COMSAT HISTORY PROJECT

Interview with Sidney Metzger

Interview conducted by Thomas Maxwell Safely

Interview with Sidney Metzger
COMSAT Headquarters
10:00am
11 July 1984

Thomas Maxwell Safely: When and in what capacity were you most closely associated with COMSAT?

Sidney Metzger: I was interviewed by Charyk in mid-May 1963, and he hired me as manager of the Engineering Division. I came here on June 6, 1963, and found that the Engineering Division consisted of one person, myself, which was very good in that one of the major jobs that I had the first few years was hiring people. There was no Personnel Department, which was good. You just had to read letters or read applications from personnel agencies. A number of people just walked in because they had heard about COMSAT, it was very exciting, and they just walked off the street. I interviewed them and spent a good deal of time.1/ I would interview them.2/ I would call references. As a result the people I hired, with all due modesty, are the people who became the managers of the Company later on. That was very satisfying. The major problems . . . . Well, I'm sort of jumping the gun. That was my capacity. I

1/ change to: I spent a good deal of time interviewing them.

2/ delete: I would interview them.

was hired as Manager of Engineering, and the same week Sig Reiger was hired as Manager of the Systems Division. There were just two divisions: Systems and Engineering.

TMS: Did you hire Mr. Reiger?

SM: No, [Dr.] Charyk did. We were equal. Charyk hired him from Rand. He was in charge of Systems, and I was in charged of Systems and I was in charged of Engineering which was the hardware.[3/] And eventually I became the Chief Engineer and Assistant VP. Then a number of years later the Chief Scientist and VP of the technical area.

TMS: Let me dwell, for just a moment, on this because it suggests a question that I hadn't thought of asking. You were given the mandate of developing the Engineering Department at COMSAT, hiring the people that you thought would serve best. What did you have in mind at the time? What was your vision of what the Engineering Department of COMSAT would actually be doing?

3/ change to: He was in charge of Systems, and I was in charge of Engineering, which was the hardware.

SM: Well, the charter was pretty clear. The Communication Satellite Act had been written, and we knew we were not going to build the satellite ourselves. That was a given. Charyk, who had worked with rockets for many years at Princeton, said, "We are not going to spend any money developing rockets," which was a very wise choice because that takes an enormous amount of money and there is no reason to do so since the rocket used to launch other satellite,[4/] could just as well launch communications satellites. There is nothing peculiar. So, what we had in mind was to build up an engineering staff which would know how to specify, buy,[5/] and operate satellites. In order to do that, you've got to have people who have experience in that.

By the way, this leads into another question, but the two are so intertwined that I might as well cover it. The question of a lab . . . . You're going to write a specification for a satellite, and that has to cover the various major sub-systems. You've got to have someone who specifies what kind of solar cells you need, what kind of altitude control you want, what kind of communication, what kind of antenna, and so on. To do

---

4/ change "other satellite" to "other types of satellites"

5/ add: test

that you've got to have someone who has actually worked in the field. The people I hired were people who I had worked with at RCA or people who I knew[6/]. The business, the whole field wasn't very large; it was just a handful of people, and I knew many of them personally. So, I would get people, from various companies, who had actually worked in these areas. But if you get a fellow who has actually built a communication repeater, and you put him at a desk and say, "You write a specification," after a couple of years he is not going to be a very good engineer anymore. He is going to be a little stale. To keep him aware of what's going on, you've got to, if not design a satellite, which we said we would,[7/] do, at least let him work on his particular specialty. You've got to give him some lab space and he doesn't there's no point it would be inefficient for he himself to pick up a solar iron so you got to give him some junior engineers and some technicians.[8/] Now, the purpose isn't to design the satellite but to keep him

---

6/ add: from other companies

7/ change "would" to "would not"

8/ change to: You've got to give him some lab space and it would be inefficient for him to pick up a soldering iron so you've go to give him some junior engineers and some technicians.

up to date by taking good ideas and working on them himself in his field.[9/] Gradually, that becomes a laboratory.

It's hard to picture what happens if you don't have that. But INTELSAT has been in that position, the Europeans are[10/] in that position. You've go to write a spec and you've got to have somebody who knows what they are talking about, to say, "Well, here is what we will put in this paragraph what we should ask for." The only way you could realistically do that is by having people who are working in the field. That's why you've got to have a lab. It's easy to take these things for granted. I'll give an example. After INTELSAT was formed in 1964, the member countries came to us and said we would like to be able to send people over to COMSAT to work for a year or two to become familiar with this new field. They would be either technical types who later went to the lab, (he lab wasn't formed until 1967 though we had something of a lab in the basement of our building at 2100 L Street, N.W., Washington, D.C.). They had people in Operations, they had people even in Finance who would stay a year or two, get some flavor of the subject and then go home.

9/ delete: in his field

10/ change "are" to "were"

There was one Englishmen, a very excellent engineer, who worked at Standard Telecommunication Laboratory. That's an ITT affiliate. The English Government sent him over, and he worked with us for a couple of years. Then he went back. At that time, this was in the latter sixties, the early seventies, Europe formed a number two consortia, what they call mesh and star.[11/] These were[12/] representatives from each of the major countries who had joined together to develop[13/] satellites because they didn't like the idea of the U.S. being the sole supplier of these satellites. So, they said, "We have got to develop our own expertise." Then because they had many countries, they said, "Well, you'll do this part and you'll do that part."[14/]

TMS: That's the way they build Airbus today.

11/ change to: At that time, this was in the latter sixties, the early seventies, Europe formed a two consortia, which they called Mesh and Star.

12/ change "were" to "included"

13/ add: and build

14/ change to: Then because they had many countries, they designated each one to specialize in some particular aspect of satellite technology.

SM: Yes, that's one of the problems. This fellow came over here about a year later and said, "You know, when I was here I took things for granted. If I wanted to write something and wanted to know about antennas, I would go up the hall and talk to Ernie Wilkinson. He was one of the best men in the country.[15/] If I wanted to talk about solar cells, I would drive up to the lab, and I could talk about solar cells. Now, I'm in this laboratory in England, and I am the only one who's concerned with satellites. I have nobody to talk, too." That's a very important point. People can tend to underestimate that when they have it, when they live with a lab like this. But when they don't have it, that's when the impact really hits them.

TMS: In many ways COMSAT Labs, if I understand you correctly, served as a kind of school for people involved in satellite communications. That is to say, not only were the engineers here at COMSAT allowed to do research and stay fresh in their field, but also people from other countries-Europe and I would imagine developing countries as well-came to be exposed to the

---

15/ change to: He is one of the best antenna engineers in the country.

practical side of satellite communications.

SM: There are about perhaps a dozen engineers.[16/] It wasn't the major purpose of the lab. These were the developing countries; the under-developed countries at times didn't even have stations.[17/] They came later in the seventies, and they didn't bother to send people over because they really didn't have people with the necessary background to go into the details of satellite design.[18/] What was the point of it? They weren't going to build it. So, they really weren't involved with that. But that was an important function of the lab.

We also acted, and still do act, as the engineering arm for INTELSAT. When INTELSAT went off on its own they had to write specifications. It's awful nice to be able to go to a lab and say, "Look, what number should I put in here? What's a

---

16/ change to: There are about perhaps a dozen such foreign engineers per year at our lab.

17/ change to: These engineers were from the developed countries; the under-developed countries at times didn't even have stations.

18/ change to: Their stations were built later in the seventies, and they didn't bother to send people over because they really didn't have people with the necessary background to go into the details of satellite design.

realistic number to ask for?"[19] You can't say, "Well, can you look in the literature?"[20] Well, no, you can't look in the literature.[21] First, when you read it in the literature, it is several years old.[22] Besides is it a realistic number or something from a figment of the imagination of the engineer who would like to meet that number? So, you got to have someone who does it. We were fortunate in that we made the decision at the beginning to do something that had never been done before, and it has since been adopted by just about every commercial satellite system that they ever built. That was to buy satellites at a fixed price with an in-orbit incentive. Prior to that, the only people who bought satellites were NASA or DOD, and they were always cost plus. In other words, NASA or DOD would say, "Here is the satellite I want." The contractors would come in and say, "Okay, I can do that for X million dollars." Well, if it turned out, as it

---

19/ change to: It's very helpful to be able to go to a lab and look for realistic numbers to be used.

20/ change to: You can't look in the literature because by the time its published in the literature it is several years old and likely obsolete.

21/ delete: Well, no, you can't look in the literature.

22/ delete: First, when you read it in the literature, it is several years old.

usually did, since you were building something that had never been built before . . . . You don't really know how much it's going to cost. It is not like buying shoes. You've made a lot of shoes; you could predict the cost. Here, you always want a satellite of a type that has never been built before, so cost is questionable. That was cost-plus. If it overran, the military would pay the additional cost but not a profit on it. In other words, you had cost plus a fixed fee. You did it for X million dollars, of which so much was profit, and if there was an overrun you got paid but you still only got the same profit. Now, we said, "No, we are going to have a fixed price with incentive in orbit." That had several affects on the design. First of all, you wanted to get a fixed price. The contractor knows he is not going to get any more money if he doesn't meet it. He has to meet it. If he is an honest contractor (and most of them are), he will bid on that only if what you are asking him to do is very realistic. You are asking him to do something which has never been done before. He can't honestly take a fixed price contract. So, what we ask for (and this was one of the main reasons for our success as compared, say, to the military who didn't use that approach) was that we asked for things which a knowledgeable engineer would be able to say, "Yes, I can do that," which means you are taking little steps. You are not asking for big steps.

Then, the second thing--the business of the in-orbit incentive--that was put in for this reason: If you are the engineer-in-charge of designing a satellite, you are constantly faced with decisions: "Should I do it this way or that way?" Of course, the specification gives you a broad picture of what you are suppose to meet, but you can meet that in several different ways. The pressure on you, since it is a fixed price, is to do it for the lowest cost. On the other hand, we want him to do a good job. In order to give him a carrot, an incentive to do a good job, we came up with the idea of when the contractor gives us a quote, he says, "Say, here is the price you pay when I deliver the satellite." For each year that that satellite operates in orbit, we give him an additional number of dollars. This incentive has varied anywhere from fifteen to thirty percent. So, it was very significant. This was his incentive to do a good job, not to say, "Well, this is the cheapest way I can get this out of the door, but I don't know how long it is going to work." We didn't want that. So, instead, we wanted to have him look at it from the view point of, "Well, I could do it this way, or this way might be a little more expensive, but I know its going to last longer. Since they are going to pay me every year it lasts, I will do it that way, even though it might cost us more initially." That's an approach we have taken. Since then, every domestic and international satellite has copied that approach, and that was unique to COMSAT.

But, now in order to write this, to write specs reflecting that approach, you've got to have people who know what can realistically be done. The only way you can do that is to get people who have actually built satellites. In fact, that leads to another question you have here. Why did we build satellites? You've got to have a lab if you want.... Well, the first thing is, you've got to have people who can write sensible specifications. To do that, you've got to have people who are actually working in the field. For that you need some kind of laboratory, and that's how you get to the lab. Now, some of the people in the lab have said, "Shouldn't we actually build satellites. Won't that give us even better knowledge?" The answer is, yes, it would. But then you get into some difficult problems, like why should INTELSAT commit to the satellites to be built in the lab. They want satellites to be built, at least, part of it in their own country. They've got a real problem.

Let me digress. Its important because it gives you some of the forces acting. Here you have these, for better or worse, you've got these independent countries [European countries] which grew up hundreds of years ago with lines on pieces of land, artificial lines. And now, these countries are in the twentieth century and the question is, "Should we teach astronautics to our young people at college? Well, we've got to do it. They are going to ask about it. We can't say, 'Well, if you want to learn this, go the United States.'" So, you teach them. Then, they graduate. Then, what do you do with them? You say, "Well, now that you got your degree go to the United States to work." They can't do that. So, they say, "Well, gee, we've got to do some space work of our own."

It's very expensive. To go, develop, and build a couple of satellites is a couple hundred million dollars, to launch them. These countries have, therefore, been forced to spend money for satellites as members of INTELSAT. They have to give money to INTELSAT. They want to have their own national program, but, also, they realize they can't possibly do it by themselves. So, they join together a European Space Agency. They are all members, and they have to contribute to that. So, their resources in space are being spent in three different areas, and that's inefficient. But what else can they do? They've got a tiger by the tail. As a result, they go, and they build some little scientific satellite. They get it launched by the U.S. Then, they decide they can't do that (especially France was against it) so they finally, at great expense, develop the Ariane. They recognize this problem in the early sixties and they formed ELDO and ESRO. ELDO is European Launch Development Organization, ESRO is the European Space Research Organization.

TMS: Both predecessors to the ESA?

SM: Yes, they recognized that they've got to join together, so they did. ELDO was going to use a British first stage, a rocket which the British had developed for military [purposes], a French second stage, and a German third stage. The Italians made, I think, the nose cone and a little satellite. They had outlined, over the mid-sixties to the mid-seventies, a program. Over ten years, they were going to test the first stage; and they were going put the second stage on top and test that. They would go this way [for] several flights of each. Finally, they culminate the whole thing by putting the nose cone and the satellite and prove it. That was ELDO I. Then, ELDO II would be an operational rocket, and that would be used to launch their satellites. This was going to cost six hundred and fifty million dollars to go through this whole stages of rocketry. They went on, and they had trouble after trouble. Finally, by 1974, I believe, they finally got the three stages up, and they had them working. They had some kind of trouble and they got a fellow from Boeing to solve it for them. They finally did. They put the nose cone on with the satellite. They launched it, the nose cone didn't open, and the thing went in the ocean. They said, "Well, it didn't work, but we know why. We've learned. We will go right on to ELDO II. We'll forget ELDO I. We will build ELDO II."

In the meantime, in 1967, recognizing that the U.S. had this head start in the satellites and recognizing that INTELSAT was bound to buy a satellite which would meet the spec at the lowest cost, which meant [from the] U.S.; they decided we have to show the US. We have to develop our own expertise so that we can bid as primes rather than just be content with building little bits and pieces for the U.S prime. To do that the French and Germans got together. They were going to build the Symphony satellite. That was 1967. The specifications were very [sophisticated]. It was a more advanced satellite than our INTELSAT III, which was being built at that time. (INTELSAT III was a simple spinner.) Their Symphony was more advanced. It was three axes. It was higher powered. It was very nice, and they were going to launch it with ELDO II. They hoped that this would show that they could do the job, and, therefore, they would be able to bid on the next satellite for INTELSAT, and say, "See, we did it." Fine. And to be realistic, they said, "Okay, the Americans do it in two-and-a-half or three years, we are going to allow five years." That was '67, and that would be '72. By coincidence '72, would be the Olympics which were held in Munich. They would use their satellite to broadcast the Olympics. Well, that was terrific. Well, they learned the hard way. It didn't work that easily. They had trouble. The 65 million dollars which they had estimated to develop, build, and launch two satellites by the time it was over, was more than triple that. It was about a couple of hundred million dollars. They put the first one on the ELDO II, and the ELDO II failed. They pinned it down. There was, as I remember, a German power supply on the second stage along with an English computer. Apparently, they had tested each of them individually, in Germany and in

England, but they put them together, and the magnetic field from the power supply messed up the computer, and that was it.

TMS: And the satellite was lost?

SM: It was lost. By then they gave up. And the U.S., meantime, had come and said, "We will launch a satellite for anybody, excluding military, excluding a satellite which would compete with INTELSAT, and we will do it at cost. Whatever it costs us, we'll do it."

TMS: Not cost plus?

SM: No, at cost. This was the killing blow. So, they dropped ELDO II, and they dispanded. Then, the French came out with the Ariane. The French were determined to do it. They were going to go, even if they had to go alone. They did take about sixty percent, I think, of the cost. They came out with an ATLAS-CENTAUR. This was a design they came with in the early seventies. By then, it was a copy of the ATLAS-CENTAUR. They were going to do it, and they did. They had their troubles. They had two failures out of the first six, but that's all right. That's par-for-the-course, and they've done it.

TMS: This kind of leads us to the question of vendors; the contractors who design and build satellites. As I've read about COMSAT, I have been struck by the fact that of six generations of INTELSAT, Hughes has been responsible for . . . . well, let's see, it was INTELSAT II went to TRW, as I recall.

SM: No, INTELSAT III.

TMS: INTELSAT III, yes, I beg your pardon.

SM: The others were all INTELSAT I, II, IV, IV-A were all Hughes.

TMS: Five is the Ford.

SM: Then VI is back at Hughes. Why is that? The reason is quite simple. In satellites, those of us who work [in this business] originally, our background was all on either military or NASA satellites because those were the only users. You quickly learn [that] satellites are very expensive, and we are just not smart enough to anticipate all the things that could go wrong. And that's why when we came to COMSAT, and Joe [Charyk] certainly agreed with the philosophy, we were suddenly faced with the fact we were dealing with hundreds of millions of dollars. It makes you very conservative. No more fooling around. Which means that you want to stick to proven designs wherever possible. Obviously, you can't go 100% [with this philosophy] because if you do you never have a new design. On the other hand, everytime you do go to a new design, you are in trouble.

One of the most successful programs in the country was the so called TIROS program. It was T-elevision IR O-ptical S-ensor or something. (I think that they first make up a nice sexy name, and then think up letters.) It was a weather satellite. The first one was launched in 1960. It was built by RCA for NASA.

TMS: You were involved in the design?

SM: I had charge of the communication equipment, radio equipment, and that was very successful. Then, for the next one, what we did was we kept everything unchanged to the greatest extent possible. We just changed one item, and then, for the next one, we would change some other items and so on. So, that it progressed. By the time we came up with two dozen the [sic] satellite, it was completely different from the first. But if you would lay them all out, you could see the changes were little by little, and that was very successful.

Similarly, the JPL programs were their interplanatary probes based on the same thing. They would get a design and they would use it to the greatest extent possible. Maybe they would have to change a camera, but they would try to keep everything else. Now, when we went out, there was a big question, which I'll discuss [sic] on the medium altitude or synchronous. For the moment leave that not to interrupt this train of thought. We went out with the satellite which was synchronous for a reason which I've discussed before, and the only one who had built a synchronous satellite was Hughes. They had built SYNCOM. The Army had attempted it in ADVENT and the project after spending a horrible large amount of money perhaps a hundred, two hundred million dollars, was dropped for good reason, but nevertheless that never got off the ground. SYNCOM did go up successfully. The first one failed, that February of 1963, but the second went up in July of 1963, successfully and the third one went up in August of 1964, successfully. So, when we went out with specs in April of '64, there had been one success. SYNCOM II. Hughes was the only one who bid, because our specs were clearly patterned after theirs. As I say, we wanted something that worked. Here was something that worked and we asked ourselves how could we take that and modify it as little as possible but still come out with something useful. We estimated that we could get two hundred-and-forty telephone circuits out of that design. So, we wrote a spec. Now, it wasn't that obvious. People said, "Oh, well, that's not a good spec because you're writing a spec for a satellite that doesn't operate during eclipses. Of course, that has to have storage batteries to do that." We said, "Yes, we know." They said, "It doesn't have multiple access. That means you can't have six countries talking over it at once." We said, "We know that. They said, "It only has a life of a-year-and-a-half, we want a ten year life." We said, "We know that."

TMS: That turned out to be bit of a surprise item as I recall. It lasted longer than expected.

SM: Yes, but the point of this is why go ahead with things which other people don't want. The answer was simple. There was a question about the synchronous satellite. There were some unknowns. We'll discuss them in more detail later. There was no point in saying, "I'm going to build a satellite which will last ten years, which will have multiple access, which will work through an eclipse if, when you put it up, you quickly find that the time delay is excessive. Then people wouldn't accept it. Why have something that lasts ten years, if the first six months might prove it a poor design. It wasn't clear that valves would operate in a vacuum. Why attempt a design for ten years? It would take you longer to make the design. It would be more expensive to build. And why do that if the first six months would prove that that concept of synchronous was untenable. So, we said, "Let's," because we could get this little eighty-five pound bird, which was all we could get in the Delta as of 1965, when this would be launched.

This was the argument which took place in 1964, when we wrote the spec. The bird would be launched in 1965, and the biggest Delta available in 1965, would put up 85 pounds. Therefore, we asked ourselves what could we put into 85 pounds that was realistic. Now, the picture I'm trying to paint is that we built this based on SYNCOM because you could do that with the greatest degree of credibility. There was nothing else. Okay, now once having that, and it worked and it proved that the synchronous did work, the time delay was acceptable and then we said, "Okay." In the fall of 1965, we told INTELSAT, (We in '64, when we wrote the specs, was only COMSAT because in April of 1964, INTELSAT hadn't been formed). In the summer of 1964, INTELSAT was formed. INTELSAT I went up in April of 1965, and it started operation in June. This was a success. Now, let's build a proper satellite which will have multiple access, which will have storage batteries, and which will last five years. We said five, we thought we could then do that. That became INTELSAT III. Now, INTELSAT II came in sort of unannounced. The NASA space program was coming--the Gemini and the Apollo--and they needed satellites in orbit for the tracking ships in the ocean. They had ships stationed at places in the Pacific (especially where you couldn't tell land stations to track these low altitude satellites like the Gemini) where the only way to get the data back to NASA was by means of a satellite. INTELSAT I couldn't hack it, it didn't have enough power. So, they came to us, and said could we get an interim satellite: that became INTELSAT II. Now, again

INTELSAT II was bigger because it was going to go up in 1966, the end of '66, and at that time the delta had the capacity of twice what it had in '65. Its capacity was about a hundred and seventy pounds instead of 85. Therefore, we wrote a spec which would be the INTELSAT I but blown up. Again, Hughes was in a good position because they had done INTELSAT I. Anybody else coming in would have had to start from scratch and therefore, wouldn't have the credibility of Hughes. So, Hughes got INTELSAT II. They didn't get INTELSAT III, though. For INTELSAT IV. . . . Oh, because TRW had come in. TRW had done a good deal of work for NASA and had some credibility. As it turned out they got into trouble, but they did it. For INTELSAT III we had some satellites last seven, nine years. A couple failed after a year and a half.

TMS: Why did TRW get INTELSAT III, given the longstanding Hughes expertise with this general type of satellite? What was the consideration?

SM: As I recall, (I'm not a hundred percent certain of this), oh, yes, my recollection is this: at the time we wrote the specs it wasn't yet clear that the time delay would not be a problem. If it turned out to be a problem, we would have to go medium altitude. Therefore we wrote the original spec that the satellite would be such that sometime down the road, like a year down the road when we figured we would have the answer on INTELSAT I, we could make a decision whether it would go synchronous or medium altitude. Hughes didn't want to have anything to do with medium altitude. They wanted to be known only for synchronous. As I recall, Hughes originally didn't bid, only RCA and TRW bidded.

Now, COMSAT in 1964, had done two things in parallel. We said we were going to give a contract to Hughes for the Earlybird, which we called experimental/operational. (We didn't know that the concept with synchronous would work: Would valves work in a vacuum? Would time delay be acceptable?) The beauty of the synchronous was that you could put up one satellite, find out if it would answer these questions experimentally, then, if the questions were answered positively, you are in business. Whereas with medium altitude, you have to put up about two dozen satellites because they go around randomly. You would assume on the profitability basis there's always one in view. To ensure that one is in view with a high probability, like 99.9 percent, you would have to have about two dozen. Before you would build two dozen, which you would launch maybe two at a time, you damn well better build one or two of them and just put it up and let it go for six months to prove out the design, forgetting about the time delay. What's important is whether this particular design is sound and if it works then you would say, "Now, we will build two dozen more." So launching one medium altitude satellite had no use other than as an experiment. You can't operate with one satellite because it's just in view for an hour or so. You can't run a business that way.

So, here you have the picture. I could build a satellite, launch it and, if it works, it's an experiment. On the other hand, I could build a satellite, launch it synchronous and, if it works, I'm in operation. That thinking is what led us to go and say, "Yes, let's go ahead and build it that way," and we built Earlybird.

Earlybird we knew had all these basic defects and even if we went synchronous we would have to overcome them. We would have a to have a design which solved those problems. On the other hand, if it went medium altitude we'd need a completely different type of design. So we did two things: we gave out a contract for an Earlybird and at the same time we gave out three study contracts. One contract was to Hughes for a synchronous satellite. Another contract was to TRW for a medium altitude stabilized satellite, say at 12,000 miles with engines in it (It wouldn't be in view all the time, so you would need a number of such satellites. They would be locked to each other so as one went out of view the other would come in.). This way you wouldn't need two dozen satellites. You would only need about a half dozen satellites. The third contract was given to a team of Bell Labs and RCA for a low altitude satellite, something with no engines. You just put up two dozen simple satellites and they would float around. We gave them six months to study this. No, I don't think we gave Hughes a contract because we were going to learn what would be from the Earlybird. So, we gave out the other contracts.

Now, in April of 1965, Earlybird went up, and it was successful. Then in the Fall of 1965, we said, "Okay, now we are going to write a spec (we weren't quite certain about the time delay) which could go up for about a year and then go either way." By then we would have enough data on the time delay, because that's a statistical thing. It's not a matter of somebody listening and saying, "Yes or No." It's something you have to get a response on from thousands of people in order to answer the question.

Hughes didn't bid. They said, "We don't want anything to do with the medium altitude. We know synchronous are all right if you want synchronous. We will build it that way." RCA and TRW bid and both bids were good. The thing that swung it to TRW was the fact that they had six months of experience on a stabilized satellite because of the study, while RCA worked on this simple satellite. We felt that that would give TRW six months advantage. The second reason was that we ran into a lot of trouble with RCA on patent clauses. I think those two items threw the ball to TRW.

Now, when INTELSAT IV came along we wanted a much bigger satellite. By then it wasn't clear whether we should go with a synchronous spinner or a three axes synchronous. We knew we wanted the synchronous--by then INTELSAT III had proved that concept was sound. So we gave out two study contracts: one to Hughes for a synchronous spinner--a big satellite--and one to Lockheed for a three axes synchronous. Lockheed had done military work on the three axes synchronous. They did six months studies and it turned out, unlike what some people thought, that the three axes stabilized [system] would not give you more capacity for given weight. So, the Hughes design was able to give as much capacity as the Lockheed design, even though it was a spinner. After that study, when we went out for the real contract, a number of companies bid--TRW, I guess RCA, GE and everybody. But Hughes got the contract again because, in the meantime, they had begun building the TACSAT.

TACSAT was also a big satellite, about as big as the INTELSAT IV. INTELSAT I, II, III were Delta birds. INTELSAT IV was an ATLAS-CENTAUR--a big bird--and they were building TACSAT, which looked the same. It was a different frequency, but it was a big spinner. We said, "Well, they are already doing it; we know they have experience with spinners; the spinner is just as good as the three axes; and we have experience with it." We didn't have experience with the three axes. Because of these things Hughes, got it again. Now, of course, the follow-on to the IV was a IV-A and nobody could bid on that except Hughes because three quarters of the satellite was identical with the IV, so that was Hughes'. Now, the V, Ford got the V. Votaw would have a better picture on that. I was out of it at that time. I wasn't as directly connected with the satellite projects as I had been earlier.

TMS: What was your impression of it? It does seems a little out of place. Here you have a geosynchronous?

SM: It was very risky in the sense that, as I told you, the motivating factor in writing our specs was to take little steps. INTELSAT V with Ford's approach didn't do that. First, it was three axes instead of a spinner--we had no experience with that. Second, it used eleven and fourteen GC for the first time, not that there is anything magic about eleven and fourteen, but it was a new frequency. This approach means new tubes, new components which always brings up the probability of new troubles and we did have some. Finally, it used dual polarization, which we had used in COMSTAR, but still it hadn't been used in INTELSAT. Again, these were all quite radical things. I think it speaks well for the Ford design that, though we had a little trouble with the tube, in general none of those factors really turned out to be a major problem.

TMS: Yet for the VI, COMSAT/INTELSAT has gone back to Hughes with a design that appears to the eye to be essentially the same a IV and IV-A.

SM: Yes, well it is similar in that it is a spinner. It is my understanding--again I wasn't directly involved, but I have a clear picture of what happened--the team that evaluated the designs picked Ford for various good technical reasons. Some of the points of the Hughes design were questionable. The Ford design was able to expand in a more sensible fashion. In other words, you have a design which a few years from now you could make into a little bigger satellite. The Ford design lent itself to that and they picked Ford. Then, at the last minute, in fact, I think after the bids were officially closed, Hughes came in and chopped fifty million dollars off the price. That was something that we couldn't brush off. The technical people said, "Well, I like this better," but the non-technical people said, "Yes, but it's fifty-million dollars and that's a lot of money." Ford objected violently to re-opening the bids, but INTELSAT looked at fifty million dollars being waved in front of their eyes and took it. Hughes, I think, did it because Hughes is the leader in the sense that they've made and launched more communications satellites (not more satellites) than anyone else. They felt that they wanted to keep out competition so they got the contract. It's a spinner but it's not like a IV--it's much bigger. A IV weighed about 1600 pounds, this thing is going to weigh about 4500 or 4800 pounds.

TMS: It's about 30 feet tall or something like that, as I recall.

SM: All opened up, it's about 39 feet tip to tip. It's a big drum about 12 feet in diameter.

TMS: The people at COMSAT and INTELSAT, the technical people and the operations people, adjusted well and became comfortable quickly with an entirely different kind of satellite--the three pole, three axes rather.

SM: Yes, there used to be many arguments in the early days about the relative merits and people would say for satellites up to so many hundred pounds the spinner is less expensive and is preferable, but above that the three axes is better. I have never bought that. My own feeling, and I think it is been borne out by experience, is that they both are equally good and it's more a matter of the details of the design. In other words, if company A designs a spinner and company B designs a spinner one of those could be a poor job and give you trouble, not because it's a spinner--there's nothing inherently wrong it with a spinner--but because this group doesn't know how to build them. The same with three axes: all three axes satellites aren't necessarily good--it depends on the details of the design. The only generalization you could make about it, I think, is that the three axes lends itself more readily to a higher powered satellite. If the intent is to get a lot of power you could do it more readily with three axes because you could just extend the arms. Whereas, with a spinner, like INTELSAT IV, what they did was to build a cylinder and coat it with solar cells. When they wanted to go to the next step with their HSC 76, that's the SBS type of satellite, Hughes didn't have enough solar cell area, so they built another cylinder which when the bird was in orbit slid down like a skirt and doubled the effective length. That gives you a factor of two, but you can just do that so much. Whereas, with the three axes, if you had something like a broadcast satellite where you would want a lot of power--you don't have much weight of equipment--you can use that weight to build more solar cells. As far as operation, for at least for the type of pointing accuracies that we have had thus far, they are both equally good. We are comfortable with both. Our experience is that it took a lot of learning to learn how to operate the three axes but the fellows learned that. Each have their advantages and disadvantages.

TMS: You could see COMSAT or INTELSAT in the future going back to a three axes.

SM: Either one. Oh, yes.

TMS: That's very interesting. Lets shift gears a little bit and talk about synchronous. In reading about satellite telecommunications and about COMSAT, much is made, justifiably so, about the initial decision to go synchronous. The argument is most often put in technical terms; that is, the technical advantages and disadvantages of geosynchronous orbits and the necessary ground stations, equipment, and that kind of thing, that seems relatively clear to me. The thing that is a little less clear is commercial aspects of it. COMSAT is a business after all. What were the advantages for COMSAT's business of going synchronous? They must not have been all that clear given the fact that the decision was such an agonized one and the risk initially taken so obvious and recognized by all.

SM: Yes, it wasn't clear to all. In fact, the first problem we had when we formed in 1963, was which should it be: synchronous or medium altitude. The arguments were these. The prior experience as of June 1963, was that there had been one attempt at synchronous by the military, the ADVENT. As I mentioned before, ADVENT never got off the ground because of the way in which they approached the problem. It was a very clumsy way. I could go on a long time on the details, but the point is that they turned off the project after several years before it ever flew. It rapidly was coming to be a white elephant, so they killed it and properly so. That was a black mark against synchronous. The second synchronous was the attempt by NASA to fly the SYNCOM I which had been proposed, designed, and built by Hughes. In February of '63, that went up and that failed. Just as it got up into orbit (of course, nobody knows exactly but this is the best guess) one of the propulsion tanks exploded. So that was bad, too. As of June 1963, when we got there, there had been two attempts, both of which were negative experiences. On the other hand, there had been the TELSTAR and RELAY--TELSTAR funded and designed by Bell Labs, RELAY funded by NASA and designed and built by RCA--both of which were successful. They showed that you can take a simple satellite, throw it into orbit with no propulsion and no attitude control, and it would provide a wide band transmission path for TV or for hundreds of voice channels in a stable predictable matter. So, there were the points. Here you had a medium altitude system which had actually flown. There were some obvious disadvantages. You would need two antennas on the ground because as you are tracking this one you wanted to pick up another satellite so the instant this satellite went out of view you would just throw a switch and transfer the circuits to this other earth station. You couldn't wait while the antenna swung over if you are carrying hundreds of circuits. It would be like suddenly you pulled the rug out from under you. So you need two antennas. One obvious shortcoming is that you are essentially doubling the most expensive part of your station. The advantages were that it had performed in orbit, it had no valves, it had no attitude control and most important it had no time delay. The synchronous satellite orbits at, let's say twenty-five thousand miles. This means that a signal from one station to another goes up twenty-five thousand miles and down. That's fifty-thousand miles. Light, electric, or radio waves go at the speed of light, roughly two-hundred thousand miles a second, so that fifty-thousand mile trip from one station to the other is a quarter of a second. Then, the other person answers. So, if I ask a question it takes half of a second until I get your answer. That doesn't sound like very much, but in practice it turns out that the way people talk, considering that some people interrupt, this delay is noticeable. There was no question that it was noticeable. The question was, was it acceptable? If people spoke politely, if you waited until the other party asked a question, then you thought, and then you answered the question, you weren't even aware of the delay. But if I interrupt you and say, "Now, wait a minute, Tom," then it got confusing. I would say, "What do you think of this?" and then I wouldn't hear anything because the electricity was going there, you were thinking, and then there would be a delay coming back. So, before I even got your answer, I would say, "Well, can't you make up your mind on this?" In the meantime, you've gotten the signal and you start talking. It all gets confused and this had been proven. With medium altitude satellite in orbit at a few thousand miles this didn't happen. So, that was a big plus.

So, if someone had to make a decision in June of '63, about where to spend this couple of hundred million dollars, by God that person would have to pick a method that would work. The only method that would work at that time, that had been proven to work, was the medium altitude. Fortunately, we didn't have to make the decision at that time, but that was a real question. I (by the way on the twentieth anniversary of COMSAT in '63 [sic], I had a little article in this newspaper that COMSAT puts out. You might look it up for the details.) However, the essence of it was simply that the time delay [was the big problem]. I recall going into Charyk's office and pointing out that if we were going medium altitude we would have to put up a satellite anyway, to prove the design of the satellite divorced from whether the time delay was acceptable or whether valves would work. The question would be: Is this specific design going to fail or not? And if it was successful, it would still be an experiment. We'd still have to put up two dozen more. On the other hand, if we launch this one synchronous satellite and it worked, it would prove the answers to the specific questions of time delay and valves, but more importantly, it could go into business. The decision seemed so obvious then: we should go ahead and put up this experimental/operational satellite. Charyk was very excited about that. He had come to the same answer himself and he felt doubly happy about it because he always looked at me as the advocate of the medium altitude satellites, since at RCA I had built the RELAY. Well, we (RCA) built whatever NASA wanted. If NASA had wanted us to build a synchronous satellite we would have been delighted to build one. So, based on this decision, we went ahead in the Spring of '64, and wrote up a spec which became the INTELSAT I. However, we also had to go out for money and it wasn't clear which system we would eventually build. The synchronous was clearly less expensive because you could put up three satellites and you would cover the world. The other way, you need two dozen medium altitude satellites. Now, those two dozen were much simpler but the difference in cost wasn't 8 to 1.

TMS: Right.

SM: Especially the earth stations were almost half the cost for the synchronous. Synchronous was clearly the way to go, that was obvious. Everyone agreed, providing the time delay was acceptable and providing the valves would work. So, provided nothing else happened in the telephone network because of this long delay, problems with dialing and things like that, we just didn't know. [sic] So, it was decided to go for enough money for both. The reason for that was, say you put up the synchronous thing and it didn't work. For example, if you went to the public in '64, for say a hundred million dollars, and it cost fifty million or seventy-five million (a synchronous was less expensive) and then a year later it goes and fails. Then, you would have to go back to the public and say, "Well, gee that didn't work. If you can give me another hundred and twenty-five million we will start all over again." Well, you would never get away with that. So we said, "Let's go out with everyghing at once, enough money for both, because you only have one crack at this." That is what we did. Fortunately, it did work but nobody knew that in advance. The FCC made a big flack about the fact that we went out for all that money. It's easy to judge after the fact, but by God the fellows who had to make the decision then weren't that certain about it.

We said a year and a half life, why a year and a half? Well, nobody had ever flown a valve in space before. We didn't know how long it would last. I remember arguments that the valves would "cold well". That is the term, because up there there is no air, it is so clear and there is no moisture. Some people argued that these factors would make the valves stick together. Could you prove it? You couldn't. So, we said year-and-a-half and that number was just taken out of a hat. Well, it turned out to last about four years. It failed when the peroxide, which was used as a propellant, turned to water. If you have peroxide in your medicine chest it's [sic] H_2O. After a while that extra oxygen goes away and it's just H_20, which isn't a very good propellant, at least not the way we used it. So, that was the background of the synchronous. The solution to the problem of choosing a satellite type was to try this experimental/operational satellite. It turned out that the synchronous it was acceptable.

The delay is still a factor, there is no question. I interrupt a lot, When I call my wife on a satellite, she'll immediately notice that we are talking over a satellite.

TMS: I've noticed it too, when I talk to people in Europe.

SM: Originally, it was much worse because of the surpressor. The surpressor is a device that was developed for telephone lines many years ago, like fifty years ago, because for certain technical reasons you get an echo even on a telephone line over a thousand miles. This surpressor was a means of stopping the echo. Well, the annoyance of the echo is proportional to the delay. Of course, with satellites you've got not a thousand miles, but you've got fifty thousand miles and for this the surpressor was very poor. So they went to the echo canceller which is a great achievement. It's a great improvement, you don't notice the chopping that you had before. But there is nothing you can do about the delay and some people notice that.

TMS: That's very interesting. Was there any pressure especially from the quarter of AT&T to go with a medium altitude [system]? No, AT&T, I think, took a very sensible approach. Within AT&T (I lump their labs and AT&T together), you had both groups: you had people who felt the synchronous was all right, and then you had others that felt that the time delay was going to be excessive. But, AT&T did something very sound, I respect them for this. In December of '63, they wrote us a letter in answer to a letter COMSAT had written. They said, "If you put up this satellite and the quality is acceptable and the costs are comparable to our cable costs we will order sixty circuits." That's what they did, of course, and the sixty quickly went up to three hundred--the two hundred forty circuits of the satellites plus the margin. Satellites have a little extra margin. You always have to design that way because nobody can quarantee exactly what amount of circuits you are going to get. It's going to be a little less or a little more, the probability of being exact is quite remote. Therefore, because you want to meet the specs, you have to design for a little better hoping that if you don't quite hit this at least you'll still meet the specs. In practice, the engineers usually come up with the extra, at least Harold Rosen has, he is a good engineer. So AT&T said, "If the costs are comparable, we will do it." They were open-minded about it and they ran extensive tests along with the English, Italians, Scandinavians, French, and Germans.

After Earlybird was up, all of these countries participated in testing. They did it in different ways. AT&T did it with a call back method, because according to FCC rules they're not allowed to listen in on conversations. So, they would keep a record and after a call was made they would have somebody call up the party and say, "Mr. Safley you just made a call to England. Would you mind answering some questions concerning the quality of the call?" and they would ask a number of questions. The Europeans didn't use that method. They used what they called service observing. They had a skilled operator who would listen to conversations. He would then answer from his observations whether the quality of the circuit affected the conversation. For example, whether people kept on saying, "What did you say?" and "What?" The conclusion of each of these tests was that the delay was acceptable. In fact, the Europeans compared it to the cable. The cable only lands in France or/in England and then goes to Germany or Scandinava by land lines, whereas the satellite goes right into these countries. In many cases people remarked that the quality of the satellite was better than the quality of the cable based on the voice they heard through the land line. The amount of signal noise and of voice delay appeared to be very acceptable.

TMS: In talking about the voice delay, you raise an issue that's been sensitive with COMSAT on a number of occasions, and that is the competitive technology of cable. Trying to find a market in international voice transmission, well in all kinds of transmission actually, but in international telecommunications for satellite circuits. What is your perspective on this? Some people have said with the time that AT&T sat on the Board of COMSAT it was really difficult for COMSAT to prosper in the most effective way given that AT&T was always protecting its investment in cable.

SM: Well, my feeling on that was that, based at least on 80 years of radio, there has never been one method of communication that's best for everything. We have seen HF radio, we've seen wireline, we've seen Coaxial cable, microwave links, and tropo scatter satellites. They each have advantages and disadvantages. AT&T's approach, I think, always was let's have both cable and satellites. Let's split it fifty-fifty. This is what they did terrestrially, too. They had coaxial cable as their wide band system across the country and then, after the war, they went to microwave link. They found that each of these have advantages and disadvantages. Smart people are working on both. Someone will come up with a microwave link which is cheaper but after a while someone else will come up with a cable which is cheaper and better and so you go on with both. Until the point where one becomes ridiculously out of line with respect to the other, I think that's a good idea. AT&T still does that, I think the same would be true of satellites and cable. The cable has proven they have new designs which keep getting cheaper but you also have new satellites which keep getting cheaper and if I were running the show I would keep both. Now, for some countries you've got to have satellites because a cable is only good for heavy traffic. Most of the countries of the world don't have heavy traffic, so it wouldn't be economically feasible for cable to go to many countries of the world. On the other hand, in the developed countries, industrial countries such as England, France, and Germany, you have both. I don't think it should be either one or the other.

TMS: Well, if you were to look into a crystal ball, just imagine that you had one, can you see satellites ever wresting a clear advantage over cable along the way?

SM: For certain things.

TMS: Such as.

SM: Well, an obvious one is [handling the telecommunication needs for] countries which don't have much traffic. If some country on the coast of Africa has two dozen circuits nobody is going to put in a cable there. It doesn't pay. So satellites are very useful for remote areas, like northern Canada. Satellites are very useful for broadcasting, because if you want to send messages from Washington to all parts of the country you've got to have some means, some piece of wire or some kind of microwave to link all parts of the country and that could be very expensive. With a satellite, you put up one satellite and earth stations and there you have it. You have an instant network, which is a great advantage. Satellites are very good, even among industrial countries, if you have very heavy traffic between two points. You can take satellites and use very narrow beams to get extremely cheap communication between points. So, I think we'll have both for the foreseeable future and I think we should. I think it's not a case for one or the other. For certain places it is clearly satellites only, but for others I think you can have both.

TMS: As COMSAT diversifies, in terms of a strategy for their business, what are the kinds of things they ought to go into to prosper as a company that specializes in satellite telecommunications?

SM: Well, they have tried. SBS was a first attempt to get into the domestic picture. Well, you know the story on that--apparently the digital approach just hasn't grown as fast as people thought it would.

They have gone into the maritime which is a natural for satellites because the only alternative there is HF radio. HF radio does not have the quality or the reliability of satellites at all. You can't talk with HF radio 99.99 percent of the time. Its reliability is a function of the ionosphere and that changes day to night, winter to summer, depending on where you are in the world, and depending on noise levels. Well, to give you an example, when we started talking about maritime satellites to Exxon, they operate a lot of tankers, they claimed on the average it could take them eight to twelve hours to get a message through to a tanker. They would have to wait until conditions were right, while with satellites they could dial it up today. Assuming that the ship has the equipment, you could go to an office phone here in this building (you want to know if its in the Atlantic or Pacific), dial a number and there you've got it. You also have a high quality circuit, the quality is as good as if you are talking on a local circuit. So COMSAT has gone into that.

They also have gone into satellite television. Technically, there were questions. Could you build a high power satellite? Could you build receivers for some hundreds of dollars? I think those are all being answered positively. There is a question on the programming. I don't know the answer to that, but they have gone into it. So, COMSAT has gone into the use of satellites for international, for domestic, and for maritime purposes.

We also went into aeronautic satellites. In this case, COMSAT was pushing the idea in the Sixties because, again, it's a natural for planes flying over the ocean. They only have HF radio. Technically there is no question you could do it, but then the U.S. had a big problem internally as to how it should be done. There was a big fight with the airlines as to what they should do vis-a-vis the government. Finally, the Europeans took the ball and they became the leading actors. It was pretty sad. The U.S. sent a little team of COMSAT people to Holland for a couple years to write specs and they were just about ready to give out an RFP when 1974 came and the airplane companies' fuels skyrocketed. The airplane companies had more to worry about than radio sets so that idea was dropped, but they hope to rejuvenate it. So, COMSAT is going into all the things that one could think of for satellites.

TMS: We covered a lot of the ground kind of indirectly that we hoped to cover in the questions today, but let me ask just one more question. And that is for you to relate an incident that strikes you as particularly dramatic or important that you are aware of in COMSAT's past during your association with COMSAT? We have talked about a number of them already is there one that really stands out?

SM: Well, I think that that would be the basic philosophy which was followed that: we should write specifications which call for relatively small advances in the art which would permit us to go out at fixed price contracts with incentive clauses. This doesn't sound like much until you compare the results we have gotten to the results say of the military. They have had very sad experiences with horrible overruns and with technical problems. They did not follow that philosophy. I think one of the problems COMSAT has had was with everybody wanting to get into the act because it was so successful technically. At the beginning, the companies meaning the other communication companies, RCA, ITT, and Western Union weren't interested in getting into this because they thought it would fall on its face. They were perfectly happy with letting us carry the ball, but then it turned out that satellites became successful. While nobody had wanted to plant the seed, everybody wanted to eat the bread. They took it for granted that this was just like a big vaudeville show. In fact, even later as more systems went up, people still followed this belief. I clearly remember one of Hughes' vice presidents pooh-poohing COMSAT's approach as being much to conservative. This was before a domestic satellite had ever been built. If you look at the domestic satellites though, they have been outstandingly conservative. Their design was a simple spinner right from the beginning and even in the later models, like the SBS, the only new advance was to extend the skirt. They have been very conservative because, like I said, if you take an engineer who's got technical responsibility for a design and he suddenly realizes that you are talking of several hundred million dollars, he becomes very conservative. I think that's the biggest single contribution that we made. Now, somewhat more specifically, we have already briefly discussed the story of the synchronous versus medium altitude satellite.

TMS: Let me inject a question quickly and that is: who is really responsible for the philosophy? How did it envolve? It seems, when you think about it, given the backgrounds that all of the technical people had, in fact more than the technical people, most of those who were in COMSAT in the early years were from academic or military backgrounds of one sort or another or working on military contracts.

SM: Not academic. People's backgrounds were in NASA and the military.

TMS: But at least coming from situations in which to extend the technology would have been expected, at least from an outsider's point of view, from my point of view. Therefore, it seems usually that such a departure as you point out would have been made. I would have expected, if it had been left to me to say that business would have continued as it always continued, that is with each satellite being a major departure, a major extension of the technology. How did it actually come up? Who was responsible?

SM: Well, I don't think it was a case of any one individual coming up and saying here is the philosophy we should follow. I think it was something that evolved. I have had actual experience with TIROS and with RELAY. The satellite business is very complicated. You are dealing with new things, very complex things and very expensive things, you have to be very conservative, especially if it is going to be a commercial operation. I think, we were fortunate in that the satellite on which we based our design was the SYNCOM, which was a beautiful concept. I'd certainly have to give credit to Harold Rosen and Don Williams and Rosen's people, that's Tom Hudsperth and Martin Ike. They stressed simplicity. They hadn't been, the word which comes to mind is contaminated by the military and by previous military contracts on satellites like ADVENT. ADVENT's contract asked for far too much considering they'd never built a satellite. They came out and asked for things which were absurd and, instead of experimenting they came with thick piles of paper of specifications. They went with a heavy handed approach, whereas Hughes had come up with this concept. I remember how we kicked ourselves at RCA because we had been I think, if not the first, one of the earliest users of spinning satellites. TIROS was a spinning satellite. We kicked ourselves for not thinking of that method of the jets stabilizing the spinning satellite in synchronous orbit. But Hughes did it and they certainly deserve credit for that. I think some NASA people contest that. I think it went to court. Nevertheless, Hughes built the first one; they did a great job -- it was simple. You can couple that with the point I made before: if you are dealing with hundreds of million of dollars and the people who actually have to have the responsibility of telling the boss, "Yes, let's do this," become very conservative. They are likely to show that conservatism by picking a design which is proven. I mentioned in TIROS we had done this. The DELTA is another example of that philosophy.

The first DELTA, which was launched in 1965, had a capacity of 85 pounds. Todays DELTA is about 1200 pounds . . . the only thing in common is the word DELTA because DELTA consisted of a first stage, which was a military rocket, second stage and a third stage. Each of these stages had been used elsewhere. What McDonell Douglas did was to take one of these, and one of these, one of those and put them together. They built the sheet metal to tie them together and it was successful. Then they said, "That's great." That was for SYNCOM. But that method couldn't get a bird into stationery orbit. The early SYNCOM's weren't moved up and down in orbit. So, they added these three strap-ons which we used in the INTELSAT I which permitted it to go into truly snychronous orbit (geostationery) with 85 pounds. Then the next year for INTELSAT II, I don't remember the change, I think they modified the second stage. The next year they modified the third stage. Each time modifying the DELTA by using an improvement made someplace else. Instead of three strap-ons, they put six strap-ons, then they went to nine strap-ons. They kept going to bigger strap-ons. This approach is the same as the one I described before. You take something that works and then you just make one little change at a time. That was the philosophy we followed. The thing we started with was this simple Earlybird. So, I think it was a combination of these two that led us in this way of righteousness.

TMS: Was there any resistance to it? Were some of the engineers who came to COMSAT disappointed, that the kind of specs they were going to be writing were not revolutionary?

SM: Yes, not only that, there were some of the European partners who, as I mentioned before, said, "Oh, that satellite is no good it doesn't have a battery." Well, we didn't have weight for batteries. If we had said we'd put batteries in then instead of two hundred-forty circuits we might have had, I don't know, maybe a hundred fifty circuits. Well, since the eclipse only occurs one percent of the time of the year, why hurt yourself 99 percent of the time in order to get with this one percent, especially when you don't know if this is the concept that you want in the first place. So, they were unhappy with that. The Europeans also wanted multiple access: we didn't have multiple axes, only two countries could use it at a time. What happened was there were six countries the U.S., Canada, England, France, Germany, and Italy. The way we operated England, France, and Germany would tie together with terrestrial lines and each earth station would work for one week at a time. So the U.S. would send the signals to England where they were divided into three and shipped to the others. The next week U.S. would work with Germany and so on. Then on weekends, Italy, which had a smaller station (they didn't have an 85 foot dish they had a 40 foot dish or something), would work with Canada because traffic wasn't as great. So everybody was learning this clearly isn't how you would like the system to work. With INTELSAT III we didn't work that way. Even in INTELSAT II we had multiple access. But you have to get started somehow. I remember in the court hearings with the FCC in '72. They called me [to testify]. I was the first witness about some of the technical matters. I recall a statement that's attributed to Sir Watson Watt, you know, the inventor of English radar. He said, "Give me the third best radar because the first best I will never get and the second best I will get too late." I remember the DOD fellow at the hearing jumped up at that and objected to my statement -- I just hit a sensitive nerve.

But that was the philosophy: Get started with something. We did and fortunately we picked a good thing with INTELSAT I. We took little steps for INTELSAT II, and for INTELSAT III, even then we had our share of troubles. INTELSAT III we had this bearing trouble, they locked up. Each of the satellites have had little troubles but you never got into a really drastic thing where we had to throw the design out, like the ADVENT. Also the overruns, there were overruns in each case because even though the contracts had fixed prices as you go down you find a problem arise. It's not always clear whether this is really the contractor's fault or if it is the fault of the specification. So you worked out some way of handling that. However, these changes have usually amounted to no more than a few percent--two or three percent--when you compare this to military contracts with tens and hundreds of percent overruns, I think we had a good concept, but I don't think any one person developed it. I know I felt strongly that way. Charyk certainly agreed with that approach because he had been with the military and he knew what the other side looked like.