"JOURNEY TO MARS"

SHOW 902 Episode

EPISODE OPEN

APOLLO 11 CREW: Thirty seconds, picking up some dust…Contact light, okay, engine stop.

MISSION CONTROL: We copy you down, Eagle.

APOLLO 11 CREW: Houston, Tranquility Base here. The Eagle has landed.

ALAN ALDA Where were you when Neil Armstrong stepped onto the moon? I was on vacation at a thoroughly forgettable hotel but I'll never forget that hotel because I sat in the lobby for hours with all the other guests watching the most amazing television show we had ever seen. But you know what? Probably half the people watching this program weren't even born when astronauts made that giant step in 1969.

NEIL ARMSTRONG: I'm at the foot of the ladder. I'm going to step off the LM now. That's one small step for man, one giant leap for mankind.

ALAN ALDA This program is about our next giant step- going to Mars. And for scientists, it's a step that is in many ways more exciting. When we went to the moon it was a tremendous technical challenge that needed brilliant engineering and courageous astronauts. But we knew then that the moon was probably lifeless and barren. Mars is different. We know there was once liquid water on Mars and an atmosphere. It's an altogether more hospitable place than the moon. Mars, in other words, might have had life and it still might. So, the first big

question is, can we find signs of life on Mars? And then once we humans get there, can we settle down, set up colonies, begin to spread beyond our own planet? These are startling questions. This isn't science fiction. We'll probably begin to answer these questions within the lifetime of most people watching this show -- and it's probably not going to cost too much. How are we going to do it? Stay tuned.

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OUT OF THIN AIR

PRESIDENT GEORGE BUSH: From the voyages of Columbus, to the Oregon Trail, to the journey to the moon itself, history proves that we have never lost by pressing the limits of our frontiers. We must commit ourselves anew to a sustained program of manned exploration of the solar system and yes - a manned mission to Mars.

ALAN ALDA (Narration) Ten years later there is no official manned Mars program, but the idea is still very much alive. If any one person can claim credit for that, it's Bob Zubrin.

ALAN ALDA This is it here?

BOB ZUBRIN: Yeah, this is it.

ALAN ALDA (Narration) We're at his makeshift test site near Denver.

ALAN ALDA So tiny.

BOB ZUBRIN: Yeah, rocket engines are usually not that big, but this little engine produces a hundred pounds of thrust.

ALAN ALDA How big is this in comparison to the rocket that will lift the people off to take them home again?

BOB ZUBRIN: The engines for sending people back to Earth from Mars would need to have about a hundred times this thrust, which means a rocket engine that's around ten times this diameter.

ALAN ALDA (Narration) It's the rocket's fuel that for Bob opens up the possibility of a small, cheap Mars mission.

BOB ZUBRIN: This is the lab where we have the machine that can make rocket propellant on Mars. Here it is. The carbon dioxide from the Martian atmosphere comes in here, goes down into a reactor here which is something just the size of this, where it reacts with some hydrogen that you've brought from Earth, to turn into carbon monoxide and water.

ALAN ALDA (Narration) Out the other end you get rocket fuel and many other useful chemicals. And it all happens on Mars.

BOB ZUBRIN: This is a general purpose Martian still. It makes oxygen, water, methane, methanol, kerosene, ethylene, anything you want.

ALAN ALDA This is going to affect the whole cost of the mission, won't it? What will that effect be?

BOB ZUBRIN: Well the effect is enormous because, let me put it to you this way -- in 1989 President Bush asked NASA to come up with a plan for sending humans to Mars. And the plan that they came up with involved building gigantic spaceships in Earth's orbit, which required building giant orbiting platforms to build those spaceships on. And the cost for that program was four hundred billion dollars, okay, mostly involved in creating all this infrastructure on orbit to build these Battlestar Galactica spaceships.

NASA INFORMATION FILM: The spaceship for a Mars mission is a huge structure, too big to launch from the surface of the earth. Instead, the components for the mission are carried into space and assembled at the space station.

ALAN ALDA (Narration) It was cost that killed this kind of elaborate Mars mission. But Bob Zubrin did the critical numbers, which once again made a mission possible.

NASA INFORMATION FILM: The interior of the craft is spacious, providing the crew with room to live and work during the six-month journey...

BOB ZUBRIN: Most of what those spaceships were sending to Mars was the fuel and oxygen required to come home. If you made your return fuel there, the mass of those ships would drop so much you wouldn't have to build them on orbit at all. You could launch them direct to Mars with launch vehicles the same capacity as the Saturn 5 moon rockets we used in Apollo. And in fact the cost estimates for this type of program are on the order of twenty to thirty billion dollars to develop all the hardware needed to get going, and then around two billion dollars per mission once you get going. And that's something this country can afford.

ALAN ALDA (Narration) Bob calls his approach "Mars Direct".

ALAN ALDA And there it is, that's the mission.

BOB ZUBRIN: Yeah, that's it, the Mars Direct plan.

ALAN ALDA (Narration) Bob -- who's now funded by NASA -- splits his scheme into a series of connected missions.

BOB ZUBRIN: The first one shoots out to Mars the Earth return vehicle with no one in it, and it flies to Mars and lands on Mars unfueled. And then it runs a pump, it sucks in the Martian air, which is carbon dioxide gas, reacts that with a little bit of hydrogen that you bring from Earth to make a large supply of methanol and oxygen rocket propellant. Now you got a fully fueled Earth return vehicle sitting on Mars. Once that's done, then you shoot the crew out in the habitat.

ALAN ALDA And so when they land in this, this is already there waiting for them to take them home.

BOB ZUBRIN: That's right, all the fuel has been made before they even leave Earth, okay, so then they land in one of these and they use this as their house on Mars for a year and a half while they explore Mars. And then at the end of a year and a half they get in the Earth return vehicle, take off and go home directly to Earth. They leave the hab behind on Mars, so each time you do this you add another hab on the base and gradually you build up the beginning of the first human settlement on a new world.

ALAN ALDA It seems ingenious to say we'll send a return vehicle ahead and the machinery to produce the fuel for that vehicle. We'll send all of that ahead and we'll use the planet, we'll use the planet's resources to get back again. When I first heard that it sounded like a brand new idea, but it's not a new idea, is it?

BOB ZUBRIN: No, it's as old as the hills. It's the way that people have successfully explored on Earth. I mean, consider, Lewis and Clark crossing the American continent with 25 men, hunting as they went. Imagine what they would

have had to take with them if they had tried to bring along their food, water, and air for themselves and their horses. They would have needed hundreds of wagons filled with supplies and all of those wagoneers and their horses would have needed thousands of wagons full of supplies to support them and they would have needed even more, etcetera. In fact, if you had tried to do the Lewis and Clark expedition that way, it would have exhausted the economic resources of Thomas Jefferson's America.

ALAN ALDA (Narration) Explorers ignore this rule of living off the land at their peril, Bob says. Take Sir John Franklin's 1845 expedition to find the northern sea route from Atlantic to Pacific -- 2 fine ships, fully provisioned and fueled, 127 men. Trapped in the ice, they exhausted their supplies and perished. Roald Amundsen and his six companions also got their 30-year-old fishing boat frozen in -- but they learned the Inuit way to live off the land. Dog sleds gave mobility, for hunting on the ice... The Arctic had been a hostile wilderness to Franklin, but to Amundsen it was bountiful. Amundsen took 2 years to navigate the Northwest Passage -- but he made it. On Mars, locally filled sandbags make a radiation shield on Bob's simple habitats. Inflatable greenhouses grow crops -- the Martian atmosphere, day length and sunlight are all sufficient. The Mars rovers run on locally made fuel. Bob's an aerospace engineer by training, but an explorer at heart. He believes putting people on Mars is the next essential step in human development.

BOB ZUBRIN: People do a lot of things for themselves, but the most important things they do, they do for the future. Benjamin Franklin gave one of his electric demonstrations in Paris in the 1770's. A French aristocrat came up to him and asked him, "Dr. Franklin this is all very interesting but of what possible use is this electricity thing of yours?" Franklin said, "Of what use is a baby?" Well, there's our baby. So would you like to see it fire?

ALAN ALDA Yeah, if I can get really far away from it.

BOB ZUBRIN: Yeah, well we've got some protection. Let's go. 3…2…1…0...

ALAN ALDA Blast off! Oh, look at that! Whoa! Okay, now, so are we in orbit now, is that it? That would be using fuel that you had been making in that little machine...

BOB ZUBRIN: That's right...

ALAN ALDA On the surface of Mars.

BOB ZUBRIN: Correct.

ALAN ALDA And it would get back to Earth using that fuel.

BOB ZUBRIN: Right. That's the right size rocket engine and it's using the fuel that we make.

ALAN ALDA And it's made on the spot. I mean like Lewis and Clark you've got your energy where you were.

BOB ZUBRIN: We make it out of thin air!

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NASA'S WAY TO MARS

ALAN ALDA (Narration) The international space station's first components are due for launch at the end of 1998. At 5 billion a year -- more than enough for a Zubrin-style Mars program -- it monopolizes NASA's human spaceflight dollars. But within NASA, a few people are working on Mars plans. Houston is the NASA center that handles human spaceflight -- Apollo, Shuttle and now Space Station. These are mockups of some of its components. There's also a small planetary exploration group, run by Doug Cooke.

ALAN ALDA Hi.

JOHN CONNOLLY: Hello

ALAN ALDA (Narration) Right now they have a Mars mission plan, which uses three separate flights.

JOHN CONNOLLY: The first flight will take an Earth return vehicle and park it in orbit around Mars. The second mission will take a cargo vehicle, and that will drop to the surface of Mars and await the crew when they come out 26 months later. And between this and that you have all sorts of redundancy to make Mars, the surface of Mars in particular, the safest place in the solar system other than being back here on Earth. Then at the end of 500 days on the surface, you take a

crew picture, you launch back to Earth and 6 months later you're home here on this planet, and the parades start.

ALAN ALDA So between lifting off and the parade, how long does that take?

JOHN CONNOLLY: Uh, between the time the crew lifts off from Florida until the time they land, probably again in Florida, the whole trip is two and a half years.

ALAN ALDA (Narration) OK, let's take a closer look at that mission plan. First, it depends only on Shuttle-type launches from Earth -- no fancy new technology needed here. Each of its three flights requires two payload launches -- so each needs just a simple docking in Earth orbit. No giant spaceships have to be constructed. Each flight takes only the fuel needed to reach Mars, but not to lift back off its surface. Flight One is the Earth-return vehicle. It parks in Mars orbit without a crew. Flight Two is the cargo vehicle, also without a crew. It heads for the surface. To save on fuel, it uses the Martian atmosphere to slow down. A brief rocket burst is needed in the final seconds. Flight Two lands and begins to make fuel. 26 months after the flights without crews left, when Earth and Mars are again lined up, the crew sets out. They travel for six months, across 250 million miles of space -- but knowing that the cargo vehicle on Mars has already made their return fuel. When the crew lands, they head over to the cargo vehicle for their exploration supplies. After 18 months on Mars, they blast off from the surface in a small capsule, using Mars-made fuel, then join up with the Earth-return vehicle. It's basically the Bob Zubrin plan, but with the Earth-return vehicle added to provide better crew space. And the price tag is down to 40 billion dollars -- one-tenth the original NASA Mars-mission cost.

ALAN ALDA Bob Zubrin seems to be a guy who is a kind of a maverick -- thought a little bit outside of the box. DOUG COOKE: He is very healthy for us I think. It's always healthy to have people out there pushing at you, making sure you don't go to sleep on them.

JOHN CONNOLLY: I think when we started looking into his ideas we found that more and more of them were credible. I mean Bob is an idea guy and you can't ignore the ideas he comes up with.

ALAN ALDA (Narration) In the quest for smaller, lighter, cheaper missions, NASA's coming up with some ideas of its own. Here's an inflatable habitat that could be used on Mars, or during the journey. In Houston, Donna Fender showed me what the core of an inflatable habitat might look like.

DONNA FENDER: This is only one little piece of the whole inflatable structure, and this is the central core where the crew will be sleeping. This kind of gives you a representative size of how big a bedroom would be.

ALAN ALDA Oh, I see the bed goes up the wall here because it's not a wall.

DONNA FENDER: That's because you're in zero gravity. This is a conceptual layout for zero gravity.

ALAN ALDA It never would have occurred to me that you don't have to have everything on the same plane.

DONNA FENDER: They'll have their pillows and be able to Velcro themselves in so they won't float around.

ALAN ALDA Velcro themselves in for the night.

DONNA FENDER: So they won't wander around in the middle of the night, I guess.

ALAN ALDA Their children will grow up on some future space flight. They won't say "tuck me in" they'll say "Velcro me in".

DONNA FENDER: That's right, "Velcro me in," yeah, ha, ha, ha.

ALAN ALDA (Narration) The inflatable habitat is small enough to be brought up to the Space Station, for testing, in the Shuttle cargo bay. This could be happening in a few years' time. The habitat docks -- uninflated -- to the station. Then it's inflated to provide a 30-foot diameter structure -- big enough to accommodate 6 Mars crewmembers for their 6-month flights. Interplanetary space is filled with fast-moving and potentially lethal bits and pieces of dust and rock. The inflatable habitat uses a multi-layer fabric wall designed to break up anything that hits.

ALAN ALDA Is this the same thickness as what will shield the habitat?

ERIC CHRISTIANSON: This is one of the possibilities. We're going to be testing at around seven kilometers per second and we are going to impact this target with a particle of this size. It's about marble size and it weighs about 1.5 grams. It's made out of aluminum.

ALAN ALDA It feels like how much a pearl might weigh on a necklace, it's very light.

ALAN ALDA (Narration) At these kinds of speeds, even this can do tremendous damage.

ERIC CHRISTIANSON: Have you seen what happens to the back of this? It blows off the back and here's all the particles that fall off the backside.

ALAN ALDA (Narration) Actually the pieces come flying off the back -- not good for the people inside.

ERIC CHRISTIANSON: This is around one and a half inches of aluminum. We're shooting with the same size particle we'll shoot the transhab shield. The transhab shield weighs one tenth of this. And so you see that we're saving a lot of weight with the transhab shield.

ALAN ALDA This is really heavy stuff. I mean, you know, I'm surprised. Is this how thick...

ERIC CHRISTIANSON: It would need to be? If we made it out of all aluminum, this is how thick it would have to be.

ALAN ALDA (Narration) The chance of running into a particle this size on a Mars round trip is about 1 in 34,000 -- not such a remote risk. Here's the charge for the gun -- half a pound of gunpowder.

ALAN ALDA Dale.

DALE NEWCOTT: Yes, sir.

ALAN ALDA Good Luck.

DALE NEWCOTT: Oh, it's gonna work. I've got faith.

ALAN ALDA Feels like a missile launch here.

ALAN ALDA (Narration) Dale's the first to open up the chamber -- now filled with thousands of tiny fibers from the test sample. It looks like a clean shot, but to make sure they check the high-speed X-rays. Filmed at a million frames a second, here's the result. Here's a replay -- the pellet penetrates the first layer, breaks up, and penetrates layer two. That's where the film stops -- it's only to confirm a good hit -- but in the chamber, here's the hole in the top layer, and here's the smaller hole in the second. The gray foam's just for spacing, by the way. Here's layer three -- a still smaller hole. And layer four was intact. As I hear

BOB ZUBRIN: and the guys at NASA, it seems to me that we might really be on our way to Mars.

ALAN ALDA Is it going to be a place to go for the holidays? I mean are we going to have tourist excursions to Mars, are we going to have the Love Rocket?

DAVID KAPLAN: The answer is emphatically, yes, but the correlate question is when. When is the only issue. We will go to Mars and we will explore Mars and humanity will expand. It's the when question which is the real perplexing one.

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WHY GO TO MARS?

ALAN ALDA (Narration) You are watching the first interplanetary hit movie. It's the Martian surface, brilliantly computer-rendered from thousands of photographs taken by the Viking spacecraft in the 1970s. There are huge extinct volcanoes, arid plains. Mars seems to be a forbidding place. But wait a minute. What's that down there? It looks like a canyon. In fact, Viking revealed that Mars is full of features that can only have been created by running water. Today scientists agree -- the planet must once have been warm and wet. A hundred years ago, Percival Lowell built an observatory in Flagstaff, Arizona to study Mars. Lowell believed he saw the signs of a dying civilization, desperately building enormous canals to conserve the last of their water. This romantic view of Mars persisted for about 50 years, inspiring countless stories.

FILM DIALOGUE: The mind that conceived this must have been of a high order of intelligence, at least the equal of Earth's, perhaps considerably above ours. To think that a complex, organized society existed here once.

ALAN ALDA (Narration) The Viking missions found no canals, although hopes were high that the robotic laboratory in the lander would find microbes in the soil sample it scooped up. But results were ambiguous. There is, however, a short cut to Mars.

KATHIE KEPRTA: You look great.

ALAN ALDA Should we synchronize our watches or anything?

KATHIE KEPRTA: That's all right, no, ha, ha, ha.

ALAN ALDA (Narration) My guide is Kathie Keprta, a NASA biologist.

ALAN ALDA What's happening?

KATHIE KEPRTA: We are being aired off, to try and remove any debris.

ALAN ALDA (Narration) All these procedures are to prevent contamination of what's in the cases.

KATHIE KEPRTA: Now is this your first look, this is your first look at Mars?

ALAN ALDA I can't believe I'm that close to it.

KATHIE KEPRTA: That's right

ALAN ALDA How long ago did that get knocked off Mars?

KATHIE KEPRTA: About sixteen million years ago.

ALAN ALDA (Narration) Meteorites regularly crash into the Mars surface, and bits come flying off. Occasionally a piece reaches Earth -- there are 13 we know of.

ALAN ALDA So these scissors as they are making contact with the rock, they are not contaminating the rock?

TECHNICIAN: They're stainless steel.

ALAN ALDA Stainless steel, so if you find out there is a lot of stainless steel on Mars, you'll know where it came from.

ALAN ALDA (Narration) They know this is a Mars rock because its components closely match observations made by the Viking lander. And recently what they found inside the rock caused quite a stir.

ALAN ALDA Well I see a dark crack.

KATHIE KEPRTA: Do you see anything orange?

ALAN ALDA Orange, yes, oh yeah wow, there it is.

ALAN ALDA (Narration) The orange blobs are a simple carbon mineral deposited when Mars was wetter. But inside the blobs they found microscopic crystals of an

iron compound called magnetite. And some of those magnetites have a telltale teardrop shape.

KATHIE KEPRTA: We don't know, on earth, how to produce teardrop shape magnetite in this size range without bacteria.

ALAN ALDA Did you find anything that looked like it was some trace of the thing that had made the tear shaped magnetites?

DAVID McKAY: We have not found the typical big bacteria that we see on earth that make those little tiny magnetites. We have not found that yet in these rocks. What we have found are a lot of smaller features, interesting features, the worm picture everyone has seen...

ALAN ALDA Yeah, what about that? It looks like a bunch of worms crawling around. I would just sort of run out to the newspapers and say, "I've got it!"

ALAN ALDA (Narration) Critics say the rock could have been contaminated on Earth, but the NASA scientists counter with these tiny threads -- often associated on Earth with bacteria.

DAVID McKAY: This is clearly buried within part of the Mars meteorite. It is not something that fell on it, it's totally incorporated in the Mars meteorite.

ALAN ALDA The fact that it's incorporated in the meteorite makes you know that it couldn't be contamination?

DAVID McKAY: Right.

ALAN ALDA (Narration) The Mars meteorite results are controversial, but they've greatly encouraged those who want to go to Mars to look for life.

ALAN ALDA When you get to Mars how do you feel about the possibility of finding stuff there that's still living?

DAVID McKAY: If life starts anywhere it's going to be very difficult to kill it out. And we think on Mars at some depth there is liquid water, and on the Earth anyplace you find liquid water there's life. So, my personal opinion is that if life were ever on Mars, it's still there.

ALAN ALDA (Narration) On the Earth, we don't know where life began. But the leading contender is a hot, wet environment like a hot spring or deep ocean vent, where today you find microbes that are Earth's most primitive life forms. 3 billion years ago, parts of Mars must have looked like this. The planet cooled down

more quickly than Earth, so today its water is probably locked underground as permafrost. If hot springs on Mars worked the way they do now on Earth, they'll provide a treasure trove of information.

JACK FARMER: Here along the edge of this spring we have a place where organisms are being turned into fossils right before your very eyes. These orange areas are communities of microorganisms which grow upward toward the light creating all kinds of interesting patterns and surface textures.

ALAN ALDA (Narration) The dried and hardened organisms are new fossils. Poking around in old hot springs is what the geologists on our Mars crew will have to do.

JACK FARMER: It's possible if life developed on Mars it never got beyond thermal springs. So that's why thermal spring environments are really the best bet, I think, for an initial look at the possibility of life on Mars.

ALAN ALDA (Narration) But it's often said that the easiest way to look for life on Mars is to send robots. Robot missions can work really well, as Pathfinder recently showed. The problem is, only a few rocks contain fossils -- you have to search with a trained eye. If we leave it to robots, we may always fail.

BOB ZUBRIN: If we can go out, and if we can find these fossils, what we will have shown is not Mars once had bacteria, or something. What you will have shown is that the processes that lead to life have a high probability, and what that means is that when you look up into the night sky and see a million stars, you're seeing a million inhabited worlds. On the other hand, if we go out and we do some serious fossil hunting on Mars and we find, yeah, this place was warm and wet for a billion years but no, there is no evidence whatsoever that life ever appeared here, then that would suggest a different theory altogether: that the processes that lead to the development of life have an element of free chance to them. In which case we could be entirely alone in the whole universe. And, either way, it's a question of immense philosophical importance. In fact, that alone fully justifies the program as far as I'm concerned.

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WE'RE ON OUR WAY

ALAN ALDA Hello Andy, it's Alan Alda, can you hear me up there?

ANDY THOMAS: I can hear you loud and clear. Welcome aboard Mir.

ALAN ALDA Andy, do you know what's interesting to me, you're in a completely new experience living in space like this and you're probably going through things that you just couldn't have predicted.

ANDY THOMAS: It is an unpredictable environment, but you know one of the really amazing things about it is that even though we're in this weightless environment and you've got things floating around in front of you like this, and even though this is a completely unnatural state for all of your human lifetime it does absolutely amaze me how quickly you become adapted to this, and accept that this is the natural way of things.

ALAN ALDA (Narration) In adapting to space, the Russians have more experience than anybody. Space station Mir has been in orbit for 10 years. Russian cosmonauts have spent up to 14 months in orbit -- more than twice as long as the trip to Mars. But when they land back on Earth, there are often problems. Bones, muscles, the heart -- all are dramatically weaker, with maybe 40% less bulk. It can take months to recover.

ALAN ALDA Tell me about the effect of this weightlessness on your body and what you are doing about that. What kind of exercises do you do to keep from undergoing bone loss and muscle loss and that kind of thing?

ANDY THOMAS: We use a regime of exercise up here. We have a treadmill that we can run on, and in order to run on the treadmill we actually put on a harness which has bungies which simulate the load and ties us down to the treadmill.

ALAN ALDA (Narration) Bungies are partially successful -- they help the leg bones and muscles. But the heart still doesn't have to pump against gravity, and in fact, without gravity everything that the body does is easier -- so it gets weaker.

ALAN ALDA It's a great room.

ALAN ALDA (Narration) This disused vacuum chamber turned out to be about the same size as a spaceship -- which is what it feels like.

ALAN ALDA Why does this look like a diving bell?

JOHN GREENLEAF: Gradually squat and sit down slowly.

ALAN ALDA (Narration) I don't mind exercise, but I wasn't totally sure what I was in for here.

JOHN GREENLEAF: And we'll hook your feet in here.

TECHNICIAN: Do you want blindfolds?

ALAN ALDA I don't know, do I?

JOHN GREENLEAF: Yes.

ALAN ALDA Maybe a blindfold and a last cigarette? I don't know.

JOHN GREENLEAF: I think we'll let him have a blindfold.

ALAN ALDA What's gonna happen to me? I don't know what this does.

TECHNICIAN: It just spins.

ALAN ALDA So why are you giggling? I'm trying to read all the signals here.

TECHNICIAN: When people have a hard time they close their eyes but then they get really tempted to open them.

ALAN ALDA And then they like fall out?

TECHNICIAN: And then you might get a little nauseous and dizzy.

ALAN ALDA Okay, let's have the blindfold.

ALAN ALDA (Narration) I'm in a prototype pedal-powered centrifuge.

DAN GUNDO: 5…4…3…2…1…Start pedaling.

ALAN ALDA (Narration) Dan Gundo's helping me out, but just one person can operate it. The idea is to force the blood out towards the feet -- as gravity does -- so the heart has to pump harder, and more naturally.

DAN GUNDO: Okay, you're at 1-G.

ALAN ALDA (Narration) As we speed up, I'm happy to say that DR. PELLIGRA, along with the researchers, is literally watching my every heartbeat.

ALAN ALDA It feels more comfortable.

DR. PELLIGRA: Comfortable in what sense?

ALAN ALDA My heart is beating great, at least it feels like it is.

DAN GUNDO: We're at 22.

ALAN ALDA (Narration) What they don't know yet is how effective this method could be in countering the effects of weightlessness -- or how to actually build a centrifuge in a spaceship. At one time it was thought artificial gravity would be routine in space travel -- just spin the whole spaceship. But then it was realized we know nothing about how to build structures like this. Maybe some time in the future, but not now. Next stop on my exploration of new kinds of space exercise -- the vacuum treadmill.

RESEARCHER: It's going to be a little tight.

ALAN ALDA You really think there's room for two legs in here?

RESEARCHER: It's going to give you a little bit of a wedgie.

ALAN ALDA Whoo!

ALAN ALDA (Narration) In this one, first you have to be suspended horizontally, to approximate weightlessness. It's quite a rigmarole here on Earth, but of course floating in space it would be a lot easier.

ALAN ALDA Oh yeah, the old cutting the woman in half thing. I saw this, yeah.

ALAN ALDA (Narration) The lower body has to be sealed in to the vacuum chamber. Now the pressure in the chamber is reduced, which begins to suck my feet down onto the treadmill inside. We're heading first for the equivalent of Mars gravity.

ALAN HARGENS: Now we'll go up to the Martian three-eighths of a gravity.

ALAN ALDA Here I am on Mars, huh? I like this. It's a lot easier to get around on Mars.

ALAN ALDA (Narration) Then we reach full Earth gravity. In weightlessness, it would feel just like a regular treadmill. OK, how about space exercise number three?

ALAN ALDA I can feel the pressure in my ears. Don't go too fast.

ALAN ALDA (Narration) In this one, a big balloon pushes me down onto the treadmill -- and I'm gaining weight alarmingly.

ALAN ALDA So I weigh 50 pounds more now because of air pressure on me.

ALAN ALDA (Narration) It's another way to get exercise under a normal load.

ALAN ALDA I can really feel like somebody's pushing me down. ROBERT WHALEN: Not from your upper body, you don't really know where it's coming from, do you?

ALAN ALDA No, it's an amazing feeling because my upper body doesn't feel that pressure.

ROBERT WHALEN: Exactly.

ALAN ALDA (Narration) We won't know if any of these new systems can ever make it into space until they've been more fully explored. But meanwhile, NASA's investigating how to take care of the crew's most basic needs on the journey. Sealed inside this chamber, a crew of four are guinea pigs in a remarkable experiment.

MARYBETH EDEEN: These portholes actually look in on their exercise area. If you look right here this is their treadmill and in the back they have a resistive device similar to a home gym. And then when we get over here this is the water treatment system. We use this to purify all the wastewater generated by the crew. We mix the urine, the laundry water, the hand wash water and the shower water all together and then we feed it through these two bioreactors. All of this brown, slimy stuff is microorganisms. Instead of just cleaning and filtering out the waste they're actually reacting it and getting rid of it, turning it into biomass, more microbes, carbon dioxide and water.

ALAN ALDA (Narration) The water's so pure at the end it's drinkable -- and it goes right back into the chamber.

ALAN ALDA It seems that every time you go through a cycle you would lose a little, don't you? Do you get a hundred percent when you are done? If you run this for two years aren't you going to keep getting less and less usable stuff?

MARYBETH EDEEN: Every drop of water that goes in dirty comes out clean. And in the 75 days or so we have been in test we have not added any water to this system at all.

ALAN ALDA So you're going to be growing food on Mars, and will you also grow food on the way to Mars?

ALAN ALDA (Narration) The eventual goal is 100% recycling of water, air and food.

DANIEL BARTA: ...and it would be nice to have vegetables and other fresh food to go along with that that we would likely grow on the vehicle.

ALAN ALDA Wow, look at that. That's a lot of wheat. How much wheat is this?

DANIEL BARTA: Well, we have about ten square meters of plants in here. That's about enough to provide oxygen for one person's needs.

ALAN ALDA (Narration) The wheat absorbs CO2 from the chamber, it grows, and gives off oxygen which is returned to the chamber. Harvested wheat is also returned to the chamber, through an airlock, as flour -- right now enough for about half a loaf a day.

CREW MEMBER: Door's open.

CREW MEMBER #2: Thank you.

ALAN ALDA (Narration) The crew gave me a guided tour. JOHN LEWIS: We're coming up here on the third level, you can look on in to my room over there.

ALAN ALDA Very lovely.

JOHN LEWIS: And this is Nigel's room right here.

ALAN ALDA Very homey.

JOHN LEWIS: And we can come on in here and see Laura in her room working.

ALAN ALDA Hello Laura.

JOHN LEWIS: Back over here is the bathroom and if Nigel can follow me in this is basically our fancy urinal. The nice thing up here is that we do have doors, so

whenever you -- although I'm breaking a rule, here, we never open a door from the outside -- but Vicky's in here trying to make it look like she's working hard.

ALAN ALDA You never open a door from the outside, why is that?

JOHN LEWIS: This is the only privacy that we have in the chamber is the door and usually it's the common courtesy of -- if somebody closed the door they probably really want to be left alone.

ALAN ALDA So Vicky, sorry about that.

VICKY: Oh, no that's okay.

ALAN ALDA (Narration) The experiment is about air and water, but I was also interested in the psychological aspects.

ALAN ALDA Having been in this, for this length of time, what do you think about being cramped up on that long trip to Mars and back?

LAURA: Actually it's amazing how quickly you adjust to your environment and also how close you get to your other crew members, and just the excitement about what you are doing would carry you all the way to Mars, in my opinion.

ALAN ALDA (Narration) Natural life support systems are light and efficient, and they're new thinking for NASA. One day they may be in use on the surface of Mars.

ALAN ALDA Let me see you drink a glass of water, if you don't mind. Ha, ha, ha… far out, nice, huh, good, tasty?

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HOUSTON, WE'VE HAD A PROBLEM!

MISSION CONTROL: 13 -- we've got one more item for you when you get a chance we'd like you to stir up your cryotanks

APOLLO 13: Okay, standby. Okay, Houston we've had a problem here. We've had a hardware restart… I don't know what it was.

ALAN ALDA (Narration) Apollo 13. On their way to the moon, Lovell, Swigert and Haise had their now famous problem. After an explosion their spacecraft lost power, leaving them dependent on the small lunar module, which was attached.

EUGENE KRANZ: OK now lets everybody keep cool, the LM spacecraft's good so if we need to get back home we got a LM to do a good portion of it with. I want you to get some guys figuring out minimum power in the LM to sustain life.

ALAN ALDA (Narration) Almost every aerospace engineer in the country worked around the clock to get the astronauts home. It worked -- with a little improvisation involving duct tape and tubes. The big lesson, though, would be repeated over and over -- things are going to go wrong. Russia's space station, Mir is part of the pattern. A collision with a supply vehicle...Lost power... Constant onboard repairs, both inside... And out. In the 70s America's Skylab lost some of its thermal insulation, so astronauts rigged a makeshift sunshade.

ASTRONAUT: Well your parasol, Dick is really blowing in the breeze, looks like about a ten to fifteen knot gale every time the thrusters fire in just a very gentle fly around here.

ALAN ALDA (Narration) And no account of space problems would be complete without Apollo 18's famous fender repair on their moon buggy.

ASTRONAUT: Man, I'll tell you -- Indy's never seen a driver like this.

ALAN ALDA (Narration) The dust was endangering equipment, so a map, tape and clamps from the lunar module telescope were pressed into service. So on a journey to Mars -- yes, things are going to go wrong.

TIM SAITO: Go ahead and slip this on.

ALAN ALDA Are there little sensors in here that know when I bend my fingers?

TIM SAITO: Exactly. As you can see there, you are able to change some of your attitude inside the environment.

ALAN ALDA What happens when I pull this trigger, do I blast the Martians?

TIM SAITO: Uh, we haven't programmed that in yet, but eventually…

ALAN ALDA So the trigger is deactivated?

TIM SAITO: Exactly.

ALAN ALDA That's good, peaceful uses of space, very good.

ALAN ALDA (Narration) The system allows astronauts to move around inside the Space Station.

TIM SAITO: How's that feel?

ALAN ALDA Good.

TIM SAITO: Okay, now what happens here is...

ALAN ALDA I see a hand, is that my hand?

TIM SAITO: That is your hand.

ALAN ALDA Oh, there it is, woo hoo, ha, ha, ha.

ALAN ALDA (Narration) Virtual astronaut companions are even included.

ALAN ALDA Oh, I just went outside, I'm in space, right? I just thought I'd take a little walk. It was such a nice night out I thought I'd walk. Whoa, this is a strange room, what's in here?

TIM SAITO: Okay, that is where we stowed one of the boxes that you need to retrieve. Grab one of those handles there, can you see those?

ALAN ALDA Yes, I see, my hand disappears behind it.

TIM SAITO: Pull back a little bit, okay, see that? Now make your fist.

ALAN ALDA Have I got it?

TIM SAITO: Back up a little bit, there you go, grab again.

ALAN ALDA I've got it! Ah, this is great!

ALAN ALDA (Narration) Well it's fun, but it's not a game. The idea is that a Mars mission will take with it a complete virtual version of itself. When things go wrong, the crew can work out, and learn, their fixes before they do them.

TIM SAITO: At that point you can go get another box.

ALAN ALDA Another box? I think I've got to take a virtual break here.

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GETTING THERE

ALAN ALDA (Narration) OK we've spent 6 months in space -- cramped quarters, same old food -- we're coming in to land. You wouldn't want to hit the wrong button now... I'm going for a ride to see how alarmingly easy that could be.

JON GRIFFITH: Is it okay?

ALAN ALDA Yes, it's fine, this is great. Will I be exhaling during this?

ALAN ALDA (Narration) The one thing you have to do in a centrifuge is keep still -- or call in the cleanup crew. So things are kept nice and tight. I'm going to try out the procedure they've developed here to test motor skills under changing gravity.

ALAN ALDA You know, my orthodontist said I shouldn't wear one of these.

ALAN ALDA (Narration) As the centrifuge spins, the seat will tip to direct the extra forces down through the body.

JON GRIFFITH: This is the emergency release lever. You just release that and it brings the centrifuge quickly to a stop. It's a safeguard that if you were to lose consciousness we would know immediately.

ALAN ALDA Okay.

ALAN ALDA (Narration) This seems pretty serious.

DR. PELLIGRA: Okay, would you release your switch, please. Okay, this is a simulated operation red walk through.

ALAN ALDA (Narration) Right now they're just rehearsing how they're going to save me if my heart stops.

CENTRIFUGE CREW: Okay, up, up, up, tension set, talk through, shoulder straps, chin straps, lap belt, be ready to remove the helmet, and oxygen, okay, all set, good show.

JON GRIFFITH: Okay moving. Going up to 14.87 rpm.

ALAN ALDA (Narration) Once again, Dr. Pelligra's watching my heart.

DR. PELLIGRA: Looking great. Barely a dent in your pulse rate.

ALAN ALDA (Narration) The concern is because my heart now has to work harder to pump. Everything, including blood, becomes heavier.

DR. PELLIGRA: How do you feel?

ALAN ALDA I feel good, but for the first time now I feel the Gs, I feel a little pressure in my chest when I breathe.

DR. PELLIGRA: That's expected. Your rate is beautiful, though, you haven't exceeded 75, so it's not a major cardiovascular stress at this point.

ALAN ALDA (Narration) The test begins at twice normal gravity.

MALCOLM COHEN: Okay, now just reach your arm out and just hold it out.

ALAN ALDA It's like there is a heavy weight on my arm.

MALCOLM COHEN: There's no weight on your arm, of course, it's your arm itself.

ALAN ALDA Yeah, but it's as though I'm supporting about 25 or 30 pounds on my arm. It's as though my arm has some magnetic force pulling it down.

MALCOLM COHEN: Well, that's G forces.

ALAN ALDA Unbelievable.

MALCOLM COHEN: Okay.

ALAN ALDA Unbelievable feeling.

DR. PELLIGRA: He's working at it, now. We should be wrapping up fairly soon.

MALCOLM COHEN: Okay, before we wrap, Alan, I'd like you to just get some practice reaching out at the screen rapidly and then we'll do that as soon as we come down.

ALAN ALDA Okay, way off.

ALAN ALDA (Narration) Until I get used to the high Gs, I can't help undershooting the target lights.

DR. PELLIGRA: Let's come down.

JON GRIFFITH: Coming down

DR. PELLIGRA: Flex your legs, look straight ahead.

ALAN ALDA (Narration) Now they'll quickly halt the centrifuge, and run the test again.

MALCOLM COHEN: Okay, in another five seconds the lights will come on and each time it comes up try to rapidly reach out and touch the screen.

ALAN ALDA Ha, ha, ha

MALCOLM COHEN: What happened? Tell us.

ALAN ALDA My arm just shot up in the air because I'm used to all that weight and 2- Gs. Whoa, wait I'm an inch off.

MALCOLM COHEN: Okay, keep going, now if you would reach out and try to touch the tip of your nose very quickly.

ALAN ALDA I overshot my nose a little bit.

MALCOLM COHEN: That's because you adapted to the 2-G condition, which made you inappropriately adapted for the normal 1-G world.

ALAN ALDA Right

MALCOLM COHEN: Now in a mission to Mars, people would be weightless for a prolonged period of time and the question is what does it take to readapt them to a gravitational condition ...

ALAN ALDA If I had been weightless for a couple of months would it take me longer than this to readapt?

MALCOLM COHEN: Some of the data that they have gotten on the shuttle and on Mir missions would suggest that it would take considerably longer to adapt.

ALAN ALDA (Narration) One idea is to pre-adapt -- to give the crew simulated Mars gravity practice en route, using one of the vacuum treadmill systems.

ROBERT WELCH: One of the most dangerous times is just when you land, if you had to engage in some kind of a sudden egress from the spacecraft because of an emergency you would want to be able to run and to do the things right without running off a cliff or running into a wall or something, and if you are not adapted to what it is like to walk on Mars you might make a serious mistake at that point.

ALAN ALDA (Narration) Once on the Mars surface, our crew will need spacesuits.

APOLLO ASTRONAUT: My golly, the time goes fast!

ALAN ALDA (Narration) The Apollo space suits were stiff, awkward balloons.

APOLLO ASTORNAUT: I'm going to get this thing out while I've got it…oh, dadgum it!

ALAN ALDA (Narration) A new spacesuit for Mars is well under way. It aims for mobility, with a lot of rotating joints that have to move freely while staying airtight.

RESEARCHER: Nice and cozy. Okay, start pressurization.

ALAN ALDA (Narration) This is a test in the Arizona desert, to simulate a fossil hunt on Mars.

RESEARCHER: Okay, here we go. Okay, what we are going to do, Dean, is leave our trailer and proceed to Station 1.

ALAN ALDA (Narration) The Mars suit has to be comfortable and flexible. There'll be 18 months of activity like this. So far the rotating joints are working well.

RESEARCHER: How's the mobility in general? Good, good.

ALAN ALDA (Narration) They're also testing on NASA's famous vomit comet -- the plane that creates weightless conditions, or in this case Mars gravity, by constantly diving. With so much metal in it, the Mars suit weighs 180 pounds -- 60 more than the Apollo suit -- although in Mars gravity that 180 pounds feels like about 70 pounds. We'll be seeing something like this on the Mars surface before long.

ALAN ALDA What do you think is the most important reason for going to Mars? Is it to preserve the human species, give them a place to survive on after Earth, or is it something else?

BOB ZUBRIN: Let me put it this way. I think that if we do our job on this, two hundred years from now there will be hundreds of millions of people living on Mars. There will be a new branch of human civilization, a new culture there adding it's own chapter to the human story, and if we don't seize this frontier we're going to move into a period of stagnation and decay on Earth. And my bet would be that sooner or later limited to one planet the human race goes extinct, but then around ten million years from now the raccoons will evolve intelligence and they will go and colonize Mars.

ALAN ALDA Ha, ha, ha. Raccoons on Mars. I think we have a whole other show there.

ALAN ALDA (Narration) That's all this time. See you on Mars.

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