

John B. Lee, Rotary 5/02/11

Brief Summary, Manned Spaceflight History

Today I will speak to you on little known history of the early days of the beginning of the MSF Program at the NACA, (the National Advisory Committee for Aeronautics), at Langley Field, Hampton, Va. before there was a NASA. It was started by Robert Gilruth, Max Faget, Paul Purser, Guy Thibodaux and about six others, most of whom are no longer with us. How many of you remember who **Buck Rodgers** was? As a boy on the farm, I was a **dreamer**. Every Sunday morning, I would run down the road to the mail box to get the newspaper to read about Buck Rodgers.

Today I will cover for you, **from my perspective as an Engineer**, some of the history of the early days of the Manned Space Flight Program that was officially started some **54** years ago. I will briefly review how and why certain decisions were made, also some of the problems we were faced within these Programs. However, I will briefly cover about **64 years** of history in about 30 minutes, so you will have to think fast. Before the advent of NASA, most of our **Technology advancements came out of the Military**. In my WW-II presentation to you, I pointed out how the Germans were ahead of us in some areas of technology. Today I will discuss the positives that came out of WW-II and how some of these technologies have affected us since then, especially in the Space Program. Today I will cover those areas in more detail, because they were **very significant**.

I now refer to **my graduation from VPI, as my launch pad to the future**. After graduating from VPI in 1948, I went to work for the NACA. The one page functional statement for the NACA was to do Research and Development for Military and Commercial Aircraft. **(Show Charter)**. I wanted to design airplanes and to fly in the Air Force Reserves at Langley Field. The Air Force now had Operational Jet Airplanes: the Lockheed F80, and the North American F-86. Owen Morris and I both joined the NACA in August of 1948.

At the NACA, I was **hired by Robert Gilruth**, who had formed, and was the **Division Chief of the Pilotless Aircraft Research Division**, (or PARD). He put me in the Propulsion and Power branch under Paul Hill with Max Faget. Paul Purser was head of the Aerodynamics Branch, and Guy Thibodaux was the head of the Propulsion Branch. Bob Gilruth had built a Rocket Launch Test Facility at Wallops Island on the Eastern coast of Virginia. In this Division we flew scale models of Supersonic Jet and Rocket Aircraft for contractors as well as those that we had designed and built in our own shops at the NACA. They were boosted by Solid Fuel Rocket Motors in free flight out over the Atlantic Ocean. Guy Thibodaux provided the solid fuel booster rockets for our flight models. We would analyze the telemetry data, and write the final reports. We took a project from **"Birth to Grave."** **This was before the Air Force had built their launch facility at Cape Canaveral, Florida.** In the community we were known as those **"Crazy Naca Nuts."**

In August of 1947, **Chuck Yeager** had broken the Sonic Barrier in the Bell X-1 Rocket Airplane, and had flown faster than the speed of sound. This was a joint Project between the NACA and the Air Force. We soon found out that we couldn't get an airplane to go much faster than Mach #6, and that we would have to go in a new direction. Nine years later, we had developed the capability to boost Nose Cones and Ballistic Missile Reentry Vehicles at Mach No. 15, into outer space. We developed and tested the heat shield material so that these Nose Cones and Blunt Shaped Reentry Missiles could reenter the atmosphere without burning up. They were **models of Atomic Warheads for the Air Force.** From these programs, **my boss Max Faget, a Branch Head at that time,** decided that the United States had the capability to put a man in space using the blunt-shaped ballistic missile as a reentry vehicle.

We had a bullpen of about 10 engineers, with a couple of drawing boards where we would lay out the designs for our flight models. I would see Max in his office using a slide rule. How many of you remember what a **slide rule** is/or was? He was running calculations of a Spacecraft/Booster design to put man in space, using the blunt-shaped Ballistic Missile as a Reentry Vehicle. This data was turned over to our Computer Section to run the flight trajectories and the heat transfer calculations on a Freidan calculator.

A Freidan calculator was like a cash register that you would punch in the numbers, pull a crank handle, and the data would be printed on a piece of paper. These data would then have to be plotted by hand. Some of these Calculations were done by my Ex-wife Dottie who was a mathematician. How many of you today can believe that the Manned Space Flight Program was started using **a Slide Rule and a Freidan calculator?**

At that time, I didn't know what Max was doing. One day he called me into his office and asked me to go to work with him on a **Project to put a Man in Space**. I asked him, "**Max, how are we going to do that?**" He said, "**I do not know. That is what we have got to find out.**" He and Robert Gilruth, (who was then the Assistant Director of the NACA Langley Research Center), had already sold the concept to Congress. This Division was "**The Eye of the storm for the Manned Space Flight Program.**" They had presented their proposal to the Air Force, but The Air Force wanted a winged vehicle, so they could maneuver upon reentering the Atmosphere and land on land. Max told them that he could land the spacecraft anywhere they wanted it. He pointed out that the technology to reenter a winged vehicle successfully had not been developed at that time. The Spacecraft weight of a Winged Vehicle to be boosted was prohibited for the available boosters in the Air Force arsenal. The Air Force had been working on a Manned Space Flight program, called the **Dinosaur**, for three years. The Air Force turned them down.

Dr. Hugh Dryden, the NACA Administrator, along with Robert Gilruth and Max Faget, then went to see President Eisenhower who liked the idea and he sent them over to talk to Congress. Congress had a small subcommittee on Space. The Russians had just **launched Sputnik**. As Max puts it, "**Congress was in a panic**, and they had **gone Ape.**" When word got out that two young engineers from the NACA were going to talk about how to put a man in space, the congressmen immediately filled the conference room and the hallways. **Max Faget would review his hand sketches** of the Spacecraft with the Committee Members around the table. These sketches were then passed around the room, and out of the door, and down the hallways, for all the congressmen to see.

As a result of that meeting, the Committee decided that since the Air Force and the NACA had two different concepts, they would proceed with both projects, **The Air Force with their Winged Vehicle, and the NACA with their Blunt Shaped reentry vehicle.** **In the hallways of Congress,** a surprised Dr. Dryden, Robert Gilruth and Max Faget looked at each other and realized that **Congress had told them "To go and do it."** **Only verbal authority** had been given. Robert Gilruth and Max Faget returned to the Langley Research Center, whereupon Gilruth wrote a memo setting up the **Space Task Group,** with **35 handpicked people from the NACA,** which included Chris Kraft from the NACA Flight Research Division. That was the **first official piece of paper** that started the Manned Space Flight Program. In those days, ideas were started from the bottom and were sent up to the top for approval and funding. The **Space Task Group** was responsible for starting the **Mercury Project.** 3 1/2 years later, we (NASA), had put **John Glenn in orbit around the earth,** and the **Dinosaur program had been canceled.** The Air Force has never forgiven us. But, I am getting ahead of my story. I was to see a **"Dream"** turned into a **"Goal"** and a **"Goal"** turned into a **"Reality"**.

In October of 1958, **President Eisenhower established NASA, (the National Aeronautics and Space Administration).** President Eisenhower set up NASA as a Civilian Agency and not under the Military. NACA became a part of NASA and became **responsible for the Manned Space Flight Programs.** The Jet Propulsion Laboratory in California was put in charge of the Unmanned Flight Programs. The NASA Goddard Space Flight Center, in Maryland, was responsible for the World Wide Communications System. In WW-II, **Wernher von Braun** and his staff were on a Rock Island in the North Sea named Peenemunde. At the end of the war, **Wernher von Braun** and his people hid in the Mountains. He made certain that they could **surrender** to the Americans, and not be **captured** by the German SS Troops that were looking for him to kill him, or the Russians, so that his work could not fall into their hands. They were sent to the Army Ballistic Missile Agency at White Sands, New Mexico. They were added to NASA later, and made responsible for the Manned Space Flight Boosters Rocket Motors . This was the nucleus for NASA.

In **combat** in WW-II, I knew that I was witnessing history, but I did not realize that I was **witnessing the birth of a whole new era**. As I pointed out to you last year, the Germans were ahead of us in some areas of technology. They had developed the **first Operational Rocket Airplane** and **Operational Jet Fighter Aircraft**. These were the inventions that helped us to develop the capability to break the Sonic Barrier in flight, and fly faster than the speed of sound.

Wernher von Braun and his people had developed the first Operational Guided Missile, the **V-I "Buzz Bomb"** and the **V-II Rockets** that were used to bomb England, especially London.

PowerPoint Slides.

First let's go back in time for a minute. **Solid Fuel Rockets** were used by the **Chinese** in 300 BC., and they were first used in this country in the **War of 1812**. **Slide**

- **Dr. Robert Goddard**: This is Dr. Robert Goddard of the US who developed the first **Liquid-Propellant Rocket Motor in 1926**. The NASA Goddard Space Flight center is named after him. **Slide**
- **German V-II Rocket Motor**: This is a photo of a model of the V-II Rocket motor that was in Space Center Houston that was used by Wernher von Braun in WW-II. On missions over Germany, I saw these Rockets being launched from Germany on their way to England. **Slide**
- **German Messerschmitt Me-163 Rocket Airplane**: This is the **1st Operational Rocket Airplane the German Me 163**. **Slide**
- **German Messerschmitt Me 262**: This is the **1st Operational Jet Airplane the German Me 262**. **Slide**
- **Bell X-1 Rocket Airplane**: This is a photo that I took of the Bell X-1 in the Smithsonian Air and Space Museum that Chuck Yeager flew faster than the speed of sound. **Slide**
- **Astronaut Supersonic Trainer, Northrop Talon T-38**: This is the Northrop Talon T-38 Astronaut Trainer. I got to fly this faster than the speed of sound. **Slide**
- **Russian Sputnik Satellite**: This is the Russian Sputnik, the **1st Satellite launched into Earth Orbit** in October 1957. It was a simple steel ball with a transmitter inside. These are antennas. **Slide**

- **Explorer I:** This is the launch of Explorer 1, the first US satellite on the Jupiter C Rocket built by Wernher von Braun, to orbit the Earth on Jan. 3, 1958. This was **after 2 unsuccessful launches by the Navy Vanguard Program. Slide**

Mercury Program Planning Session:

I will now discuss the Spacecraft Programs. This is a slide of **Charlie Donlan, Robert Gilruth, Max Faget, and Bob Piland** in a Planning Session on the Mercury Program.

The **objectives** of **Project Mercury** were to orbit a Manned Spacecraft around the earth, to investigate Man's ability to function in space, and to recover both man and the spacecraft safely. At that time Van Allen had just discovered the radiation belt. People were worried about meteorites in space. The G forces on the Astronauts could be as high as 12 to 14 G's on launch and landing impact. **Slide**

- **Mercury Spacecraft sketch:**

The contract for Project Mercury was signed 6 weeks after the NASA Request for Proposals (RFP's) hit the street, a feat unheard of before or since. We, the Space Task Group had essentially laid out the spacecraft design. Here we see a **great Paradigm shift**; a man would be riding in a missile instead of an airplane. Max Faget had designed the Spacecraft with a couch so that the Astronauts G forces would be through his chest on launch, and through his back on landing. Colonel Stapp of the US Air Force took 20 G's in a sled test on the ground in this couch configuration. This solved our problems of high G's on launch and impact. From wind tunnel tests, Max had found a radius for the heat shield and the angle of the side walls so that the heating was evenly distributed over the capsule's entire surface on Reentry.

We were not very well organized at that time. I had **voluntarily** picked up the responsibility for the Propulsion Systems and the Pyrotechnics. So I was assigned as the **Chief of the Mechanical Systems Section**, responsible for the Design, Development and Testing of these Subsystems on the Spacecraft.

It included the Hydrogen Peroxide Reaction Control Systems, the Solid Fuel Rocket Motors for the Launch Escape System, not shown here, the Parachute System, and the Retrorockets used to slow down the Spacecraft for reentry from orbit, the Pyrotechnics, used to cut the Mormon Clamps on the Launch Escape systems and the Heat shield.

I went to Robert Gilruth and I told him that I had picked up the responsibility for the propulsion Systems and that I did not know anything about Propulsion. Instead of saying that he would turn them over to someone else, he responded in one short sentence: "Why don't you go over to see Guy Thibodaux." Guy became my teacher and mentor. With his help we corrected some ground test problems, but we never had any failures in these systems on the Spacecraft. It was called "**On the Job Training.**" I was also responsible for **the design and development of the Ring Sail Parachutes**, an entirely new concept in Parachutes. It also included the development of the only successful Supersonic Drogue Parachute. These Drogue Chute tests were performed by dropping a Test Vehicle from an F-104 Jet Airplane at Mach# 1.4 into the Muroc Desert at Edwards Air Force Base in California. The Pilot for these tests was Neil Armstrong before he became an Astronaut. The Launch Escape Rocket Motor was designed to pull the Spacecraft from the Booster at 14 G's in case of Booster malfunction. I had found out by using a Scale Model of the capsule in my bath tub at home that it had two neutral buoyancy points. That is, it could float with the nose (or Apex) up or down. **(Show Capsule)**. In the nose down position, the Crew would not be able to get out of the Spacecraft safely. This I confirmed by **full-scale tests of the Spacecraft** that I conducted in our Water Tank for testing Seaplanes. Tests also showed that the G forces could be as high as 14 g's if landing in rough seas. The Heat Shield was then designed with a skirt so that it could be lowered for landing to cushion the spacecraft on impact, and to assure that the spacecraft would float upright. The Launch Escape System and the Heat Shield were held on by "Mormon" clamps that needed to be cut by the pyrotechnics. **Slide**

• **Original 7 Mercury Astronauts:**

These are the first Seven Astronauts with their first training airplane. I had the pleasure to be in the group that welcomed them to the Space Task Group, and to help train them in some of my Subsystems.

They are (from left to right) Scott Carpenter, Gordon Cooper, John Glenn, Gus Grissom, Wally Shirra, Alan Shepard, and Deke Slayton.

Slide

- **Mercury Astronauts in their Space Suits:** These are the Astronauts in their space suits that had been developed by B. F. Goodrich for the Navy. **Slide**

- **Ham, Astrochimp:**

I have been misleading you. **Ham was our first American Astronaut.** (He was actually named an **Astrochimp.**) The Astronauts said that they were upset because they felt that NASA considered a Chimpanzee to be smarter than they were. The story I liked the best is when Alan Shepard said that the only reason he got to fly was because Ham refused to fly any more, which was partially true. On an attempt to launch Ham on the Redstone Booster, the System detected a malfunction of the booster and cut off the booster engines. The Launch Escape Rocket motor extracted the Spacecraft safely from the booster at 14 G's. This was at a much higher rate than the 10 g's for which Ham had been trained. Ham refused to get back into the spacecraft again. **This unplanned failure completely checked out our Launch Escape Rocket Motor and Parachute System from a booster failure mode.** **Slide**

- **Alan Shepard:**

Alan Shepard was the first American Astronaut in Space. Bear in mind that at that time, as part of their training, the Astronauts had witnessed many Air Force boosters blowing up on launch at Cape Canaveral Florida, and they were all still willing to risk their lives. NASA went through all of the boosters that we would be using with a fine tooth comb. We eliminated any single point failures that we could find to make the boosters as safe as possible for the Crews.

Slide

- **Launch of Freedom-7:**

This is the launch of **Freedom-7, the first US suborbital flight, on May 5, 1961,** using the **Army's Redstone Rocket Booster** which was developed by Wernher von Braun and his people with the Army Ballistics Missiles Agency. On top are the Launch Escape Rocket Motor and Tower. **Cosmonaut Yuri Gagarin from Russia was the first man to orbit the earth on April 12, 1961.** The Russians were still ahead of us in the Space Race. Due to an extended delay in the launch, Shepard had to **relieve himself.** The ground personnel were afraid that if he did, he would **electrocute himself.**

But nature finally took its course and the decision was made for them, and everything turned out OK. Alan Shepard was losing his patience, and told **Launch Control**, quote: **“Go ahead and light this firecracker.”** End quote. The flight was being controlled by Chris Kraft and his Operations team at Cape Canaveral, Florida. {Wernher von Braun and his launch team tried to interfere with the decisions that had to be made by Chris Kraft and his team.}

Before Alan Shepard's flight, Max Faget again called me into his office and asked me to be one of the three Study Managers to show that man could go to the moon. I asked him **“Max, how am I going to do that?”** He responded, **“I do not know. That was what you have to find out.”** Under Bob Piland, I managed one of the three parallel, feasibility studies. I was responsible for the Contract at Martin Air Craft Co. in Baltimore, Maryland. Bill Petynia was responsible for Convair in San Diego, and the third with GE in Philadelphia. **I was now on the fast track for Advanced Designs. In the past, one of the three study Contractors would win. When the three Study Proposals came in, North American also submitted a proposal. North American won the contract to build the Command and Service Module, (or CSM).** This had never been done before. The contract had been signed the Xmas before we relocated here to Houston, TX in 1962. As a result of these studies, the start of the Apollo Program to land a man on the moon had already been started. With this information, and Shepard's successful suborbital flight, President Kennedy was able to say that **“The United States would go to the moon in this decade.”** We hadn't even put a man in orbit around the earth. This came as a complete shock to so many people including Flight Operations and The Astronauts. What Kennedy did was to set the Goal of **“Landing a Man on the Moon in this Decade.”** That was a **“Huge Incentive”**. 9:27 20min

Move to Houston, Texas:

About that time, we had a Vice President in the White House by the name of Lyndon B. Johnson who decided that our country needed a Space Center in Houston, Texas. (Max Faget would correct me and say it was Texas Congressman, Albert Thomas.) The Space Task Group had grown from 35 people to about 750 people, and about 450 of us chose to make the move from Virginia to here in Houston, Texas. **Slide**

* **Site Selected:** Exxon had donated 600 acres to the Rice University, who was then able to donate it to the Government. The Government then bought an additional 1000 acres from Exxon for the Manned Spacecraft Center. Then, the Friendswood Development Co., an Exxon subsidiary, built a whole new city, Clear Lake City, around the new facility, which is now a part of Houston, Texas. **Slide**

* **Space Center:** This is the Spacecraft Center which was built in one year by the Core of Engineers. We still had to build our **Test Facilities**, including the **Mission Control Center, and our Environmental Test Chamber**—the largest in the world that could simulate a Space Environment. Jim McLane became the Division Chief. **Slide**

* **Mercury, Gemini, and Apollo:** Before we moved to Texas, we had flown Shepard and Grissom on their suborbital flights in the **One-Manned Mercury Spacecraft**. We were building **an up-scaled model of Mercury**, the **two-man Gemini Spacecraft**, and we had just signed the contract for the **Apollo Spacecraft CSM with North American Aviation**. The Apollo Contract was the largest contract that the US Government had ever written. It was larger than the Manhattan Project that built the Atom Bomb in WW-II. We were now writing the **Specifications for the Request for Proposal** for bids from industry for the **Lunar Excursion Model** (or the LEM), and to pick its contractor, the Grumman Aircraft Co. I was on the Evaluation Committees that picked the contractors for both the Mercury and the Apollo Programs. We had to build the Space Center, and staff up to about 3000 Government personnel, and bring on board about 6000 Contractors.

Dr. Robert Gilruth became Director of the Manned Spacecraft Center. Dr. Max Faget was made Director of Engineering and Development; Chris Kraft was made Director of Flight Operations; and Astronaut Deke Slayton was made head of the Astronauts Flight Crew Operations Office. **Deke had been diagnosed as having heart palpitations and had been taken off of flight status.**

Dr. Robert Gilruth and his people accomplished an amazing feat during this period of time. We were working 10 to 12 hours a day, and sometimes seven days a week. I was traveling all over the country and having a ball.

One weekend when I returned home, my wife informed me that my oldest daughter, Laurie, who was about 6 years old at the time, had asked for a new Daddy, quote "One that would stay home sometimes." End quote. That was a real wake up call. **We were in a race to beat the Russians in space, and to the moon. Slide**

* **John Glenn**: This is John Glenn going to the launch pad with Dr. Douglas, and his **Space Suit technician, Joe Smith. Slide**

* **Friedship-7 Launch**: This is the launch of **Friendship-7** on the Air Force's **Atlas Rocket Booster. John Glenn was the 1st American to orbit the earth on Feb. 20, 1962.** Remember, **Yuri Gagarin had orbited the Earth on April 12, 1961, 10 months earlier. Slide**

* **John Glenn in Orbit**: This is John Glenn conducting a simple experiment. We were still Launching from Cape Canaveral, Florida. Prior to reentry, the light came on in the cockpit, indicating that the heat shield may have come loose. At this time **I was working on the Apollo Project.** I received a call from the Cape asking if it would be OK to reenter with the Retrorocket package left strapped on the Heat Shield in case the heat shield had actually come loose. **I did not know.** I also did not know at that time that Dr. Faget had run some wind tunnel tests showing that it would be OK. In the meantime, Wernher von Braun and his people kept trying to tell Chris Kraft what to do. **John Glenn had to come down at the end of the 3rd orbit.** The decision was made to reenter with the retro package left on, and the mission was successful. On reentry into the sonic region [?it?] was oscillating and John Glenn said that he reached for the Drogue Chute button but he did not touch it, but the Drogue Chute came out. **I believe to this day that if the Chute had not been qualified for supersonic speeds, we might have lost John Glenn.** On reentry, the Ablating Heat Shield causes a communication blackout. These were very anxious times on the ground. It was later determined that the light on the control panel had malfunctioned, and that the heat shield had not come loose.

It now became clear that the **Mission Control Center** for the Manned Space Flight Missions had to be at the Space Center, in Houston, Texas, where the expertise on the Spacecraft Systems and Subsystems would be available to support the operations of the missions. Subsequently, **George Low set up the Mission Evaluation Room, under the Apollo Program Office to support Flight Operations on all of the Flight Missions. I was the lead engineer from E&D for the Subsystem Managers and their support team in the Mission**

Evaluation Room.

Gemini Program:

In order to go to the moon, we had to develop the capability to change orbits in space, and rendezvous and dock with other orbiting space vehicles. During this time, the Mission Control Center had been completed at Houston, Texas. Gemini 4 was the first flight controlled from the new control center. **Slide**

* **Gemini Spacecraft:** This is the launch of the Gemini 4 Spacecraft on the **Titan Booster**, built by the Martin Aircraft Company. **Slide**

* **Ed White:** Just before Gemini 4 launch, it was decided to try for the first man walk in space. The Russians had put a man outside of their spacecraft on a tether in March of 1965. A system was developed in complete secrecy, and delivered to the Cape in two short weeks by our Crew Systems Division, headed by Dick Johnston. Ed White was the first man to walk in space with a **tether and with hand-held jets** for maneuvering in space in June of 1965. We considered this to be our first victory over the Russians in the Space Race. Ed White was having such a good time that he had to be ordered back into the space craft because he was using up his consumables, i.e., Oxygen and Coolant.

On our first docking attempt of the Gemini Spacecraft with the Agena Rocket motor, the combination went into a violent uncontrolled spin. They thought that it was due to **Cross Couplings of the two vehicle control systems. Neil Armstrong was the Pilot.** He undocked from the Agena, but the Gemini Spacecraft continued to spin at a high rate of speed. Both of the crew members were about to blackout. Neil turned off the Reentry Control System, (or RCS), and the Spinning stopped. One of the RCS Jets had stuck opened. The crews' lives were saved. 9:35

Apollo Program: I will now discuss the Apollo Program

The **primary goal** of **Project Apollo** was to land American Astronauts on the moon and return them safely to Earth. **Slide**

* **Wernher von Braun:** Wernher von Braun and his staff were brought on board at the NASA, Marshall Space Flight Center in Huntsville, Alabama, to develop the Saturn Boosters for Apollo.

When we started designing and building the Apollo Spacecraft for landing on the moon, **we did not even know what the moon was made of.** Some 20 years later after WW-II, I found myself in staff meetings, and standing on a Saturn Booster Test Stand with **my World War II adversaries,** Wernher von Braun and his staff, from Peenemunde. I still had mixed emotions. I still wasn't talking about my World War II experiences.

Jim Elms who was the Assistant Director to Dr. Gilruth came up with the idea of assigning subsystem managers to the spacecraft. I worked with Bob Piland to set up the 1st 35 Subsystem managers for E&D. This number later grew to 42. As Technical assistant to Dr. Faget, I was made head of Subsystem Managers Office, keeping him apprised of their activities. I also represented the Directorate on the many review boards that they had to go before to show that their Subsystems were ready for flight and to review all of the Post Launch Reports.

For the Apollo Program, NASA built a new **Launch Facility at Merritt Island, Florida,** that was later named **Cape Kennedy,** after our late president. General Curt Debus, also from Germany, became its first **Launch Facility Director. Slide**

* **Apollo-8, Borman and crew:** This is the Apollo-8 crew, Commander Frank Borman, Jim Lovell, and Bill Anders. Astronaut Frank Borman and his crew were the first men to leave Earth Orbit and go to the Moon. This spacecraft was originally scheduled to be an **Earth Orbit Mission.** George Low, the Apollo Program Manager, came up with the bold idea to change this Mission to a **Lunar Orbit Mission.** I was the lead Engineer from E&D on the team that helped determine what upgrades would be needed, if any, so that the schedule could be moved up. **This was our single most important mission, to show that man could be sent to land on the moon. Slide**

* **Apollo-8 launch.** This is the launch of Apollo-8 on the Saturn V Booster from the Kennedy Space Flight Center. **Slide**

Apollo-8: This is a photograph of the Earth rise taken from the Moon on Xmas Eve of 1968, just 24 years after the "Battle of the Bulge" in Europe which I was in. When this happened, I had to marvel in how far we had come in 24 years. I was also Co-Chairman on a Committee with Jim Chamberlin that helped to resolve problems that we were having with Astronauts' Helmets to be used on the moon and its Communications System.

It was a great thrill when I heard the first communications from the crew, as they came from the backside of the moon on **Xmas Eve**. It sounded like they were in the next room. **We were now ahead of the Russians in the space race to the Moon.** Jim Lovell was asked what impressed him the most about the flight. He responded, "**The Magnificence of the Earth.**" **Slide**

* **This is the Earth Rise over the Moon:** When I saw this picture I thought that it was the picture of the Century. How little did I know of the things yet to come? I still think it is one of the best pictures of the century. **Slide**

* **Apollo 11 Crew:** This is the Apollo 11 Crew for the First Lunar Landing Mission: Commander Neil Armstrong, "Buzz" Aldrin, and Mike Collins. Before this mission, Neil Armstrong had awarded me one of the **1st Snoopy awards** given by the Astronauts. Dr. Faget sent Alec Bond, his assistant Director, and me to Cape Kennedy to witness this launch. **Slide**

* **Apollo 11-Launch on the Saturn V Booster:** This is the launch of Apollo-11 on the Saturn V Booster. I had grown up with the Rocket Test Programs at Wallops Island, Va., the Boiler Plate tests for the Apollo Spacecraft at White Sands, NM, and at Cape Canaveral, Florida. Even I was not ready for the launch of Apollo 11 on the Saturn V Booster. On launch, I witnessed grown men crying. **It was certainly one of the most thrilling moments of my career.** **Slide**

* **Transfer of LEM in Earth Orbit:** Here is an Artist's concept of the spacecraft in earth orbit. The Saturn booster has been expended; the Command and Service Module has turned around and has removed the Lunar Excursion Module from its adapter. The Service Module then takes the spacecraft configuration into Lunar Orbit, and later it returns the CM back to Earth Orbit. The CSM stays in orbit around the moon while the LEM with its Descent- and Ascent-stage Engines, lands on the moon. Now you can see why the Gemini Program was so important to us in learning about Rendezvous and Docking, and Orbit transfer. **Slide**

* **Mission Control Center-1:** This is a photo of the celebration in the Mission Control Center after Neil Armstrong's call from the moon: **"Houston, Tranquility Base here. The Eagle has landed."** Dr. Chris Kraft who had started the tradition of lighting up cigars after the successful landing of a Spacecraft is shown lighting up Dr. Faget's cigar. To his right is George Low, the Apollo Program Manager, and Dr. Gilruth, our Center Director. **Slide**

- * **Mission Control Center-2:** This is Dr. Gilruth with the Cigar—the man who assembled the team and made it all happen. He was our leader. I, and many others, considered him to be like a father to us. Dr. Max Faget is behind Dr. Gilruth. As Director of E&D, he was responsible for all of the Design, Development, Testing and the support of the Flight Missions for the spacecraft. To the right of Dr. Gilruth is Dick Johnston, who was chief of our Crew Systems Division, responsible for all the Crew's Life Support Systems. **The first landing of the man on the moon was also one of my greatest thrills.** Slide
- * **"Buzz" Aldrin:** This is a photo taken by Neil Armstrong of Buzz Aldrin descending the ladder to step on the moon. Neil Armstrong was the first man to set foot on the Moon. Slide
- * **American Flag on the Moon:** This is Buzz Aldrin planting the first American flag on the moon designed and built by one of our own, Jack Kinzler in his shops here at the Johnson Space Flight Center. Slide
- * **Moon Plaque on the leg of the LEM:** This is the plaque on the leg of the LEM that was left on the moon. **"HERE MEN FROM PLANET EARTH FIRST SET FOOT UPON THE MOON. WE CAME IN PEACE FOR ALL MANKIND."** It was dated July 20, 1969, and signed by the Astronauts and President Richard Nixon. We had fulfilled President Kennedy's proclamation. Slide
- * **LEM leaving the Moon:** This is a photo of the LEM's Ascent Stage returning to the CSM in Lunar Orbit. It was taken by Mike Collins from the CSM. Slide
- * **Command Module in Lunar Orbit:** This photo was taken by Neil Armstrong, from the LEM as he was approaching the CSM in Lunar Orbit. They were both very glad to see each other before docking for their return to earth. Slide
- * **Apollo 15 with Lunar Rover:** This is Apollo 15 with the Lunar Rover that had been stowed, folded in the side of the LEM's Descent Engine. The Descent Engine and the Lunar Rover both stayed on the moon. This is the Ascent stage that takes the crew back to lunar orbit. Slide
- * **Lunar Rover transverses the Moon:** This is the Lunar Rover with steel belted tires, without the rubber. This increased the capability of man to traverse the moon and to conduct experiments. Alan Shepard, on his mission, hit a golf ball on the moon. Slide
- * **Last Foot print on the Moon:** This is the last foot print left on the moon by the Apollo 17 crew Commander Gene Cernan. Slide

* **Earth and Moon:** This is a photo taken in Earth orbit of the Earth and the Moon. We were now becoming aware of how small and fragile our Planet Earth really is.

AS mentioned earlier I was the Lead Engineer from E&D in the Mission Evaluation room with a team of 36 Subsystem managers and their technical support. **On the Apollo VIII accident, we in E&D were able to tell the Mission Control Center within 8 hours after the oxygen tank explosion in the Service Module, what had happened to the Spacecraft, what they had to do to stabilize the Spacecraft, and how they could use the LEM as a life boat to save the crew and the mission.**

At the peak of the Apollo Program, Chris Kraft was quoted as saying that we had about 450,000 people working on the program. In response to the Press, Al Shepard pointed out that we didn't spend all that money on the moon. It was all spent right here on Earth. **Slide**

- **Skylab Program:**

The **objectives** of the **Skylab** were to prove that man could live and work in space for extended periods of time, and to expand our knowledge of Solar Astronomy. The Skylab was built inside of a Saturn Booster Fuel tank, and its power supply was obtained from the Solar Arrays. These missions gave us the data we needed to show that we did not have to design for artificial gravity for the space station. As some of you may remember, **Wernher von Braun was proposing a Space Station Concept that was a large wheel rotating in space to produce artificial gravity.** It would have been **very complicated and expensive.** **Slide**

- **Skylab in Orbit with Parasol:**

This is the Sky Lab in orbit with its Parasol. The Solar Arrays had hung up on deployment and had failed to deploy fully, so full power was not available. Because of the lack of an adequate power, the Skylab could not be rotated, to keep the sun from making one side too hot. In our shops here at JSC, Jack Kinzler developed a blanket, and a way to deploy it. It was sent up and deployed by the Astronauts to protect it from the heat. Later, Pete Conrad, in a Spacewalk, released the stuck Solar Arrays to obtain complete power allowing the Skylab to rotate in what we called "**the barbecue mode.**" **We no longer have these capabilities** to do these kinds of things here at the Space Center. **Slide & Slide**

* **Astronauts Inside Skylab:** In these 2 slides you can see how the Astronauts enjoyed the space available to them in the Skylab and for Astronaut bathing.

Space Station Design Concepts:

During this period of time, Max Faget was designing and developing the Space Shuttle. Dr. Faget asked me to be the lead engineer from E&D on the team to develop a Space Station Design concept under René Berglund, the Project Manager. The shuttle would be used to supply the Space Station, and the Space Station would help to justify the Shuttle. **By that time I had gotten smart and I didn't ask him how I was going to do it.** I knew by then that was what I had to find out. **Slide**

• **Space Station/ Saturn Booster Concept:**

We developed a Concept where we could put up the Space Station with the Saturn Booster. The Booster was 30 feet in diameter, so we made the Space Station 30 feet in diameter and 40 feet long. It was 4 stories high: One story would be used for the Crew Quarters, another one for the Control Center, another for the Experiments, and another for the Propellants. It included the Solar Arrays for the Power Supplies. It could support a 12-man Crew for ten years. This was a real simple and straight forward approach that could be put up with one launch. It would have been far superior to the **Russian Mir Space Station**. When we took it to NASA Headquarters, we were told that President Nixon had just canceled the Saturn Booster so we would not be able to do it. I thought, **"What a big mistake!" Slide**

• **Space Station/Space Shuttle Launch Concept:**

I went to Dr. Faget and asked him, "What was I to do now?" He said, "Put it up with the Shuttle". I asked, **"How do I do that?"** As you can see, **I was not very smart, for very long.** He laughed, and pointed out that the Shuttle Cargo Bay could carry a payload 15 feet in diameter and 30 feet long. The Shuttle could put up the individual modules and they could be put together like tinker toys. We developed this concept but we had to put it on the shelf in the early 1970's because we didn't have the funds to do both the Shuttle and the Space Station at the same time. This is the Concept that was started some 10 years later. It has been expanded into the International Space Station (or ISS).

About this time Dr. Gilruth had retired as Director of the Johnson Space Center. Dr. Chris Kraft became the centers 2nd Director. **Slide**

- **Apollo-Soyuz Program:**

The Space Program needed a mission to fill in the gap between the Apollo Program and the Space Shuttle. René Berglund was the Project Manager and once again I was the lead engineer from E&D on the team that developed the Apollo/Soyuz docking concept with the Russians. The **objectives** of the **Apollo-Soyuz Test Project** was to test the compatibility of Rendezvous and Docking of the American and the Soviet Spacecraft, and to open the way for **International Space Rescue**, as well as future joint manned flights. Glynn Lunney, who had been a Lead Flight Controller, was made the Program Manager. **Slide**

The Apollo-Soyuz docked on July 17, 1975. This is an artist concept of the Apollo-Soyuz with the Docking Module. Deke Slayton's heart palpitations had been corrected by this time, and he was the final member of the Original 7 Astronauts who got to make a space flight on this mission.

- **Space Shuttle Program:**

I retired from NASA in 1980 before the first Space Shuttle Flight in 1981, but we had been developing and building the Shuttle for ten years. Let me review some of the program with you briefly. Dr. Max Faget and Dr. Chris Kraft stayed on with NASA until after the successful launch of the Space Shuttle. **Slide**

* **Space Shuttle /Boeing-747:** This is the Space Shuttle flying over the Johnson Space Center, being transported by the Boeing-747 Airplane from the West Coast to the launch pad at Cape Kennedy. This concept was conceived and developed here at NASA by John Kiker in Kinzler's Shops. He had Scale models built of these two vehicles in Jack Kinzler's shops and flew them together. I was instrumental in getting John Kiker hired from WADC at Wright Patterson Air Force base to take over my parachute systems when I was put on the Apollo Study Management team. He was an outstanding engineer. **Slide**

* **Space Shuttle at VAB, (Vertical Assembly Building):** This is the Space Shuttle in front of the Vertical Assembly Building (or VAB) at Cape Kennedy. Now the Air Force had their winged vehicle, but had chosen not to use it. This Vertical Assembly Building was originally built to put the Apollo Spacecraft and Booster assembly stack together. It is 351 feet tall. **Slide 951**

- * **Space Shuttle on the Launch Pad:** This is the Space Shuttle on the Launch Pad with its fuel tank and solid fuel rocket motors. These Boosters were developed by von Braun's team. **Slide**
- * **Space Shuttle clearing the Launch Pad:** This is the Space Shuttle clearing the launch pad. **Slide**
- * **Space Shuttle in flight:** This is the Space Shuttle in Flight. **Slide**
- * **Satellite Business System (SBS-3) Communications Satellite:** This was the first Communications Satellite, the SBS-3, being deployed from the Shuttle. **Slide**
- * **3 person EVA (Extra Vehicular Activity):** This is a photo of three Astronauts repairing the Intelsat V1 Satellite that had been retrieved in space. This is a good example of no Gravity in Earth Orbit. **Slide**
- * **Astronaut on Manipulator Arm:** This is the Manipulator arm that was developed by the Canadians. It was used to move experiments and to deploy and retrieve satellites. **Slide**
- * **Astronaut Bruce McCandless Space Flight In the (MMU), Manned Maneuvering Unit:** (This is Bruce McCandless testing the Manned Maneuvering Unit. **I now have my Buck Rogers.** The one thing wrong with this picture is that it wasn't me. **Slide**
- * **Hubbell Telescope:** This shows the 2nd retrieval of the Hubbell Telescope to repair its flawed optics. Pictures of the universe have been amazing. They have found new planets, constellations, solar systems, black holes, galaxies, and the birth of new stars. The Hubble Telescope has proved the **"Big Bang"** theory, that is, that our universe is still expanding. **Slide**
- * **Birth of a new star:** This is just one such slide that shows the birth of a new star. This Cloud is made up of Hydrogen and dust. There are Stars inside of this cloud, which is 7,000 light years away. I understand that we have the capability to see the stars inside of this dust. We now hope to determine **"How old is our universe?"** **Slide**
- * **Shuttle Docking with the Mir Space Station:** In 1995, we had our first docking of the Shuttle with Russia's Mir Space Station. Several of our Astronauts spent extended periods of time on the Mir. **Slide**
- * **Astronauts and Cosmonauts:** This shows the American and Russian crews shaking with their left hands. Our Astronauts found out about this Russian custom/superstition just before launch. **Slide**

9153

- * **Comparison of Launch Vehicles and their Space Craft:** This is a comparison of the different Spacecraft and their launch vehicles: the **Mercury-Atlas, the Gemini-Titan, the Apollo-Saturn V, the Skylab-Saturn V, the Apollo/Soyuz-Saturn S2, and the Shuttle with its Solid Fuel Rockets.** Slide
- * **ISS July 4, 2006:** This is an early Artist's concept of a shuttle docked with a Space Station.
- * **Shuttle Landing:** This is the Shuttle landing with Ring Sail Drogue Parachute. This helped to save a lot of tires on landing which was a big Problem. The Ring Sail Parachutes have been used on all of our Spacecraft.
- * **Original Control Center:** This is the Original Control Center that is now a Historical Museum. Slide
- * **New Mission Control Center:** This is the new Mission Control Center that is used today. Slide

· **Summary:**

I love this slide. I am sure many of you can also relate to it. It represents the many changes and things that I have seen, and participated in during my life time. I have been very lucky and blessed. I have gone from the days of the Depression, behind horses and mules on the farm, to flying open cockpit airplanes, to encountering the first operational Jet Aircraft in combat, seeing the first Operational Guided Missile, the V-I Guided Missile, and the launching of the V-II rockets from Germany on their way to bomb England, and to flying a Supersonic Jet Airplane. I have participated in the Design and Development of Supersonic Jet and Rocket Aircraft, to putting man in Space and sending him to the Moon. I have helped develop a concept of joining with our **Cold War** Adversaries the Russians, in Space. The Hubble Telescope has found new Planets, Galaxies, and Solar Systems etc. In the meantime, Unmanned Spacecraft have landed on Mars and gone to other planets, Mercury, Jupiter, and the [Sun] and beyond. We helped to write the books in Aviation and Space travel. We have opened the way for Interplanetary Space Travel. I can't imagine anyone having a more exciting career, than I, and many others, who have had the experience of working on the space program, except for maybe the Astronauts. I have a couple of questions for the group. We now ask the question, "**What is our true place in the Universe?**" **Think about it.** **Is this a great country or what? I Thank You.**