

I'm going to do that.

I encourage questions.

I may not be able to answer all your questions either because, A, I don't know or, B, I cannot say.

I am going to leave it to you to figure out which one is which.

[LAUGHTER] I would like to say a few things before I start.

One is I'm not a historian so I'm not here to give a history of the military and the Shuttle.

I am here to give you my experiences with it which is a very select data slice, I think, as you will see.

Second, the things I say here, although we're going to tape them, I have to [NOISE OBSCURES] very carefully.

And, third, I really speak from a different era.

I speak from an area of the '70s and early '80s when the political situation was a lot different than it is today.

When a Cold War was hot.

When there was a real threat of a massive land war, plus worse, in Northern Europe.

When there were real threats of nuclear exchanges between the super powers.

Things which are not true today, thank goodness.

We have now been overcome by other threats and challenges, but I speak really from an era of the '70s and '80s.

So, with that, I would like to start.

Again, I encourage questions.

Here is what I would like to do today.

I would like to give you a little bit of intro and background.

Talk about DoD and Air Force space missions.

There is a difference which I shall highlight.

I will talk about military system requirements and impacts on the Space Shuttle as a system.

I will talk about facility impacts because that is easy to do, but there are impacts that are far more far reaching than that.

I will close a little bit on national space policy and then I will show you a ten minute video. For the video I would like Tom to turn off the recording and we will just watch it kind of in silence.

OK.

Any questions?

My background is I served 29 years in the Air Force.

As you folks know, you can retire up to 20, so I couldn't count.

I stayed far longer than I should have.

The reason I stayed was because the Air Force gave me assignments I could not turn down.

I have had lots of experience from a program office payload user perspective on Shuttle, Titans off both coasts, MX, Pegasus XL.

Last January I gave a talk, which I will repeat this year, on my activities on two accident investigations.

One on Titan IV and one on Pegasus.

I do that at one time.

It takes about an hour and a half.

If any of you are on campus in January, please come by.

It's an interesting story.

I served in multiple program offices in programs A and B.

Programs A and B are subsets of the NRO.

I won't say any more about that, but Program A is the Air Force element.

Program A not only built Air Force satellites for the intelligence community, they also provided all the launch services for the intelligence community.

I have been director of two major programs.

The first one Space-Based Infrared Low.

The second one was the DoD Space Test Program.

I have also been the NRO Director of Safety.

In general, Air Force and DoD space missions fall into this laundry list.

The first one is Navigation which you know from GPS Communication which has many satellites of which Nelstar and DSCS are the ones you recognize.

DSCS was launched on the Space Shuttle I believe twice, I'm not sure.

Meteorology, the Air Force launches the DMSP which is the polar orbiting weather satellite now replaced now by the NPOESS system.

For missile launch detection, the intelligence community and the Air Force have either operated the DSP satellite system or else proposed SVRS which is suffering tremendous programmatic problems currently.

For arms free verification, it is terribly important to have complied at one time with [UNINTELLIGIBLE] limitations.

That is an interesting slice of history where at one time the total number of warheads, total number of bombers, submarines, ships, this sort of thing was limited by international agreement but it was the responsibility of the other side to verify compliance.

There is also nuclear weapons test detection on Vela.

And then a whole handful of what I call intelligence community or IC programs.

Bob Siemens, a retired professor emeritus is planning to drop by today for the Q&A.

His position, his role in this story is really very central.

His influence is woven throughout the whole story of the DoD and the Space Shuttle, and I hope you will get a chance to talk to him.

An extremely interesting and very pivotal guy.

I would like to concentrate on Vandenberg Air Force Base right up on the Eastern Range for the Space Shuttle because the Vandenberg Air Force Base launch site was really built up for sun synchronous polar orbits, for really one payload, and that was the fellow here depicted in the late 1970s, launching out of the Western Range.

This is a Titan IIID.

I have helped launched, I think, eight of these off the West Coast.

This is a heavy lift machine.

It is roughly 30,000 pounds in low earth orbit, 27,000 to 30,000.

It has two solid strap-ons.

I saw the first one go in 1970 and subsequently was able to transition into the Program Office to launch several times out of there.

As some of you are aware because I have talked to you out of class, I served for many years not in what we call the regular Air Force but what is called the Office of Special Projects.

It is called an Air Force Element.

We did not report for the usual chain of command through the Air Force chains.

We went straight up to the secdef of the JCS.

We were given the responsibility to launch things quickly, quietly, with great national pressure.

And we did that.

And the machines we used to launch, payloads included, are Titans of various kinds, Atlases, as well as the Space Shuttle.

The story I am going to tell you is really the special projects utilization of the Shuttle.

More so than what I call the regular Air Force missions.

In any case, when I joined SAFSP in the late 1970s, life was really exciting.

We were in the midst of phasing out all the expendables for the Space Shuttle.

And when I went in there, I found within the first week they said the Space Shuttle is designed for our program,

because we were flying on a regular basis out of the Western Range.

So, the payload that sits inside here is a form, fit and function drop-in in the Space Shuttle bay.

At the time, there were no Space Shuttle payloads of that size yet on the drawing boards.

The intent was to have a seamless transition from Titans into Space Shuttle, first for our program and then for others.

We drove the payload bay size, as you've heard from Professor Hoffman and Aaron Cohen, 15 x 60.

The cross-range requirement dictated the configuration of the vehicle plus the wing size because the Air Force and the DoD was very, very insistent on having a return to launch base capability.

First orbit deploy, come back cross-range, land back at Vandenberg, recycle, be ready to go hopefully in a matter of days.

It is interesting to note the evolution of the Titan space launch family.

In the 1970s we pick it up with the Titan IIID we see here.

The 3E was a Transtage version used for basically out-of-space missions.

This is a commercial version.

But the DoD use went from the 34B, 3C, 34D through this family here, and now we see the 4A and the 4B which are the heavy lift guys.

These guys basically were the follow-on to Shuttle.

They lifted the Shuttle payloads that the Shuttle could not carry.

And I will explain that in a few minutes.

Very large, expensive, complex machines, complex programs.

At Vandenberg, it turns out that back in the '60s there was a program called the Manned Orbiting Laboratory, MOL.

Many of the original Space Shuttle Mercury astronauts were part of that.

They built up a space lodge complex up there called Slick-6 to launch the MOL.

It was going to be a space capsule with military officers onboard to do recognizance and surveillance flying off a rather large Titan IIIC.

To do that, again, back in the '60s, they built a launch pad.

I'm sorry.

As we got ready for the Shuttle, they took the MOL things and did all these things to it to make it shuttle-ized.

They operated a launch pad.

They put in a Mobile Service Tower.

As you know, at the Cape, what they do is kind embrace the Shuttle and its stack with a gantry.

And they pull back a little bit and then they launch.

The Mobile Service Tower is a large, almost like a skyscraper complex that completely encloses the rocket during processing and then rolls back several hundred yards to expose the vehicle for launch, a totally different OPS concept.

This facility here, the OMCF is similar to the KSC Orbiter Processing Facility.

Then they have other facilities here.

The payload preparation room where the payloads are received from transportation put together and tested.

The PCRs were the payloads actually put into the shuttle bay.

The Vandenberg runway was almost doubled in length.

And then all this infrastructure is put in here, including crew quarters for the astronauts.

And they were able to reuse the MOL facilities.

A lot of [UNINTELLIGIBLE].

But what you see here is the buildup of a complex very similar to Cape Kennedy only on a California coast.

Very, very elaborate, very, very complicated, very expensive, and taking a tremendous amount of budget to go do it.

Back in the '70s by law or by policy, which is perhaps even more powerful, the Space Shuttle was going to be the only launch system for all military, civil and commercial payloads.

This is somewhat of a forgotten fact, but at one time the cry went out from the advocates that said by having a reusable spacecraft that can launch 25, 30 times a year from both coasts, so that is times two, we can do great things.

And certainly, coming from the folks that gave us Apollo, this did not seem that farfetched.

The idea of launching a spacecraft like an airliner, as we know, did not happen in our generation.

I think in your generation, if you can make that happen, that would be extremely wonderful.

But at one time there was going to be a phase out, a shutdown of all the launch vehicles.

All the launch vehicle folks were told fly out what you have, close up business, break up your tool and dies, send your people home, we are going to go with Shuttle.

And to do that there was extensive redesign of payloads to fit the payload bay, the width, the length, to fit the safety requirements.

All these things changed.

So, it was not just a matter of just taking your existing payloads for these guys and dropping them into the shuttle payload bay.

It was a huge engineering effort.

And we thought at one time this is the way it is going to be forever.

The things that are unique about this is, first of all, liftoff and flight loads are much different because of not only the main events, everything from the SRBs, the staging, but also being able to survive safely, things like slap down on landing if you had to come back home with a payload.

Many of the heavy payloads require, as you know, upper stages.

The PAMs are the small payload assist module, small [UNINTELLIGIBLE] upper stages.

The IUSs, as you probably heard, are much, much more elaborate solid fuel devices.

The Shuttle Center, Cryo Center was going to be a cryogenic upper stage that was going to take our biggest

payloads up to GEO.

That never got through the safety process but they worked it hard.

The safety requirements, to make sure that the crew was not endangered at any time by anything, either accidental or inadvertent or a mishap, were huge.

That is a whole separate discussion in itself, which I will be glad to have with you, but basically everything was looked at in terms of being dual fault tolerant so that in no case could any two events link up to cause hazard to the crew, even including accommodation of hardware and software errors.

This was huge and caused, in many cases, extensive retests and redesign of payload systems.

National Space Policy, back in the '70s and '80s.

First of all, in '78 there was "strong endorsement for the Space Shuttle to be the prime mover for national security and civil missions".

What is missing from this lineup here?

Commercial.

There were very few, almost no commercial missions at the time.

Civil means NASA.

The launch business of that time was dominated by the government, NASA and the DoD.

1982 the position was strengthened.

And, by the way, I suggest if you haven't already to look up these documents.

National Space Policy is voiced in these documents.

It is extremely powerful.

It is the basis for programs.

It is the basis for legislation.

It is the basis for budgets.

It is huge.

Every word in these documents is worked over at great length by all the competing stakeholders, and it is big.

But in '82, SCS was going to be the primary launch for national security in civil missions.

What that really meant was anybody else with a rocket was told you're in the wrong list, don't come back.

Then we had Challenger.

And in 1988 there was now a directive.

A 1988 PD that said we shall have a mix between man and unmanned launch systems.

This is in contradiction to this I'm sure as you notice.

An NSPD4 in 1981 now gave us the words "assured access to space." Code words.

Anybody here care to tell me what that really means in plain English, anybody?

Yes.

Even if the Space Shuttle won't fly they want to have some alternatives.

That's right.

It says don't put all your eggs in one basket.

Have two ways to get to space for your heavy payloads.

This is authorization for what we now know as the EELV.

But also at the time shortly after Challenger, Pete Aldridge who was Secretary of the Air Force at the time, now an executive of the Aerospace Corporation, previously the director of the NRO, prior to Challenger in the '84, '85 time period started getting a little bit antsy about access to space because of all the delays in the Shuttle Launch Manifest.

And so he authorized, on his own authority, a start-up of the Titan fleet again.

This led to huge problems with NASA because what they saw that as, correctly, was a loss of support for the Space Shuttle Program.

But he did that.

And when the Challenger disaster occurred in '86, the Air Force was about 18 to 24 months ahead of where they would have been.

Here is Dr.

Siemens.

Hi, Bob?

Hi, Pete.

You want to sit over here?

I would like to have you meet Dr.

Bob Siemens.

And he will be here for the Q&A afterwards.

Bob, I'm just going over some of the National Space Policy.

Write-ups that kind of led to where we are today.

This was NSC37.

This was NSC42, the primary launch.

This was the post-Challenger mix between the manned and unmanned systems.

And then this was the assured access to space presidential declaration.

From a user perspective, the security requirements to fly on Shuttle were huge.

What was required to be protected was any information on the mission type and details.

LEO, GEO, HEO, you name it, that could not leak out.

Any information on the spacecraft, who made it, where it was supposed to go, of course what the payload did had to be protected.

Also protected was the Program Office and the prime contractors because often you can tell from that who does

what.

And during operations the deployment time location and the final payload orbit had to be protected.

This is huge.

As you know, thousands of people participate in getting a mission together for the Shuttle.

It starts with a mission planning template that is roughly two to three years prior to flight.

It goes all the way through preparation of the flight plans, the mission rules, the launch constraint documents, the processing, and finally the on orbit ops.

All that had to be protected.

And that was big.

It was a huge and expensive philosophy.

It was called the Control Mode Security System.

It took a lot of effort from all parts and was almost airtight.

Yes, a question.

Was this for every shuttle mission or just DoD payloads?

No, this is for what I call the intelligence community DoD missions.

If you go back and look on the Shuttle Manifest, and I am not going to do it for you but you can do it if you want, you will see a number of missions where they will say DoD mission payload type, not unknown, but not available, NA.

Also, the DoD/Air Force missions were all military astronauts.

That is felt to be a safe thing to do.

For implementation of encrypted voice data and commanding links starting, really, with the testing at the launch sites but also going through the flight ops.

I mention all these things having been involved in the safety certifications.

I will say that was long and arduous.

The safety review process has to be extremely, extremely thorough starting early on.

It is not just a whitewash of what the hardware is that comes with the pad.

In many cases, it changed the design of the spacecraft, the design of its deployment systems and things like that.

To protect classified information there also had to be need-to-know access to program details.

This was a major, major set of impacts to the Space Shuttle system and payload mission.

All these areas, which I can talk to you about at great length afterwards.

I will say, thought, that when I do get back to JSC or when I talk to my NASA friends, they all say they were proud to have been on those missions.

They were all hooked together on missions of great national importance.

To the best of my knowledge, security has held tight over all those years, despite all the people who were cleared of the programs.

And the programs were extremely successful as a result.

Yes.

You said all military crews.

Does that mean active military or people who have been transitioned to the regular astronaut corp.

from the military?

These are military folks who transitioned to the astronaut corp., yes.

There were also impacts of the Air Force Satellite Communication Networks.

As you know, these are the worldwide set of tracking stations that were going to be replaced by TDRS.

That is an interesting story.

The selling point for TDRS was they would shut down the AFSCNs which were getting old and were very labor intensive.

Well, we still have them both today.

Worldwide network scattered around the world, but to provide secure Shuttle communication there had to be extensive upgrades because working with the Shuttle with a complicated payload in orbit, getting it initialized, tested and deployed was something new for the SCN.

The SCN ordinarily just did space-to-ground data transfers through orbiting satellites, so to be working with a human crew and human system, to have all the contingencies in place was big.

The SCNs were involved in the all the prelaunch testing and commanding, health and status checks, as well as all the deployment and post-deployment payload communications.

I wish I could show you the contingencies, all the workarounds, the plan As, the plans Bs required for a complicated mission.

It is immense.

It takes a long time to do it right.

The point is that when you're ready to fly, you should be ready for all know contingencies, even up to loss of communication, failure of critical computer systems and that sort of thing.

You never want to fly and have to scratch your head and say what should we do next?

Pre first flight issue was an STS1.

Another MIT professor, Gene Covert who is also here and someone you should really talk to at some point in time, was part of our panel that reviewed Space Shuttle main engine quality testing.

And they were the folks that really came to grips with this new and emerging issue called turbine micro-cracks.

The turbine blades in the SSME were found to be developing very small cycle dependent micro-cracks.

The question came up what is the ultimate failure mode?

How many cycles can they stand?

How good are they good for?

The original intent, as you know, was to be able to re-fly the SSMEs with zero maintenance between flights many times.

That hasn't happened.

But even the question of would it be good even for one mission was a big, big question.

And Gene, who is an extremely thorough manager and engineer, a lot of common sense, a lot of smarts, worked that very, very hard.

There were also issues, of course, about thermal tile loss.

There were questions about whether those would fall off.

This is not ice now.

This is thermal tiles.

And, at the same time, there were huge costs growing in the development of the IUS, the Shuttle Centaur upper stage and also Vandenberg facilities.

Everything was either late and/or over cost.

Many folks thought that the IUS would never fly because the development problems were so huge.

The fact that it has flown as many times as it has, on a variety of launch platforms, is truly amazing from my sight.

And we also saw, prior to first flight, several delays, two and a half years is about right.

And then more delays ensued.

And so, from a user perspective, all these delays really added up to lost opportunities, extensive cost growth and things like that, really a heartbreaking story.

This is a picture of a Defense Satellite Program, DSP.

A machine lifting out of the shuttle bay.

I think you have seen this.

This is the IUS turntable that rotates the vehicle up and pushes it out with springs.

This is a two-stage solid misconfiguration that takes the beast out to geosynch.

Post-Challenger, the space policy was changed.

The Shuttle was not to be used anymore for lifting all satellites but only for mission where human presence was required.

But there was a problem.

Because of the backup of missions, the SCS had to fly out the existing DoD payloads.

We looked very hard at converting them back to the Titans.

Since we were taking steps to shut down the Titan line, the Titans weren't ready at that time.

But what we saw afterwards was increased use of, a restart, really, of these efforts, modernizations.

And that was interesting because there was always the chance the Shuttle could come back and launch, hopefully, 15, 20 times a year.

And we hoped it would happen but it never did.

Steven Dorfman from Hughes was here as a visiting professor several years ago.

He was extremely bitter about the fact that, from a satellite manufacturing point of view, he had to eat the cost to switch back to extendables from Shuttle.

First he was told by National Space Policy, "Thou shalt fly on Space Shuttle." Then he was told, "You are now bared from flying that Space Shuttle." A huge lost to him.

And I think Hughes is still contesting it.

I don't think it will ever win that in court.

And kind of most importantly, from a Central California point of view, the Vandenberg shuttle facilities were shut down completely.

My DoD SCS mission involvement personally was I worked on the very first DoD sponsored mission STS4.

It was Columbia launched in late June of '84 flown by Ken Mattingly and Hank Hartsfield.

This was a pathfinder for the DoD.

It was a test not only of the security procedures but also the ability to do launch operations, orbital operations in a classified way.

It came out truly successfully.

We learned a lot.

It was not easy.

Getting any complicated mission to fly on the Shuttle is a very, very difficult process.

To do it under the cloak of security makes it even harder.

I was a primary DoD launch integrator, the interface between the Program Office and the Air Force, for two primary missions.

I shadowed three others.

I was also member of the NASA DoD Safety Review Team.

This was interesting.

The Safety Review Team or SRT was a very small, streamlined, fast-moving team that basically reviewed and bought off on the payload.

As opposed to having the figurative casts of thousands, we had a cast of just a very small number of people both from the DoD and the NASA side.

And we moved as quickly as we could to get these missions approved and bought off.

And, lastly, in the mid '90s, I was a program manager for the DoD space test program.

STP is in existence today.

Their charter is to be the sponsor for space experiments with military relevant.

They flew, among other things, the first atomic clocks that led to GPS as we know it today.

They continue to fly numerous secondary and piggyback missions not just on Shuttle but also on Ariens, Russian vehicles, Korean vehicles, Indian vehicles.

When I was the manager of the program it was great.

It was like you were running a big used car lot and you were offering rides to everybody.

It was terrific.

The emphasis here is to use excess launch capacity to fly space experiments that you would screen every year.

And then, on rare occasions, you would build a dedicated satellite and launch vehicle about every four years to launch the bigger satellites.

My summary is that the DoD had requirements that really went back to the first years, the first days of the Shuttle Program.

They were extremely demanding and dramatically affected the architecture of the Space Shuttle system.

The heartbreak, of course, as we know, is that we never were able to achieve the launch rates and the low recurring costs that were promised.

That really when we realized it was slipping away, those were truly sad days.

I don't think anyone ever anticipated the one-time expenses and effort required to redesign payloads.

Not just for mechanical form-fit function but also for safety.

No one realized the extensive work required to certify the payloads for manned operations.

The mission integration at the Cape was very complicated, and security, as you can tell, permeated everything.

And, lastly, the sad thing is that MOL and SCS at Vandenberg all suffered from the curse of Slick-6, which was that both programs were cancelled despite millions of dollars put into refurbishing the facilities.

I have here a list of references.

Heppenheimer's book "Development of the Space Shuttle" I found was quite good.

It talks a lot about the programmatic of the Space Shuttle.

I hope you've had a chance to read it.

I took some information from here.

The Federation of America Scientists, the FAS site is interesting.

I think it is still current on the Space Shuttle.

And there are these books here which I point you to give you a little bit more insight into the missions, the roles of the intelligence community doing things such as flying and operating satellites in space.

If there are any questions, I will be glad to take them now and then I will show a short ten-minute video.

How am I doing on time?

I'm moving fast.

Yes, question.

How many times was the [UNINTELLIGIBLE PHRASE]?

Was it even used to launch the Shuttle?

Slick-6 never saw anything launched out of there until they launched a Lockheed low-cost machine called the Athena in about 1996.

Presently, the Delta 4, remember the big machine that flew out of the Cape about nine months ago, is stacked there at Slick-6 ready to go with an operational payload.

They are having big concerns, though, about fuselage so their launch date, which was going to be last week, has been rolled off to the right several months.

They had a problem on the first flight of basically fuel cavitation.

And they are not happy with it yet.

It is ready to go.

When the Delta 4 launches out of Slick-6, it will be the first large payload system to go out of there for the first time.

Question. Yes. I don't know if it is really fair, but in hindsight, was it worth it for the military to get onboard with the Shuttle from the military's perspective?

Well, if the promises had been kept it certainly would have been worthwhile.

With the way things have turned out, was it worth it?

We were kind of driven into it.

Can you say was it worth it from a cost point of view, from a schedule point of view?

The answer is no.

I think from the perspective of having people do extremely difficult tasks under very pressing circumstances, it showed us what NASA and the Air Force could do, although at a great cost.

It was certainly one of the more, I will say, exciting times.

It was one of the more exciting times for NASA.

Questions?

Yes.

When you talked about safety certifying these payloads, was it mainly an issue of the fuel supplies for the payloads?

Well, I will just give you one example.

To get a payload into the bay and withstand launch loads, you have to have very large structural members, steel rods, for example, that had to take all of the launch loads and not have the satellite break away inside the payload bay in the worst case either during liftoff or in the worst case on landing.

You could have as many as 18 to 24 steel bolts that all had to be fractured simultaneously within seconds by pyrotechnics to get them out.

You had to prove by analysis and by test that you could have these simultaneous events for which you could not have any redundancy.

You just couldn't do it.

These were must-work devices.

As probably Professor Hoffman has told you, on every Shuttle launch there is a large number of must-work category-one issues and items.

Like the bolts that free the external tank from the vehicle, if those don't work you've got a big problem.

From a safety certification point of view on the Shuttle, we had to make sure that in no case could the payloads pose any hazard to the crew under any circumstances, including the ones that are the most farfetched such as

landing overseas in Spain or Morocco.

But the things we were worried about was having a payload hung up during deployment so the Shuttle couldn't return or a payload damaging the Shuttle at any time and causing obviously big problems there and things like that.

Plus things such as propulsion systems accidentally activating.

Liquid solids, it didn't matter, all extremely hazardous.

And we found out a lot, because it is one thing to design a payload for launching an expendable.

There are certain things that you can or should not do.

But when you go to a Shuttle context, we have a lot of commanding going into the vehicle.

Pre-flight, during ascent and ops, it becomes a much more tough a problem.

For example, I will just give one example.

If you have a very complicated payload which consists of a spacecraft bus, all the housekeeping and the payload front-end which may have all kinds of hazards associated with it like antenna booms that come out on command, how do you verify final configuration before you liftoff?

How do you know every system is in the state that you think it is?

How do you verify that?

That is very hard.

Because you can go in there with test equipment, but test equipment has subtleties all its own.

OK.

Questions?

Do you think it would be possible to do the one orbit and return to base type mission?

It sounds very difficult to do.

It is not that hard.

First orbit deploys were not easy but they were done.

Coming back, I think the big problem is that it really forces the timelines.

Because, as you know, to do a de-orbit burn and return to earth, it requires quite a bit of mission planning, real-time updates to verify you're on the right track, plus making sure that you have everything right so when you do the de-boost you're going to be within your corridors.

To the best of my knowledge, NASA has never done a first orbit return.

And I don't think they would want to.

It's very stressing because in 90 minutes you have to not only get the spacecraft out, but then the vehicle re-safed and buttoned up and planned out to land back either at the primary or an alternate landing site.

That's a lot of work to do in 90 minutes.

Any other questions?

Yes.

Is there any way to give a ballpark figure of how many DoD payloads can be put in space by the Shuttle?

Ten or hundreds?

Oh, not, it's not hundreds.

The NASA Manifest is published.

From what they call a regular Air Force site, they launched a whole series of communication satellites, DSCS, DSP.

In fact, the very last DSP satellites are still Shuttle compatible and could be launched if there was a problem with the Titans.

They are up there in storage in Southern California.

And then there are a fairly large number of what are called Intelligence Community Missions that are flown.

And all the manifest will say is that these were just DoD missions.

Let's see.

What I would like to do is ask Tom to shut off the videotape and I will give you a little introduction to my video which I hope will run.

We are ready to start her, folks.

Bob Siemens is really a very pivotal person, not only in the Space Shuttle story, but also in the Apollo Program, which he can probably talk to you at a separate time.

But I think he will like to spend ten or fifteen minutes talking about his role in the Space Shuttle story.

OK.

Here we go.

I'm just wondering where to go to get comfortable.

Can we turn that off?

We cannot.

All right.

I would just like to get comfortable here.

You know, as Pete said -- First of all, I thought that was a great summary of actually a very difficult subject to discuss.

Let me just take you back, first of all, to the early '60s.

I know that is going awful far back, but that was when I joined NASA as a general manager.

And, before we knew it, we had gone from a billion dollar a year operation with the Mercury Program to a situation where we were given the assignment of putting men on the moon.

And that was a gigantic shift in our responsibility.

And in all of the planning and the discussions and so on, and we did work very closely with the Department of Defense, the Department of Defense had all kinds of assets that were going to be required in the Space Program.

The Navy, for example, to pick up the astronauts.

One example, a major example most people never heard of, was we had to construct very large facilities.

The most famous and obvious is the Vertical Assembly Building and the large facility down at the Cape.

You just saw the Shuttle taking off from that facility.

And, in operating down there at the Cape, there already was Cape Canaveral.

And there was not room for what we were going to do to fit on Cape Canaveral.

We looked at seven different world sites and finally decided to camp on Merritt Island which is just across the river from Cape Canaveral because, again, the Department of Defense had all kinds of facilities down there with a tracking range and so on.

But the biggest support that we got was in the building of those facilities.

There was absolutely no confidence in NASA to build the largest structure in the world, the VAB, or many other facilities for assembly and for tests and so on.

The Corp of Engineers was a major part of the operation.

I am bringing this out because we had to figure out how far we were going to go with our launch vehicles on a shared basis.

This is before anybody thought of a manned shuttle that would carry stuff up and stick it into orbit.

But we put together a planning organization that actually operated for over a year's time.

A fellow named Golivan for NASA, a fellow named Cavanaugh for the Department of Defense put this together.

One of the big emphases was the use of the Titan.

The Titan was coming along to the point where we thought that the earliest version would be suitable for the Mercury Program.

And, at that time, in 1961, we were thinking that Mercury only weighed 3,000 pounds.

You could put one man in it.

You couldn't do much with it.

But if we could, in effect, just enlarge it and have a more powerful vehicle, an Atlas, namely the Titan, we could

really have a vehicle that would have some capability to run through a lot of the orbital operation and so on that we're going to ultimately be required for going to the moon.

And out of that came the planning for the Titan III, the Titan IV and vehicles that proved right off the bat, and over time, they still are very important to our defense capability.

Well, I don't think that is quite true.

I don't think we are using any of those assets today within NASA.

And if you then go forward in time, in 1968, I have been down there in NASA for 7.5 years.

I planned to go down for two.

I came back.

MIT was nice enough to invite me back, and I came back right here as a Hunsaker professor.

To my very great amazement, I got a call one day from somebody I had never met, a man named Mel Laird.

I just barely knew that he had been designated by Nixon to be the next Secretary of Defense.

He said are you going to be down here in Washington the next day or two?

As a matter of fact, I was because I was going to go down the next day to get on a plan and fly down and see the launch of Apollo 8 which was going to fly around the moon.

And he said come on for lunch.

That is when he asked if I would be the willing to be the Secretary of the Air Force.

I told him that was absolutely impossible.

We just moved our family back here.

My wife is in the hospital, which she was.

But he was very persistent.

And after about ten days I agreed to go back down in the government, but that is a long story you don't want to hear the details of getting my wife well and getting a house and all that stuff.

One thing that I inherited right off the bat was the Manned Orbital Laboratory.

And, even then, it was clearly in some jeopardy.

When programs start getting a ceiling built in where they say we're going to keep it going but it is going to be kept going at a level of, and I forget what the level was for MOL, something like \$500 million or something like that.

Because any large program over time there is always opposition to it and there is more time for it to be shot down and ultimately eliminated.

I realize that it was in deep trouble when I was over in the Bureau of the Budget talking to a junior member of the Bureau of the Budget and he said I hope you realize that the Shuttle is in deep trouble from a standpoint of support here in the White House.

And so I went back to Mel Laird and said, look, one thing I want to do is to have one shot with the President to be sure he fully understands what the capability of the MOL will be.

It was far along.

Lots of expense had gone into it, including major facility construction out of Vandenberg.

I had my day in court.

It was a sunny afternoon.

I got General Stewart, who was very involved in the MOL, to join me and Mel Laird.

And we went over there.

It was just Kissinger and the President.

And I had a few simple-minded charts that showed what we were going to do from a resolution standpoint if we kept going with the MOL and what that would mean in terms of understanding more clearly what was going on in a given situation.

I had my half-hour in court.

I could see a band outside getting ready to play so I knew that the President was about to be rushed out for some kind of a ceremony.

That was a Saturday.

Monday morning I got a call from Kissinger.

And he said Bob, and I cannot really imitate his German accent, that was a very, very fine presentation.

And a day later I found out that MOL was cancelled.

That was with President Nixon.

He sat there the whole time.

He had a yellow foolscap and took prodigious notes of everything I was saying, which was sort of nerve-racking, the President of the United States bothering with what I am saying.

Anyway, that was sort of where I came from, from the MOL.

The next step along the way was after Apollo, what was going to happen in space?

There were to be eight launches of the Apollo Lunar Program.

Nixon cut that back to two sort of arbitrarily.

And there were no plans for using those assets.

Jim Webb was my boss in NASA.

And I used to see him.

He was very, very ill the latter part of his life.

And I would drop by.

And he would ask me strange questions like what do you plan to do with your life before you kick the bucket kind of questions like that.

And he said I haven't got long to live.

And I would say you're doing fine, Jim.

And I am just going to work along and see what I can do to help out here and there.

Anyway, his big thrust was we felt we were building a major capability for the country and now it is all being washed away.

And what is going to replace it?

The Shuttle came up as an option.

Actually, to say on the surface, it makes an awful lot of sense to recover something.

We could easily visualize a transportation system for the country where every time a 747 went across the country with a payload everybody jumped out and then you threw it in the ocean.

It didn't seem to make much sense.

You just knew it had to be more efficient to reuse something.

Although, with Gemini, we had looked into that possibility.

We were recovering the Gemini's, why didn't we use them again?

And we found that we are going to have to put probably 75% of the original cost into reactivating the Gemini's.

So, actually, I had a hunch that it wasn't going to be quite as simple as landing an airplane and then taking off again.

The Air Force was going to be one of the prime users of the Shuttle.

And the question was how large did the bomb bay -- Not the bomb bay.

[LAUGHTER] How large did the experimental bay have to be for the missions that were going to be carried out?

There was no thought, let me just quickly say, of putting armament aboard the Shuttle.

I misspoke.

And then one of the questions was how rapidly did you have to recover it if something happened and you wanted to bring something back in a hurry?

And to bring it back you had to make up a co-planer change, and that was going to take a certain amount of energy, to put it mildly.

Anyway, those are many of the issues.

And I think, as I remember it, my friends in NASA thought the Air Force was being pretty tough on them.

But if we were going to accept the use of a vehicle, in all seriousness, as you've just heard, it had to have ability to carry out the missions.

And so that was sort of the next step along the way.

And then, after I got through in the government, I ended up some years later out at Aerospace and ended up as the chairman of the corporation.

And they worked closely with that element in the Air Force that was so much involved in these type programs that you've just been hearing about.

And we were beginning to go into shock, at least those in the nucleus who were sort of running the aerospace.

[UNINTELLIGIBLE] and myself.

More and more it appeared that we were going to not be allowed to put anything in space except through the Shuttle.

And that seemed to be imminently wrong.

To think that you're going to have to risk the life of astronauts every time you wanted to put any kind of a satellite in orbit.

From the standpoint of a paperclip individual who is looking at cost, to just have the one vehicle and use it and use it and use it and thereby supposedly cutting the cost, had a lot of charm.

And it reached the point where he and I decided we had to try to do something about it.

And we made an appointment with the then Secretary of the Air Force and said you've just going to be stashing away Titan somewhere so that if we run into trouble with the Shuttle we are going to be able to move over and put these very important payloads into orbit.

And then they had the Challenger accident.

At that point this, I think, major fallacy in policy was changed back where it should have been.

You just shouldn't rely on a single vehicle.

And that is my introduction.

Yes.

You wanted reusability, but some people also didn't want to risk the lives of astronauts.

Why not make a reusable unmanned vehicle?

That's a very good question.

Why couldn't we do it?

That might be a good design challenge for you guys here in this class to investigate that possibility.

Unmanned.

We've gone partway in that direction by, say, recovering the Shuttle casings, obviously the Shuttle itself.

But, trying to recover at least elements of the unmanned launch vehicles, I'm not prepared to really give you a definitive answer on that.

That's a good question and we will talk about it later.

Yes.

Before the Shuttle concept was finalized and military requirements were finalized for the Shuttle, the military had been launching their satellites and their missions using Titan's and Atlas's, correct?

So why this requirement of the Shuttle having to be able to bring back a satellite using really a military satellite when that wasn't being done or required beforehand?

Like why was that created?

What was so special about it?

We worked very hard on proposals to bring back satellites that were out of fuel or needed refurbishment, but when I was referring to landing with the Shuttle with payloads in the bay that is for a failed mission.

And for some reason the payload could not get ejected.

You still had to be able to land back what was now a very heavy spacecraft and glide on it and land safely.

That turns out to be a really hard thing to do, especially if you're carrying solids and liquids onboard that were close to being ready to ignite, so to speak.

But there is talk of retrieving satellites.

And, as you know, NASA did bring back some small satellites, the Palapa one from Hughes.

And also did a lot of very innovative repairs in space.

But when we looked at it from a customer point of view, it turns out there is a lot that wears out in satellites, not just using a propellant.

But the processors degrade due to radiation, solar panels degrade just due to micro dust and things like that.

And so bringing back a satellite for reuse was never felt, at the time we looked at it, to be a worthwhile thing to do.

And that ties in directly with what I was saying about recovering a Gemini.

And, of course, on top of that with a Gemini is the fact you are landing them in the water so they got a good dousing of salt.

And so the degradation of the Gemini's were such that we just didn't think it made any sense to try to refurbish them.

Yes.

The military was only really looking to capture and service in space, then release, not necessarily capture and bring back?

They never seriously went after the capture and refurbish and release.

They really went after launch and deployment.

But I would say that in that theme the most successful story actually of refurbishment is the Hubble Space Telescope.

And not for the reasons that you think of.

When you think about stories of the Hubble Space Telescope you hear about Jeff Hoffman going up there and changing processors and fixing the optics.

Also on those missions they replaced solar panels that were causing huge problems due to thermal warpage and shrinkage and what they call oil canning due to thermal stresses.

And so the replacement of those solar panels, which turned out to be not very good as initially designed, is one of the really true success stories of man in space.

And there is actually a very nice video which maybe you have seen of the lady astronaut who did the replacement of the solar panels on Hubble pushing out and releasing the solar panels.

Things fly away in the sunshine looking like giant butterfly wings reflecting all the colors and then finally fall into the atmosphere.

It is almost poetic, I tell you.

It's amazing.

On the Hubble, one of the considerations right from the beginning was that it should be a serviceable satellite.

It was designed so that you could get inside of it relatively easily and so on.

Frankly, I don't know of any other satellite that was really designed quite that way.

Maybe I'm wrong.

I believe you're right.

Yes.

On the solar panel, it wasn't designed to replace the panel.

But you can go back to SkyLab, which was the next to last launching of the Apollo.

On that one, I guess, we decided to take what was the third stage of a Saturn and just gut it, not have any propulsion in it and fit it out to be a spacecraft, namely a space station.

And, when they got up there, the solar panels got fouled up.

And one of the real tricks when the astronauts first got to it because it was not launched manned was to unravel some wires that got caught on it so actually the panels could spread out and it could start to operate again.

Colonial Siemens, I don't know if either of you would know, but what are the duties involved in like the heavy payload aspect of the new CEV project?

Delta 4 going out of Vandenberg was carrying classified payload.

It's not a dummy either.

It is real.

They have standing requirements for these types of things.

The national needs go on.

The international stage, as we know, is filled with new actors and new threats.

We have what is called unsymmetrical warfare, things that are hard to counter by conventional means.

Back in the '70s and '80s we had symmetrical warfare, submarines versus submarines, missiles versus missiles.

Now, as we know, it is much harder, much tougher, but the needs are still there.

But is the collaboration between NASA and the military still pretty active?

It is not in terms of payloads.

It is there in exchange of technologies, things like development of more efficient sensors, processors, that sort of thing.

It is everybody's benefit, for example, to have more powerful, faster, rad-hard space processors.

Everybody wins in that type of situation.

Back to your question on reusability.

You will notice that one of the real strong pluses or the calling cards of the Space Shuttle Program was the fact that it was a reusable launch vehicle.

In this current environment of the CEVs and new launch vehicles, what do you hear today about reusable launch vehicles?

Nothing.

Isn't it amazing how things have changed just in a matter of 25 years?

One thing I just sort of forgot to mention with regard to the Manned Orbital Laboratory.

It was thought, at that time, that by having men there and their ability to inspect a fairly wide swath that they would

have time in flying over that swath to do some searching.

And could do a better job of detecting possible items of tremendous interest from a military standpoint than trying to do it all automatically.

And, of course, what finally washed out that argument was the ability to have satellites that had almost instantaneous transmission of information back home.

What was the design for the MOL for crew transportation?

They were going to take off on a Titan, they were going to aboard a Gemini, and they were going to have a laboratory of sorts which would have the necessary reconnaissance and other equipment aboard.

So it was similar to SkyLab in that you had a non-reusable capsule as the crew transfer?

It had a Gemini type return vehicle, but it was definitely going to be very small and cramped compared to Shuttle.

There was no thought of having another Gemini come up and make use of it.

Yes.

Why did Gemini, Apollo and Mercury all land on water, because that is very expensive, and the Russians landed on land?

Well, very simple. If you take a look at where the launch sites were for the Soviets, if they aborted they had to have the capability of coming down on land, any kind of abort mission.

Similarly, operating out of the Cape Canaveral area, if you abort, you have to come down on the water.

The question was then was it worthwhile to have the capability of doing both?

Well, that just added weight.

And so we stuck with the water and they stuck with the land.

Do any of the new defense payloads require human intervention in their deployment or are they all completely [OVERLAPPING VOICES]?

They are all Titan IV EELV compatible.

Anything else?

I think we wore everybody out.

Well, you know, Bob and I will stick around, but we're not going to hold you down here if there are no questions.

I guess we will call the class.

And we will stick around if anybody wants to ask any more detailed questions or have follow-ups.

My phone number and email is up there.

I will be glad to talk to any of you one-on-one about any of this.

There is quite a lot more detail we can provide, either Bob or myself.

And, if I have to, I will write Bob a note asking for further information.

OK?

Well, thanks a lot.

[APPLAUSE]