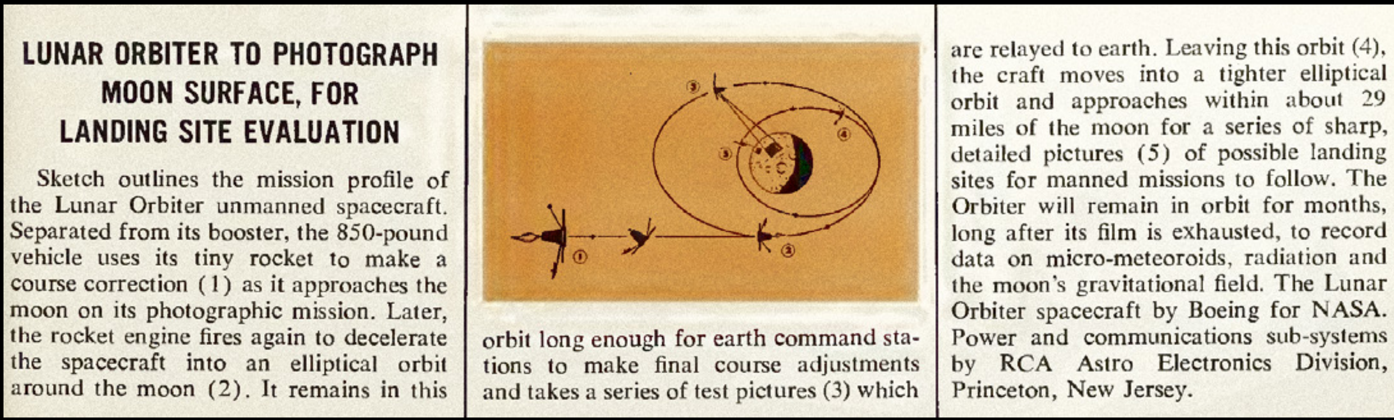
The television camera systems for all the Ranger spacecraft were designed and built by RCA, and RCA built the ground-based receiving equipment for the Ranger television signals and the television recording and display equipment.

Artist's conception of Ranger spacecraft nearing impact on moon. The "eyes" of the spacecraft, six specially designed television cameras, were built by RCA in Princeton, N.J.

18 ELECTRONIC AGE, SPRING

RCA's Electronic Age magazine [above] trumpeted the success of the Ranger 6 through 9 missions. RCA provided the video cameras used on the probes.





LUNAR ORBITER TO PHOTOGRAPH MOON SURFACE, FOR LANDING SITE EVALUATION

Sketch outlines the mission profile of the Lunar Orbiter unmanned spacecraft. Separated from its booster, the 850-pound vehicle uses its tiny rocket to make a course correction (1) as it approaches the moon on its photographic mission. Later, the rocket engine fires again to decelerate the spacecraft into an elliptical orbit around the moon (2). It remains in this orbit long enough for earth command stations to make final course adjustments and takes a series of test pictures (3) which are relayed to earth. Leaving this orbit (4), the craft moves into a tighter elliptical orbit and approaches within about 29 miles of the moon for a series of sharp, detailed pictures (5) of possible landing sites for manned missions to follow. The Orbiter will remain in orbit for months, long after its film is exhausted, to record data on micro-meteoroids, radiation and the moon's gravitational field. The Lunar Orbiter spacecraft by Boeing for NASA. Power and communications sub-systems by RCA Astro Electronics Division, Princeton, New Jersey.

After the Soviet Luna 3 probe took pictures of the dark side of the Moon and radioed them back to Earth, in late 1959 the Ranger program was established to send probes the the Moon with the intent of acquiring further both scientific data and imagery. But the success of Pioneer 4 turned out to have been a bit of beginners' luck.

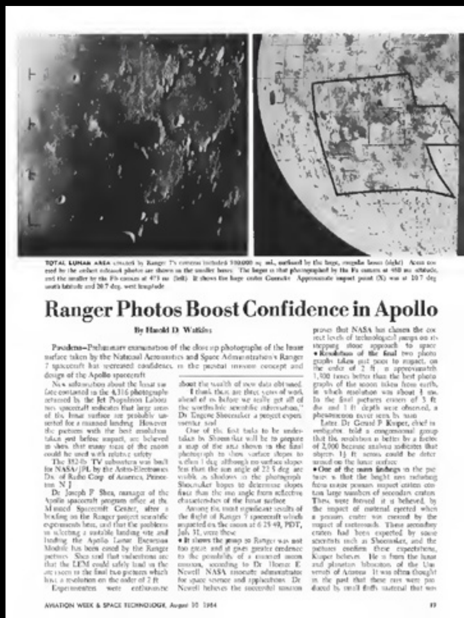
Perhaps due to corner-cutting in NASA's frantic quest to land humans on the Moon before the Soviets, the first six Ranger missions failed. Problems with the launch vehicle left Rangers 1 and 2 in short-lived low-Earth orbits. Rangers 3, 4 and 5 missed the Moon, suffered equipment failures and missed the Moon again, respectively.

The program's early expensive failures earned it the derisive nickname 'shoot and hope', and the US Congress launched an investigation into 'problems of management' at NASA and the Jet Propulsion Laboratory (JPL) – not the kind of launch NASA preferred.

Just before the launch of Ranger 6 it was discovered that gold plated on to elements inside a type of diode used in the Rangers' circuits could flake off and float about in zero gravity, shorting out the diodes. It took three months to replace the diodes and retest the probe, but while Ranger 6 made it to the Moon, a charge of static electricity picked up in the Earth's atmosphere damaged the circuitry responsible for switching on the video cameras. Congress was furious and held more investigations.

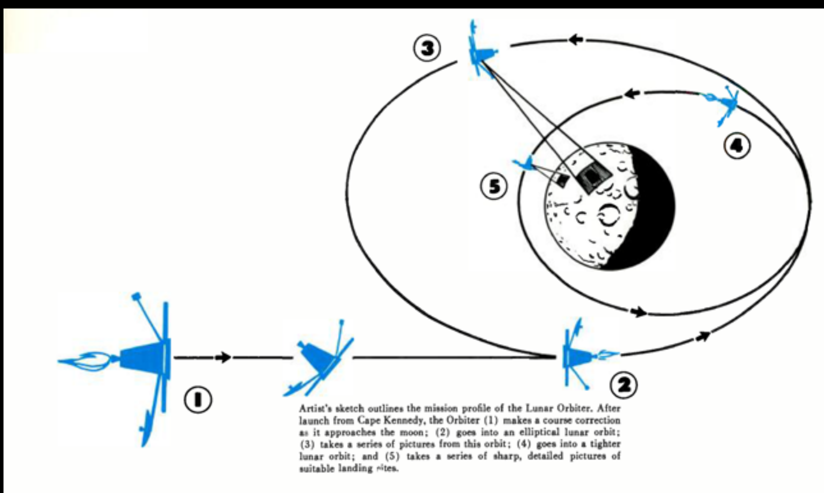
But finally, Ranger 7, launched on the 28th of July, 1964, both made it to the Moon and returned video images, to the great joy of those involved. After the misery of six failures, NASA engineers finally had confirmation their design of Apollo's landing gear was prudent, and lunar scientists were able to confidently determine the substance and makeup of the Moon's surface.

The Rangers made Apollo possible.



Ranger Photos Boost Confidence in Apollo

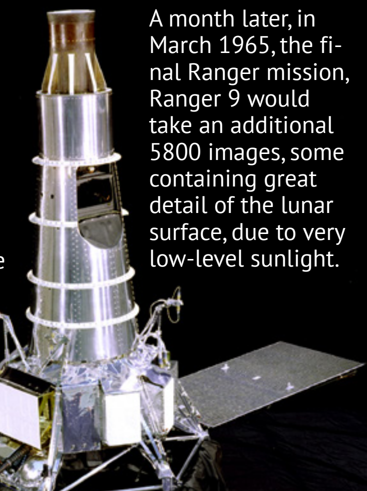
Ranger TV Performed Near Design Point



This diagram [above] describes the flight path of the July 1964 Ranger 7 probe. It orbited the Moon twice, the second time more tightly, before crashing in a lunar plain named Mare Cognitum, south of the crater Copernicus. The more than 4300 images captured by six cameras revealed that impact craters covered the Moon's entire landscape, even the areas that seemed flat when viewed from Earth.

In February 1965 Ranger 8 confirmed Ranger 7's findings, its 7000 images covering a wider area but reaching the same conclusion – the Moon was covered in craters. Even the craters had craters, and those craters had craters! It was craters all the way down.

A month later, in March 1965, the final Ranger mission, Ranger 9 would take an additional 5800 images, some containing great detail of the lunar surface, due to very low-level sunlight.



The six video cameras placed in the Ranger spacecraft took images from a variety of wide and close-up angles, which were then transmitted back to Earth using slow-scan television. Two isolated transmission chains of three cameras each assisted reliability.

HAMATEUR HOUR

MOON REPEATER TO PERMIT INTERCONTINENTAL UHF QSOs

by N. K. Marshall W6OlO/2

The design, development, and test of an operational prototype UHF amateur repeater unit is now in progress and final construction of a flight model is imminent. When completed, NASTAR hopes to have NASA carry the Moonray repeater to the moon via one of the remaining Apollo missions. One of our astronauts will emplace and activate Moonray I. Target objective is to have a continuously operational repeater for a period of one year or longer.

Moonray's primary purpose is to serve as a free-access UHF repeater for worldwide line-of-sight amateur communication and experimentation within the 450 MHz band. A secondary function will be its capability to serve as an emergency backup voice communication link for our astronauts in the event of an unlikely (but possible) breakdown or failure of their regular communications system. Moonray can also be used as a landing-site relocation beacon for homing-in on the site at some later date. If the laser experiment is successful, location accuracy will be better than 2 ft.

Moonray I will contain a highly sensitive low-noise receiver, a signal processor, an identifier, a timer-cycler-sequencer, six to eight channels of telemetry, and a laser receiver with optics. Power will be supplied by an isotope-fueled thermoelectric generator having a half-life of 87 years. Thermal controls, antenna, pointing system and all auxiliary devices will be self-contained. The final package will be a metal cylinder about the size of an oatmeal box. Three retractable legs will be used for support and leveling. The up-link frequency will be 439.9 MHz and the down-link 430.1 MHz. A 10 kHz passband on both links will accept all modes of modulation and/or transmission.

Moonray's call sign will be the identifier SS in Morse code (. . . . . .) transmitted every 10 minutes along with a telemetry sequence. Repeater operation will be on a continuous-duty basis with only one-minute interruptions each 10 minutes.

Amateur ground stations should have high-gain antennas capable of tracking the moon; low-noise 430.1 MHz crystal-controlled converters, and stable, tunable i-f's. Detailed info on Moonray is available from NASTAR, Box T, Syosset, LI NY 11791.

Moonbouncing

In 1944 a German radar station inadvertently beamed its signal toward the Moon, receiving an echo back. In 1946 the US Army Signal Corps' in New Jersey succeeded in intentionally bouncing signals back from the Moon. In 1950 some American amateur radio operators set about attempting to replicate the Army's experiment at much lower power levels, meeting with limited success. They kept working at it, and in January 1953 they bounced a solid signal. This caught the interest of other amateur radio operators and various projects attempted to bounce a signal off the Moon between two Earth stations, something that finally happened in April 1964 between an American and a Finnish amateur radio operator.

Successful 'moonbouncing' by amateur radio operators in the mid-1960s led to attempts at convincing NASA to place a 'repeater' on the Moon, dubbed 'Moonray'. The proposed nuclear-powered repeater would have received UHF signals from amateur radio operators on Earth, amplified them and then broadcast them back on a different frequency, allowing ham radio operators across the globe to communicate with each other. However, despite NASA's initial enthusiasm toward the proposal, Moonray never happened. In the Cold War-era, unrestricted global communications may have been deemed undesirable.

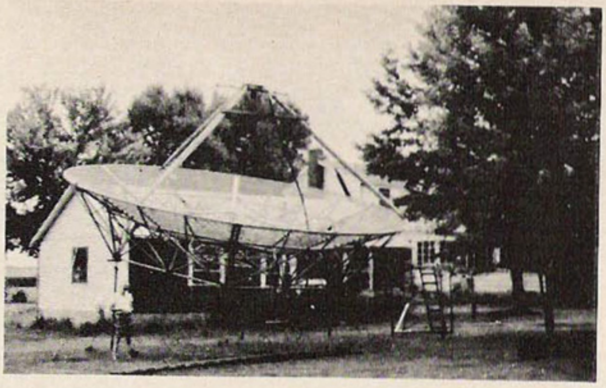
Clippings from 73 Magazine

FAMED EME SITE TO BE DISMANTLED

by WA3AJR

Bill Smith (W3GKP) was the first ham radio operator to make EME (moonbounce) on 2304 MHz, and he didn't do it with an ordinary dipole. As the photo shows, it takes a real antenna. The approximate size of the big dish can be estimated by comparing it with Bill himself, who is standing at the lower right. In this picture, he is actually closer to the camera than the dish itself.

According to Smitty, he will be leaving the area soon, and the historic site will be no more. The dish? It goes with Smitty, of course!



IF YOU WERE A GEEK IN 1969, YOU WEREN'T WAITING FOR THE MEDIA TO TELL YOU WHAT WAS HAPPENING UP THERE...

The July 23, 1969 edition of the Louisville, Kentucky *Courier-Journal* told the story of Larry Basinger, an amateur radio operator under the callsign W4EJA who accomplished an amazing feat – he independently detected and heard the astronauts' transmissions from the lunar surface during the Apollo 11 moon walk.

Lunar Eavesdropping

Louisvillians Hear Moon Walk Talk on Homemade Equipment

By GLENN RUTHERFORD
Courier-Journal Staff Writer

Thanks to some homemade electronic equipment, including a rebuilt 20-year-old radio receiver from an Army tank and an antenna made of spare pieces of aluminum, nylon cord and chicken wire, a small band of Louisvillians was able to "eavesdrop" Sunday night on the Ameri-

Edwin Aldrin on the lunar surface and their orbiting companion Michael Collins. But the signals were received directly from the moon, over a quarter of a million miles away, not through the Houston Space Center.

The success of the jerry-built equipment provided a just reward for Larry Baysinger, an electronics technician for

singer home at 7115 Deanna Drive, were Larry, his wife, Mary, his daughter, Sandy, and this reporter. The room was full of flashing, blinking lights, dials and indicators—just like in science fiction movies.

And out in the back yard, the hand-built chicken-wire antenna was monitoring the 30-watt, VHF signals from the lunar surface and the orbiting spacecraft.

hollering, no one checked the corder. And sure enough, just Aldrin was describing how his impaired when he walked out into the shadows, the recorde of tape.

A new reel was installed in seconds and about 35 minut astronauts' conversations were —including the entire text of

According to the Courier story, Basinger accomplished this with "a rebuilt 20-year old receiver from an Army tank and an antenna made of spare pieces of aluminum, nylon cord and chicken wire".

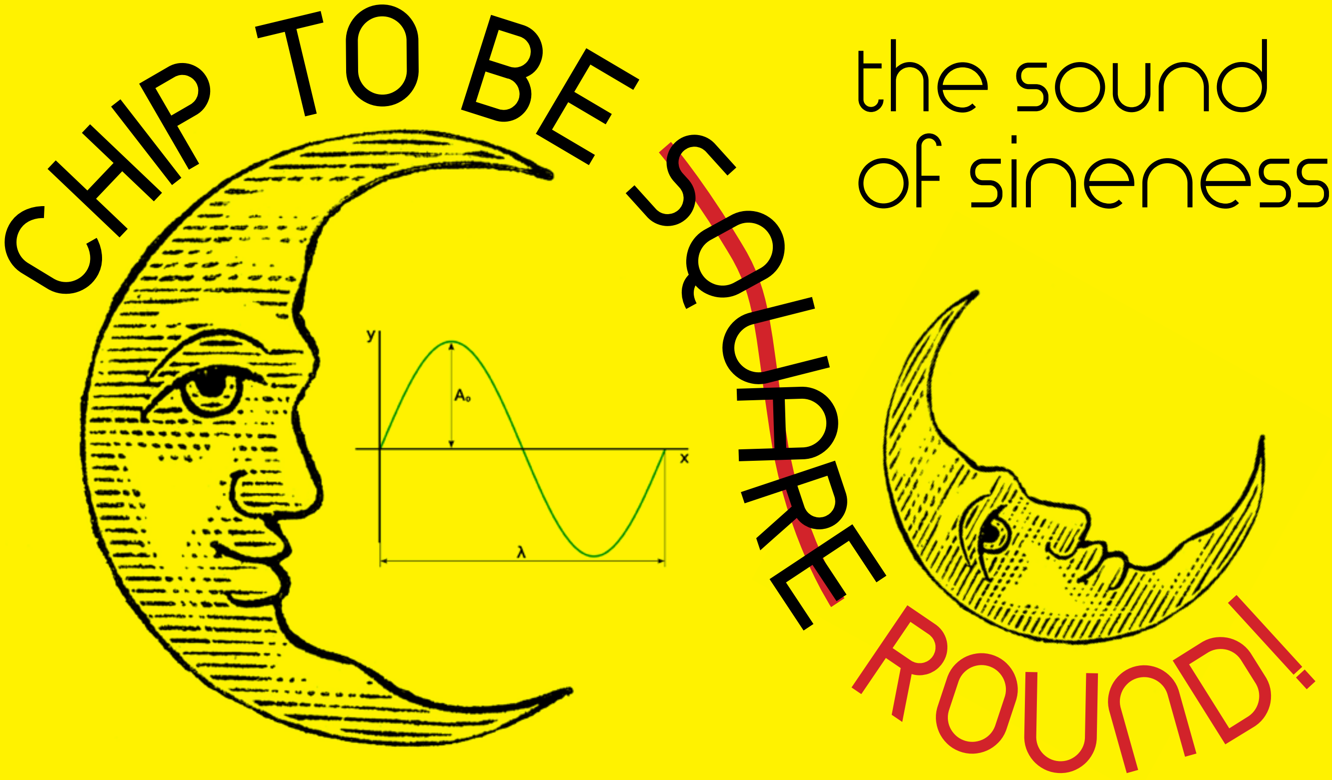
Basinger built an 8ft (2.4m) by 12ft (3.6m) antenna and modified his receiver to amplify very weak signals – and the signal Basinger captured was very weak: not the S-Band signal beamed back to Earth, but the VHF voice signals broadcast between the astronauts on the lunar surface! Basinger recorded 35 minutes of conversation between astronauts Armstrong, Aldrin, Collins and then-US President Richard Nixon.

LUNAR EAVESDROPPING

GEEK UNDERGROUND

CHIP TO BE SQUARE ROUND!

the sound of sineness



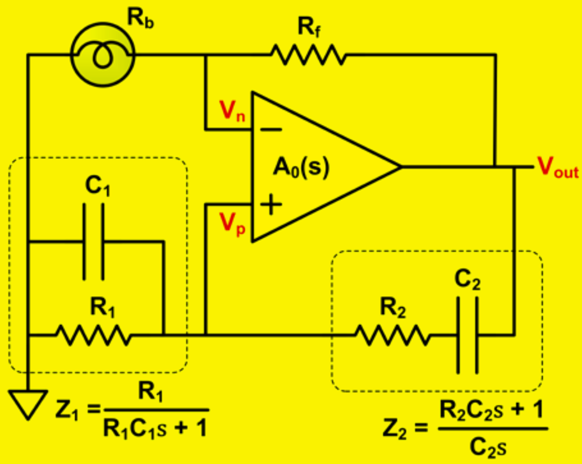
An oscillator is an electronic circuit that produces a periodic, oscillating electronic signal.

In practical terms, an oscillator converts DC (direct current, or current flowing in one direction) into AC, or alternating current, current which flows both ways, changing direction at intervals measured by how often they happen each second, also known as the oscillation frequency. This can happen more gradually, as in a sine wave, or more abruptly, creating a square wave.

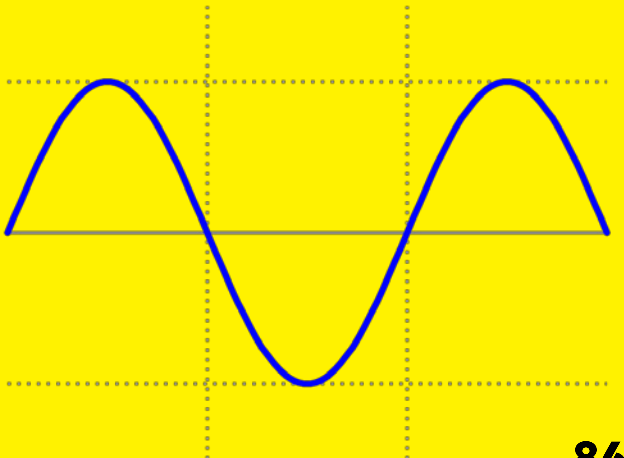
Oscillators are used to generate radio waves, clock signals used by quartz watches, and by electronic organs, analog synthesisers and sound chips embedded inside 1980s video-game consoles and home computers, most of which produced square waves but some could produce other waveforms such as triangle, sawtooth, pulse and yes, sine waves.

Sine waves in the audible range are typically generated using a Wien bridge oscillator. The oscillator is based on a 'bridge circuit' – a circut that has two branches that are 'bridged' by a third branch connected between them – developed by Max Wien in 1891, hence the name. The bridge is made up of four resistors and two capacitors (the diagram to the right uses a light bulb in the place of one resistor, to bleed off excess energy). The resistors and the capacitors should each be of similar values. By changing the value of the capacitors or by using a potentiometer one can change the frequency of the sine wave.

By oscillating at a frequency similar to that of the root harmonic of each note on a piano, music can be electronically generated, and a pure sine tone is the simplest way this can be done. A sine wave produces a sound like a flute. Sine waves of differing frequencies can also be overlaid, a process known as additive synthesis, or subtracted from each other (subtractive synthesis) allowing for the generation of a wide variety of timbres.



Circuit diagram of a Wien bridge oscillator. This version is regulated by a small incandescent lamp at R_b



the theremin

sounds from outer space...

...and the future...

The performer used two hands to control the instrument; her right hand adjusted the pitch by moving it closer to or farther away from the vertical antenna, while her left varied the volume by interacting with the loop antenna in a similar fashion.

It was 1927, the height of the Roaring Twenties and America had well-and-truly shaken off the yoke of Victorian conservatism, embracing more liberal social and artistic norms. The relatively recent technologies of audio amplification and radio broadcasting had become well established, and musicians were eager to explore their potential not only in an effort to expand their audience but to also create new and interesting sounds.

Enter Leon Theremin. His arrival that year in New York City, the young man eager to demonstrate his new invention, an instrument which married aspects of radio and amplification, heralded the start of a new age of electronically-created music. Not only did his new instrument require no mechanical method of producing sound – no blowing, no striking, no sawing – the performer didn't even touch it at all! She merely moved her hands in the air, varying their distances from two antennas, to adjust both volume and pitch.

Lev Sergeyevich Termen (1896-1993) also known as Leon Theremin was a Russian and Soviet inventor. Aside from the theremin, he also invented the interlaced scanning technique which improved the fluidity (or framerate) of CRT-based analog television, and designed a listening device that allowed Soviet spies to eavesdrop inside the American embassy in Moscow, known as **The Thing**! Hidden within a wooden replica of the Great Seal of the United States, it intercepted confidential conversations inside the US ambassador's office for the first seven years of the Cold War.

Contolled by a talented performer, Theremin's instrument could produce a rich variety of sound, from somber, low cello-like tones to agitated, high-pitched wailing. Sometimes, it could even bear an uncanny resemblance to a human voice! Theremin originally called his instrument the aetherphon and later the thereminvox but audiences insisted on associating the machine with the man, referring to it as simply the theremin, and the inventor was thereafter forever branded by his own invention – not that he minded that much, for his creation was about to give him far more than the standard fifteen minutes of fame.

By the time Theremin stepped on to the American shore in 1927 his theremin had already developed a bit of a reputation in the musical world. The first composition expressly for the instrument, "A Symphonic Mystery" by Russian composer Andrej Filippowitsch Paschtschenko had been premiered by the Moscow Philharmonic four years earlier, and audiences during a European tour earlier in 1927 had been wildly enthusiastic. Therefore, it was really no surprise that his New York demonstration concert was widely praised, subsequently creating a sensation amongst both musicians and listeners. Theremin set up a laboratory in the city to build new instruments and train performers to use them, and soon theremin concerts became commonplace.

THE MECCANO MAGAZINE 689

Music From The Ether

Loud-Speaker Howls Turned to Good Account

SOME time ago a great deal of interest was aroused by a series of concerts given in Europe and America by a Russian scientist, Professor Theremin, who produced the sounds of various orchestral instruments without any apparent mechanism.

The instrument is really a generator of electrical oscillations, and it turns to good effect phenomena that are a source of considerable annoyance to the radio experimenter, namely "hand capacity" effects, that result in howls and squealings in the loud speaker. Every reader who has operated a wireless set will know that when this is in its most sensitive condition a slight movement of the hand close to the tuning dial will result in a squeal or whistle in the loud speaker. This is due to the fact that the tuning circuit of the receiver has a certain electrical capacity to earth, and when the hand, or other part of the body, which may be considered as at earth

sounds; and this is what Professor Theremin does in his apparatus.

The instrument, which can be seen on the table on the left-hand side of the photograph, has a close resemblance to a radio receiver cabinet. On the top of the cabinet is mounted a long metal rod which is connected to a source of electrical oscillations very similar to the tuned or high-frequency circuit of a wireless receiver. The frequency of the oscillating circuit is determined by the

The concert platform of the Opera House, Paris, during Professor Theremin's demonstration of his new musical instrument. The inventor is standing before his "magic box" at the left.

low notes.

On the left-hand side of the cabinet is a metal loop, the capacity of which may be altered by movements near it of the left hand of the performer. This is a volume control and the intensity of the sound produced may be varied from silence to full strength by making use of it. When maximum volume is required, the hand is raised to a distance of from 12 to 18 in. from the loop.

An ingenious device enables the characteristic tones of a piano, a violin or any other instrument to be reproduced. When a musical note is played, the sound waves of the fundamental frequency are accompanied by subsidiary vibrations. These are known as harmonics, and their fre-

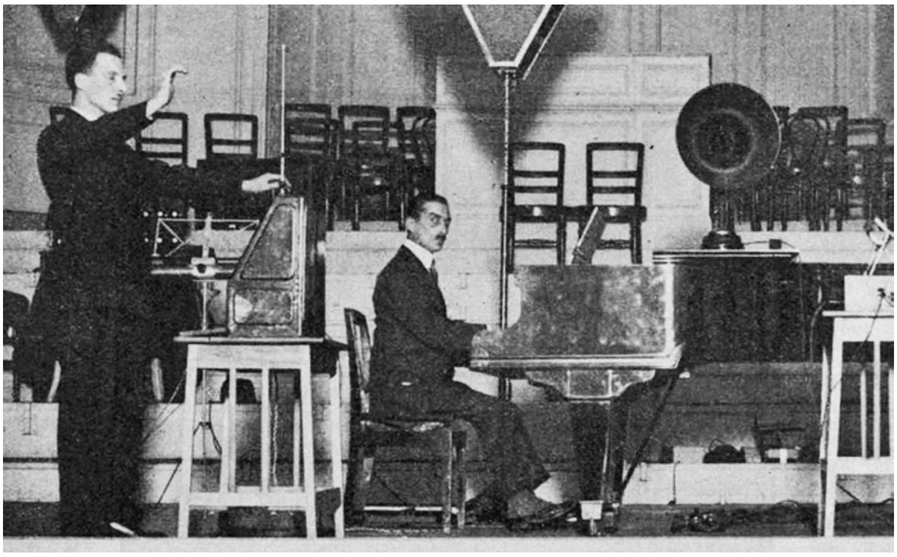
account for variations in tone. In order to imitate the sound of any well-known instrument by means of Professor Theremin's apparatus, the oscillating circuit to which the vertical rod is secured is therefore adjusted to give suitable harmonics. These are reproduced by the loud speakers, the characteristic timbres of various musical instruments thus being reproduced without difficulty.

Professor Theremin's apparatus is extremely interesting but its practical value is doubtful.

Professor Theremin's apparatus is extremely interesting but its practical value is doubtful.

It might seem curious to the modern reader that something that seems so mundane (and perhaps even chiché) today was able to create such a stir, but from the point of view of the 1920s, the field of electronics still seemed like science fiction, and new electronic devices couldn't have appeared more strange to the average individual if they had been knowingly brought back from the far future using a time machine.

So while the theremin's practical use was limited, people were in awe of it for what it was as much as what it did – just half a century earlier there was no electric lighting, no telegraph, no radio, no telephone, no automobiles...it seemed as if there was no limit as to where this new technology could take humanity, and the theremin exemplified that notion, inspiring the imagination to consider just what the possibilities were, and what fantastic innovations and strides the future could bring – even the crazy idea of a man walking on the Moon.



Professor Theremin demonstrates his invention at the Royal Opera House, London.

The Journal of Electrical Workers and Operators 95

RADIO

BEYOND THAT WELL-KNOWN SATURATION POINT

By AUSTIN C. LESCARBOURA, Member A. I. E. E. Member I. R. E.

ON the threshold of 1930, we are confronted with another year of radio progress. What will the next 12 months bring forth? ...

... an attachment for the usual radio set with power amplifier and a good loud-speaker. The Theremin, invented by a young Russian scientist, Leon Theremin, is simply a radio ...

But if we have an hour to handle the same photograph, the detail is excellent. Now let us see what this may mean in broadcasting. From midnight to about 6.30 ...

To the writer's way of thinking, the Theremin is the first of many devices for radio self-expression. When the family tires of listening to professional talent, the family circle can try its hand at entertainment. It may be that 1930 will see the electric or radio organ introduced, utilizing much the same principle as the Theremin, namely, the oscillator. Thus it may be possible to provide an instrument with a number of oscillating tubes and various combinations of inductances and capacities for obtaining a wide range of simultaneous audio frequencies, delivered to the loud-speaker of the radio set. By means of a keyboard, it should then be possible to play the radio set with the effect of a beautiful organ. The average radio set today has ample volume and tone quality to approximate organ music, and many of us who have craved for an organ may soon have one available as an attachment to the good old radio set.

The opening gun is the RCA Theremin, or "ethereal music" instrument. It comprises ...

If we must handle a photograph in ten minutes, the detail is exceptionally crude.

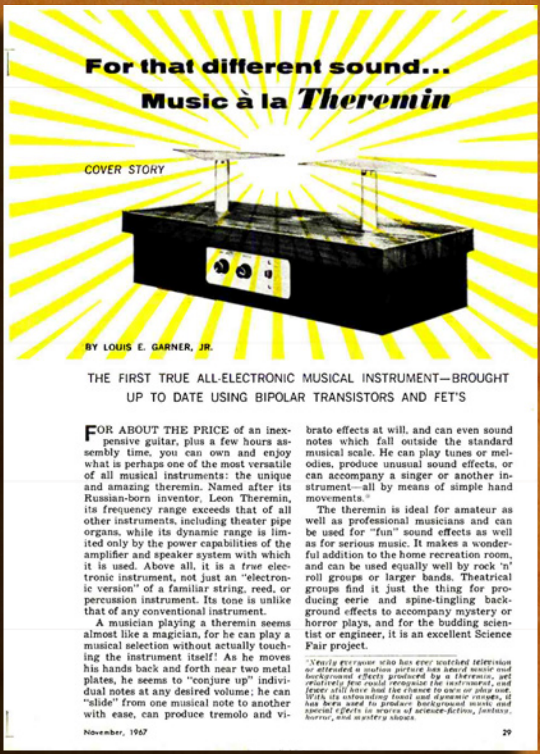
(Continued on page 150)

Theremin performers often seemed as if they had come from the future (and the Moon), their rigid postures and strange gestures summoning forth other-worldly sounds and (often unintentional) dissonances that, to a listener used to a very fixed tonal scale and the aural characteristics of common acoustic instruments, must have made them wonder when they would be able to board a flight to the Moon themselves – it was a magical time.

And the theremin was a magical invention. In 1929, attracted by its ballooning popularity, RCA purchased a license to manufacture the instrument and quickly produced around two hundred of them. RCA marketed their theremin toward the home consumer, advertising it as a simple instrument to learn ("nothing more complicated than waving one's hands in the air!") that could be mastered by anyone who could "hum or whistle": "(I)t is the simplest and most universal of musical instruments, because no technical knowledge of music, no tedious practice, no long period of study is necessary in order to play it."

Of course, the reality was the theremin was an extremely difficult instrument to master. Players needed a very good sense of relative pitch in order to land notes at their correct frequencies when accompanied, and perfect pitch in order to pull off a solo performance – a very rare talent. There were few customers who, after forking out US$600 (US$8800 in 2018!) for their shiny – but ultimately mostly useless – new wonder, were pleased with their purchase once they (or their family members) attempted to play it.

The 1929 stock market crash and the subsequent financial depression put the final nail in the coffin of the theremin as a commercial product, and it was never widely adopted. But its legacy lived (and still lives) on in science fiction and horror movie soundtracks.



For that different sound...
Music à la *Theremin*

COVER STORY

BY LOUIS E. GARNER, JR.

THE FIRST TRUE ALL-ELECTRONIC MUSICAL INSTRUMENT—BROUGHT UP TO DATE USING BIPOLAR TRANSISTORS AND FET'S

FOR ABOUT THE PRICE of an inexpensive guitar, plus a few hours assembly time, you can own and enjoy what is perhaps one of the most versatile of all musical instruments: the unique and amazing theremin. Named after its Russian-born inventor, Leon Theremin, its frequency range exceeds that of all other instruments, including theater pipe organs, while its dynamic range is limited only by the power capabilities of the amplifier and speaker system with which it is used. Above all, it is a *true* electronic instrument, not just an "electronic version" of a familiar string, reed, or percussion instrument. Its tone is unlike that of any conventional instrument.

A musician playing a theremin seems almost like a magician, for he can play a musical selection without actually touching the instrument itself! As he moves his hands back and forth near two metal plates, he seems to "conjure up" individual notes at any desired volume; he can "slide" from one musical note to another with ease, can produce tremolo and vibrato effects at will, and can even sound notes which fall outside the standard musical scale. He can play tunes or melodies, produce unusual sound effects, or can accompany a singer or another instrument—all by means of simple hand movements.*

The theremin is ideal for amateur as well as professional musicians and can be used for "fun" sound effects as well as for serious music. It makes a wonderful addition to the home recreation room, and can be used equally well by rock 'n' roll groups or larger bands. Theatrical groups find it just the thing for producing eerie and spine-tingling background effects to accompany mystery or horror plays, and for the budding scientist or engineer, it is an excellent Science Fair project.

Nearly everyone who has ever watched television or attended a motion picture has heard music and background effects produced by a theremin, yet relatively few could recognize the instrument, and fewer still have had the chance to own or play one. With its astounding tonal and dynamic ranges, it has been used to produce background music and special effects in scores of science-fiction, fantasy, horror, and mystery shows.

November, 1967 29

The November, 1967 issue of Popular Electronics contained the plans for a very 1960s-style theremin.

The accompanying article touted the merits of the theremin: that it is a true electronic instrument, with an extremely wide frequency range and its volume is limited only by the audio amplifier you connect it to. That it is cheap to build, and that its timbre is unique. That there is entertainment value in the (attempted) act of playing the theremin; the odd gestures made by the performer controlling it are as intriguing to an audience as the strange sound it produces. All of these points are true.

However, the article also seriously understates the difficulty required to play the theremin with any accuracy, selling it as 'ideal for amateur as well as professional musicians'...well, 'ideal' might be a bit of a stretch. But, questions over the ease at which you might conjure coherent music from your theremin aside, it's still a fun and interesting electronics project. At the very least, you'll be able to create creepy sound effects to back your indie horror movie or liven up your next Hallowe'en party! Woo-eee-ooo...

HOW IT WORKS

A theremin usually has two radio frequency oscillators, one at a fixed frequency, the other variable, which starts at the same frequency as the fixed one.

The frequency of the variable oscillator is controlled by an 'antenna', which in this case is a simple metal plate. As the player's hand is moved toward the antenna, the variable oscillator increases in frequency, and decreases when the hand is moved away.

The difference between the fixed oscillator and the variable one is extracted as its own frequency and amplified, producing the theremin's 'tone'.

A second antenna and third oscillator are used to control the output volume – the closer the player's hand comes to the second antenna, the louder the theremin's tone becomes. This is how one creates the howling crescendos the theremin is known for.

In this design, transistors Q1, Q2 and Q4 serve as oscillators. The base frequency is determined by the L1 coil and the combination of capacitors C1 and C2.

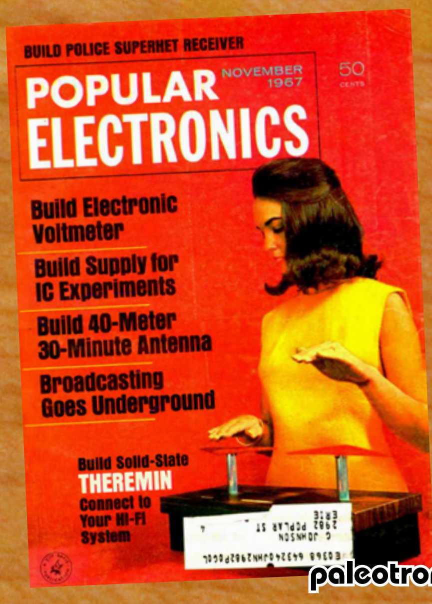
Q2 generates the fixed frequency while Q1 and Q4 are connected to the antennas. When a hand is placed near one of the antennas, its natural capacitance 'loads' the antenna, changing the capacitance of its circuit and disrupting the oscillation frequency.

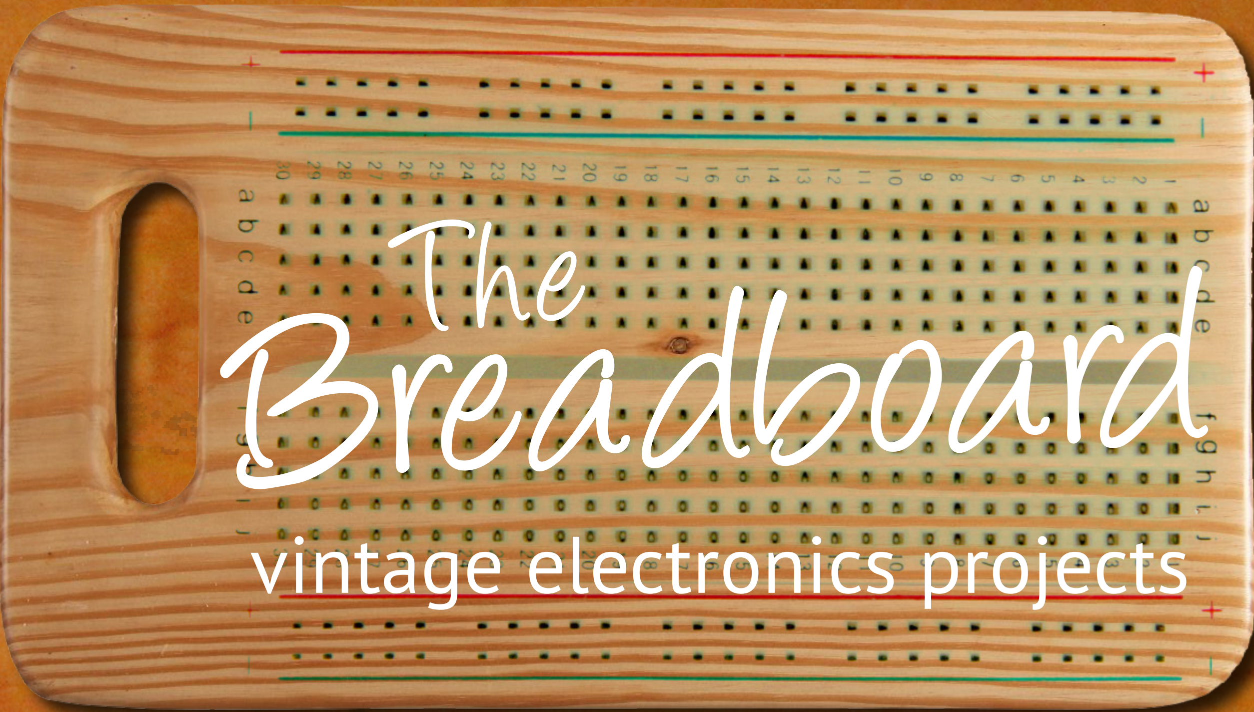
Q1 and Q2 are both coupled to Q3. If Q1 and Q2 are the same, Q3 will output nothing – if they are different, Q3 outputs that difference, which is passed to the volume circuit containing Q4.

The circuit containing L4 and C22 generates a base frequency, which Q5 uses along with the output from Q4 which is affected by the second antenna. Q5's output goes to Q6, which varies the volume level, then Q7.

Once the theremin is assembled and tuned, it can be 'played' by moving your hands toward both antennas simultaneously. As you approach the pitch plate, a low-frequency note should be heard, increasing in pitch as the hand moves nearer, rising beyond audibility as the hand almost touches the plate. As the other hand approaches the volume plate, the amplitude of the sound increases.

Let's ~~bake~~ make a Theremin!





CONSTRUCTION

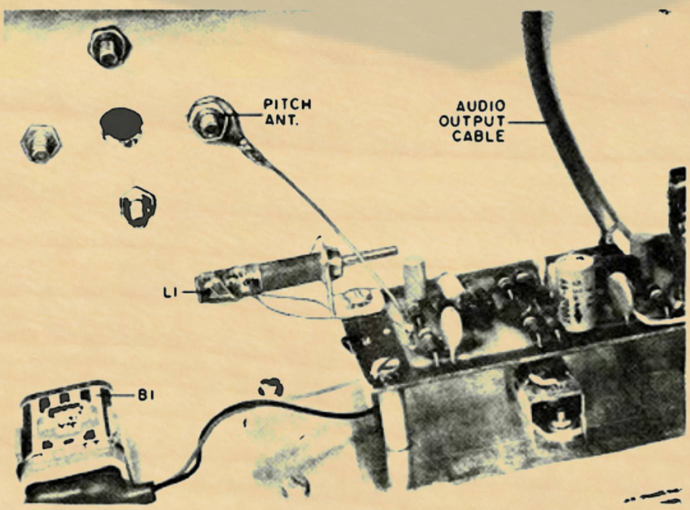
Except for the two control antennas, power switch and battery, all components are assembled onto a printed circuit board as shown full-size on the right-hand page of the next spread. The parts are assembled as shown in the Component Layout section on the bottom of the following page. There is an insulated jumper wire between C15 and R20 that is indicated by a dotted line.

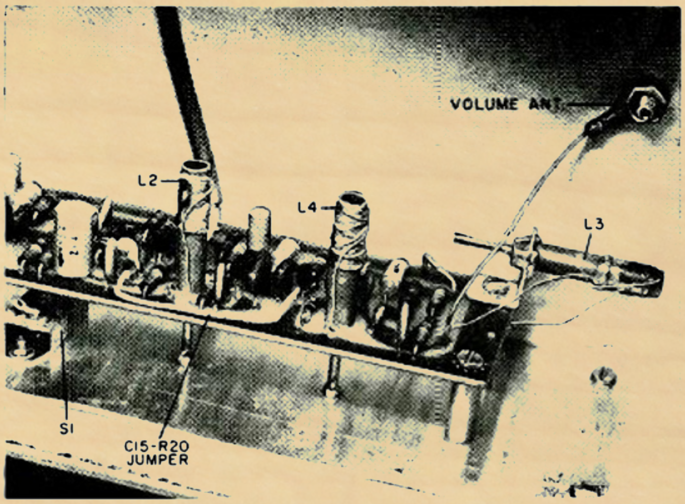
Once populated, mount the printed circuit board (PCB) in a suitable enclosure with four spacers. Make sure there are holes in the enclosure so that the tuning-slug screws of the L2 and L4 coils are accessible. Coils L1 and L3 should be mounted on small L-brackets, placing them at right angles to L2 and L4.

S2 is mounted in the enclosure in the area of the L2 and L4 screws, and the battery is secured to the enclosure's wall. Ordinary copper-clad circuit board can be used to make up the antennas, mounted on aluminium tubing using plug buttons soldered to the bottom of the antennas. The antenna lead from the PCB is connected to the aluminium tubing using a solder lug under one of the mounting screws as shown in the illustration below.

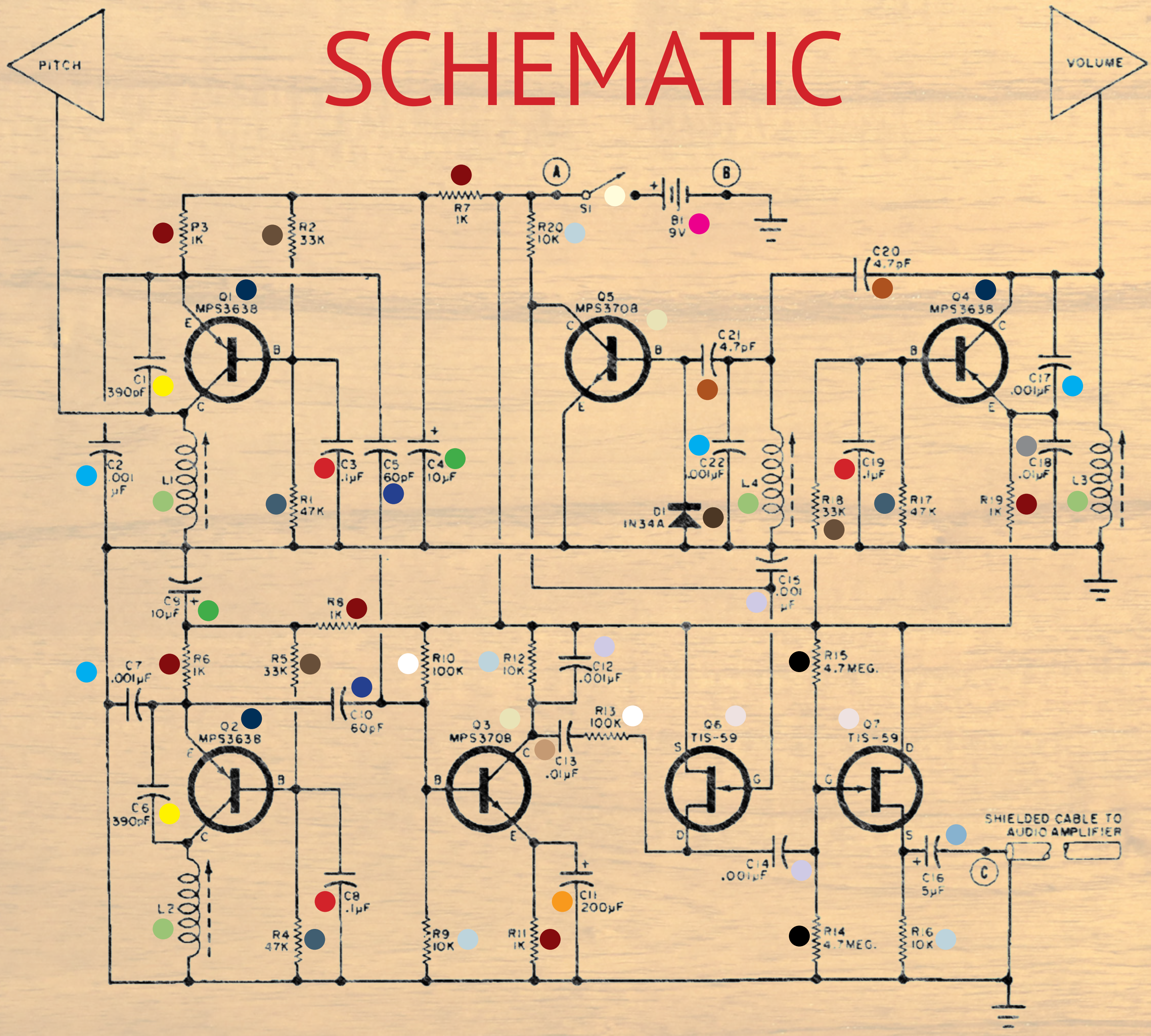
Connect the negative lead of the battery to terminal B on the PCB, then connect the positive lead, via S1, to terminal A. The centre lead of the audio cable is connected to terminal C, while its outer foil is soldered to the PCB ground. foil

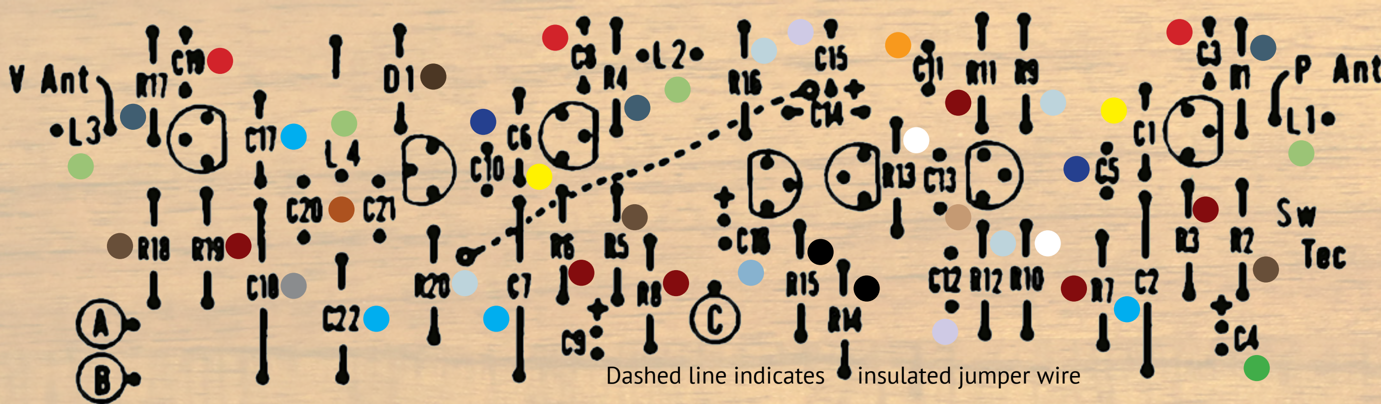
Connect the volume control antenna lead and one lead from L3 together and solder them to the proper hole on the PCB, then do the same with the pitch control lead and one lead from L1. The other ends of both coils are soldered to the ground foil of the PC board. Connect the audio cable to an amplifier and perform the tuning procedure on the following page, bottom.





SCHEMATIC





Dashed line indicates insulated jumper wire

COMPONENT LAYOUT

Tuning: Temporarily short Q6's gate and source electrodes together using a short wire, soldered in place. Reset the four coils to their mid-positions. Connect the theremin to an amplifier, such as a guitar amp, and turn it on with volume to nearly full. Turn on the theremin with S1 and adjust L2's slug (keeping hands away from the pitch antenna) until a low frequency growl is heard. Turn off the theremin and remove the short from Q6. Turn the theremin back on and adjust L4 until the growl is heard again. Then adjust L3 until the growl nearly disappears. Finally, adjust L2's slug until the growl becomes so low as to be inaudible. The theremin should now be usable.

PARTS LIST

Part	Description
B1	9-Volt Battery
C1 C6	390 pF polystyrene capacitor
C2 C7 C17 C22	1 nF polystyrene capacitor
C3 C8 C19	100 nF disc ceramic capacitor
C4 C9	10 µF 15V electrolytic capacitor
C5 C10	60 pF polystyrene capacitor
C11	200 µF15V electrolytic capacitor
C12 C14 C15	1 nF disc ceramic capacitor
C13	10 nF disc ceramic capacitor
C16	5 µF 15V electrolytic capacitor
C18	10 nF polystyrene capacitor
C20 C21	4.7 pF polystyrene capacitor
D1	1N34A diode
L1 L2 L3 L4	50-300 µH adjustable coil
Q1 Q2 Q4	NTE159 (MPS3638) transistor
Q3 Q5	NTE123AP (MPS3708) transistor
Q6 Q7	NTE132 (TIS-59) FET transistor
R1 R4 R17	47 kΩ
R2 R5 R18	33 kΩ
R3 R6 R7 R8 R11 R19	1 kΩ
R9 R12 R16 R20	10 kΩ
R10 R13	100 kΩ
R14 R15	4.7 MΩ
S1	SPST slide or toggle switch
Misc.	Etched circuit board
	Metal for control antennas
	1.9cm (3/4in) antenna pipe and mounts
	Wooden case 46x15x10cm (18x6x4in)
	Battery mounting clip
	Shielded audio cable
	Two small knobs
	Spacers
	Hookup wire
	Solder

All resistors 0.5W 10% tolerance

Make sure to use grounding strap when handling FET transistors!

Note: you can use polypropylene in place of polystyrene capacitors.

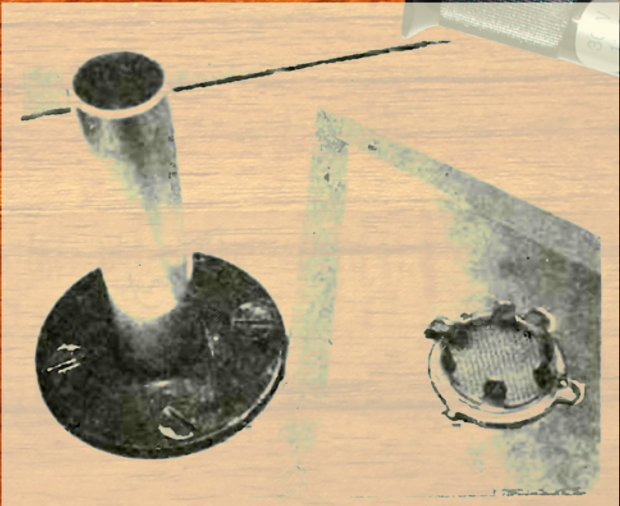


Fig. 4. Plug buttons soldered to metal plates that serve as antennas provide electrical coupling and mechanical support between antennas and pipes.

"Your ghost stories don't scare me..."

Jamie Silicon's voice betrayed a certain lack of confidence, and his older sister seized on it like a wolf lunging for a rabbit. "Did you know that one night, not so very long ago, around a campfire just like this one, during a full moon just like this one, three children were devoured by a giant man-beast?"

"They were not!" Jamie wasn't going to fall for it this time. The last time the Silicon children went "camping" (really just two blocks away from their house in Schenectady, New York) he didn't get any sleep at all. That time it was some silly story about a poltergeist or something, and Jamie had since hardened himself to a belief that ghosts didn't exist. But his sister appeared to be trying a different tack this time, one he wasn't so sure about.

"Yes, they were. If you don't believe me, you can check the newspapers in the library." Of course, it helped Sarah's case that the library was currently closed. But Jamie was forced to give her the benefit of the doubt – for the moment. "It all started with an eerie wolf howl, in the distance, just as they had sat down around their fire to roast marshmallows. But it was far away, and they paid it no attention. A wolf wasn't going to travel all the way to them, it was sure to find prey before then. And so they laughed and joked and ate their marshmallows." Jamie winced. There was always a 'but'.

"But, an hour later, there was another howl, closer. The children were drinking hot chocolate, much like we are now, and once again, felt confident there was no way the wolf would get to them before happening on a rabbit, or a fox. The hot chocolate started to make them sleepy, and they began to nod off."

"Yeah," interrupted a drowsy, annoyed Pippin. "I'm sleepy. Could you please be quiet?"

Jamie laughed. "'Out of the mouths of babes...'"

"Go to sleep then Pippin," Sarah said dismissively, "I'm almost finished. So, as the children were falling asleep they heard a howl, even closer. But they were sleepy, and had already convinced themselves that there was no likelihood of the wolf reaching them, and so they drifted off to sleep without a care.

"They would never wake up again."

There was silence then, for several seconds, while the fate of the fictional children was pondered, and imagined to be quite gruesome indeed. Jamie laughed, "You really had me going there! But there's no way they would have been that complacent. Surely they would've taken it seriously before they got eaten!"

"You know how you boil a live frog to death? Slowly." Jamie didn't know how to respond to that. But a wolf howl punctuated the silence, then, and the frog was instantly forgotten. Even Sarah's face went white with fear at the unexpected embellishment to her tale.

"That's not funny!" Pippin shouted, unimpressed.

"Uhh, Pip, it wasn't..." Jamie was interrupted by his sister before he could finish.

"Yes, Pippin, that was just part of the story. Neat, huh? Nothing to worry about." Another howl, slightly louder, shattered the night air a second time. "Actually, I just remembered I forgot... umm. I forgot spare batteries for the flashlight, and I don't know how long these are going to last for. It wouldn't be safe to be out here without extra batteries, so I'm afraid we're going to have to go home."

"I don't have a problem with that!" Jamie began collecting their belongings.

"I don't care. Carry me!" Pippin demanded. Sarah picked him up, and after pouring water on their campfire, they made their way out of the local woods and back to suburbia. Once Pip was safely home and in bed, Jamie became insistent about his need to go back out and investigate.

"I just realised, there's no wolves around here! And I don't like my camp-outs interrupted like that. Whoever's responsible has to pay."

"It's midnight, Jamie."

"Fine, stay home if you want." Their father Steven was out of town on business, and with no parental authority to stop him, Jamie was firm in his plans.

"I'll call John if you go out again." John was the local cop.

"No you won't. If you do, Dad will find out about our little camping trips..." Sarah frowned and started formulating a suitably foul retort, but before she could reply there was another howl.

"Okay, fine. Pip's out cold, let's go see what it is. But only for a few minutes!" Jamie grabbed his baseball bat for protection and they set off into the night.

Happily the creature was accommodating with subsequent howls, and the Silicon children quickly narrowed down the property that was the source of the noises.

"Go away," a man shouted from an upstairs window. "Leave me alone!" Sarah hoisted Jamie up so he could peek over the fence from the alley behind the lot in question, and he saw the "wolf", a very hairy, but naked man. Other neighbours must have had enough, because a police siren joined the wolf-man in chorus then, and he made a hasty retreat, leaping over a side fence and disappearing into the darkness.

"The police must not really want to deal with him," David, the man shouting from the upstairs window the night before, lamented to the Silicons after they showed up that morning eager for an explanation. "I don't blame them. He seems quite deranged."

"Do you have any idea why he's doing this?" Sarah began her questioning. "Why howl during the full moon? And why at you?"

"I have no idea."

"Are you sure...? Maybe if you thought about it a bit more..."

"No, I assure you, I have no idea. I don't care who he is anyway. I just want him to stop! It's driving me crazy. This was the third full moon he's done this on, and I'm starting to get really anxious every time another one approaches. But I'm not leaving – I'm not going to give him the satisfaction, even if I end up jumping out the window!"

"For someone who doesn't know who's harassing him, this seems a bit personal."

"You don't have to know your tormentor to hate him." The middle-aged man was firm on this.

"Okay, well, we can help you, but you need to be an open book. Because there's no way this 'wolf' picked you at random. There has to be a motive."

"Fine, whatever you need. Just find him!" Sarah and Jamie began by trying to learn what they could about David, and try to extrapolate likely suspects but that information turned out to be extremely limited. David Johnson didn't think revealing details about himself was useful to the case, and dismissed any attempt by Sarah or Jamie to pry anything out of him. "If you're as good as you say you are, you won't need to violate my privacy to track down your man."

Public records and a search at the library didn't yield anything either, aside from a deed for David's property, which listed his middle name as Aaron and his year of birth as 1935, making him 53 years old. He had only bought the property three years earlier, and didn't seem to have any other history in Schenectady – or anywhere, for that matter.

David Aaron Johnson, 53, owned a house, and that was all. No job, no family, and nothing to say. The Sliced Salami Society had never had such a hostile client before. But Sarah was undeterred. They monitored David's comings and goings, and identified a suitable time to search his property.

"Sometimes you have to investigate your client to investigate the case" – Sarah had read that in a detective novel, somewhere. Jamie, the little delinquent he was, had no qualms about a little break-and-enter himself. Extreme? Perhaps. But necessary.

David went out to play bridge on Tuesday nights, and this left a decent period wherein Jamie could, under the cover of darkness, sneak in through a basement window, and ransack David's belongings.

"No, 'discreetly search'," Sarah corrected him as they stood across the street. "Discreetly!"

Jamie sighed, and after verifying nobody was watching, went through David's side gate and slid through an unfastened window. He unlocked the front door and beckoned his sister within.

The house was surprisingly free of nostalgia. That is, there was nothing more than a few years old. No albums of photographs, no old records, no correspondence of any kind. It was as if David arrived in Schenectady with the clothes on his back and nothing else. "Maybe he's in witness protection," Jamie mused. "If I was in witness protection (perhaps one day he would be) I wouldn't keep anything that would let a nosy little brat like myself figure out who I was."

Sarah stifled a laugh at Jamie's surprising self-referential insight. "Maybe our wolfman is part of whatever he's hiding from?"

Jamie wrinkled his nose. "Nah, if he was, why go through all that trouble? He'd just pop him." Jamie pointed his finger as if it was a pistol and 'fired'. "Pop... pop... pop..."

"You've made your point. Still, we've committed a felony for nothing." Sarah sighed.

"Well, we haven't searched everything yet."

"I'm not digging up the back yard." Sarcasm.

"Well, if we were to dig up the back yard, what would we need?"

"Shovels?"

"Which we would get from where?"

"The garden shed. Is there a point to this?"

"The night of the full moon I noticed the garden shed had a big padlock on it. Who padlocks a garden shed? This guy doesn't even lock his storm windows. There's gotta be something in there."

"We need to find the key." The search of David's house resumed in earnest, but the key was seemingly nowhere to be found. The children stood in the living room, frustrated.

"Just let me break a window," Jamie implored, but Sarah wasn't having it.
"We don't want to risk facing trouble ourselves. Hm." Sarah scanned the room. "Notice anything unusual?"

Jamie looked around. "Not really."

"Look at the television."

"Looks like a television."

"But it's missing something."

Jamie glared. "Now it's your turn to get to the point."

"Dust. There's dust everywhere; David obviously doesn't dust. But the TV is much cleaner, despite being several years old."

"Maybe he's recently had it repaired?"

"It's solid-state, so that's less likely. Let's look inside."

"I saw a screwdriver in the kitchen drawer."

“Get it.” Jamie returned with the screwdriver and the children carefully took the back off of the TV, being careful not to touch any high-voltage components or the fragile picture tube. Taped to the inside was a key. Obviously, David didn’t enter the shed very often. He probably wouldn’t miss the key any time soon, so the children returned the back onto the television, and put things back the way they were as best they could.

Sarah decided a foray into the shed would better occur during daylight, and so they returned home, to a restless night’s sleep in anticipation of the wonders they might discover the next day. After school, the three Silicon children staked out David’s house, waiting for him to leave. Impatient, Jamie eventually ran to a payphone, calling David and, impersonating a police officer as best he could, attempting to convince the man to travel to a police station on the other side of town and make a report about the wolfman.

David resisted the bogus demand over the telephone, but a few minutes later he emerged from his house, got in his car and drove away. The children emerged from the bushes across the street and ran into David’s yard, rushing to the shed and hurriedly unlocking it.

It was full of junk. Old junk. At least to Jamie. Oddly oversized electric typewriters, gigantic reel-to-reel tape machines, cabinets whose fronts were covered with switches and lights... the junk looked like refugees from a 1960s science-fiction movie, and Jamie said so.

“It looks like old mainframe components,” Sarah said, “from the 1960s, I agree. Why would David have all of this stuff...?”

“Maybe he was in to computers?”

“I’d say that’s a fair assessment. But how does all of this connect to our wolfman? It’s too bad the computer itself doesn’t seem to be here. Then we could hook all of this up and read these tapes.”

“What about this?” Jamie motioned toward a box about one foot (0.3m) square, with wires coming in and out of it. “Is this a computer? It looks like it’s connected to this control-pad thing.” Jamie held up a smaller box containing an LED readout and a keypad.

They heard an automobile approaching, then. “I don’t know, but let’s take it for analysis.” Jamie grabbed the mystery box and control-pad while Sarah hoisted Pippin, and they fled the shed and subsequently the yard, returning to the Silicon house to examine their treasure.

They descended to the Silicon workshop in the basement, a screwdriver was obtained and the metal case surrounding the box was easily removed, revealing the contents within to be banks of transistors. A survey of the appropriate electronic components revealed the voltage and amperage required to power the box, and a supply was fashioned from parts strewn about the somewhat disorganised workshop. With the flip of a switch the box came to life.

The control pad also illuminated into operation, displaying some sort of numeric code on the screen. Jamie pushed a few buttons, which led to different numeric codes, but there was no immediate rhyme or reason to it. “We need a manual”, Sarah lamented.

There had been no paper of any kind in the shed; David seemed to be allergic to printed materials full-stop, and perhaps for good reason; but still, it made the Sliced Salami Society’s task more difficult than Sarah would’ve liked. They ventured to the library, but there was nothing in the computer section that indicated what the mystery box was – its description didn’t match that of any known mainframe or mini-computer. It looked as if the children had reached a dead-end.

But Sarah wasn’t ready to give up yet. Returning to the workshop with a stack of electronics books, the box was completely dismantled and its components catalogued. It all seemed like pretty standard stuff, with nothing to give away the box’s purpose or identity, but Sarah soon zeroed in on one particular component, a long strand of intertwined wires which ran in and out of a series round metal loops. Her books called it “rope memory”, meant for non-volatile storage of computer code – and Sarah became determined to read it.

This rope memory seemed more advanced than the memory described in the library books, with many more wires, but it also appeared to be connected to some kind of ‘controller’ that had three external ‘serial’ plugs that looked like it might be compatible with the Silicon’s IBM PC.

Some quick experimentation soon confirmed they weren’t. But diving deeper, Sarah started applying appropriate voltages to each of the pins on one plug, and reading the voltages from pins on the other plugs, and soon patterns began to emerge. By applying voltage to combinations of certain pins in one connector, voltage appeared in various pins in the other connector – patterns that Sarah identified as binary code, a series of zeroes and ones.

By sequentially working her way through the ‘control’ pins in a binary sequence, she was able to read and record the binary sequences returned by the “output” pins, creating a matrix of memory ‘addresses’. However, rather than the 8 bits Sarah was accustomed to, each output sequence contained 16 bits! If there was any identifying text information hidden in the memory, Sarah had no idea how to decode it – she didn’t know of any character set that mapped to 16 bits. Sarah was stumped.

“ASCII is only 7 bits,” she lamented to Jamie. “On 8-bit computers you can ignore the 8th bit, but I don’t know what to do with the other 8 bits.”

“What if they stacked two ASCII characters together side-by-side?” Jamie offered. “To use all the bits.”

“But the computer this connected to wouldn’t have worked that way. It would have worked with all of the bits at once.”

"Maybe, but that doesn't mean the programmer didn't leave an Easter egg, like Atari 2600 Adventure." You could count on Jamie to squeeze in a videogame reference somewhere.

"Well, it's worth a shot." Sarah and Jamie began to read the bits from the rope memory, splitting them into blocks of 8 and then looking them up in an ASCII table printed in one of their computer books. It was gibberish, or so Jamie declared once they had gone through a thousand bytes or so. "There's no recognisable words in here."

"Let me see." Sarah looked over Jamie's translation. He was right, it was just a jumble of characters. But there were the occasional groups of three letters. Some, like ZXQ, didn't make any sense. But some, like MIT... that rang a bell with Sarah somehow. And after it was COL, LOS and USA... Colorado? Los Angeles? Maybe that was where it was programmed?

Cause Still Undetermined in First Official NASA Apollo Fire Report

Inquiry Focuses on Electrical Systems

"Hey, where'd you kids find that?" Steve Silicon said after coming down the basement stairs. "Oh, I know what that is. That's rope memory, like they used in the Apollo missions."

Of course! Sarah smacked her forehead. It wasn't a location, it was COLLOSUS, the name of the software that ran on the Apollo Guidance Computer. The rope memory must be from NASA. But why did David have it in his garden shed? They would've asked him, but Sarah didn't expect David to be any more forthcoming than he had been previously.

But it didn't take a genius to connect the Apollo lunar missions with werewolves howling at the Moon. Sarah decided it was safe to assume that if David was associated with Apollo somehow, their 'wolf' was too. Armed with that information, the wolf might be easier to unmask than David was. After giving their father a quick hug, it was off to the library again.

It wasn't easy, though. But while scanning through microfiche of 1960s newspapers, Sarah finally hit on a promising lead. The Apollo I mission never got off the launch pad – during a test run, the oxygen in the command module caught fire, killing the astronauts. There was an article on the front page of the local newspaper about it.

But there was also a quote from a local resident, Bob Jenkins, who was a cousin of one of the astronauts! If there was anyone in Schenectady that could have a grudge with someone connected to the Apollo project, it was Bob.

The Sliced Salami Society paid Bob a visit, and while Bob was very surprised to see them, he was not shy about admitting his guilt.

"Yes, I'm the werewolf." Bob declared, with a hint of pride. "'David', or whatever his real name is thinks he can hide away from his part in killing my cousin, but I used to work at the post office and I've personally put letters from NASA into his PO box. But my connections at NASA have never heard of him, at least not by that name. I wasn't entirely sure he had anything to do with the Apollo program, but why hide if he didn't? I figured if I howled at him someone would connect me to him if he was – I just didn't expect it to be a couple of kids!"

Bob refused the childrens' request to cease his endeavours, insisting that David had to come clean and apologise if he was in any way responsible. The Silicons then left Bob and went to David's house, and told him they had found the werewolf and knew why he was howling, but didn't tell David the details, hoping he would crack.

"So someone found me. I thought that was probably the case, but why reveal myself if I didn't have to?" David sighed. "The Apollo I fire wasn't caused by my mistake – I didn't design the door, or pressurise the cabin with pure oxygen, those were other people's decisions. But I did sign off on them. I trusted my engineers.

"And when there were hearings in Congress I was at the bottom of the totem pole and so the buck – and the blame – stopped with me. I was ruined. I wasn't fired but I lost my management position and never got another one. I'll explain it all to Bob."

After Sarah and Jamie put on their coats, David stopped them at the door. "One more thing. The other night someone called, someone who knew who I was. He said if you solved my case to tell you to take a break, it was finally time to play. Whatever that means." Sarah knew. The game was afoot.

Have you written a retro-technology related short story you think would suit Android Dreams? Send it in and if picked you could make US$50!

RETRO-CODING CONTESTS!

Get your retro-geek on and code a game or application on your 8-bit platform of choice using BASIC, Pascal, Logo or Assembler, annotate it, then send it in to us and you could win US$100 and be featured in an upcoming issue of Paleotronic!

A second prize of the same amount is also offered for programs demonstrating the best use of microM8's features, including microBASIC's expanded syntax and 3D graphics modes, 3D microLogo, and/or microPAK configuration files and control programs.

The deadline for both contests is January 31st 2019, so get busy! Winners of both contests will be featured in our Q2 2019 issue.

WIN US$100!

...and a trip to a secret Nazi moon-base...?

(...maybe not.)

■ Oh no! Trapped by the evil Leirmeister a quarter of a million miles from Earth, Jane and RR battle for their lives.

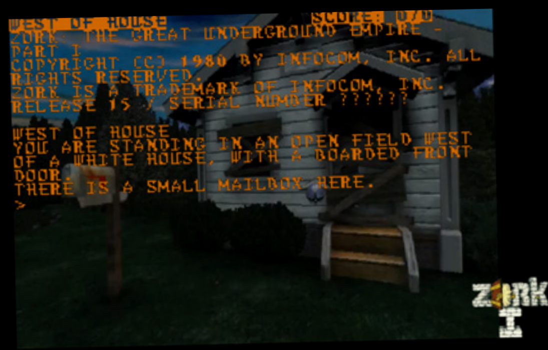
paleotronic microM8 update

It is dark. You will be eaten by a Grue.

At Kansasfest 2018, renowned Apple II disk-cracker 4am released Pitch Dark, a compendium of Infocom text adventures that even includes box art! Due to its size, it comes as a virtual hard-disk image, rather than a bunch of floppies.

Unfortunately for us, there had not previously been a compelling reason to add support for hard-disk images to microM8. But there was now!

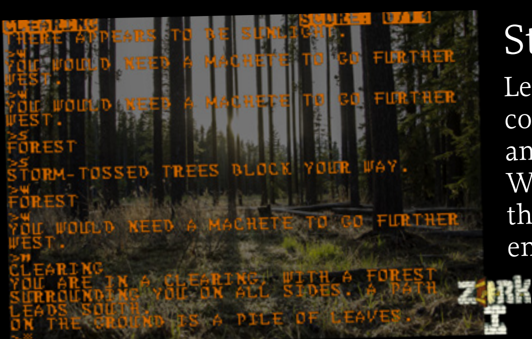
And so, after a week of frenzied development, microM8 now supports 2MG and HDV large disk images, and you can run Pitch Dark on microM8. You can find it in /appleII/Disk Images/2mg_hdv/



It's not just action games that can be 'upcycled'...

But, while Pitch Dark is a really awesome way to play Infocom's text adventures, they are still text. Which can be a little uninteresting to modern retro-adventurers. Since microM8's mission is to spruce classic games up, what can we do with these?

Well, using the microPAK configuration files, we can change the text colour and font, and add a background and an overlay image. Let's use Zork I as an example:



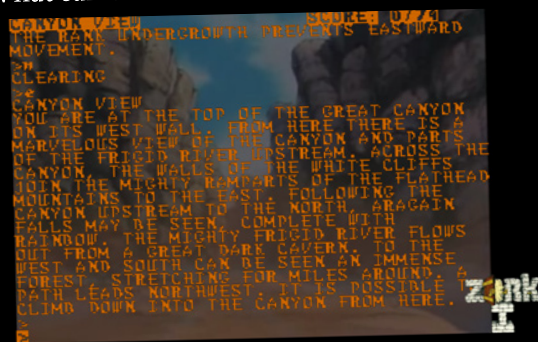
Step 1: Changing up the Apple II text font...

Let's face it, text on the Apple II is boring – no graphics characters, no colours. But the Apple II uses a character generator, which means as an emulator we just paste letters on to the screen from an image map. What if we replaced the dull image map with a fancier one? And since the white text colour is also arbitrary, what if we let users set a different text colour? You can change both of these in the .pak config files.

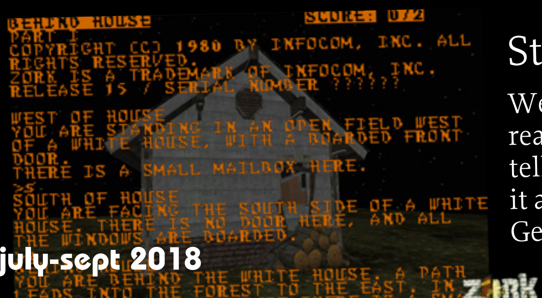
However, plain black backgrounds leave nothing to the imagination – absolutely nothing! What can we do about that?

Step 2: Adding foreground and background pics...

microM8 renders its graphics in OpenGL, which means we can do neat stuff like have 3D 'voxels' instead of 2d pixels. But we can also do other interesting tricks like put PNG images behind and/or in front of the Apple II video 'models' by specifying them in the .pak config files.



But as nice as the backdrop is, it's going to lose its novelty fast. Lucky for us, microM8 can run Applesoft BASIC-based 'control' programs in parallel with other BASIC or machine language programs – like Zork!



Step 3: Making the background more dynamic...

We had to create a new BASIC command – called @SCREEN.READ to read the text screen and then it was easy to write a control program to intelligently change the background as we journeyed around Zork. See how it all works by looking inside zork-demo.pak in the microPAKs folder. Get microM8 from paleotronic.com/microm8

OLDE ENGLISHE

I have been on a crusade over the past few years, trying to discover the true origin of the word "byte," but my efforts have been unsuccessful. I have begun to think that the origin is lost, but I have decided on one last attempt.

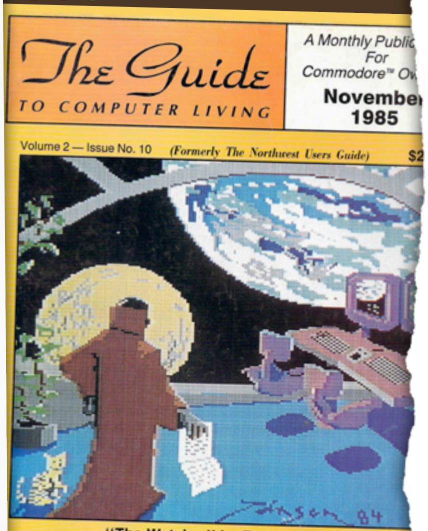
Since the name of your magazine happens to be the very same word that has been the source of my frustration, I am hoping that you can shine some light on the origin of this small word. I have looked in just about every textbook that I can get my hands on.

If you can provide some relief to my plight, it would be most appreciated. Thank you for your trouble.

Thomas P Bishop
PL/C Project Manager
Department of Computer Science
Cornell University
Ithaca NY 14853

I first ran across an etymology of the word BYTE in a book I read on the IBM "Stretch" computer borrowed from an associate of mine at Intermetrics Inc, where I worked prior to founding BYTE. In that book, which was published in the early 60s, a research precursor of the IBM/360 series was being described. The "Stretch" computer (if I remember correctly) had a large bit addressable memory, in which the term byte was an arbitrarily coined word used to reference an arbitrary bit string field of length "n". The term at that time was meant as a generalized concept of a bit string subfield. When the 360 came out, all that changed, since after System/360, almost all published literature references 8 bit bytes. Perhaps a reader can supply a more definitive answer to the question of the term BYTE's origin, and some of the history of the early "supercomputer" work following the "second generation" transistorized computers of the late 1950s and early 1960s. . . .CH

Byte Magazine, November 1976



"The Watcher" by Eddie Johnson

Many of us can very clearly remember the day that John Glenn first orbited the Earth. And who doesn't remember the thrill that rippled around the world when Neil Armstrong took that "small step/giant leap" on the moon? We have watched the world, and the vastness of space, shrink on an almost daily basis. Space flights are now routine, something that you more often than not have to turn several pages into the newspaper to even find.

The conquest and exploration of space has been so interwoven with the development of computer technology that the two are in many ways quite synonymous. Accordingly, it's only natural that when computers got smaller and cheaper and moved into the home that they would bring *Space* along with them.

Randy Chase

OUTGOING MAIL

It took only took 10 years from the time President Kennedy launched the space program until men were walking on the surface of the moon. With the launch of the space shuttle scheduled for April we find ourselves on the edge of a new era. And this promises to be an even more amazing era than the last.

The space program offered us many things. From microwave ovens to microcomputers. This magazine itself, is an indirect by-product of the space program. More than the advancement in technology, the space program offered us a final frontier. When the Apollo program finished, we lost that horizon. With the development of the shuttle, we now have a new horizon, a new place to examine, a new place to learn from.

While discussing new horizons, I guess it's appropriate to tell you about my departure from **SoftSide**. This will be my last Outgoing Mail. I am relocating to Florida to

finish school and continuing my efforts in writing software. I plan to remain active in the software industry and continue to attend the national computer shows, so maybe someday we will cross paths again.

Besides, who could give up an opportunity to be there when the launch of the space shuttle signals the start of the second space age.

SoftSide MARCH, 1981 Phillip

Dean Derhak's complete entry to Microscreens included 11 striking scenes entitled "Dean's History of Space Exploration." He originally created them for a computer art contest sponsored by a television station in Salt Lake City. He won First Prize: an Atari 800.

On July 20, 1969, Neil Armstrong became the first man to set foot on the moon. This microscreen depicts an Apollo landing site. A lunar rover is also pictured.

Antic July 1984

LOST IN SPACE

Dear Sir
Please could you send me the information I need to colonise a planet in *Millennium 2.2*? I have done the following:

1. Researched and found the planet
2. Have two grazers orbiting the planet, eg Leda.
3. I can land probes but not the grazers.

I have not the raw materials to build the rest of the transport vehicles (apart from fighters). I have a Solargen 10 x.

Please could you tell me what to do. Keep up the good work. Could we have an Amiga disk on the cover of ZZAP! like Commodore User?

Richard Gore, Bourne End SL8 5SN

Overall Millennium 2.2 is fairly easy, but this first problem does cause a lot of trouble. All you need to do is send a grazer or two to the asteroid belt and leave it there until it comes across an asteroid packed full of rare minerals. It'll take a lot of supply runs, but eventually you'll have enough to build what I think is called a SIOS ship, which can be sent to the planets to establish colonies. These can then start mining for other minerals.
LM

ZZap!64 April 1990

VOLUME 2

Apple in Outer Space

Technology makers caught in the middle

Microchips and supercomputers like the Cray didn't originate with the military. Even artificial-intelligence research, heavily funded by the Defense Department, has had primarily commercial uses (so far) and is done openly at universities (although I would prefer that it be funded by a nondefense agency). There seem to be plenty of nonmilitary innovations in the computer industry.

There isn't that much job security in any industry that relies on government contracts. Witness aerospace after the SST was killed or NASA after Apollo. Some companies famous for protecting their employees' jobs (Hewlett-Packard, for example) deliberately avoid defense contracts for that very reason.

Karl C. Stengel
Bartelsville, OK

Infoworld
July 1983

JOIN THE CLUB

Dear Lloyd
I have written in to inform you and other ZZAP! readers about the excellent service Activision/Electric Dreams gave me. I purchased the brill game *Millennium 2.2* but, alas, the Craft Roster icon did not work. I then wrote a letter to the company and in time they sent a reply telling me the problem I had. Not only did they send the reply but a replacement disk completely free (gosh, yes!) This disk worked and I got along fine with it. So if you're reading this letter Activision, keep up the good work.

Also I would like to know if there are any Amiga clubs (not the biscuits, dummy!) because I haven't heard of any. If you know please print them in you're fab, brill, superb... etc mag.

Robert Whatmore, Frindsbury ME2 4RT

Letters

DB Magazine
October 1969

The Editor:

The July issue with its articles and information on television sound was one of the most informative published by db. It is good that we have the truths about the frustrations of good TV sound. Why this has never been said before, I'll never know, but now, at least, it has been.

It is interesting that so much reinforcement was added by the two articles from opposite coasts. Apparently, there is little doubt that the difficulties experienced in the east as explained by the transcript of the AES discussion on TV sound are little different from those so excellently expressed by Marshall King in his article on these facits as he sees them in Hollywood, California.

Now that these unhappy situations (and I am most distressed by the line-feed problems of sound deterioration) are illuminated, what is going to be done about them? How long, pray, is the television industry going to continue to have the attitude that the average listener/watcher doesn't appreciate quality—so why give it to him. It just isn't so. The movies have taught us that good sound enhances a good picture. The same can be true of television, but it is the industry leaders that must now establish the fact that this must be given to us. It would seem that if we can send picture and sound from the moon, we can surely send wide-band and low-distortion sound around the country.

Robert A. Ellis
Harrisburg, Pa.

Another practical application of particular interest to me is computer portraits. I hear they're a potential money-maker. I think it's about time the six-million-dollar toy started earning its own keep.

Anyhow, thanks for your time and keep up the good work!

Ken Wong
Edmonton, Alberta
Canada

Computer portraits . . . oh, boy! What a money-maker those systems are! I had a promise of an article on such a system some time ago . . . but it fell through. The commercial versions of those systems sell for around $24,000. I'd be willing to bet a hobbyist could make one for between $7K and $10K. – John.

Kilobaud, December 1977

the ~~dead~~ moon letter office

fidoMail

Recently, an SOS went out on social media asking for individuals to 'rescue' items from an Australian Computer Museum storage shed due to be demolished. However there was some subsequent confusion over ownership of the items. We reached out to ACMS for clarification, and here is their response:

Recently, the ACMS was advised of the impending demolition of its storage space at Villawood by the owners of the property. In response to the short time-frame given, Hon. Treasurer John Geremin put out a request for people in the community to come and take inventory items to temporarily store until such time as the ACMS can find a new space in which to store its vast collection.

At some points during the reposting of this message on various message boards and forums/social media, we believe that the parts of the message which indicated the items must be returned were omitted, leading some people to believe these items were being given away. This was never the case, never the intention of the ACMS. Several instances of inaccurate news coverage did not assist in the matter.

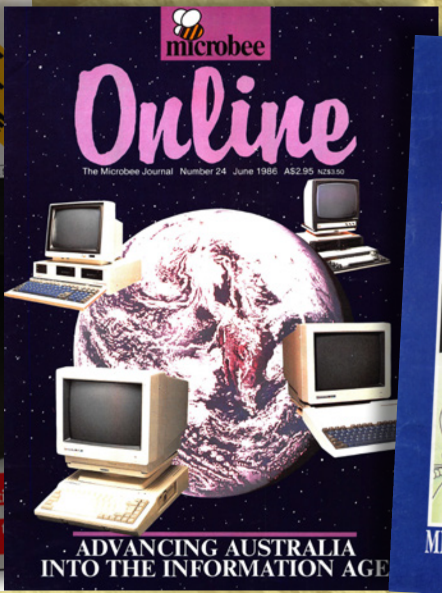
In any event, by the second week of the doors opening, things came under control, with nearly all visitors to the site being informed of the real nature of the distributed storage programme, and almost everybody who then went on to take something to store leaving their details so that the items can be recovered in the future. The vast bulk of items and documents were transferred into storage containers, which will soon be transferred to a new storage site.

The silver lining to this dark cloud has been that we have had a surge in new supporters signing up, and some very talented people have come together to work towards a brighter future for the ACMS wherein we will have a physical space in which to host an actual museum. Expect exciting developments soon.

The ACMS would ask that anybody who took items without leaving their details please get in touch with ACMS at their soonest convenience, as these items will find their best use as exhibits within our upcoming public museum space, telling the important story of computers throughout history. Please call Tennyson Delarosa on 0405-496-283 or John Geremin on 0427-102-060 or email media@acms.org.au or info@acms.org.au

- ACMS

Thanks ACMS!



The Australian Computer Museum Society is a registered educational charity dedicated to preserving vintage Australian computer equipment with a long-term objective of opening a public museum. This includes the Australian-made MicroBee, an educational computer based on various S-100 bus cards designed for the Altair, released in 1982. A new MicroBee was relaunched in 2012.

interesting developments
the lunar code

analysis by April Ayres-Griffiths. See the Apollo 11 AGC code @
https://github.com/chrislgarry/Apollo-11

The Apollo Guidance Computer (AGC) was a fascinating design for its time, and demonstrated many concepts that would take hold be used for many years to come.

The 512Khz master signal (derived from a 2Mhz crystal clock) was divided down into a number of smaller timing signals that were used to trigger events at regular intervals, for example a 100Hz signal was used to update a real time clock, and an even lower frequency signal (every 1 and a half minutes) could be used to wake the computer when it was in a low power state.

The CPU had a multitude of registers, but the core registers were A (accumulator), Z (program counter), and Q (quotient but also used to store a return address from a call).

The instructions for the AGC used a 16 bit word, with 3 bits for the opcode, and 12 bits for the address value. This gave 8 basic instructions, and 3 additional instructions by use of a special call beforehand.

For example: TC transferred control to a specified address. It stored the next instruction address in the Q register, so it could be used for subroutine calls. This was before processors used a stack to keep track of such things.

AD, SU, DV and MP implemented addition, subtraction, division and multiplication of the accumulator (A) register with a value specified by the address portion of the instruction. Other instructions were responsible manipulating data and registers.

Additionally, to provide further functionality, interacting with specific memory addresses could trigger other specific functions in the computer, almost acting as soft switches or virtual instructions.

In order to supplement the simple instruction set and to perform more complex tasks such as trigonometry, the AGC implemented a "virtual machine" that supported more complex instructions. These instructions could be intermixed with the real opcodes, and the assembler would make sure there was a smooth transition between these and the regular instructions. This is why one will see more than 11 instructions in the source code.

Looking at the code, for example, one will see a MXV instruction which is actually a matrix operation. This is an instruction that is implemented within the interpreter to multiply a matrix by a vector.

The system also supported interrupts. When an interrupt was triggered the CPU would save it's current state, call the interrupt service routine, then resume where it left off previously. There were five types of interrupts in total. ERUPT was a critical one, that was triggered when an alarm was triggered so that the astronaut was alerted. DSRUPT was used to update the display data, KEYRUPT handled user input.

Another feature the system implemented was an element called the waitlist which could schedule and manage multiple short tasks, predominantly driven by timers. These tasks could reschedule themselves back onto the waitlist for further execution at a later interval. Longer running tasks generally were managed as jobs by another module called the executive.

These elements were impressive to me; it allowed a lot of different threads of execution to be tracked and maintained -- and flying a spacecraft needs them! Many, many subsystems need to be managed and orchestrated in such a way, that critical tasks are executed in a timely fashion.

The amount of ingenuity and forethought that seems to have gone into the guidance computer - both into its engineering and its software remains impressive to this day. It is easy as a software engineer in the modern sense to forget that we stand on the shoulders of giants.

Yesterday's News

They want it!

Defying speculation, the Indiegogo campaign for the AtariVCS (formerly the AtariBox) retro-inspired console has been a runaway success, selling over US$3million of the US$329 units. The AtariVCS will come with 100 pre-loaded Atari 2600 and vintage arcade titles including Missile Command, Centipede, Asteroids and Lunar Lander. The AMD/Radeon Linux-powered platform will also run a proprietary app store allowing users to buy classic Atari games and modern titles from independent developers. Other features include web browsing, streaming video playback, multi-player on-line gaming (of classic titles? It's not clear) and a voice-activated digital assistant.

The promised delivery date is July 2019.

Well, the design's not our cup of tea, looking more like networking equipment than a videogame console – but other folks like it.

Tech-museum proprietor dies

Sad news from Canada. Syd Bolton, founder and curator of The Personal Computer Museum in Brantford, Ontario passed away recently at the age of 46. His museum featured a large collection of early personal computers, and over 15,000 videogames, including every game ever produced for some of the major consoles. He also claimed to have Canada's largest collection of CED videodiscs. Unfortunately the web page for his museum indicates that the museum will remain closed for the foreseeable future – hopefully someone will step in and take up the mantle.

The BBC Micro, originally the Acorn Proton, became a common sight in British schools, in part due to Acorn's positioning of it as an educational computer. Acorn later released the Electron, a cheaper home version.

Beeb releases BBC Micro archive

The BBC has opened a treasure-trove of BBC Micro-related software and media, including 146 episodes of various BBC Micro "Computer Literacy Project" television programmes, 121 related programmes and 166 pieces of software used in those programmes.

Designed and built by British computer manufacturer Acorn, the BBC Micro was released in 1981 as part of a national effort to educate children about computers.

https://computer-literacy-project.pilots.bbcconnectedstudio.co.uk/

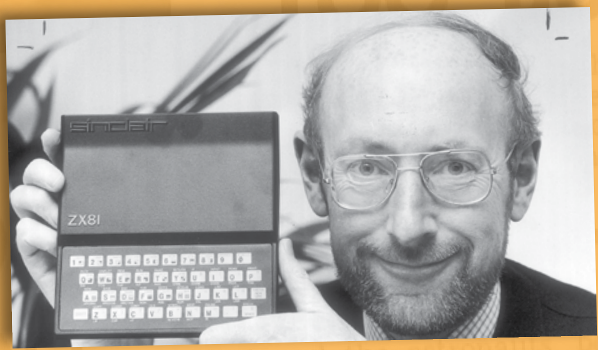
Vega+ Ships...Kinda

So how is it? Well, UK website The Register called the Vega+'s buttons 'crap' and that it was uncomfortable to hold due to rough, unfinished edges.

Also according to El Reg, the Vega+ runs open-source emulator FUSE, in likely violation of its GPL license. They were distinctly unimpressed with the 'finished' product.

Better late then never! Some backers of the Spectrum Vega+ handheld console have finally received them, over two years after the crowdfunding campaign finished. However, its been a rocky road for the project over the last few months as many games-rights owners withdrew permission to include their software, forcing Retro Computers Ltd., the British company behind the Vega+ to ship the console with far fewer games than was promised. A large number of backers are demanding refunds, and RCL is apparently refusing to issue them, raising questions about its solvency. To make matters worse, Spectrum trademark-owner Sky has enforced a clause in their agreement with RCL terminating RCL's license to use the Spectrum name – putting further shipments of the console in jeopardy. Meanwhile, there's an ongoing effort by activist backers to remove RCL chairman David Levy from the board of directors.

Sir Clive Ill?



Where is prominent RCL shareholder Sir Clive Sinclair in all of this? Sadly, there are reports he is not well. Retro Computers Ltd. has apparently filed paperwork striking Sinclair Research off of its board of directors. Hopefully it's nothing serious and we wish him a speedy recovery.

Nintendo Cracks Down

Nintendo's had enough of ROM pirates, sending legal notices to a number of emulation sites and leading some of them to shut down.

In its letter, Nintendo demanded US$150,000 for each game shared on the websites, forcing LoveRetro, LoveRoms and EmuParadise to close their doors.

Nintendo described LoveRetro and LoveRoms as "built almost entirely on the brazen and mass-scale infringement of Nintendo's intellectual property rights" accusing them of "trafficking in pirate copies" of its games. Why is Nintendo cracking down now? Well, they've launched a subscription service for their Switch console that includes access to NES titles!

Beware the angry Japanese lawyer!

HYPERKIN®

PLAY WELL. LIVE WELL.

In North America in particular, Hyperkin has made a name for themselves releasing clone systems for a number of classic consoles. We take a look at the range available, the pros and cons each and what you can expect.

Retron 1

The Retron 1 was Hyperkins first foray into clone consoles and used NES An A Chip (NOAC) to emulate a Nintendo Entertainment system. It was primarily notable for being able to use both the controllers and the light gun from the standard NES (with a CRT television only), and provided composite output of for video and audio. Famicom cartridges were not supported, owing to the different form factor.

Compatibility was generally good, however some older multicarts and approximately 20 titles including Castlevania III will not work on the device. There were also some complaints that the pins could bend when removing cartridges from the device, owing to a very tight port.

During our brief foray into running a retro-gaming store, the Retron 1 was a hot seller. For people who only wanted to play one game such as Mario or Zelda it was a much cheaper, more reliable way to accomplish that rather than buying a used NES, which at the time was around $100 and frequently has reliability issues. For $40, the cost of the game (or a multicart) and optionally a used NES controller (the one that comes with the Retron 1 isn't great) you were off and playing – good value.

If Super Nintendo was more your jam, the Retron 2 gives it to you – plus it's a bit better constructed and comes with nicer controillers that, although still not completely authentic, at least don't fall apart in your hands! It even has the eject button.

Retron 2

The Retron 2 adds to the Retron 1 functionality by adding in support for the Super Nintendo Entertainment System (SNES). The system has quite a high quality video and audio output adding an S-Video connector to the mix. It has four controller ports, with on NES port, and one SNES port on both the left and right hand sides.

The unit seems to feature the same NES slot as the Retron 1 along with the death grip on the cartridge, but thankfully adds an eject mechanism to assist for the SNES portion of the unit.

Compatibility of the system is generally fairly good, however there are about twelve titles (including Street Fighter Alpha 2) which do not work with the system due to having unsupported custom chips - in particular the S-DD1 and SA-1 chips.

The Retron 1 gets the job done but it's kind of a piece of junk. The Retron 2 on the other hand is much sturdier and easier on the eyes.

Hyperkin's strategy is to make each Retron model a little more featureful and a bit better quality than the one before it, to encourage upgrading and justify the added cost. From a retail perspective this means having a range of products at different price-points...which is quite desirable for a retro-gaming shop.

Retron 3

The Retron 3 upped the ante by bring in support for the Genesis / Sega Megadrive console. It is based on Genesis On A Chip (GOAC) and as such has issues with PAL games, but supports Japanese and US Genesis cartridges, in addition to the requisite support for NES and SNES.

Video output is similar to the Retron 2, and includes composite stereo output and S-Video output. There are six controller ports, 2 per supported system. The console itself comes with two wireless controllers, styled after the Sega Genesis.

Compatibility is generally fairly similar to the Retron 2 for the NES and SNES portions. Almost all PAL Megadrive titles will not work with the Retron 3 (this is an issue with GOAC in general and affects most Sega clones), and specialist titles such as Virtua Racing will not work properly due custom chip support. There have been some reports that multicarts such are the Everdrive will not work with the device.

If you were more of a Genesis fan, the Retron 3 has you covered – although at around $100, if you have no desire to play NES or SNES games at all, you might consider the AtGames Sega Megadrive Classic or the FEO HAO Retro Game HD, botrh of which we've reviewed in previous issues. Otherwise, the Retron 3 is once again better constructed than the 1 or the 2, and comes with wireless Genesis-style controllers.

Retron 4

Hyperkin was expected to release a Retron 4, with support for NES, SNES, Genesis and GameBoy, GameBoy Color, and GameBoy Advance. Slated to be announced at the Midwest Gaming Classic expo, Hyperkin instead announced the Retron 5.

Retron 5

The Retron 5 is what the Retron 4 was intended to be, except with the addition of an extra slot for Famicom cartridges. Hyperkin extended the supported systems list to include NES, Famicom, SNES, Super Famicom, Genesis, Megadrive, Gameboy, Gameboy Color and Gameboy Advance.

Video output uses HDMI, and there are controller ports for SNES, NES and Genesis controllers. The system comes with a wireless controller that can be reconfigured through the in-built user interface.

The system itself eschews the use of custom chips to provide the systems support as used in previous models and instead is effectively an ARM quad core based system running each system under emulation. People have examined the system and found it appears to be based on Retroarch, an open source emulator platform and library that implements cores for all the specified systems.

ATTACK OF

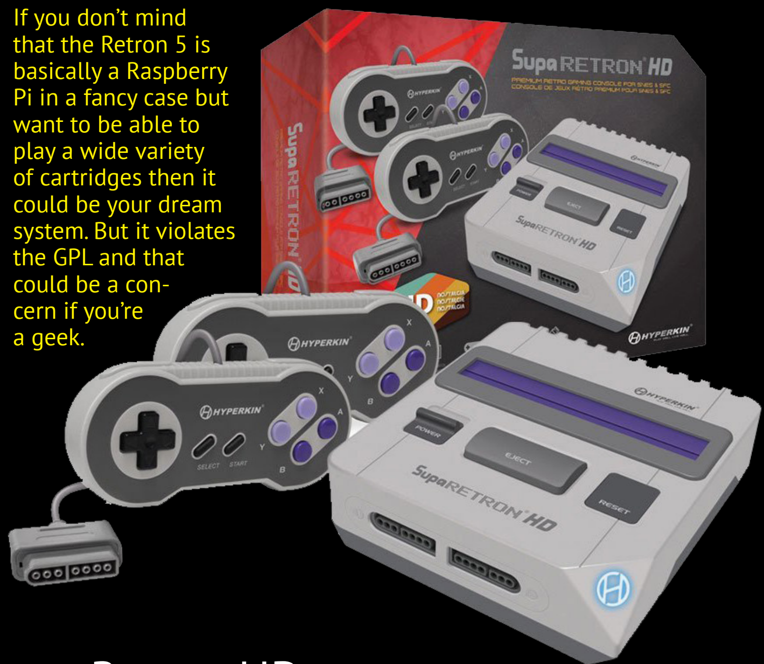
Controversially, some of the licences for the cores are incompatible with commercial use, and the retroarch developers were unhappy with the appropriation and use of their work in violation of the licensing.

Emulation on the Retron 5 does however seem to support a broader range of titles than the On-A-Chip based systems, due in part to the more flexible nature of emulation, and that the core code in question has been refined by the original developers for many years. There have been some complaints of lagginess with regards to controllers / video with the system (some users claim this is an issue with the TV sets themselves) but generally the emulation is decent.

SupaRetron HD

So, where do you go after the Retron 5? Well, all of the models we've covered here so far only have analog video out. Now, whether that matters to you or not is going to heavily depend on what generation you're from – if you're an actual former 80s kid, then you're going to have grown up with blurry video and interference and colour distortion, so blowing up a composite signal on a large flat panel is probably not going to bother you that much. However, if you're a millennial, you're going to be accustomed to somewhat better quality in your gaming, and so the HD models are likely to be up your alley. Rather than blowing up a low-resolution screen, each pixel is made larger, filling up a higher-resolution screen. This makes edges of objects crisper.

If you don't mind that the Retron 5 is basically a Raspberry Pi in a fancy case but want to be able to play a wide variety of cartridges then it could be your dream system. But it violates the GPL and that could be a concern if you're a geek.



Retron HD

Upscaling also makes game elements look more pixelated, which while attractive to some younger generations, might be enhancing an aspect of vintage videogaming those from older generations may consider undesirable. The HD models also feature redesigned (and in our opinion much more aesthetically-pleasing) cases and controllers.

The emulation and video ouput of the HD Retrons isn't perfect but they are much cheaper than the Nintendo Classic Minis, and they allow you to play your own cartridges, something Nintendo's offerings do not.

The updated case and controller designs are also an improvement over previous non-HD versions.

They also officially support both NTSC and PAL games unlike earlier models, and have a 16:9 / 4:3 aspect switch.

THE RETRON

Retron 77

Most recently, Hyperkin released the Retron 77, its tribute to the Atari 2600. It contains a cartridge slot, HDMI output and the various toggles and switches needed to play 2600 games.

As with the Retron 5, the decision seems to have been to use emulation to provide the Atari compatibility. The hardware base seems to be a 1Ghz ARM quad core chip (a bit less powerful than the one in the Retron 5). The system has a slot for reading cartridges and also an SD card slot for using roms. The emulation is provided by a version of the Stella open source emulator (3.7.5).

Compatibility with cartridges for the most part is ok, however any cartridges with custom chips such Pitfall II will not function correctly. Pitfall II can be played as a ROM however. Cartridge-wise, most of the affected titles are Activision or Parker Brothers.

There were some complaints also with early versions that the joysticks were not quite reinforced enough and the sticks would break with very little use. This has apparently been addressed in more recent units.

Atari 2600s are getting harder and harder to find, and consequently much more expensive to acquire than they once were, making the idea of a modern 2600 clone seem like a great one. But, let's also consider the now-defunct Atari Flashback 2, which while it doesn't come with a slot by default, can be made to have one with some straighforward modification.

The Flashback 2 uses hardware to emulate the 2600, which provides a more genuine experience (in particular regarding controller responsiveness) than the ARM-based Retron 77 – we're not sure why Hyperkin went the way that they did (probably to cut development costs) but we don't agree that it was the right direction. It also made the 77 more expensive – not groovy.

If you're interested, you can find Flashback 2s on eBay, and Google will lead you to conversion kits and instructions.

So, where can I get a Retron in Australia? The newly expanded amazon.com.au has various Retron models for sale, most of which appear to be coming from overseas. There's also eBay, which has models available from Australian sellers, but prices vary and ordering from overseas could be cheaper.

While our Retron 2 does play PAL NES cartridges, the music seems to be faster (due to running a 50hz cartridge at 60hz) so that could be a consideration if you're in Australia and trhinking about getting a Retron. On the other hand, the games run a bit faster too, which livens some well-worn titles up a bit.

Generally, the Retrons are a good choice for affordable retro-gaming, despite their issues.

Conclusion

A device like this can be a good substitute for an original system, particularly in the case of an NES, which tends to need regular maintenance to keep running, however they each have their pros and cons, and some may find the emulation aspects of the Retron 5 and Retron 77 to be less to their taste than original hardware. That being said, the more systems there are that can allow their users to keep enjoying their libraries of games for longer, the better.

Can't fault the exterior design of the Retron 77, though – in our opinion it's much nicer-looking than the AtariVCS (formerly the AtariBox) , which looks like some sort of WiFi router. It's just too bad that it uses software emulation...otherwise we'd love it to bits! (8 bits, to be exact.)

This joystick looks really cool! Hopefully it lasts longer than the original often didn't.

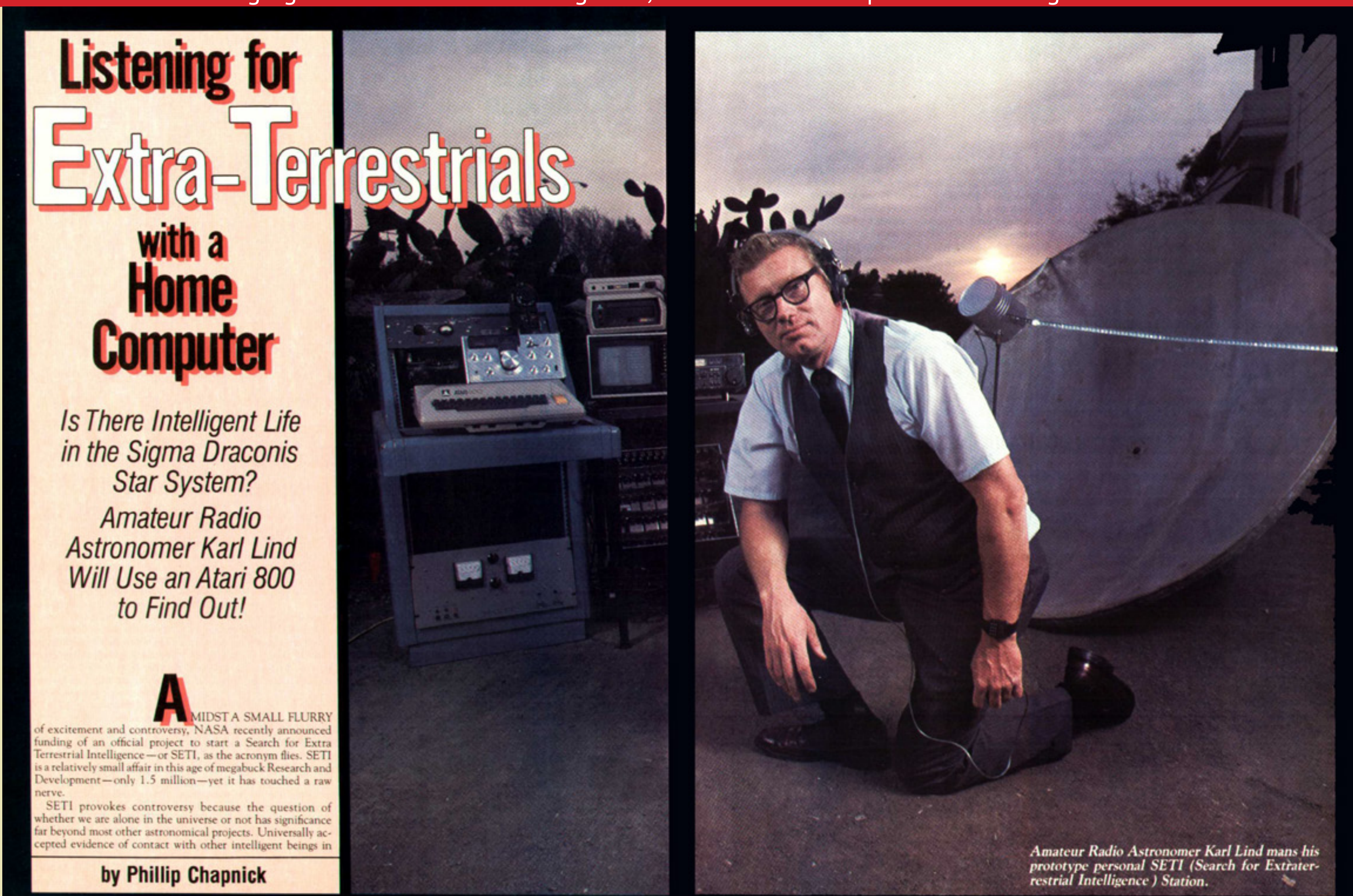
Cover Stories

We here at Paleotronic love vintage magazines! Here are a few interesting covers (and cover stories) we came across while researching this issue...

Atari Connection's readers got an out-of-this-world surprise in their mailbox upon receiving the Summer 1983 issue. Aliens were big in popular culture at the time, with films such as ET: the Extra-Terrestrial (1982), Star Trek II: The Wrath of Kahn (1982) and Star Wars: Return of the Jedi (1983) inspiring the imagination of both young and old alike.

This month's cover stories also include a look at Aviation Week and Space Technology, a great resource for anyone researching the space industry in the leadup to Apollo 11, and covers from various computer magazines including Byte, Computer & Video Games, Creative Computing, Micro, Softside and Computer Express...

The article chronicled the exploits of amateur radio astronomer Karl Lind, who used an Atari 800 computer to perform signal analysis in his personal SETI (Search for Extra-Terrestrial Intelligence) project. By taking repeated measurements of incoming signals from Sigma Daconis and averaging those measurements together, Karl hoped to eliminate random noise and see if he could uncover any signals buried beneath. His focus was on 1.42 Ghz, considered the safest frequency for transmitting thorugh space. The assumption is aliens would know this too, and use the frequency to send out their own queries searching for other life.



Listening for Extra-Terrestrials with a Home Computer

Is There Intelligent Life in the Sigma Draconis Star System? Amateur Radio Astronomer Karl Lind Will Use an Atari 800 to Find Out!

AMIDST A SMALL FLURRY of excitement and controversy, NASA recently announced funding of an official project to start a Search for Extra Terrestrial Intelligence—or SETI, as the acronym flies. SETI is a relatively small affair in this age of megabuck Research and Development—only 1.5 million—yet it has touched a raw nerve.

SETI provokes controversy because the question of whether we are alone in the universe or not has significance far beyond most other astronomical projects. Universally accepted evidence of contact with other intelligent beings in

by Phillip Chapnick

Amateur Radio Astronomer Karl Lind mans his prototype personal SETI (Search for Extraterrestrial Intelligence) Station.

Aviation Week was first published over one hundred years ago in 1916! It is still published weekly.

"Gus Grissom, Ed White and Roger Chaffee were dedicated to the task of pushing the Apollo program to the most dramatic and technically meaningful chapter of man's effort to break out of his earthly environment..."

– Quote from editorial following Apollo 1 disaster, 1967.

In defense circles it's informally called "Aviation Leak and Space Mythology" due to the magazine's reputation as a source for insider gossip and speculation.

Aviation Week & Space Technology extensively covered the progress of the Apollo program and its successes and failures from an industry (read contractor) perspective.

Besides articles and gossip, because it was an industry magazine it also contained advertisements from various aerospace companies declaring their part in the various NASA space programs. Browse them on archive.org

Byte always had the best cover art, and this lunar-eclipsing cover was no exception. Although we're not certain what the point of the Byte balloon is... but it's very arty! You can check out all sorts of Byte covers on the Internet Archive @ archive.org

Aliens! Remember them? Those little green men from outer-space that were coming, or could already be here, controlling our minds? Whatever happened to them? At some point we forgot about them. But maybe that was their plan...

From Creative Computing came this trippy 1979 cover reminiscient of the adult cartoon mag Heavy Metal, wherein an astronaut finds a TV on the moon playing... hangman?

Strange new worlds...through the computer! But not with graphics like this. Not in the 1970s – computer spacefaring required imagination.

Your editor also did too much Atari ST in the 1990s... only the British could create a tabloid computer magazine!

Tandy Assembly

Tandy Assembly is an annual gathering of enthusiasts of Radio Shack's TRS-80 line of personal computers.

The 2018 event will feature a keynote by Computer Chronicles producer and presenter Stewart Cheifet (who we interviewed in our first issue. Great guy!) as well as a number of other speakers, exhibitors and an auction of vintage Tandy and Tandy-related gear.

It all happens November 10-11 in Springfield, Ohio USA

For more information or to register see www.tandyassembly.com

VCF Pacific NorthWest 2019 will take place March 23-24, 2019 at Living Computers Museum in Seattle WA vcfed.org for info.

combine to make the HP-65 so powerful that it was used to backup the on-board computer on later Apollo missions. Byte, December 1975

Celebrating 50 years of HP programmable devices, the HP Handheld Conference happens September 29-30 in San Jose, CA USA.

Attendees will give talks on the history of HP calculators, advanced calculator mathematics and other topics most of which hurt my brain. But if you're a calculator geek you should definitely go!

For more information go to hhuc.us/2018/

At HPHCC you might see an HP-65, the first magnetic-card programmable handheld calculator. It had a memory of up to 100 6-bit instructions that could be stored on magnetic strips. Released to the public in 1974, HP claimed that prototypes were used as backup computers on later Apollo missions.

Community Calendar
retrotechnology events

Adelaide retro-computing enthusiasts meet the second Friday of each month. Their October 12th meeting will be music-themed. For more information visit adelaideretrocomputing.blogspot.com

PAX 2018 AUS MELBOURNE, VICTORIA

The Penny Arcade Expo comes down under October 26-28th in Melbourne and usually has plenty to interest retro-gamers including pinball machines, arcade cabinets and consoles. Register soon at aus.paxsite.com

wozfest

The regular gathering of Apple II enthusiasts in Sydney returns on the 13th of October with the usual 8 and 16-bit geekery, apple cider and pizza. For more information check out the.europlus.zone/wozfest/

An ancient tome that has circulated on university mainframes, corporate servers, on-line services, bulletin-board systems and the Internet progressively since the 1970s states that Real Programmers have a dot-matrix printed Snoopy calendar from 1969 on their wall. Now you have one too!

kansasfest

As usual, Kansasfest 2018 did not disappoint. HyperStudio publisher Roger Wagner's (left) keynote was outstanding.

We'll have a comprehensive article on Kansasfest 2018 in our next issue, including more on the event's history and speculation on where it might be headed in the future... stay tuned!

reddit

Reddit has a variety of "subreddits" on retrogaming and retrocomputing topics. Here's a small selection of some of the more popular or notable ones:

r/PixelArt features posts by "pixel artists" who create 8-bit-styled still and animated artwork.

r/RetroGaming contains a wide variety of vintage console gaming discussion.

r/RetroBattleStations does similar for vintage computing.

r/chiptunes showcases new 8-bit-style music.

r/MAME focuses on arcade game emulation, and contruction of MAME-based arcade cabinets.

r/CRTGaming discusses the repair and restoration of vintage televisions and computer monitors.

r/BBS lists new bulletin-board systems, and helps visitors with starting their own.

usenet

UseNet is a good source for retrocomputing discussion and information. You can access UseNet groups through groups.google.com and subscribe to have new posts sent to your inbox!

comp.sys.apple2 is an extremely high-traffic usenet list about all things Apple II! If you're interested in getting into 8-bit computing, this is a good place to start, if only to get a taste of the depth of the subject matter, and the enthusiasm many people have for it...

Companion groups comp.sys.apple2.programmer and comp.emulators.apple2 talk about Apple II programming and emulation respectively.

Other retro-related UseNet groups:

comp.sys.cbm	Commodore discussion
comp.sys.sinclair	Sinclair discussion
comp.sys.tandy	Tandy (Radio Shack) discussion
comp.sys.TI	Texas Instruments discussion
comp.sys.acorn.*	Several sub-groups about the Acorn computer family
comp.sys.amiga.*	Several sub-groups about the Commodore Amiga family.

@mailing lists

ClassicCmp maintains two well-traveled mailing lists dedicated to "classic" computing, which they define as topics related to any computer or software more than ten years old. There's a casual discussion list that allows for off-topic chatter, and a strict on-topic list for those who don't want unrelated banter.

You can subscribe to either list at classiccmp.org

The Apple IIoz mailing list connects Australian Apple II enthusiasts with each other for information and to organise meetups. Subscribe by sending an e-mail to mail-subscribe@appleiioz.com

Retro Roundup sends out daily digests of updates from a number of retro-related blogs. Subjects include vintage home computers, video-game consoles, news and upcoming events.

You can subscribe at retroroundup.com

podcasts

Retro Computing Roundtable (@RCRPodcast) releases monthly podcasts that delve into various aspects of the retrotechnology community including events, new products, auctions for vintage hardware and more. www.rcrpodcast.com

Hosted by Mike Maginnis and Quinn Dunki, the Open Apple Podcast talks about all things Apple II www.open-apple.net

Eaten by a Grue! monsterfeet.com/grue/

Do you have something to add to this list? E-mail editor@paleotronic.com

THE BBS LIST

facebook

Members of the 8-Bit Computer Clique Facebook group post about all sorts of early 1980s computers, including new product announcements.

If you're looking to discuss anything more recent, Retro Machines allows members to talk about any computer more than a decade old.

Facebook group Space Hipsters is a high-traffic group focusing on space exploration, both historical and contemporary.

www.facebook.com/groups/spacehipsters/

CED Magic looks back at the SelectaVision video disc system, a video record player!

Apple II Enthusiasts is one of the largest retrocomputing groups on Facebook with over 5000 members.

I Am A Classic Videogamer covers all vintage consoles and arcade games with news and reviews.

twitter

C64audio (@C64Audio) is working on a multifaceted project related to Commodore 64 musician Rob Hubbard, including a book, game and music.

Antoine Vignau (@antoine_vignau) is an Apple IIGS programmer who posts and retweets about all kinds of Apple II stuff.

Digital archivist Jason Scott (@textfiles) posts about current news and events in the retrotechnology community. You should also follow his cat, @sockington

Yesterbits (@yesterbits) has a feed chock-full of retrocomputing goodness.

4am (@a2_4am) releases a constant stream of previously unarchived Apple II software.

DataDoor (@datadoor) posts PETSCII art and 8-bit computer generated music.

BBS bulletin board systems

A 80's Apple II BBS: a80sappleiibbs.ddns.net:6502

This BBS is running on a live working Apple II serving data off of real floppy disks. Because of that only one user can connect at a time, so if at first you don't succeed, try again later (just like the old days!)

Did you know that you can "call" hundreds of telnet-connected BBSes via a vintage Apple II terminal program using microM8? Get it from microM8.com

The Telnet BBS Guide is the largest active listing of telnet-accessible bulletin board systems on the Internet: www.telnetbbsguide.com

Absinthe BBS: absinthe.darktech.org

In contrast, this multiline Amiga-based BBS has multi-user chat and gaming.

chat rooms

irc.freenode.org hosts several retrotechnology-related channels including #C64, ##amiga, ##atari, #retro-computing and #classiccmp

Apple II Slack group Apple2Infinitum is hopping with discussion about all things Apple II. Signup at: http://apple2.gs/slack

Chat about all things Apple II on A2Central's IRC server. Point your IRC client at irc.a2central.com and join #a2c.chat

You can connect to IRC servers using XChat available at xchat.org (Windows or Linux) or XChat Azure available on the Mac App Store.

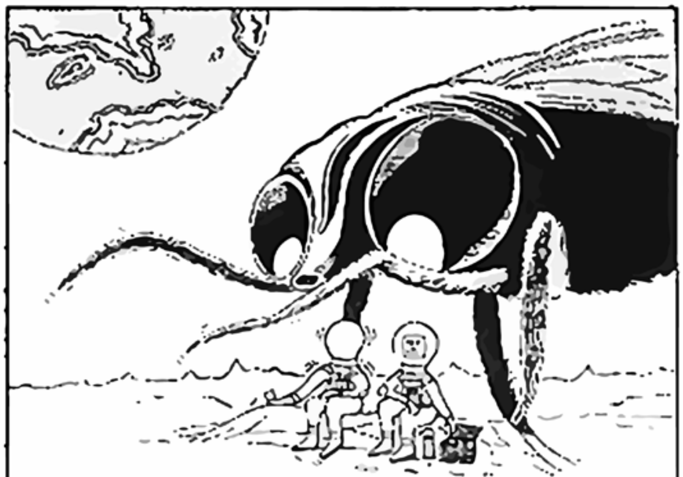
www: ftp:

www.racketboy.com features articles on retrogaming, including collecting, and forums on various retro topics including a marketplace.

ftp://ftp.apple.asimov.net/pub/apple_II/ features a gigantic collection of vintage Apple II software and documentation organised by category.

www.lemon64.com hosts games and reviews on thousands of classic Commodore 64 games. It also features a gallery of graphics, a music archive and a collection of game box art.

THE FUN ZONE

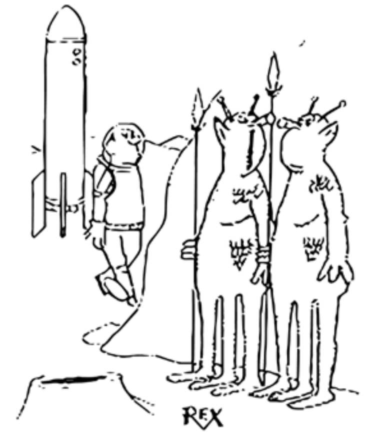


SO THERE ARE INSECTS AROUND!
WHO CARES ABOUT A FEW INSECTS...?

MISSION CONTROL..?
YOU'RE NOT GOING TO BELIEVE THIS, BUT...

Something tells me it's one of those days"

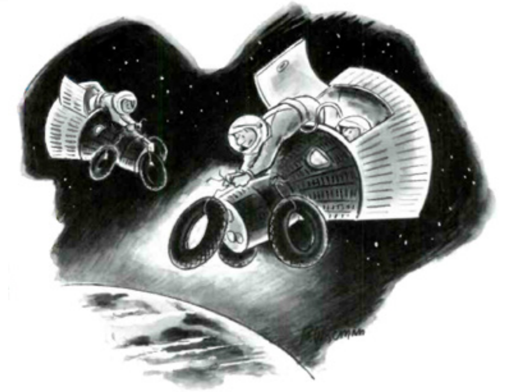
10-9-8-7-6-5-4-3-2-1...
NOW BLAST OFF TO BED!



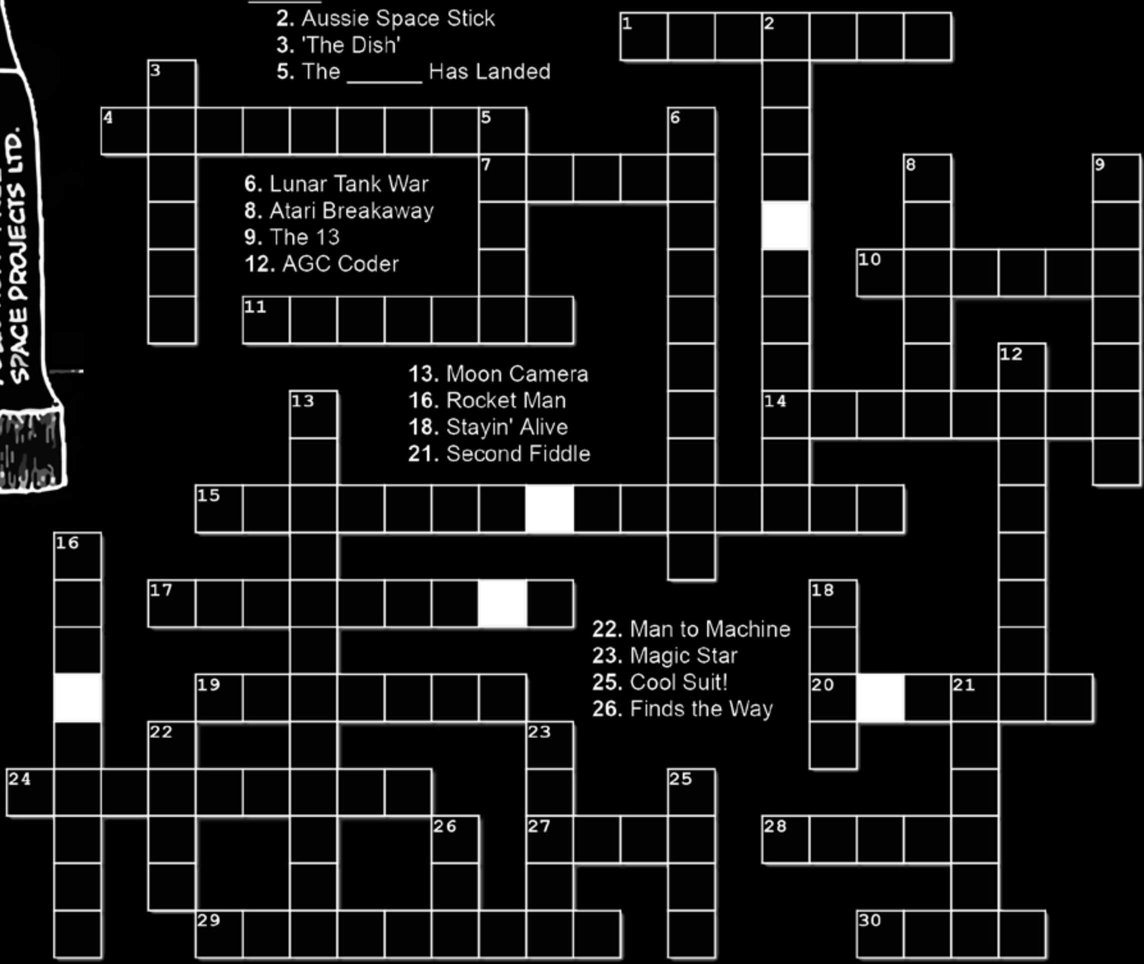
"He's pretty nimble for someone who's lost a leg"

"How was it apart from the meteorites?"

I've phoned the Air Ministry, and they say there's a perfectly logical explanation . . ."



Lunar Crossword



Down

2. Aussie Space Stick
3. 'The Dish'
5. The ______ Has Landed
6. Lunar Tank War
8. Atari Breakaway
9. The 13
12. AGC Coder
13. Moon Camera
16. Rocket Man
18. Stayin' Alive
21. Second Fiddle
22. Man to Machine
23. Magic Star
25. Cool Suit!
26. Finds the Way

Across

1. 2001: A Space...
4. IBM System/360
7. Moonbase
10. Lunar Photographer
11. Moon Manager
14. Sir Clive
15. Apollo Phone Home
17. Heavy Lifter
19. Kid's Rover
20. Lincoln Frequencies
24. One Small Step
27. Guides Apollo's Arrow
28. AKA Moon Buggy
29. Eclipse Engine
30. Round Sound

The answers are hidden in this word search!

```
F A H
I A U R G C A Y A
F I K Q V R R N D M Y T H
T T Q Y Y F I A W S O V I B I F S
X P D S K A F L L H O A R L L X V Y D
I W G Z L C R E P O P P Y C T C T B I R Q
W K Q C G G I O A F R E L A I S J O Y F S
D S V H K C K A B R O O T B A P G M N N E M D
Z U R N G O G V E K I K G N W K K A R T G I B
K Y V E F P C D E V E L Y O V O G M L M A S T V J
N L R R X K S S Y Z S H I I P C C E M R I W O R H
X U W E U S C W S S Q S R Z A C L R S E F V P O E
I T W N E L A N P G R S H J C A U N C V R P O W V Y S
R A Z N P P L K U H I O E D N A H E U F C L N G E O O
E H L Q E S D E Y M K A T Y W U O K R I U R T N R B G
J T E H C C E U V M J U P I T E R Y F P Z B C L J
B Q R A R L Q B M A E S U O H G N I T S E W F S Y
Z F T X G W B U I I C F X R B A T T L E Z O N E A
Y Q A Q X M P L N I U H D A R I A L C N I S W
Q E B Y D I T H F J N R S Q N F K O T W O B J
O D E I C V I R R H I S E X G S I J O M Q
V N W E D N U A R B F R O D Z E D X X D X
B C X N E I M X N D Q D R B R R C S U
Y Q A F O E F A F D G L A G H K Q
B J H Y J F L X U T A I Y
U T H R F L S G H
W H K
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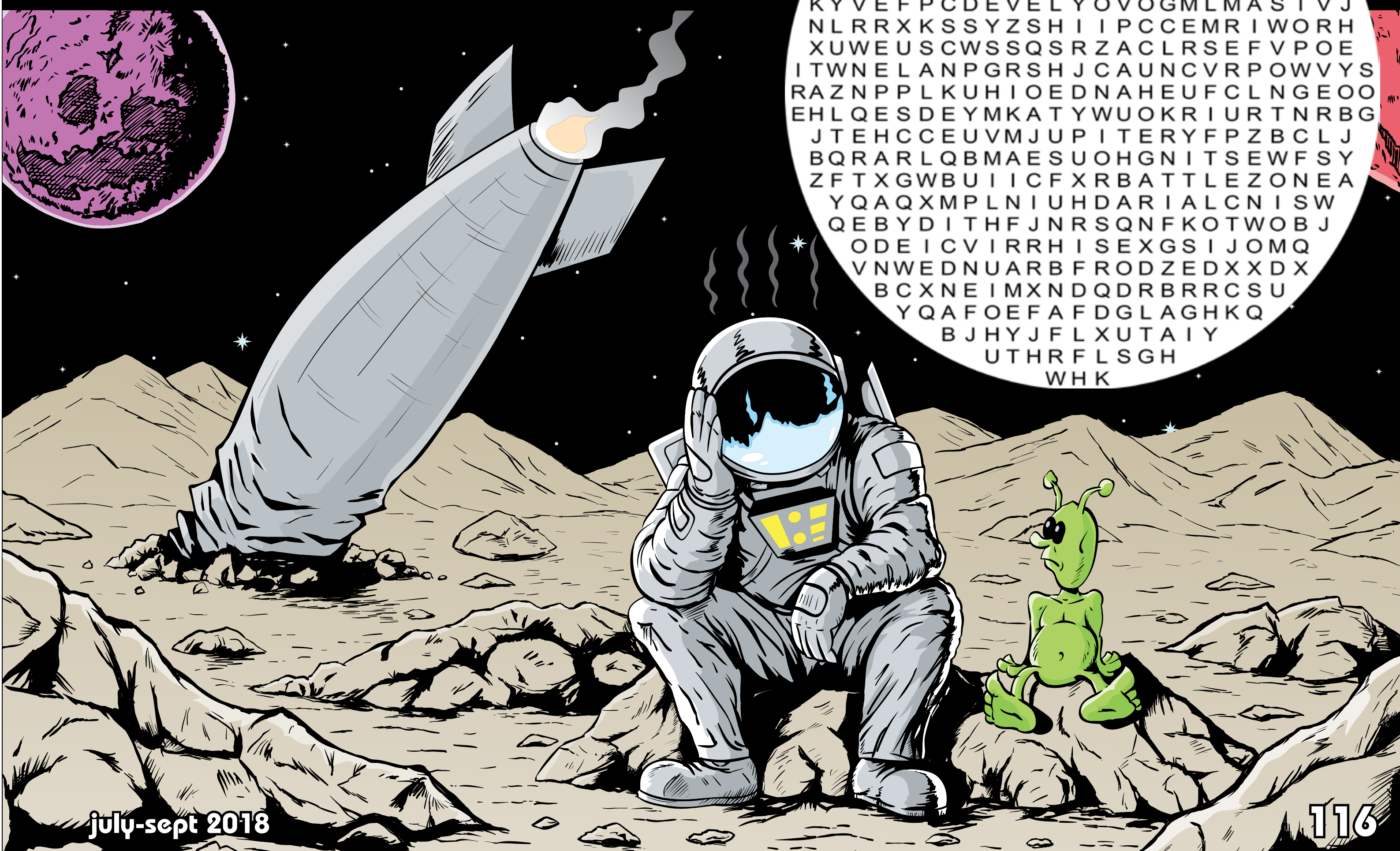

In this issue, we've been to the Moon and back.

We've looked at the innovations which, along with human grit, made the impossible possible, landing humanity on the lunar surface not just once, but six times – the first less than a decade after US President John F. Kennedy mandated it.

We've also looked at what didn't happen: the Moon colonies, lunar and asteroid mining, and further human planetary and exo-planetary exploration. But none of that ever happened! Why not?

It's not discussed much in the context of the Apollo missions, but space is a dangerous place. Solar flares, micro-meteorites, equipment failures, radiation – the Apollo 13 astronauts almost died, and while it's considered a triumph of human ingenuity they made it back safely, it's fair to say the incident at least slightly soured NASA's appetite for manned deep-space missions. The helplessness felt at Mission Control is reported to have been extremely palpable.

But we won't sugar-coat it: the Apollo program directors played dice with astronauts. They were fortunate the Sun was in a period of "solar minimum" that reduced the occurrence of solar flares and result radiation that could've been fatal. Due to gravitational forces, the route to the Moon has a low-risk of an encounter with meteorites – but it's not zero. And bursts of radiation? Just don't roll a 7 or 11.

This is why, after the Apollo program concluded, we haven't been back to the Moon in over four decades. Your editor wasn't even a thought in her parents' minds the last time a person walked on it. NASA pulled back to Earth's orbit, and after the loss of two Shuttles – Challenger and Columbia – has even given up on that. Now it's up to private aerospace companies, such as Elon Musk's SpaceX, to take up the mantle of human deep-space exploration.

But will they? It's likely the loss of even a single astronaut would cause NASA to withdraw their contracts. Would any sane CEO in this day and age, when any tragedy is amplified by the media to the point of hysteria, risk the future of their company over a vague promise of profits or publicity? That's why a government agency was doing it in the first place!

Perhaps Musk may want to ignore his shareholders' obvious concerns, but will his Board of Directors? I wouldn't hold my breath. And so we're back to "We choose to (do these things) not because they are easy, but because they are hard; because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one we intend to win, and the others, too." (John F. Kennedy)

"The others" may have been the Soviets, but while the Cold War is over (although a new one with China may be just beginning) our enemy now is simply time. The climate of the Earth is changing, while its human population is approaching 8 billion. As our planet returns to its historic equilibrium of Jurassic-era temperatures, many species that thrived during the post-ice age period are now dying out – especially in our oceans.

As custodians of our planet we need to come up with solutions to the myriad of problems we are soon to face now rather than later. These solutions are likely to require intense technological innovation, and we at Paleotronic see no greater potential nexus for that innovation than to immediately restart manned deep-space exploration. But it will need to be led by governments – not just the Americans, but the Australians, Canadians, British, perhaps even the Chinese and the Russians.

If this global effort doesn't happen quickly, we might not just find ourselves experiencing our own mass extinction, we'll also have nowhere else to go.

Paleotronic Magazine is a not-for-profit publication published by Teaching Electronics and Computing History (TECH), an Australian not-for-profit organisation dedicated to promoting understanding of formative electronics-based technologies.

The text of articles is free to distribute if credited 90 days after the date of first publication (01/09/2018).

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April Ayres-Griffiths
George Bachaelor
David Stephenson

Would you like to write for ***Paleotronic***? Contributors get free printed issues of the magazine and some pocket money to boot! We're looking for insightful articles about the history of technology, retro-videogame reviews, insights on the retro-technology community, new products and news, fiction and whatever else fits. We're also looking for original software.

No ideas? No problem, we'll find something for you to write about. Each issue has a theme, and the well is usually quite deep. No worries!

So e-mail **editor@paleotronic.com** and put your hand up to be a ***Paleotronic*** contributor!

Next Issue

It's time to party hard with our retro-celebration spectacular! The holiday season is fast approaching and we'll give you plenty of tips on how you can use retro-technology to make it an even more special time, from how to create your own 1980s-style greeting cards and party stationary to original and classic holiday-themed games you can type in yourself.

We'll also look at events celebrating retro, including conventions, expositions and smaller, more cosy gatherings of retro-technology enthusiasts. There will be interviews with the organisers of some of these events, and we'll also hear from participants about just why they take the time to not just reminisce about the past but also continue to prod their favourite retro-tech into the future.

Come along and join the party!

Big thanks to NASA for placing all of their images into the public domain, and helping to make celebrations of space exploration like this one possible! Also huge thanks to all of those involved in the production of the various vintage computing and gaming magazines we've referenced in this issue. We follow in the foot-steps of giants.

Mission Splashdown

get more retro-fun

Containing interviews with luminaries such as Steve Wozniak and Richard Altwasser, features about important technological milestones such as the invention of television, and fun looks back at both greater and lesser-known consumer electronics, Paleotronic is your go-to source for both nostalgia and history.

Our first issue explored the history of the Consumer Electronics Show, profiling notable products that debuted there including the Commodore 64, Atari ST, Nintendo Entertainment System and many, many more. We also talked with Computer Chronicles host and producer Stewart Cheifet about CES. It's 120 pages of pure retro!

Our second issue examined all things video – television's history (both mechanical and all-electronic), early computer graphics and video-games including Spacewar, Computer Space and Pong – there's even plans for a build-your-own Pong machine!

So, what are you waiting for? Head on over to our website and order these back-issues today!

paleotronic.com

electronics, computing and videogame history