# DR. RUBEN F. METTLER
# NASA ORAL HISTORY

INTERVIEWED BY CAROL BUTLER
REDONDO BEACH, CALIFORNIA – 7 APRIL 1999

*[This transcript has been reviewed, edited and annotated in detail by Dr. Mettler.]*

BUTLER: Today is April 7, 1999. This oral history with Dr. Ruben Mettler is being conducted by Carol Butler at the TRW Space Park Facility in Redondo Beach, California.

Thank you for joining us today.

METTLER: I'm pleased to be here and pleased to participate.

BUTLER: Thank you. To start with, can you tell us about your roles and responsibilities at Ramo-Wooldridge [Corporation] in the mid-fifties as the ICBM [Intercontinental Ballistic Missile] program was coming about?

METTLER: Yes. I came to Ramo-Wooldridge [RW] in [early] 1955, having just previously been in the Pentagon…for a year, working for [Assistant Secretary] Don [Donald A.] Quarles. Before that, I had [worked with] Si [Dr. Simon Ramo] and Dean [Wooldridge] [as a project engineer and manager] when they were [at] Hughes [Aircraft Company], so I was at Hughes Aircraft Company…

My first task [at RW]…was as [the] assistant director of…the Guided Missile Research Division [GMRD]. Ramo-Wooldridge had, in the prior year, received an Air Force contract to do the system engineering and technical direction for the Atlas and subsequent ballistic missile programs. My first assignment…was to begin an analysis, along with an Air Force group, of the feasibility of a rapid development of an IRBM, an Intermediate Range

Ballistic Missile, which would be aimed at achieving a 2,000-mile range, whereas the ICBM was aimed at a 6,000-mile range...

[The Air Force/RW team] worked during the rest of '55…analyzing [the IRBM] and [concluded] that it was possible to [move on a crash schedule using] technology and components and all kinds of learning [derived from]…the ICBM [program,] for the easier problem of [a] 2,000-mile [IRBM]. We got authorization in…early December, and I was appointed as the RW system engineer and program manager for…the Thor missile.

BUTLER: Before you came to Ramo-Wooldridge, had you been aware of the programs to establish the ballistic missiles, and had you been aware of the Soviet progress on that?

METTLER: Yes…I was certainly aware of it when I was in Washington [D.C.] for a year. I spent my mornings in the Pentagon and my afternoons over in the old State Department Building. [Remember that after]…the United States tested its first nuclear weapon in '52…the Soviets then tested their first nuclear weapon in '53. …It was known that a number of the German scientists had been taken…to the Soviet Union. …[T]hen a radar that the United States put in Turkey pointing up over the mountains caught the top of a…ballistic [missile] trajectory. If it's ballistic [and you see only the top part of the trajectory you]…know where it came from and where it went, so it was known that they were working on [ballistic missiles]. [Also]…the Soviets publicized…they were working on a long-range ballistic missile.

So [Soviet intentions were]…very clearly known, and understood, [which created]…a great sense of urgency, [which led to]…special [streamlined research, development, and production] arrangement[s]…for the Air Force and General [Bernard A.] Schriever…to initiate a crash program which…over the years turned out to be exceedingly successful, and reversed the missile gap…[and laid the foundation for the space program].

BUTLER: Was it quite a surprise to American engineers and scientists, and even the government, to see that Soviet ballistic program going? Because in America, the ballistic missile program hadn't been considered as a real possibility at that time? Is that correct?

METTLER: Yes, it…was a surprise and it created an alarm. At that point the U.S. missile program…[was focused on low altitude]…air-breathing missiles and…[a plan to develop] long-range ICBM[s] was…not in the [national] program…

…General Schriever and Dr. [John] von Neumann and his committee asked Si and Dean, who had just [left Hughes Aircraft and]…started the Ramo-Wooldridge Company to do…[a facility study on ICBMs].

The analysis indicated that although there were significant…technological advances, that would be required, because the technology was not all in hand, it was feasible [to develop an ICBM] if an aggressive program [was initiated with exceptional management, anticipating the need for]…new science…new engineering…[and advances in subsystems technology in propulsion, structures, guidance and control, and re-entry vehicles. And General Schriever was the extraordinary leader needed in such an effort. The Air Force awarded Ramo-Wooldridge the contract for System Engineering and Technical Direction for ICBMs and IRBMs, and Si Ramo was the extraordinary Chief Engineer that was needed].

BUTLER: As the program was coming under way and as all this technology was developing and the methodology for building it and the different materials needed, was there early discussions or thoughts on applying them to space?

METTLER: [Yes.] It was very clear…that if you could achieve a 6,000-mile ballistic missile, a little more velocity would [cause the missile to] miss the Earth on the other side and, hence,

go into orbit. So it was very clear that a 6,000-mile ICBM, if the payload was reduced or if an additional stage was added, could, without any doubt, be a launcher for a satellite. I used to [say that perhaps]…[Isaac] Newton, in the seventeenth century—I guess it was seventeenth, yes—[might have had the same vision. He]…imagined that there was a [very tall] tower…[and if one dropped a rock from it,] it would land [at the base of the tower]. [If] you threw it…harder, it would go…[far from the tower]. If you threw it hard enough, it would go around [the Earth] and hit you in the back of your head. [It wasn't hard to accept]…that [an ICBM with] some additional velocity and additional technology could become the launcher for satellites…[into] space.

BUTLER: When did you first learn that the Soviets were going to make an attempt to apply the launchers to space or was it after they did launch Sputnik? And when they did, what was your reaction?

METTLER: [After]…Sputnik, because it just happened and burst onto the scene, as the first demonstration. It surprised many people…but there were precursors. There was evidence that [the Soviets] were working [on a] long-range ballistic missile program, and there was some talk about, well, maybe in ten years or maybe in five years there'll be space [vehicles]. What was not anticipated is that the [propaganda impact of Sputnik would increase the urgency of the ICBM program, and]…accelerate the schedule…[for space-based surveillance].

BUTLER: When Sputnik did go up, were there concerns then that reflected on the programs that you were working on with the ICBM and the IRBM, with America not being able to catch up to the Soviets, and even with the size of Sputnik?

METTLER: Yes, indeed. There was no question that Sputnik changed the attitudes and a number of the decisions in the Defense Department and really all the way up to the President, President [Dwight D.] Eisenhower… If you recall…[the Soviets] tried to [claim that Sputnik demonstrated that the Soviet]…economic system [was superior] and this propaganda…was quite effective and surprised and affected many people around the world.

There's no question that [Sputnik and the Soviet ICBM efforts] stimulated the urgency [of the U.S. program]. Schedules were shortened. I can recall…one trip that General Schriever made to Washington at that time. He came back and he said, "Your schedule is now one year earlier than it was," and that went through the whole program. Also it was one of the rationales for the IRBM. It was clearly an easier problem to do a 2,000-mile ballistic missile than a 6,000 mile. The idea was that an early, quick, really very crash program for a short-range weapon could then, in emergency, be deployed forward in England or Italy, [or] Turkey, if necessary. So Sputnik was an accelerator. It was a catalyst...

BUTLER: As this catalyst did come in and spur things forward, at that time were there discussions on manned space programs?

METTLER: [Yes,] there were some. The Air Force [previously initiated preliminary]…studies about space [programs, manned and unmanned]. There was not an active, immediate program…[until] the Air Force [established a]…program for unmanned surveillance satellites. They called it the 117L…[and kept it under wraps].

BUTLER: Were you involved at all in those types of studies at this time, or were you still working primarily on the Thor?

METTLER: Once I started at Thor, I was so involved in it, I did [almost] nothing else, we went into 60-, 70-hour work weeks, Saturdays, Sunday. It was just amazing what could be done with that kind of urgency. …The Air Force received [the program go-ahead] and Ramo-Wooldridge received…the system engineering technical direction responsibility [for Thor] in December of '55. By the end of the year, [subsystem] contracts were let. [Since]…system engineering [focuses on]…an efficient integrated [end result, and we knew that we were going into a]…crash program, we took a very conservative [approach]. For example, [we] separated the autopilot from the guidance system [(not the technological optimum)] so it would be possible to fly the vehicle [before the]…guidance system…[could be available].

One half of the engine that was planned for Atlas, which was to have two barrels at 150,000 thrust, [was taken as the Thor engine]…derated…[to 135,000 for earlier flight tests, and in sizing the missile]. …We knew that with this kind of a crash program we would need to be [technologically] conservative [where needed]…but also…very aggressive [in some respects]. The Air Force and the Defense Department decided on what was then called concurrency, going immediately to production drawings [and tooling] even for the flight test vehicles. …That led to…[having] enough…[flight] test vehicles, to have a very intensive flight test program, but it meant also that there was a…very short development period.

The sizing of the missile, I remember, with [the Air Force and the associate subsystem]…contractors, took place about six weeks after [contracts were let]…based on the studies that had been made in '55…

BUTLER: And it all seemed to come together.

METTLER: Well, it did, but there were some dramatic moments. We had the first Thor missile on a pad read to test within a year, which is just astonishing.

BUTLER: That's great.

METTLER: And because of the…[short schedule], there were no test facilities [available for the combined propulsion/vehicle system], so it was necessary to use the launching facility as the test facility for the propulsion system. That meant…that [the launching facility] had to be designed…[to] hold the missile down [for an extended time]…before launch…[for flight readiness tests]. That…[requirement] became a very, very important [issue] about a month later when the first…[launch was attempted].

When the first launch was…ready to go, it was on the pad, the launching structure had been designed to hold the missile down, then release for launch. At that first launch, the missile went up about eighteen inches, fell back, exploded, and blew up not only itself, but the first launch pad.

BUTLER: Oh, that's not good.

METTLER: That's not good. We absolutely couldn't find anything wrong. I was in the blockhouse. The Air Force leaders [were] in the blockhouse. Lewis [G.] Dunn was in the blockhouse. We were at countdown… Everything was okay. [We saw]…no problem. The telemetry was perfect. But it blew up. So all the [broken] pieces were [assembled and]…laid…out. Every scrap of film that anybody had was…[examined].

And one day about—took about a month, we were looking at a film and there was a Douglas aircraft technician…pulling a liquid oxygen hose, with the back of it [dragging] in the [sand]. Even a few grains of sand [under enough impact]…in liquid oxygen can be…[explosive]. Because of the requirement…to shift the fuel from a ground tank to…the missile itself…[after a readiness test and before launch, there was a high impact gate valve

which closed just prior to launch. We were able to reproduce an explosion of sand and liquid oxygen.] You could then see that the pieces of the valve could only go together if they had broken outwardly, and that led, then, to [the] conclusion that what caused the failure was…[sand under impact in liquid oxygen]. Naturally, that changed the procedures. But after all that work, all the work, it was a dumb thing. [Laughter] And luckily, the next one flew.

BUTLER: You learned lessons from the first one and were able to apply them.

METTLER: That was kind of an exciting time. [Laughter]

BUTLER: A very exciting time, overall.

METTLER: Now, Si Ramo, who, among all of his other characteristics, has a…[good] sense of humor, said, "Well, we've shown it can fly. The only problem is, it has a 1,500-mile CEP [Circular Error Probable]." [Laughter] It [had been] aimed to go into a [landing target] down range… [Si said, "now we have only to increase the range."]

BUTLER: Only missed by 1,500.

METTLER: By 1,500 miles. Maybe he told you that story, I don't know.

BUTLER: He mentioned it briefly. He did. So it's good to hear.

METTLER: I saw it from…[close up].

BUTLER: As you were doing these programs and beginning to flight test the missiles and having successes and failures, how much was the public aware of what was going on? And if they were, what was their reaction, do you recall?

METTLER: Generally, I think the public was not aware of…what was going on [early in the program]. Obviously, once the missiles got to the launch[ing] stage…test stage…[the flights were easily visible]. But in the earliest period, there was pretty [tight] security.

Ramo-Wooldridge, as Si may have mentioned, started in a barbershop, chairs were moved out for office space. …The next facility was [an abandoned] Catholic church. …The pews [were removed to make office space and a large computer was put in]… General Schriever['s] [offices were]…across the street in a[n] [unlabeled] building… After a little while, there was a question among some of the local [merchants], "Why are these Air Force officers in civilian clothes cashing checks here?" [Laughter] But it was not known what precisely they were doing. So for, I'd say, probably for the first year and a half, until the launches began…[security prevailed].

BUTLER: As the program began to move forward and as Sputnik was going up, and then the Americans began to make efforts for launching our own satellite, were you at all involved in discussions on that, on American response to Sputnik?

METTLER: Yes…our principal role…was [related to the use]…of the ballistic missiles as launch vehicles. …When NASA [National Aeronautics and Space Administration] was just beginning [we had the opportunity to bid on NASA spacecraft contracts]… By that time, [RW had become TRW (Thompson Ramo Wooldridge).] …There was a merger between RW and Thompson Products…a Cleveland [Ohio] company, [which] financed Si and Dean in the beginning of Ramo-Wooldridge.

There was an opportunity to be a contractor for [a scientific] spacecraft. …One of the things…we did at Space Park [in preparation for the competition] was…the construction of a spacecraft design and testing facility, [before we had any contracts. That facility]…is about 200 yards from where we're sitting here today… [It was an entrepreneurial]…gamble…[and it worked]. We won the design [and construction contract for the]…Orbiting Geographical Observatory, OGO… That then put TRW into the satellite [picture], in addition to the boosters. I became the president of what is now Space Park at that point, and I finished what I had been doing on the boosters.

BUTLER: You mentioned as NASA was beginning to form and that was when you began to be involved in the satellite side of things. The formation of NASA, did you expect that? Was it a surprise? Did you feel it was a logical extension of the way the future of the space program should go?

METTLER: I certainly felt it was a logical way to divide the [national] program between [the defense programs and] a civilian program that would be focused first on science objectives and then on communication [and weather] and other civilian-oriented…[applications]. By that time, the [Defense Department] had a substantial…effort in surveillance systems and…[was in full production and development of ICBMs and IRBMs, supported by the large industrial base it had created. NASA was able to make a quick start on both unmanned and manned programs; utilized the then existing industrial base and a large number of military officers]…had experience in the…[Defense] program[s]…were secunded to NASA in various jobs. [It also] turned out that several…senior TRW employees were hired and put into jobs by Jim [James E.] Webb, who was a very effective NASA Administrator.

I think one can make the general point that without [Defense programs and their]…industrial base…[NASA could not have moved as rapidly and effectively as it did].

[The companies like TRW,] Boeing [Airplane Company] and Rockwell [International] and Bell Labs [Bell Telephone Laboratories], and General Electric [Corporation], [Lockheed Aircraft Company and many others,]…having worked [for the Defense Department]…were…there and ready to go as contractors for NASA…

…My sense is that the [benefits for NASA were]…such that there would not have been a space program of the kind that the U.S. had in the [sixties and] seventies, just wouldn't have been, without the precursor of the ballistic missile, [and the satellite surveillance programs,] and particularly the leadership of General Schriever and, I'd say, Si Ramo also. Schriever was an exceptional Air Force officer, a great leader, and he cooperated totally with NASA and helped wherever he could…

BUTLER: The evolution of the relationship, I guess, between Ramo-Wooldridge and the Air Force first, and then bringing in NASA and the Air Force, then the contractors that you talked about, was that a comfortable relationship? Did it evolve naturally?

METTLER: [Yes.] …Part of the arrangement that the Air Force had [with RW and then TRW] for [the] ballistic missile program was that Ramo-Wooldridge, and then TRW, in the role of system engineer and technical direct[or], would…[not be] allowed to bid on any hardware or any…subsystems for ballistic missiles, so that the objectivity of the system engineering and technical direction could not be questioned in terms of…self-interest. That arrangement, by the way, continued for…decades with TRW not bidding or participating in any way on any of the ballistic missile hardware.

When NASA came along, TRW was eligible to bid…[on NASA programs]. And that's…when we…bid on [NASA unmanned spacecraft]…and subsequently became a [major] contractor for Apollo…

BUTLER: Looking back on the boosters, NASA and the Air Force were working on bringing up a manned space program and needed boosters to make it possible, and so began to look at the Atlas and the Titan. As those discussions were beginning, what were your thoughts about putting a person on top of something that had been meant to explode?

METTLER: The kind of thoughts you think at four o'clock in the morning. [Laughter] …The ballistic missiles, as you know, during the test program had a number of failures. Thor [in its early flights, for example, had a defect in the]…turbo pump [which] destroyed a number of the test launches [near] the end of the…[thrust period]. The missile would take off and go, and go about 1,500 miles and then it would explode. …A very tough decision had to be made whether the flight test program should be stopped, because it was clear that there was [an urgent ] need to redesign that pump. It was a part of the Rockwell engine, and it would also be the turbo pump that the ICBM[s] would use. So a very intensive [and successful] program was focused on [redesigning the pump]. But that certainly kept in our minds [in later years], going back to your question, that reliability is [vital] in any event, but [as] those boosters were to be used…to send men into orbit…we needed to…[have super-quality].

Now, it's true that by that time Thor, the Atlas, the Titan had all had a record of successful flights, but even so, it was a difficult…[reminder]. And as you know, luckily—I say luckily…[but] it's more than luck—they were very successful in those early [manned] flights, even though the astronauts…that rode those flights were…knowledgeable and fully informed about what the…[risks were] and turned out that none of those boosters failed to do what they were supposed to do.

BUTLER: Very good thing.

METTLER: Excuse me for a minute. [Brief interruption]

BUTLER: Were you involved with taking the steps to ensure the reliability on these, that they could be man-rated? Were there certain things that had to be changed for the Atlas and the Titan, to ensure that they be safe?

METTLER: The answer is yes, there were some things. By that time I was no longer…working on the ballistic missile part of the program per se, so I was not personally involved in the man rating, so to speak. Generally those requirements went more to escape mechanisms, ways of testing more thoroughly…than previously was the case, reviewing everything that was known about the ballistic missiles that failed, to get whatever learning was possible. But I…was not [personally] involved very deeply in that.

BUTLER: How did your role change and evolve with Ramo-Wooldridge and then into TRW as the programs were progressing? You mentioned you started working on the Thor.

METTLER: I worked on the Thor, and when we were [well along in] the flight test program and it was clear that it was going [well], I was asked to become the program manager for Minuteman [which was initiated] even though there was an Atlas and a Titan being developed in parallel, with some common subsystems. The urgency of the program and the importance and the difficulty—going back to the beginning where it wasn't obvious that the technological advances could be done as quickly as what was desired—[led to the Minuteman Program]…

The Atlas vehicle had, from a deployment point of view, some disadvantages because of its [liquid oxygen and its pressurized structure]…which would…have to be maintained in…[the field]. Titan had [a rigid structure and] propellants that were more stable. …[But it was clear that] the solid propellant technology that went into the Minuteman, [and the more

advanced guidance, would provide greater accuracy, with a higher readiness, which could be deployed at lower cost]. [The Minuteman motors also served as a]…precursor for some of the large solid rockets that were [later] developed for the Shuttle… So I became the Minuteman program manager…for about [two years]…to get it going, and then was asked to be the chief project leader for the whole group, for Thor, Atlas, Titan, [and Minuteman]…a broader administrative [and engineering] management task, but no longer directly…[focused on a single missile].

About that time, Lewis Dunn, who had been the president of the Guided Missile Research Division, and the president of Space Technology Laboratories [STL], had a health problem, and I was asked to become the president of Space Technology [Laboratories, later renamed TRW Systems]. I did that and we [continued our ballistic missile responsibilities and] went on into both [unmanned] NASA and [Defense]…spacecraft [and] then became a [major] participant in the Apollo Program…

One of the particular things that NASA needed to land on the moon was a throttleable rocket engine. To that point, [liquid] rocket engines started and [burned] until the fuel [was]…either shut off or…until the fuel was gone. Then the solids, there was no way of shutting off the propellants, so they naturally had to just burn completely.

…TRW invented and developed a throttleable [liquid] rocket engine, which is what the astronauts used then when landing on the moon, to decelerate their descent. As you may recall, in the first [moon] landing it was lucky they were able to do [so], because there was a big [crater] where they were [about] to land. They were able to move sideways…using th[e] throttleable engine, [and land outside the crater].

…We were very delighted and excited as a contractor in the Apollo Program. And a very exciting thing that is almost still emotional, the astronauts came here [to Space Park] and shook the hands [one-by-one] of all of the people that had been on that program. [Mettler has tears in eyes].

BUTLER: That's wonderful. They really appreciated the work that you had done, that they needed to be able to do their jobs.

METTLER: We had [an advertisement] that said "The last 100 miles is on us." [Laughter] [We used that]…advertisement…[before the first moon launch. Quite a gamble].

BUTLER: It did. It worked great.

METTLER: One little incident. I don't know if you want these kinds of stories.

BUTLER: Certainly. Absolutely.

METTLER: …In about 1967 or '68…I had a call from the chairman of TRW. He said, "My God! We're responsible for this. The whole world's going to be watching. Oh! Is it too late to get out?" [Laughter] [I hoped he was]…kidding. "Is it too late to get out of it?"

So the answer was, there was great apprehension everywhere. We had it, but the astronauts, I'm certain, had it more, about whether they could actually accomplish [the landing and take off]. …There was a question [about whether]…the blast out of the engines [might] stir…up the moon dust, and…[might obscure their vision]. It was just a complete adventure into new territory.

BUTLER: It must have been so rewarding to see it work.

METTLER: It was.

BUTLER: Do you remember where you were when they landed?

METTLER: Oh, I absolutely do. [Laughter] I know exactly where I was. I was in Cleveland that day, and I was in a building and took an elevator down. There was a woman in the elevator who was talking to a friend, and she says, "You know, they say they're going to land on the moon. That's ridiculous. That can't happen." [Laughter]….

BUTLER: And it worked wonderfully.

METTLER: It did.

BUTLER: In fact, it even worked for Apollo 13. The engine was critical in that.

METTLER: Yes, it was. It was.

BUTLER: Were you involved with—

METTLER: Yes… The minute that happened, we were on line continuously, and…[those in TRW] that [could help and make a contribution were]…immediately available. We had a large group of engineers in Houston [Texas] on a program that was designed, I think very wisely designed, by NASA to try to anticipate things that might go wrong, [and address the question,]…"what if this occurs, what…[can we] do?" "What if—"…What new software would be needed?…

So that while no one anticipated Apollo 13, there was a background there of several years of work at Houston, and we and other contractors—we were not alone in this—worked on the "what if" questions. And there's no question in my mind that that kind of preparatory

information and thinking helped the people who…made the decisions when the Apollo 13 accident happened.

BUTLER: It must have been good to see that all come to a successful conclusion, getting back.

METTLER: Absolutely.

BUTLER: Going back a little bit toward the early programs as the missions were progressing for the Mercury, first was Alan [B.] Shepard [Jr.]. He actually went up on a Redstone, and right after his launch, President [John F.] Kennedy came out and said, "Hey, let's go to the moon by the end of the decade. Let's do it safely, bring them then back to Earth," which then led to Apollo. What did you think when you heard that announcement, that challenge?

METTLER: [Laughter] My first thought was, this is a great thing, but at the moment it seemed more like a clever political move…[without] the real knowledge that [it] could, in fact, be done in that time period. There's no question that it was an acceleration and a stimulating and really, as it turned out, a fantastic program, and it certainly had the result, it certainly did result in th[e] incredible Apollo Program, and it was in political terms and in international U.S.-Soviet Union relationship terms, a clear indication that not only was the missile gap reversed during the fifties, but that the U.S. industrial system and technology and system of governance, basically, was superior to what the Soviet Union was able to do and, of course, as we know, they never were able to [duplicate Apollo].

So it had a huge political impact, I think, a foreign policy impact, as well as simply the programmatic impact of actually putting someone there successfully and bringing them back.

BUTLER: You talked about the buildup of the programs and the importance of the programs, and you talked a little bit about General Schriever and Dr. Ramo. It seems that to have such a successful program come through, and such a challenge to be able to go from not having any missiles, ballistic missiles, and building that all up so quickly, that it really took people that had a drive and a focus and energy like that. Can you tell us some more about some of those folks?

METTLER: No question at all that it took [exceptional] people all the way—I think General Schriever, as I've mentioned, Si, who was the leader for those programs, for Ramo-Wooldridge, and [also many]…in the Pentagon, [Trevor Gardner, for example,] and going all the way to Eisenhower. He created the opportunity for us to have priority access to virtually any type of materials or contracting requirements, and a direct-line system was set up that changed the way in which the Defense Department and the Air Force administered their programs, a streamlined system that went directly from the Secretary of Defense through the Air Force to Schriever, and there was a set of special procedures put together. I remember they were called the Gillette Procedures because a Mr. [Hyde] Gillette was the one that developed them and got them approved, so that General Schriever then had extraordinary authority for an officer on a program as distinguished from other programs that the Air Force ran. So it was really [a] top to bottom [direct connection].

What Schriever did couldn't have been done without the authority he was given, which was rarely available, almost never previously available, and, of course, Si and Ramo-Wooldridge and all the contractors couldn't have done what was done without the kind of leadership that Schriever [gave], because he was strong enough and clear enough at what he wanted to do and how to do it, that the more senior people in the Air Force had confidence,

because, after all, they were giving him a huge amount of authority. It was very extraordinary.

BUTLER: And he did an extraordinary job with it.

METTLER: He did.

BUTLER: As the program progressed and the manned program continued, were you able to go down and see some of these launches?

METTLER: Oh, yes… Many of them. [Laughter] I was in the blockhouse on many, in the '56, '57, '58 time period, but also was able to go down to the Cape and see the launches much later, [from a distance].

BUTLER: It must have been interesting to see, having seen the launches first as a flight test to get the missile active, and for such an important part of national security and then to see them applied in such a different way, but yet the space program itself must have had some impact for national security as well.

METTLER: Yes, indeed, [both Defense surveillance and civilian missions,] and politically [in] foreign policy circles. I think it was a clear demonstration, as I said earlier, of the American industrial system that was noticed and known around the whole world. So it did have broader implications.

But to your question, it was very exciting. [Laughter] And to know [t]hat our hardware was going there and, of course, all of [the] contractors knew that and felt that, I'm sure…

BUTLER: Exciting to be a part of such a program.

METTLER: Yes.

BUTLER: Over time, and as NASA grew, as TRW grew, and as the Air Force, how did the relationships change and the involvements in the programs? Did that continue to evolve?

METTLER: Yes, because there was a [continuing transaction]… As I mentioned earlier…TRW [was] not being able to bid on any of the ballistic missile [hardware, but] there was [an opening for TRW in NASA and Air Force spacecraft projects and Air Force ballistic missiles, to include]…continuation of the system engineering and technical direction for…the…[latest new] ballistic missile, [named the]…Peacekeeper which…[is now] the most advanced of the ballistic missiles in military service. The Atlases were relieved of service. They were taken out of service. And then the Titan. Minuteman and the…[Peacekeeper remain and have become] the principal, in fact, the total [Air Force] ballistic missile force.

We continued that program relationship with the Air Force for the…[Peacekeeper] system, and then…in the middle eighties, there was a competition to create a prime contractor as a more efficient way…to [manage]…the program…[now that it has reached maturity]. Then principal technologies had been developed and [the subsystem contractors were in place and] TRW was able to bid on [and win]…the prime contract… So our relationship [has] continued, but in [a] different way.

BUTLER: You mentioned the MX and actually the Minuteman previously, as well, and that the Minuteman was based on a solid fuel technology, whereas Atlas and Titan had been

liquid. It would almost seem a contrast of—or actually to look at the contrast between differences and why was liquid gone with first versus solid, and it would seem almost that a solid approach would be a little easier in that there wouldn't be the turbo pumps and intricacies of the engines and so forth. Can you touch on that a little bit?

METTLER: Yes….the rationale for Minuteman was precisely to the point that you were making. It was much simpler, didn't have all that machinery, was less expensive, could more easily be protected [and easier to deploy as a military force]. The Minuteman [and the Peacekeeper were]…designed to rise up out of a silo [at launch], and it was possible then to "harden" the silo as a tough, hard target if anyone wanted to shoot at it. …The complexity and expense of maintaining liquid oxygen in a military environment, maintaining the liquid propellants for Titan…[could be awarded in fielding a quick reaction force].

…Before the beginning of the Minuteman program, there was also a precursor period when…[a] set of analyses and studies were made about whether it would be possible to go reliably and effectively from small solid propellants…[to much larger sizes]. …The Air Force had a study program…[led by] Colonel [Edward N.] Hall, who was a specialist in propulsion [to determine]…the feasibility of a large ICBM-sized [solid rocket. Up to that time the]…technology just didn't exist for solid propellants in large sizes. Solid propellants go back to the Chinese in a few centuries before Christ, in tiny little sizes. [Laughter]

…The Minuteman required an advance…[which] again created contractors who had the facilit[ies] to do the large [solid propellant] vehicles, the first stage, the second stage, the third stage…

BUTLER: And the solid propellants eventually continued to evolve and now are being used with the Shuttle Program.

METTLER: Right, and even bigger ones.

BUTLER: Even bigger, yes. Looking back over your career with the ICBM program, with TRW, involvement in the space program, what was the biggest challenge for you?

METTLER: That's hard to answer. [Laughter] I'm not sure. It seemed—well, clearly I had the opportunity to…[be in an] exciting set of jobs, from Thor to Minuteman, to the [whole family of missiles]…the president of Space Technology Laboratories, then…TRW Systems, [we] kept changing names. And then in 196[9], I guess it was, I was invited to become President [and Chief Operating Officer, COO] of TRW…and then in '77 I was [elected] the CEO [Chief Executive Officer], and then I retired in '88.

What was the most challenging? I think clearly the biggest step[s]…[were probably the first and the last]. Beginning…[it was] Thor. I was very young and [although I had a]…program management [assignment] at Hughes, but I'd never had a project that had th[e] urgency and th[e] [unknowns of a] crash…[program to reverse the missile gap with the Soviets. To be]…suddenly…overnight, almost, responsible for something like that was certainly a very big challenge. I guess the part of it after the first missile blew up was especially challenging. [Laughter]

…[The last big step was becoming the] CEO of a worldwide company, [in aerospace, electronics, automotive products, information systems]…in nineteen countries. [The first and last step are not easily compared.]

BUTLER: In contrast to that, what would you consider your greatest accomplishment or achievement or success?

METTLER: [Laughter] I guess—well, I don't know. I don't know. I wasn't one that sat around and worried about…[my career]. I didn't think of myself as working hard to advance in a career. I just thought, well, if I can do what I'm doing and do it well, then maybe someone will…[notice and give me an exciting new challenge]. So I guess I'd have to say that it was successfully completing a variety of different types of jobs and functions from an engineer to a program manager, to a leader of a small organization, to a leader of a bigger organization.

BUTLER: And that certainly is challenging in and of itself, to move up and do it successfully. When you first got started, would you have ever imagined where your career would lead you?

METTLER: No, not at all. I went to Stanford [University] in 1941 as a humanities and history student, and I [was selected for a new "independent study option." I] had an advisor, Rix Snyder, who was later the registrar at Stanford. He said to be literate in this day and age—that's 1941—to be literate in this day and age, you should know something about science and engineering. [In the]…independent study [option]…the student could elect [his own curriculum]…if the advisor would accept them. You were not required to take the standard courses, but you had to take the standard exam. So I had flexibility about what I could sign up for as a freshman, and I took calculus and chemistry because that's what he advised.

When Pearl Harbor occurred that fall, that changed things completely, and early in the following year I was still seventeen years old, but I applied to the Navy. They said, "Well, we can't take you. Stay where you are. We know where you are. We know when we want you. Just stay right there." So I switched as much as I could to engineering at Stanford.

Then about…a year or so later, they said, "Now's the time. Let's go." [Laughter] So I became an apprentice seaman in the Navy, but I was selected for a training program, and

we were sent to Caltech [California Institute of Technology] for a short, very intense technical program, and I…liked it. I thought, well, there's nothing bad about science and engineering. So in a way, I was an accidental engineer because I really was thinking of history and humanities.

I was in the Navy for four years, and when the time came [for demobilization]…I was ready to [go] home, believe me, but I was tapped on the shoulder to go down to Bikini [Atoll, Marshall Islands] as a part of the instrumentation team that set up the instruments for the [atom bomb] tests that were made. That took another…five or six months.

[The atomic bomb tests]…had an enormous impact…[on me]. Witnessing those two explosions [from less than fifteen miles, and examining the results]…emphasized the point [in later years] that when the Soviets…[developed atomic bombs and]…when the Soviets…[tested their] nuclear weapon[s]…that there was no doubt the U.S. needed, and would have, and should have, a superior defense capability. …I can't say that seeing those blasts from…[a relatively near distance—] we left in the morning on a fast boat and got out on a ship…before it blew—I can't say that seeing those two blasts is what motivated [me], for example, on Thor or on the ballistic missile program, but it didn't hurt.

BUTLER: How did the threat of the Soviet response or the Soviet programs throughout just the ballistic missiles and then even into the space program, was that a driving factor? And how serious was that threat at that time? How much did that impact your daily work?

METTLER: Clearly it was a driving factor in our government [and affected the ICBM programs], and so since we were a defense contractor and we had other defense work other than ballistic missile engineering and system engineering, and other than components of the space program, clearly that was a driving factor [for TRW]… [About two-thirds of TRW's

business is research product development, engineering and distribution, and about one-third]…is in…[defense] and space program[s].

BUTLER: Purely speculating, and just based on your experiences and thoughts, if the American program, ICBM program and space program hadn't been able to respond and build up and be successful in light of the Soviet threat, how do you think that would have affected the later outcomes, and where would we be today? Just speculating.

METTLER: Well, it's hard to [know], and certainly nobody knows, but a good example is the Cuba situation. Consider the differences in 1962 if the Soviets had the long-range ballistic missiles and the United States did not. It wouldn't have been possible then for the President to do what he did, because it was clear that since neither party…[could win with] ballistic missiles with nuclear weapons… The U.S. was able to defeat [Soviet Premier Nikita] Khrushchev's idea of putting…short-range ballistic missiles into Cuba. Consider the difference in the political relationships if they had missiles in Cuba and had long-range missiles and the U.S. did not. …Without any question, the circumstances would have been different.

BUTLER: Absolutely. Things did progress forward, and Americans did have a response and built up the programs. As the programs were building up, in fact, and then moving into NASA, were you involved in working with the NASA personnel? I know you said a lot of Air Force personnel did transfer over to NASA, and TRW personnel. But were you involved at all in training some other NASA personnel for like the launch facilities or anything to that respect?

METTLER: …No, [I] was not. Some of our employees were, but I wasn't. I was deeply involved during that whole period from the middle fifties to about 1970['s]…in working with governmental groups in trying to understand what the Soviets were doing. …In the middle fifties, because the government itself…didn't [yet] have [enough] employees…[with knowledge and experience in ICBM technology, TRW] had…an "all-sources" contract with the CIA [Central Intelligence Agency] [to] set up here at Space Park, a group of…[experienced ballistic missile engineers to interpret Soviet telemetry which was intercepted during their flight test programs]… It was possible then for the engineers that actually worked on similar programs to say, "[This signal is a]…record of a gyro [performance]," or, "This [signal is their stage separation report, etc…]"

So we were able then to monitor the Soviet launch program and provide…[reports on their progress]. …I was asked to be the chairman of…a "strategic intelligence panel" [established by the CIA in the late 50s and early 60s, to advise on their assessment on the Soviet program]… We did then assist the CIA in training and…in hiring some people who were qualified [analytic staff] so they had an in-house group that could do the work [which] we previously had done here [at Space Park].

BUTLER: With that group, were you then able to observe their efforts for the space program as well, and their lunar program?

METTLER: Yes…to observe, but we didn't have the same role…[as] we had…[concerning the ICBM programs. We did work with Defense and NASA]…advisory panels and groups…[where we could] be helpful.

BUTLER: Now, of course, in current programs, the relationship between the United States and what was the Soviet Union, now Russia, has completely changed. In fact, there's now

cooperation in the space program. In light of your experience and your buildup, is that a surprising evolution or does that seem a logical eventuality?

METTLER: I don't regard it as surprising, because I think it was, in foreign policy terms, an opportunity, after the breakdown of the Soviet system, [a foreign policy] opportunity to make common cause…[with Russia on a space project where there was an] opportunity to have common objectives. So I think it…[could] turn out to be useful, even with its difficulties… As we all know, their system is currently…[in bad shape]. And they have not been able to carry out their obligations on schedule and so forth, as you know better than I… I think it [may]…help…in the relationship between the two countries.

BUTLER: Speculating for the future and looking at your experience as a contractor, but working with both the military and NASA, how do you see the roles evolving into the future as we do become a more global society and then as NASA is branching out, the Space Shuttle, to USA [United Space Alliance]? How do you see that changing, and what are your thoughts on that?

METTLER: …I've learned that trying to predict the future is a loser's game. …We [often] look backwards [and]…say, "Look at all the changes that have occurred in the last fifteen years…" Then we tend to project the future as a continuation of the past, but when we look back…two or three years…it's going to be almost certain that what was [previously] predicted was wrong.

…There are certain trends in the world that…probably…[have significant impacts on the future, but in unknowable ways]. I think the global economy is here and it's going to stay…national security is…[a continuing vital issue, in unpredictable forms]. …The advancement of technology will continue. There's just an explosion of new scientific results

in biology, in materials, in physics. …So what we should see…and expect is continued unexpected results, new inventions, new discoveries, [new mistakes]. …We need to adopt a pattern, a mind-set, to anticipate [and accept continuing] change and recognize that…we can't sit on our haunches and say, "Well, now we've got it made. Here we are." I think we have to continue, as a country and as a company and as individuals, to move forward in an exploratory way.

BUTLER: We'll have to look forward to see what does happen. Is there anything that we haven't covered that you would like to expand upon?

METTLER: No, I think I've probably not answered your questions as well as they could be answered.

BUTLER: No, it's been fine.

METTLER: But I…[would like to repeat one point which I] mentioned to Dan [Daniel S.] Goldin, when we had breakfast…[together six or eight] weeks ago. …I [suggested that] General Schriever, who is now in his…eighties…[has] never…in my opinion, received the recognition that [he deserves]…for his role [in building the] foundation stone[s] for the space program. He [has received many honors]…for the ballistic missile program, [not for the space program]. …Without…what the Air Force and Schriever did, we…wouldn't have the space program that we have now. …So I'm hoping—and I know Dan is thinking about it—maybe this shouldn't be on your tape—that NASA will give to [General] Schriever a Distinguished [NASA] Award while he's…able to [receive] it, and for the country to know [about] it.

BUTLER: Absolutely. Well, he certainly has played a critical role, as you said, and that is an important thing to emphasize. Absolutely.

I want to thank you for your time and information.

METTLER: You're welcome.

[End of Interview]