

Extreme Exploration, Outer Space Edition: from

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Entertainment

Midnight Facts for Insomniacs

Podcast Transcript

(Note: transcript consists of
episode outline)

Duncan, I think you've mentioned before that you went to space camp as a kid. You rotten little spoiled bastard. I think it's supposed to be "spoiled rotten" but I like my way better. it's more insulting. It better captures the depth of my resentment.

This episode will be right up your alley. And I expect you to contribute meaningfully as a result of all the expertise you gained in your three weeks of hard-core immersion as a preteen cosmonaut. The topic for this episode is the history of space exploration. The entire history. Remember when I said I wasn't going to bite off more than I could chew in one episode? Doh. we could easily do an entire episode just on the Apollo program, or just on the development of rocket technology, but I'm going to

contradict my own decree from last week and attempt to stuff the entire story of space exploration into one episode, it's a really bad idea, here we go.

The most important moment in the history of space exploration, according to me, was October 4, 1957. It was important for a couple of reasons, the first is that until that day no man-made object had been successfully launched into space. So it was a gigantic milestone. The second reason involves the who and why. The who was the USSR, the former Soviet union, and the why was to piss off America. That's reductive but ultimately fair. It is tempting to view the space race as a noble pursuit, two nations engaged in competition to advance the goals of humanity and expand our boundaries as a species. But in reality it was driven by petty one upsmanship. The launching of Sputnik was a literal and metaphorical shot fired, it was a demonstration of technological dominance designed to prove to America that the Soviet Union was the world's premier superpower. This was the early days of the Cold War; since the end of World War II in 1945 there had been a tug of war between these two former allies and global superpowers, America and the Soviet union, and the space race had become a proxy battle, the

outcome of which would potentially signify and maybe even determine which country represented the future. If you could conquer space, the reasonings seemed to go, you would have a huge strategic advantage in warfare— you could attack from above —and could also conquer the hearts and minds of the people of the world. perception matters. Initially the United States was presumed to have the advantage, Americans had created the nuclear bomb and for a few years after the war they maintained their lead both technologically and in number and potency of weapons and rockets. But there had long been concerns that the Soviet union was advancing quickly and catching up in the arena of scientific education, pumping out more and better-trained scientists, and Sputnik seemed like confirmation of America's greatest fear.

You can't really overstate the emotional and psychological effect that the launch of the sputnik satellite by the Soviet Union had on the American people. For the three months that Sputnik maintained its orbit there was a new star in the sky, it felt to many Americans like they were under the surveillance of a flying eyeball, an all-seeing star with a trailing chunk of rocket that was actually visible from earth, Americans could look up at the

night sky with some binoculars or occasionally even the naked eye, and track its movement across the heavens. They could also capture its radio transmissions, and here's how that sounded...

Sputnik Beeps.aiff

Audio Recording ...



It's not the most menacing sound. It's not like numbers stations, but just knowing that this thing was hovering in the air above the earth was terrifying, the monotone robotic beep of what seemed like a flying snitch was an oppressive persistent reminder that America was no longer the undisputed world heavyweight champion when it came to technology and exploration, and that the Soviets could now insert themselves into our daily lives in ways that we couldn't prevent nor control. It felt like big brother was watching us. For the first 25 days after the launch, the New York Times ran an average of 11 breathless, alarmist stories per day about the sputnik satellite. Here's Steve Bales, who would become a NASA flight controller, describing his memories of sputnik from when he was a boy.

Steve Bales.aiff

Audio Recording ·
7.6 MB



Spoiler alert about the dog, as we'll learn the Soviets not only beat us to space but also became the first nation to commit an orbital animal abuse atrocity. Not the last though, not by a long shot. The Soviets were just so far ahead of us that we couldn't even keep up in the arena of cosmic cruelty. I love how humans reach a new frontier and immediately taint it with unspeakable travesties. We're like wow, so much new territory to be awful in. Anyway we'll get to Laika in a minute, but the so-called sputnik crisis kicked off a space race that would culminate with Neil Armstrong taking the first step onto the surface of the moon just 12 short years later. And when it comes to exploration and achievement, nothing in human history has eclipsed that accomplishment. For all that we've achieved since with the Columbia shuttle, and incredible space-telescope technology, and the International space station, we arguably reached the pinnacle of human achievement—not just in space exploration but perhaps in any discipline—on July 16th, 1969. More than 50 years ago humans

broke the yoke of gravity and propelled themselves to a new celestial body. And btw, yes, it actually happened, I'm not going to spend any time debunking the dumbass moon-landing conspiracy theories because we already talked about it in our conspiracies episode and frankly, I cannot sanction that buffoonery. Come on, guys. If you believe that the world is flat or that NASA faked the moon landing...if you believe that the 400,000 scientists and machinists and technicians and janitors who worked on NASA's moon mission, some of whom were making minimum wage....if you think they all went along with an elaborate hoax that also involved decorated American heroes like Neil Armstrong and Buzz Aldrin and every single news network and not a single muckraking reporter or journalist has been able to debunk what would be the most easily debunkable conspiracy in human history, if you think the millions of people who have witnessed rocket launches into space in person are all lying...well, then I have a bridge and some adrenochrome to sell you. So yeah, In this episode we're going to assume that water is wet and that Neil Armstrong walked on the moon because we're goddam adults, and instead of wasting time with nonsense we'll explain how space exploration evolved, why it

stagnated in the wake of the moon landing, the rise of private industry, and the current state of space exploration.

Now the space race was actually an offshoot of the race to make an intercontinental ballistic missile, an ICBM, so at its core it was really a *rocket* race. Rockets, as you might have heard, are what you currently need in order to get to space.

Instead of being inspired by a sense of adventure and the desire to go where no man had gone before, we were inspired by the prospect of killing our enemies way better than they could kill us.

It all starts with World War II.

The first rocket ever to travel to space debuted in 1942, this was the Nazi-designed German V-2 rocket, a long-range guided ballistic missile powered by liquid propellant and designed by notorious/famous rocket scientist Wernher von Braun. here is von Braun after the war explaining very casually how the V2 came into existence.

Warner von Braun

Audio Recording ...



I love how cavalier he is. Turns out the real problem with Hitler was that he was a rocket skeptic. Von Braun

seems very miffed about that fact. not as concerned with the man's other transgressions.

So The V-2 looks like a looney-toons rocket. It's the rocket you're picturing when I say the word rocket. V-2 stands for Vengeance Weapon 2, this machine seems like something created by a James Bond villain. And the reality behind their production is consistent with that analogy. The rockets were produced and built in Nazi concentration camps, with slave labor, more than 10,000 people died during the production process. And of course thousands more were killed by the Rockets themselves, the V2 could strike without advanced warning because it was capable of traveling into the upper atmosphere and then descending at supersonic speeds, faster than the sound waves that would've signaled its approach. These rockets were devastating because they were essentially stealth weapons and the allies had no effective defenses against them. Each V2 weighed 13.5 tons and the propellants included alcohol and oxygen, and steam created by vaporizing hydrogen peroxide. the explosive power was generated by a mixture of TNT and ammonium nitrate. Later versions would be guided by radio signals, aka guide-beam technology. These things were incredibly effective,

very lethal, and extremely advanced for their time. In fact the first test flight of the V-2 On October 3rd 1942 had reached an altitude of 52.5 miles, causing the head of Germany's rocket program to announce, "This third day of October, 1942, is the first of a new era in transportation, that of space travel..."

Which wasn't technically true or at least was debatable, because the Karman line, where Outer Space technically begins, starts 62 miles up. But no one was going to argue with a guy who had a whole bunch of V2 rockets

When Hitler was finally defeated and World War II came to a close, the Americans seized a large portion of the German rocket program, including Werner von Braun himself.

The soviets were sort of left to pick up the scraps, but they were able to cobble together some V2 rockets, and reverse engineer some of the technology. And for

The USSR this was extremely important because by the end of the war much of Russia had been decimated, including their young male military-age population, their military and industrial resources had been ravaged, they were at an extreme disadvantage. The United States on the other hand had not faced any battles on home soil, plus

America had created and was mass-producing the nuclear bomb, and had positioned payload-carrying aircraft strategically in allied countries like Turkey and the UK which would allow them to strike the USSR quickly. Even when the Soviet union began finding success with their nuclear program, they didn't have the capacity to attack quickly nor deliver those payloads as far away as the United States. So rocket technology became a huge priority for the USSR, their goal was to create intercontinental ballistic missiles with nuclear warheads that could travel extended distances to strike American targets. So the Russians began focusing on rocket propulsion technology, and they turned to a rocket scientist who had been imprisoned by Stalin, Sergei Korolev. Korolev had been considered a danger to the regime along with most academics and intellectuals, but now that he was suddenly deemed useful Stalin had him released from a Gulag to work on the rocket program. The result was the R7, the first intercontinental ballistic missile in history, designed by Korolev and based on the German V2 rocket.

Meanwhile the United States, comfortable in the knowledge that there were strategically positioned American bombs arranged around the Soviet union, felt that they had the luxury to focus on non-military

space-based goals. In July 1955 the United States formally announced that they were planning to design rockets capable of sending the first ever satellite into space, and that this goal would honor and coincide with the so-called international Geophysical year. I had heard of this before but wasn't really clear on the details, it was basically an informal agreement among nations to drop hostilities over scientific exploration and share information and resources with the goal of benefiting all humanity. For one year. But even that was unrealistic. It was a great concept in theory But of course no meaningful secret technologies that could benefit a rival country had any hope of being shared. The Soviet union responded to America's announcement only four days later by basically saying, "us too." And the space race was on. Russians began repurposing their missiles as spacefaring rockets, and meanwhile the American army, in a project led by warner von Braun, began producing so-called RedStone rockets, based on the wartime V2 designs pioneered by von Brown himself. But there was a competing program in America as well; the Navy had a separate proposal and took a different direction, proposing a new type of rocket for multi-purpose use, one that didn't have as much potential for negative publicity

because it hadn't been used against the allies in war. This was the vanguard rocket program.

Eisenhower chose to go with the navy's Vanguard version, for a variety of reasons, probably not least of which was the fact that there were far fewer former Nazis war criminals heading up the Navy team, plus the Navy version was completely new and wouldn't be associated with death and destruction. This decision would prove fateful and cost the United States their advantage.

Back in the USSR, led by the newly freed Sergei Korolev, soviet rocket scientists were hard at work repurposing the R-7 series to carry a satellite into orbit. Americans didn't realize it yet, but the Soviets already had a huge advantage because, as mentioned, the R7 rockets were based on military ICBM designs, and thus were capable of carrying heavier payloads into space (since they had initially been designed to carry nuclear warheads). While the United States initially planned to send up a satellite weighing only a few pounds, sputnik would be around 200 pounds thanks to the beefy R7 rockets,.

The sputnik launch, however, did not go exactly according to plan. So to envision the R7, imagine a tall thin cylinder surrounded by a Native American teepee-like structure

made of four smaller rockets that are kind of leaning against the big one. Each of the smaller rockets is fatter at the base and tapered toward the tip and so the tips are inclined against the center cylinder. It does not look remotely practical. It looks like a giant grabbed a handful of differently sized rockets and smooshed them together; it's like something a kid would draw and other kids would make fun of. I will post it in the discord. If this thing were in a science-fiction film, I would legit lol.

This weird mashup rocket weighed 280 tons and was 112 feet tall. It was a two stage rocket,...for anyone who doesn't know, each stage of a rocket is a separate segment, and each of those segments is designed to be detached. So the first and biggest stage is the base of the rocket, and when its fuel is depleted that stage is discarded. Then the next stage typically ignites and burns through its fuel. Rockets can have three, even four or more stages, but the R7 was relatively simple. The point of these stages btw is to reduce the weight as the fuel is depleted, obviously the burning of the fuel reduces some weight, but as the fuel disappears you still have the now-empty fuel-container adding unnecessary bulk. So the most efficient strategy is to deplete the fuel and then discard the fuel container. Obviously you

want your rocket to be as light as possible to achieve the incredible speeds required to push through the atmosphere and break away from earth's gravitational pull. The speed and force necessary to get into space is known as the escape velocity, and depending on trajectory and atmospheric conditions it typically averages around 25,000 mph, 11.2 kilometers per second or about 7 miles per second.

So back to the partially botched sputnik launch. It's honestly kind of a miracle that the mission succeeded. First, the engines didn't fire on time, and then 16 seconds into the mission a fuel regulator on the booster failed. Sputnik ended up orbiting at around 500 miles above sea level, below its intended elevation, although the height above sea level varied along the course of its orbit. At the apogee, or farthest point away from the earth, it was around 583 miles, and at the perigee, or lowest point in its orbit, it was around 134. Sputnik was initially intended to orbit earth once every 101.5 minutes but ended up at a speed of around 18,000 mph circling the Earth once approximately every 96 minutes. It also didn't maintain a consistent path through the sky. If a satellite is orbiting exactly over the equator, it has an orbital inclination of zero and will only be visible in the same

narrow band of sky throughout its lifetime, but if it is tilted in any way it instead wanders around the sky following different paths throughout the duration of its journey. Because of the 65 degree tilt of sputniks orbit, it would eventually fly over just about every inhabited area of the earth during its three month lifetime. as mentioned before, the satellite itself was too small to be seen by the naked eye, it was a round polished ball only 23 inches in diameter, but it was trailed by the core stage of the rocket, which was large and visible. The radio transmissions from sputniks antennas could be picked up by pretty much any standard short wave radio, so it was not intended to be stealthy, it was intended to make a statement

The United States was blindsided by the launch of sputnik, and then the Americans citizens once again executed a collective spit take less than a month later on November 3 when, before the United States could mount any meaningful response, the Russians went ahead and launched sputnik two, carrying the first live animal to ever orbit the Earth. We finally reached Laika, the first animal in orbit, although notably not the first animal in space. The first live animals intentionally launched into space were fruit flies, sent into space by Americans on a V2 rocket in 1947.

Fruit flies are genetically similar to humans, says the Internet, OK, so when the fruit flies returned to earth intact without the radiation in space having altered their genetic make up, researchers were convinced that humans could survive the trip. Anyway, the first animal that actually orbited our planet was launched into space on Sputnik 2; This was, as mentioned, a dog named Laika. We're not going to talk much about this one because I don't really want to. We had enough science-perpetrated dog murder in a previous episode. all of you traumatized insomniacs know what I'm talking about. This was right up there with the polar night of the ponies when it comes to creating even more insomnia for our unfortunate listeners. suffice to say that Laika was a stray Samoyed terrier mix who was chosen from a pool of 10 dogs, she was the lucky winner, and her prize for being adorable was the honor of being shot into space and murdered. "Sacrificed" I guess would be a better word. Incidentally, sacrifice is the only time when pretty-privilege tends to backfire. Whether it involves being sacrificed to the gods or a dragon or the sun or whatever, the preferred victim always seems to be the most innocent and virginal and cutest. Which is why, as mentioned before, I have dedicated my life to being

corrupt and ugly and slutty. I don't know if it's been working for me or not but I have yet to be sacrificed and it's been a fun ride. The Russian word Laika actually translates to barker, so it's possible that she was chosen for different reasons. I love dogs but there are a couple I have lived next to that I would be happy to launch into space.

Laika had also been chosen because as a stray it was assumed that she would do a better job of surviving in harsh environments. Which may be the most depressing sentence I've ever uttered in my life. She survived three orbits, before the the temperature controls on the rocket failed and she overheated. That fucking sucks, if I could slap a bunch of dead Russian rocket scientist I would totally do that. If anyone wants to sponsor a trip to Russia I will gladly piss on their graves. Actually I would not do that because if you can get thrown in a Gulag for being smart or more recently for carrying a marijuana vape pen I don't know what they would do to you for micturating upon the grave of a Russian hero, even if that hero is responsible for some Michael Vick level horribleness. In 1998 a Soviet scientist who had worked on the project said "the more time passes the more I'm sorry about it. We did not learn enough from the mission

to justify the death of the dog." so at least there was some guilt and regret involved.

I feel like we have to cover the topic of animals in space because it has been such a vital element of space exploration, but we're just gonna skip around here, we're certainly not going to talk about all the animals that have died in space, let's just say that the late 1950s was not a good time to be a monkey or a dog. Those were frequent victims in the first days of the space race and America was just as guilty as the USSR. at least 32 monkeys have gone to space, the first was Albert II in 1949, who took off from New Mexico and died on reentry when the parachute to his capsule failed. Two other monkeys, Albert III and IV also died when their rockets failed. Maybe stop sending Alberts up there. Not a great track record with this family lineage. Entire successive generations murdered. At least 32 monkeys have visited space. Many stayed. Sadly. Chimpanzees have also made the primarily one-way voyage.. A mouse was launched into space on 15 August 1950 but did not survive the return journey. I'm shocked it survived the launch, that poor little thing probably had a heart attack on the way up. A total of 12 dogs were launched into space in the 1950s, some survived so yay, I guess.

Other Animals that have been to space include tortoises, frogs, fish, ants, jellyfish, beetles, moths, a spider... that one was particularly interesting because there was a debate about whether a spider could spin a web in space. Spoiler alert, they can. I don't know why we figured by spider butts wouldn't work in space, I'm assuming the question was whether they would be able to manage to actually navigate around and create a web in zero G, but the answer is yes.

Midnight fact. Sometimes I wonder if this show should even exist. Some of these facts are better off remaining unknown. Like this one: The first animal to give birth in space was a cockroach. In 2007, a cockroach named Hope birthed 33 more cockroaches on a Foton- M satellite. So it's good to know that pests will accompany us as we expand across the universe.

The French sent a cat to space in 1963, the cat survived the trip...and then was dissected to examine the effects on her brain. You thought we were going to end this segment on an up note. Everyone should know better. Also the French can also suck it. Cat murdering snobs.

If you want a positive note, plenty of animals have been returned safely to earth, and we'll mention at least a couple of them later. happy now?

So back to our story, the Soviets had now launched two satellites with no response from the United States, and President Dwight D Eisenhower was desperate to score a win. He pressured the navy to speed up their vanguard rocket development. Because if there's anything you want to rush, it's the development of delicate, complex, explosive, and highly sensitive machinery. The vanguard 1A satellite was launched on December 6, 1957 and soared triumphantly four feet into the air, 1.2 meters, and then unceremoniously crashed to the ground as the TV-3 launch vehicle that was carrying it sputtered anticlimactically after two seconds of flight.

On the plus side, the radio transmitter still worked, so it was easy to locate the tatters of the broken satellite in pieces on the ground. The cause of the failure has still not been conclusively determined, but if I had to guess I'd say hastiness and hubris. Those elements were at least involved. The failed launch was a huge black eye for America, and our space program quickly became an international source of amusement. The media nicknamed the rocket Kaputnik, Flopnik Stayputnik, and Dudnik. Solid burns.

The failure did have two silver

linings, though: one, that it prompted the Eisenhower administration to pump a ton more money into space exploration, leading to the creation of NASA in July of 1958, and the National Defense Education Act, which likewise injected money into the American education system with a focus on science. The launch failure also made Eisenhower desperate enough to turn to the former Nazi Warner von Braun, and give his Redstone rockets the go-ahead. This was the Explorer program, and it would finally give the United States a taste of celestial success with the launch of Explorer 1 on the first of February 1958. This first American satellite was only 30 pounds, a fraction of the size of the much more substantial sputnik due to the American rocket's lift limitations. In fact, if I'm being honest the whole thing was a little bit of a letdown; not super exciting when your competition has already successfully launched two satellites and then you're finally able to brag that you managed to get one to not explode. But hey, small victories. Better late than never. Other cliches. The explorer program would result in five satellite launches...two of which failed to achieve orbit. Not a stellar track record, and that pattern of consistent failure punctured by occasional uninspiring success

would extend through most of the late 1950s as the result of further boomsplodes in both the Explorer and Vanguard programs.

Meanwhile, while the US flailed and failed, the Soviet Union would quietly and successfully launch Sputnik 3 in May of 1958, a research satellite, and— following a flurry of American failures in October of 1959—the USSR's Luna 3 became the first ever craft to photograph the far side of the moon. At this point the Soviets were firmly in the lead in the space race. They were space daddy. The United States WAS able to achieve a string of minor successes at the dawn of the 1960s, becoming the first nation to send a craft to another planet when the Mariner 2 made it to Venus, or at least cruised within about 35000 kilometers, but the next big milestone would once again be achieved by the Soviets who with the Korabl-Sputnik 2 managed to finally return animals to earth successfully. Dog buddies Belka and Strelka made it home in August 1960, just a few months before President John F Kennedy was sworn in as US President in January of 1961. As a Presidential candidate, Kennedy had campaigned on returning America to glory by defeating the scourge of communism, and he knew that getting his ass continually handed to him in the space race was not a

good look. So he tasked Vice President Lyndon Johnson with finding a way that America could conclusively beat the Soviets in at least one big space-race milestone. Johnson consulted with NASA administrator James E Webb, who surprisingly felt that the best option would be the one that would result in his organization receiving the maximum amount of funding: the goal of putting a human on the moon. A man, let's be honest, I'm not going to sugarcoat this, there was no talk of putting a woman on the moon, and it still hasn't been done. More on that later.

So vice president Johnson returned to Kennedy with his recommendation, and at this point the situation was dire. Just a few months after Kennedy's inauguration the Soviets had once again humiliated the Americans by becoming the first nation to send a human into space when Soviet cosmonaut Yuri Gagarin (Gah-Gar-In) successfully orbited the earth in April of 1961. He Traveled on the Vostok 1 spacecraft, which spent 108 minutes executing one orbit of the earth and then reentered the atmosphere and Yuri parachuted to safety. The Vostok 1 was not appealing, it looked like a very janky light bulb, almost like a Christmas-tree light. And it wasn't much bigger. He was basically stuffed into a tiny modified spy satellite. This

guy had balls, Jesus. This was of course another gigantic embarrassment for the United States, because the Americans had been working diligently on a project intended to launch the first human into space, a project which was officially called, and I'm not making this up, Man in Space Soonest. The US was all about epic self-owns in the 1960s. The race has been VERY close though, as the following month America responded with the Mercury program, specifically Mercury 7, sending Alan Shepard on a suborbital trip 116 miles up aboard the Mercury-Redstone 3 rocket. Shepard is kind of a character, there are some great quotes from this guy. My favorite is that "When reporters asked Shepard what he thought about as he sat atop the Redstone rocket, waiting for liftoff, he had replied, 'The fact that every part of this ship was built by the lowest bidder.'" Shepard started the tradition of a steak and eggs breakfast on launch mornings. He also had a glass of orange juice, which he would come to regret during the 3-hours-long launch delay. Shepard eventually complained that he needed to urinate and was told that urinating in the suit would be unacceptable because of the electrodes and sensors attached to his body. He finally told mission command that they would need to turn off the

electrodes because he was going to do his business, so they did, and he did, and then about an hour later 45 million television viewers watched Shepard rocket into space with a lap full of dried urine. Majestic.

The Soviets would launch two more humans successfully into space with the Vostok 3 and 4 craft, in August of 1962, and those missions would be the first to keep humans in space for multiple days, three and 2 respectively. Beaten at every turn by the Soviets, President Kennedy felt like he needed a Hail Mary. it was go big or go home time. And nothing was bigger than the moon. Except the sun. And every planet in our solar system, I guess, but those planets were harder to get to or uncomfortably warm or cold or raining acid like Venus, so the moon would have to do. And this was how John F Kennedy ended up heading to congress on May 25th of 1961 and announcing his intention to shoot for the moon, so to speak.

Kennedy at Congress

Audio Recording ·...



So that was Kennedy's very normal sounding speech announcing the moonshot, but the most famous

version of Kennedy speaking about the moon was the so-called "**We choose to go to the Moon**", speech at Rice University on September 12, 1962. You'll probably recognize this. Officially titled the **Address at Rice University on the Nation's Space Effort**, this was Kennedy at his most inspiring...question mark?

Kennedy at Rice

Audio Recording ·
6.1 MB



That's the weirdest, most absent minded speech. we choose to go to the moon in this decade and do those other things and maybe a few things that I haven't even thought of yet but don't worry we'll probably get to those things too.

To say that Kennedy's speech was a bold pronouncement would be an understatement, but also, keep in mind that this was only 1962. He was giving himself almost a decade and oh by the way, Kennedy would have to win reelection to even see his goal to fruition, so he was kind of making a case and campaigning for his reelection. Not to mention that American Presidents are limited to 8 years or two terms, so he wouldn't even be president when the clock ran out. Even in the best case scenario for him, Kennedy would have to leave office in 1969,

and if American failed to reach his goal, the next guy would have to deal with the fallout. So Kennedy gets a ton of credit for this bold pronouncement, but it was also kind just a low-stakes boast that he wouldn't ever truly need to back up. Also just like Kennedy I too enjoy setting goals and making promises that I will not personally have to fulfill. Kennedy was not a rocket scientist, he couldn't even pronounce the word decade. "In this decade I promise that a bunch of really smart other people will do some amazing things that I will in no way contribute to meaningfully." Oh and I guess most importantly to achieve this goal within his lifetime Kennedy would need to not be assassinated. So to me this whole speech is kind of depressing rather than inspiring and now I'm sad

So now that Kennedy had set the agenda for approximately a decade of space exploration, the next step was a simple matter of figuring out how to design a rocket that could make it to space with multiple people on board, carry them 238,000 miles—further than any human had ever gone into space—somehow manage a soft landing on a hard rock, launch again, cover another 238,000 miles and deliver them safely home. So, no biggie. Figure it out, scientists. I've done my part. I made a speech.

Over the course of the next year there were a few different options considered by NASA, one involved launching a giant rocket that would deliver the astronauts to the lunar surface and back while remaining largely intact. Another option was launching a similar rocket in two separate pieces that could then be assembled in space. And the final and most outlandish proposal was to launch a multi-component rocket that would enter into orbit around the moon, split in two, and one portion would shuttle a couple of the astronauts to the moon while the other stayed in orbit, then that landing craft would once again split in two and the top half would launch back into space, somehow meet up with its orbiting buddy, re-couple, fly back to earth, and split apart once again before splash down. NASA chose that option. known as the lunar orbit rendezvous, this was an incredibly complicated and patently ridiculous idea that ended up being the only one with a chance in hell of working.

APOLLO 1

So it took a year just to decide on the mission plan and the basic spacecraft design, 12 months spent arguing and debating and NASA still hadn't built a single part with fewer

than seven years to go. To make matters worse, now that America had thrown down the gauntlet, the Soviets knew exactly what the United States was planning to do and as you can probably imagine, they had no intention of sitting idly by and being space-cucked by America. I don't even know what that means but it made me laugh. Adding space to anything is great. Cats are awesome, but "spacecats," way more cool and interesting. You have my attention. So both countries decided on a plan and started taking literal moon shots. The Soviets achieved a soft landing on the moon first, with an unmanned craft but still, things were not looking good and Americans began bracing for another failure. The situation got even worse in January of 1967 when America's first exploratory test mission resulted in tragedy. Apollo one burned up on the launch pad during the warmup for a rehearsal flight, killing Roger B Chaffee, Gus Grissom, and Ed White. It would be pretty heartless to qualify this next fact as a silver lining and no American politician would say it out loud but you know they were thinking it: the Soviets experienced their own tragedy within the same year when the Soyuz 1 crashed to earth on April 24, killing cosmonaut Vladimir Komarov.

This was actually the first human

space travel fatality that happened off the ground. Americans celebrated internally. I can't prove that but come on.

Both space programs, however, would rebound, as a succession of Soyuz and Apollo launches inched closer and closer to achieving the kind of results necessary to realize the ultimate goal of a crewed moon landing. Crude being C-R-E-W-E-D, but I guess both, really. But time was running out. Kennedy's promise wouldn't actually be fulfilled into the very last year of the decade, 1969, with the launch of the legendary Apollo 11 space mission. This is a pretty amazing story, and somehow I didn't completely know it. I knew that Apollo 11 succeeded. I knew that Armstrong walked on the moon. But learning about the intricacies of this mission was mind blowing. I guess I just wasn't as into space as most kids when I was growing up. I always thought that I was ...I told people I wanted to be an astronaut because it was a thing you said, and I super wanted to go to space camp, not to serve my country or take a giant step for mankind, but just because it seems like fun. It was like the ultimate video game. but now as an adult I'm realizing how uninformed I was and how uninterested I was in correcting that deficiency. I learned a lot about astronomy and the mechanics of

the universe— stars and planets were fascinating to me — but I had no idea how space exploration actually worked. I would have been the worst space camp kid. Like I could sort of vaguely picture the iconic Saturn V rocket that took Buzz and Neil to the moon, like a phallic white missile trimmed with black segments, but I couldn't have told you a single fact about it. If you claimed it was 80 feet tall and made of recyclable plastic and the entire rocket landed on the moon and then flew the astronauts to Houston I would have been like totally. I knew that Houston was involved, because I remembered that Houston had a problem, or the astronauts had a problem with Houston, they didn't get along, and I sort of vaguely remembered that Florida was part of the equation, like maybe that was where they splashed down, but that was pretty much it. And yes now I understand that Houston was the command center, the rocket launched from Florida, it was Apollo 11 that went to the moon and Apollo 13 that had a problem, but the point I'm illustrating is that for some reason the Apollo mission was a huge gap in my knowledge and I'm so glad we did this episode because learning about this insane suicide mission that somehow worked blew my fragile little mind.

How much do you know about the Apollo 11 mission, Duncan? How

about the Saturn rocket that took them to space? Ok, so the Saturn V was a beast, it was a three-stage rocket, over 360 feet tall, and the astronauts—Neil Armstrong, Edwin E. “Buzz” Aldrin and third wheel Michael Collins—were situated at the very tippy top of the Saturn V in a miniscule command module shaped like a tiny Hershey’s kiss. They were like the cherry on top of the banana split if the banana split were oriented vertically and massively explosive. You might remember that there was one even tinier structure at the very tip, like a needle at the end of the rocket, and that was the launch escape system...it was attached to the command module and in the event of an emergency would be able to jettison the command module away from the rocket like an ejector seat. It’s a good thing it was never needed, because any minor technical difficulties would most likely have resulted in the entire structure going mushroom cloud. And an ejector seat is kind of pointless if it’s just ejecting a bunch of ashes. This would have been an epic boomsplode. In fact every launch WAS an epic boomsplode. Just a controlled one. The Saturn weighed 6.2 million pounds and approximately 4.5 million pounds of that weight was fuel...it was a flying bomb. Sidenote, keep in mind that when we talk about fuel we also

have to include oxygen. Oxygen is required for any incineration or fire or explosions, like the ones that propel the rocket forward, and in space there's no oxygen, which means you have to bring your own oxidizer, adding to the weight and subtracting from the traditional fuel. The design of the Saturn V was the result of repurposing the very best Nazi technology at the direction of the preeminent space Nazi himself, Werner von Braun. The thick base of the Saturn housed five F-1 engines which lifted the rocket off the launch platform and disengaged it from the launch umbilical tower—yes that's the real name—the bottom stage of the rocket was officially called the S-1C, and it would take 12 full seconds of its engines firing at full power for the rocket to clear the platform. As it rose into the florida sky the rocket picked up speed and the astronauts would be subjected to four Gs of pressure...four times normal gravity flattening them into their seats. Two and a half minutes into the flight, aka 42 miles in the air, explosive bolts would be triggered and would sever the base—stage 1—from the other two stages and the base would peel away, spinning down from space and crushing some porpoises and maybe a shark or two in the pacific ocean. NASA will take any opportunity to pointlessly murder some animals. So now stage

two would ignite, this was the S-II module, powered by five smaller J2 rocket engines. 9 minutes into the flight, 109 miles up, this second stage would likewise be discarded and the third stage would briefly ignite, this was the S-IVB, powered by a single rocket engine. As mentioned before, the further you climb into the atmosphere the smaller the amount of thrust that is needed, because you're moving away from the grip of earth's gravity, so each successive stage of the rocket can be smaller and less powerful (plus less power is needed because the remaining stages are lighter after burning through a bunch of fuel and jettisoning the previous stages). The firing of the third stage propelled what remained of the rocket...I think of it as the circumcised rocket...into a parking orbit. Apollo 11 orbited the earth a couple times and then when the perfect trajectory was achieved the engine fired again and propelled the astronauts to the moon. To the moon, Alice! Now that the rocket was in space, minimally affected by earth gravity, only the tiniest amount of thrust would be needed to get the rocket the rest of the way. Basically Newton's first law of motion takes over: an object in motion stays in motion until it crashes into a giant space rock, or adjusts its trajectory at the last minute. At this point in the flight,

the third stage was no longer needed and so the S-IVB peeled away, but this maneuver was different than the others. This is the first of the maneuvers that I have come to think of as space acrobatics, crazy, my jaw legit dropped when I watched a video simulation of this.

Ok, so imagine that the rocket is hurtling toward the moon. The protective panels on the tip of the rocket peel off, exposing the lunar module...this is the self-contained vehicle that is going to shuttle the astronauts to and from the moon. The command and service modules at the very tip of the craft—which are connected together and look kind of like a metal dreidel—they detach, then flip around and attach to the lunar module to draw it out of the S-IVB, and the S-IVB is then discarded. So now what started as 300+ foot rocket has been whittled down to an extremely awkward-looking and not remotely aerodynamic tiny hunk of weirdness: a space-dreidel attached to a four-legged metal stick-insect. How anyone decided that this was a good idea is baffling to me, and the fact that it worked is even more baffling. Befuddling, even.

So the arcing path of the Apollo 11—which was still essentially in a very wide earth orbit—had been calculated to intersect with the

moon in ITS orbit, in 4 days. 6 hours, and 45 minutes. The precision required for these calculations is intense, and we're talking about calculations being done on basically those TI95 calculators from high school. That's not completely fair, NASA did have giant mainframe computers but they had far less processing power than a cheap laptop today. The Apollo Guidance Computer, or AGC, was installed in the command module, it had 2 kilobytes of RAM... to put that in perspective, the iPhone 14 has 6 GB of ram, or 3 million times more.

So the Apollo reached the moon on schedule and jumped into its orbit, and then the lunar module separated from the combined command and service modules. Or you might say the stick insect broke free from the space dreidel. The lunar module, carrying Buzz Aldrin and Neil Armstrong, then descended to the moon. And this was a harrowing flight, the module came in hot, both metaphorically and literally, and it turned out that the chosen landing area was too rocky, so Neil Armstrong had to take manual control and steer this thing as it hurtled horizontally and at a slightly downward trajectory, staring through the little triangular windows and firing the jet engine in front of the craft to slow its

descent. Kudos to both Neill and Buzz, these men had nerves of steel. And a mean right hook, as we learned in another episode. Of course Armstrong managed to find a suitable landing spot because he was a goddamn bad ass, and he famously informed Houston that "the eagle has landed." Neil Armstrong became the first man on the moon some six hours later and spoke the famous words "One small step for man, one giant leap for mankind." And then Buzz got to play second fiddle, always be the bridesmaid never the bride, but still pretty good. And poor Michael Collins was stuck back in the Columbia control module, just twiddling his thumbs and wondering whether the mission was going to go full Titan submersible. Except it would be an explosion rather than an implosion, but you get the idea. Buzz and Neil used their 21 hours on the moon to collect moon dirt and a bunch of rocks and take photos...which would later become fodder for conspiracy theorists. ... the flag stiffly waving in the nonexistent breeze was actually supported by a rod to keep it erect or else it would have just hung there, the weird shadows totally don't make sense unless you understand even the basics of lighting and the fact the surface of the moon was mildly reflective... we're not going down this road

again. We don't want to get punched by Buzz. They also took a phone call from Richard Nixon, yay. No one really talks about that anymore, I'm sure they wish it had been someone else. Or that they hadn't answered. New moon-phone who dis. Anyway, the astronauts hopped back in the Lunar Module, and in another display of ridiculous complexity the lunar module now split in half, with the bottom portion—the legs of the stick insect also known as the "descent stage" being abandoned on the moon, and the ascent stage—which of course had its own propulsion...this is like nesting dolls made of bombs...just layer upon layer of complicated machinery, each layer of which has its own boomsplode—so the ascent stage ignited and took off, knocking over the American flag in the process. That's a true thing, later missions would plant their flags a little farther away from the lunar module. Climbing back into space, the lunar module rendezvoused with the control module in yet another display of acrobatic space flipper. The ascent had to be timed perfectly to intersect with the orbit of the command module, and it took around four hours of adjustments and maneuvering to achieve the rendezvous and docking. The Lunar Module ascent stage—the upper body of the insect—was now abandoned and the service module

—which is the part of the dreidel that you would hold and spin if this were an actual dreidel—fired its own boomsplode...everyone has a boomsplode. You get a boomsplode, and you get a boomplode! and then jetted back toward earth. Once earth orbit was achieved, another transformer moment occurred as the service module peeled away, leaving only the tiny Hershey's kiss shaped command module with three very ripe, unwashed astronauts who had now spent approximately 8 stressful, fear-sweat-soaked days in space. So If you're picturing the command module as a Hershey's kiss, the flat side is now aimed toward earth, because this is the all-important heat shield made of fiberglass honeycomb, impregnated with a phenolic resin attached to a stainless steel shell. As the command module entered earth atmosphere it began to glow red and essentially caught fire, it was a plunging fireball that looked like a streak of flame searing across the sky. When the command module reached two miles altitude above the sea level, three parachutes were deployed and the giant Saturn V rocket had been whittled down to a tiny nub of the command module housing three weary and heroic and once again very stinky astronauts. The module hit the water and boom. Success! 'Merica. Suck it, soviets. I

can say that because the USSR doesn't exist anymore.

So yeah, It's wild that this worked. That's not even the right word. Insane. The likelihood of nothing going catastrophically wrong was astronomical. Incidentally, when you add up the cost of the Apollo program it comes to over 25 billion, which is just under 200 billion in today's money, but I guess you get what you pay for, getting to the moon ain't cheap but once again I would argue that this was the most impressive feat humanity has ever accomplished, so hey, worth it.

After the success of Apollo 11, NASA was feeling cocky and ambitious and began developing lofty goals. Their plans for the next decade included Multiple space stations, as well as orbital fueling and docking facilities to gas up and repair a fleet of spacecraft...There would be "space tugs" which were just what they sounded like, celestial tugboats to haul gear and spacecraft, and there was even a concept design for a nuclear rocket engine, known as project Minerva. it was a very optimistic time. And over the next couple of decades all of there high altitude ambitions would come crashing to earth along with many of the spacecraft that NASA attempted to launch.

Strangely enough, NASA's one big

post-Apollo win, The space shuttle —arguably the most complex craft ever built (which is saying a lot after the Apollo 11 mission)—was almost an afterthought. NASA realized that their imaginary George Jetson future required a craft that could “shuttle” people and supplies to all of those elaborate space stations and to the moon and potentially other planets. The space shuttle itself was considered one of the least ambitious and Almost perfunctory elements of NASA’s future blueprint. Yet it would become their second biggest triumph after the moon landing, and it would define the space program for the next 30 years.

There were a few reasons that NASA’s grand ambitions had to be scaled back. First, they had basically shot their metaphorical wad with Apollo. Having set this incredibly challenging goal for themselves and then achieving it, there wasn’t an obvious next step. Mars was out of reach until probably the early 2000s by NASA’s best guess, and all of the logical next steps would be seen as anti-climactic and boring. Building a space station or a permanent lunar base might have sounded sexy when satellites were impressive, but now that there wasn’t a literal moonshot to aim for, everyday Americans head sort of moved on. It

didn't help that NASA kept returning to the moon well, Saturn V launchers facilitated 10 more lunar landings over the next decade, which...I mean cool? but it's kind of like a magic trick you've seen before. Obviously we were still learning valuable information from each new trip into space but that simply wasn't obvious to the average coke snorting bearded disco Dan in the 1970s and of course NASA also ran into the fiscal wall that was the brutal recession of the 1970s. The famous (and famously Tom-Hanks-documented) failure of Apollo 13 further eroded support for NASA's Apollo programs. Meanwhile the Russian space program literally and metaphorically sputtered as well. The Soviets worked diligently on a series of space stations, achieving slow and iterative and mostly uninspiring results. If you're a huge space geek this stuff is probably exciting to you but for the average person it just didn't have the panache of the moon race. America launched their own version of a space station, the less than stunningly successful Skylab in May 1973, which required immediate repairs and eventually crashed to earth in July 1979 after a respectable but less than scintillating six year run. The 1970s did see some successes with the Soviet union beating America to

Mars, landing the first successful Mars probe, Mars 3, in 1971, but the probe self-destructed immediately after touchdown. It would be followed five years later by America's Viking landers, two probes that successfully touched down and provided years of data. China is the only other nation to have landed craft successfully on Mars, btw.

The United States and the Soviet Union actually began working together on a combined mission toward the end of the 1970s, it involved a physical and symbolic combining of the Soyuz and Apollo craft, the two spacecraft docked together in space and Russian and American astronauts shook hands, it was obviously intended to symbolize the ramping down of the Cold War and a future of cooperation rather than competition. This happened in mid 1975 and oops. With the election of Ronald Reagan five years later the Cold War ramped up yet again, and so America would go it alone, launching back into the space race solo with the shuttle program.

So let's briefly talk about the shuttle, which was definitely the most recognizable symbol of NASA throughout my childhood. One thing I've never understood is why you couldn't just build a plane that has a

rocket engine, get super high in the atmosphere kick on that rocket engine and jet off into space. I still don't fully understand, I'll be honest. It has to do with the fact that planes are designed to use the atmosphere and air pressure to fly, and the type of engine you would need to push your plane into space as well as the types of controls you would need to successfully maneuver once you got there, simply are incompatible with plane technology. To a lesser degree you run into this problem if you try to fly a plane back from space to earth. There's a reason all of the previous spacecraft had returned to earth by using the intricate and graceful technique of crashing into the ocean. However, while the challenges of building a plane they can fly to space and back seemed insurmountable with current technology, a hang glider was another story. NASA figured they could probably create a plane that would glide back from space if they could just get it there in the first place. And that was the origin of the shuttle. The shuttle is lifted into space on a traditional rocket but it glides back into the atmosphere and then fires its engines and lands like a plane would.

What most of us think of as the space shuttle is actually the space shuttle orbiter. This is the plane

looking portion, not including the rocket that initially gets it into space. The rocket is made up of three components: two solid rocket boosters that burn solid fuel, and one giant traditional fuel tank in the middle. But the space shuttle orbiter itself actually has 49 engines. There are the three that we all recognize as the large black bells grouped together at the rear on the craft. But there are 16 in the nose of the craft and various other small engines that fire to aim and maneuver the craft. Those three big engines were great for a lift off and propulsion but once the orbiter was in space it had to switch over to smaller engines that could provide targeted thrust for navigation.

The primary and perhaps the most important feature of the orbiter was the payload bay. This is what the orbiter was built for, it's why this thing was called a shuttle. Because it was built to carry cargo. The payload bay was 60 feet long and 15 feet wide and carried valuable gear into space, including the Hubble space telescope and equipment for the international space station which was built beginning in 1998.

The Space shuttle did have two very public and very devastating setbacks. You probably remember both, but anyone of our age will certainly remember the first one.

The Challenger disaster of 1986 was traumatizing for Americans of all ages but especially for children. I remember watching it live as a kid in school and it was probably something I shouldn't have been watching live as a kid in school. The reason it was being broadcast in so many classrooms was because there was a teacher on the shuttle, Christa McAuliffe, just a standard civilian who had been given the opportunity to visit space in order to drum up publicity for the mission and for NASA and hopefully reignite American interest in the space program. Another oops. In case you were wondering, for all our complaints about the backwards communist regime, the first woman in space was a Soviet cosmonaut named Valentina Tereshkova who flew her first mission in 1963, orbited the Earth 48 times and to this day is the youngest woman in space and also the only to fly a solo mission. America wouldn't put a woman in space until Sally Ride in 1983.

The next major shuttle disaster would be the explosion of the Columbia in 2003, killing all passengers once again and essentially leading to the retirement of the space shuttle program after it had successfully contributed to the final construction phases of the

international space station.

So what's the current state of space exploration? Well, NASA is planning to land the first man of color and the first woman on the moon by 2024, this is project Artemis. I get the historic nature of this, and I feel like it's necessary, but it feels like checking boxes and obviously it isn't particularly groundbreaking beyond the diversity aspects. I would honestly rather see people of color and women be the first to go to Mars or break new ground rather than playing catch-up. Meanwhile, as most people know, non-governmental private companies have been moving into the space race. Elongated muskrat and his SpaceX because the man thinks the letter X is so fucking cool and extreme! And of course Jeff Bezos and blue origin. Ironically all of these companies have reverted back to rockets, I'm not saying there haven't been advances, but if you look at SpaceX's rocket starship" it's an almost 400 feet tall two stage rocket that takes off from a launch tower., is 100% just an upgraded version of the Saturn five rocket. The falcon nine rocket is a very nice looking rocket that once again is still an old-school ass rocket. Now the one very cool innovative feature that we've seen and I have to give musk credit here

is that the falcon nine first stage booster, after it separates from the second stage, has successfully re-oriented itself and landed so that it can be reused. That's pretty cool. But watching these explosive, fuel-heavy liftoffs it feels like we've stepped back into the past and we're trying to pick up where we left off after the moon landing, like we've lost the future we could have had. I am a huge science-fiction fan and in the 90s I would've thought that we'd have a space elevator easily by 2020. A geosynchronous space station parked above the Earth with a giant metal cable that would allow us to lift objects and people into space and then transport them off planet. But we just have to scale back our expectations. there may still be exciting advancements on the horizon, we know muskrat wants to go to Mars, blue origin is touting their orbital reef, from their website, "orbital reef will be the premier mixed-use space station in low Earth orbit. Blue Origin, Sierra Space, Boeing, Redwire Space, Genesis Engineering Solutions, and Arizona State University form the powerful industry and academic team to deliver Orbital Reef in this decade." it very much looks like a Wi-Fi router.

So NASA is limping along, and private companies are stepping in

to ferry millionaire tourist to space, it's not the future I hoped for but it's what we've got. Is that a depressing enough note to end on?

There was so much more we could've covered. The future of space exploration should be at an episode, Apollo might end up being its own episode in the future because there was a lot of drama that I didn't get to, it's an amazing historical event. We could do an entire episode on the V2 rocket. But this is what the insomniacs picked, so here we are. I like to blame our fans And listeners. Maybe if they hate us they'll stop listening and we'll never have to do a three hour episode again. no, I love you guys.

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