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Interview of Don Lenschow
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Interviewers: Diane Rabson and Nicolle Alida

Rabson: This is Diane Rabson of the NCAR archives. Nicolle Alida and I are doing an interview with Don Lenschow of MQ at NCAR today October 31st, 2001. We will be talking about the Electra aircraft.

Good morning Don.

Lenschow: Good morning.

Rabson: Peggy Lamone, we were talking with her last week or the week before about the Electra and she said, "We've got to talk to Don Lenschow." So, I am just going to open up the floor and ask you some questions about how you started doing science on the Electra and how the airplane fit in with the different projects that you were working on.

Lenschow. Ok. Actually my involvement with the Electra is more than just the science. I was out at the research aviation facility back in that period. I was the chief scientist there for a number of years. I don't remember if I was there at the time we actually acquired the Electra but the timing was not too much different. We got the Electra back in the, I think early 70's; like '70, '71, '72 somewhere in that timeframe. The acquisition of the Electra was directed towards participation in GATE but in that same timeframe we got involved in another program called AMTEX, Air Mass Transformation Experiment, and I was the U.S. representative for that experiment, which was primarily a Japanese experiment. They were the principle organizers of that experiment although there were some other countries as well, the U.S., Canada and probably one or two other countries.

Rabson: Don, I have one question for you. What did the chief scientist position at RAF mean? What did you do as chief scientist in the aviation facility?

Lenschow: My job was to pretty much direct what was going on out there in terms of non-airplane maintenance. I was in charge of the instrumentation, in charge of the projects and so on; all of the different things that were

associated with the deployment and science for the aircraft but not with the actual operation for the aircraft. I actually was sort of on leave from the science part of NCAR. Back then it was AAP.

Rabson: Which was Atmospheric Analysis Prediction.

Lenschow: That's right. So I took, I think it was, a two year sort of leave from that division and went to ATD in that position. Then I actually stayed there longer than that. In fact I am still one-third ATD and two-thirds MQ.

Rabson: Were you responsible for the original modifications of the Electra when it was brought up from Texas to make in into an aircraft that could be used in a science experiment?

Lenschow: I was the supervisor of the people who instrumented the airplane but I wasn't involved in the actual physical modifications of the plane, that was one step removed but the instrumentation part I was supervisor for that. Neil Kelly was the engineer who actually did the hands on instrument development…or it was the instrument deployment and also some development in terms of putting the instruments, the payload, on the airplane. He is now at Fuller Energy Research…well it's called NREL.

Rabson: NREL.

Lenschow: He is still in the area if you ever wanted to find out his take on the early days of the Electra.

Rabson: My understanding…I spoke with Steve Dixon who was around in those years. Steve was a budget analysis for NCAR at the time and he talked about the reasons that we first leased the Electra and then we bought it. As you said it was largely for these larger projects like GATE and AMTEX. He also said there were some problems with the plane.

Lenschow: Yes.

Rabson: Do you want to talk about that a little bit?

Lenschow: Oh yes. I can tell you at least about some of the problems.

Rabson: Ok.

Lenschow: As I mentioned GATE was…I think that was probably the primary motivation but in the same timeframe AMTEX came along and actually as it turned out AMTEX was planned for two years, 1974 and 1975, each for one month, well actually a little bit less than a month, in flying out of Okinawa over the east China sea. GATE was scheduled for the summer of

'74. So, the first AMTEX period predated GATE so this was the first deployment of the Electra for a research program other than for testing.

There was a deployment to do some testing. I think we went out to the east coast to fly off the east coast to do some testing before AMTEX. We planned to go to Okinawa in February of 1974 and we never made it so that was one big problem that we had with the early operation of the Electra. We got out to California, we got all set and in fact took off for Hawaii that was our first stop on the way over and almost half way out there was some serious problems with the airplane. We lost pressurization, actually lost the compressor, and lost the propeller controller on one of the engines. I think they were probably related I don't quite remember connections there. In fact if there was a relationship in with the perhaps the engine that had the propeller problem that was the compressor. I'm not a 100 percent sure about that. So, anyway we came back, since we were a little bit less than half way we came back, at lower altitude with three engines all the way to California and that was stretching the capabilities of the airplane to the max because three engines, low altitude and half way to Hawaii. You wouldn't have been able to tolerate much more than that.

Rabson: When you say low altitude what kinds of measurements?

Lenschow: This was because we didn't have pressurization so you couldn't…

Rabson: Right. So, what would you have to fly at then? What altitude, 10,000?

Lenschow: What altitude? Oh, It was around 10,000. I don't remember exactly but 10,000 is as high as you can go and not use oxygen if you are operating an airplane but the pilots may have been using oxygen. Of course we could go a little higher because we were just passengers so I don't remember. We may have gone a little higher than that and then used oxygen. We were using oxygen in the back until they dropped down because we were flying up at 20,000 some feet on our cruise over to Hawaii.

Alida: Don, who was on the plane when that occurred? Was Peggy Lamone on the plane?

Lenschow: Yes, Peggy was on the plane.

Alida: Because I remember her mentioning it in her interview.

Lenschow: Bill Pennell was another person who was on the plane. We were the…Peggy, Bill and I were kind of the three PI's for AMTEX in '74. Peggy and Bill didn't continue in '75, which was the next deployment for

AMTEX because they were so heavily involved in GATE and I was not nearly that heavily involved in GATE.

Alida: Do you remember who the pilots were?

Lenschow: Oh yes, Bill Zinser and Pete Horam, I guess his real name was Clayton or Clay; anyway they called him Pete Horam. I think we had…I have to remember which year is which…then the other Electra pilot was Jim Covington. I'm not sure if he was on that or not but those were the three Electra pilots or maybe two of those three or I'm not sure. We also had to fly a navigator because of the long over water route but he was not an NCAR person I think he was a contract person.

Rabson: Did you also have people on the plane who were responsible for the instruments?

Lenschow: Yes, Neil Kelly…I'm not sure about that now. I kind of mix up the two years too so I'm not exactly sure who but Dick Taylor was another one who was very likely on the plane. Another, again I'm not 100 percent sure, but Dick Garrelts was another person who was involved in the Electra program.

Rabson: He was Ann Garrelts husband.

Lenschow: That's right.

Rabson: Yes, I remember her.

Lenschow: Those are the names that come to mind. Those are the main…another Electra person who was the…what was his last name…Matt Reynolds.

Rabson: Matt Reynolds.

Lenschow: Yes. Again I am not sure if he was on that plane but he was on that Electra group who worked on the plane. Oh and Jacques Brun was another. Those are all people who were with the Electra program.

Rabson: Ok. So they were taking care of the instruments and the three scientists were going to carry out your part of the program with the Japanese.

Lenschow: That's right.

Rabson: Please feel free to ____ him with questions if you like.

Hosansky: I missed the first part. My initial questions you may have already gone over these with him. When was the first time you had flown the Electra?

Lenschow: Actually the first flight would predate that. We did a test program earlier than that where we flew out to the east coast over the gulf stream and I guess that was probably the first time I was involved in any deployment where we really tried to take serious measurements but we had a lot of local tests in addition to that.

Hosansky: Can you tell what ____ ____ ____?

Lenschow: As I was saying the first flight to AMTEX took place in February of '74 so I would….sort of try going back from that time I would guess it would be in '73 throughout that year. I am thinking we started instrumenting the airplane probably a year before that, probably around '72 that work was really instituted on Electra.

Hosansky: What were your initial impressions of the plane?

Lenschow: Of course it was never designed for research. It was configured as kind of a, I wouldn't call it luxury, but I guess at one point in its history I guess I was a commercial airliner on the west coast. It worked for one of these sort of commuter type airlines on the west coast; I don't remember the name of it. I don't think it exists anymore. Then it was acquired by a company that flew people around I think to inspect land deals where somebody moves in the property business.

Alida: The King Ranch.

Lenschow: Yes, something like that. I guess what they did was they configured it so that you could fly very comfortably to whatever locations they wanted to take people. So, it was configured in a fairly, again luxury is not the word, but a relaxed sort of atmosphere. There were little tables and things and we left some of that stuff in. Most of it was torn out because we had to make room for instrument racks but in the tail section we left some of that stuff in so for long ferries it was a fairly comfortable airplane as long as it wasn't bumpy because the tail would rock around a lot more than the rest of the plane.

Hosansky: Could you actually sleep on those long rides?

Lenschow: There were no real…

Hosansky: No beds.

Lenschow: No there were no beds. They were not particularly comfortable to sleep in so no. Besides that the maximum duration of that airplane was like seven hours or something like that. It was not that long of a range airplane.

Hosansky: When you say it was pretty comfortable for the long ferries could you focus other than working when you were going to your destination, do you remember anything else that you did at the time?

Lenschow: Of course we ran the instruments most of the time when we were on these long ferries just to see how things were working so we spent time on that. Otherwise is was just kind of…people would read materials sometimes work related sometimes not and then a lot of sight seeing, just looking out the window, observing all different things. Since were flying…the flight level is not as high as in a commercial jet aircraft so you tend to be more involved in looking out the windows and seeing what is going on and flying through things.

Rabson: As Peggy said though, when they went over for the GATE project they did not fly in the Electra over to Dacar, Senegal. I imagine the Electra had to refuel at various places. So, in that case would the pilots and the instrument technicians had just come together in the Electra and then the scientists would meet them in Senegal?

Lenschow: Yes, I'm not quite sure why they didn't do that in GATE but there was some different constraints there. It would have taken them a longer period of time. Actually, I'm thinking back now, on the second deployment of AMTEX I didn't take the Electra over it because I had a commitment back here. It takes…to get to Okinawa we would go to…I didn't go so I don't remember all the deployment and all the stops but Hawaii to like Guam or _____ or one of those islands and I'm not sure where else they stopped…oh Midway they _____…oh no, I went over…how did that go? I didn't come back with the Electra I guess that was it. So I do remember deploying Hawaii, I did the big island, and then up to Midway, way up on the northwest end of the Hawaiian islands and then down to…I guess it was Guam and then up to Okinawa, so it was several days to get there all the way over to Okinawa. Then similarly when they flew over to GATE they did some hopping around way over there.

Rabson: Right. Did you handle the diplomatic end of…?

Lenschow: No.

Rabson. No. Who did that?

Lenschow: For which? For _____ programs?

Rabson: Yes.

Lenschow: I think we worked through NSF and the NSF had some office take care of that type of thing.

Rabson: Ok.

Lenschow: But we kind of stayed on with that, other than to make the requests _____. That's actually still kind of true. Those diplomatic things are pretty much handled outside of NCAR.

Rabson: Although as I understand from our talk with Darryl Thomgardner when they flew into the Kuwait smoke that he had to do a lot of diplomacy.

Lenschow: Yes, that could be. There was a big difference there because that was a rush deployment and when you go to NSF and go through these things the first thing they'll say is, you've got to give us more time. Even if you gave them five years they'd say, this is so rushed. So, I can imagine that Darryl had to do a lot on that himself because that's sort of beyond the capabilities of an organization that likes to have everything.

Rabson: Right, set up.

Lenschow: Very slow and methodical steps.

Rabson: Right.

I'm interested in the instrumentation part because we are starting an instrument collection in the archives so; of course the Electra was a perfect platform for the instruments. Did have basic instrumentation that always was on the plane and then people would bring in specialized instruments for…?

Lenschow: Yes, we always tried to operate in that mode. We have kind of at the heart of things a central data system so that all the instruments can go in and be recorded and be synchronized and processed like filtered and that type of thing before they are actually recorded. Back in those days things were a bit more primitive so that was a bigger investment. We had to have dual tape drives and it was physically a big part of the whole instrument deployment, the data system, the amplifiers and filters and all that kind of stuff. Then we had standard instruments like temperature, pressure, static pressure, humidity and then we had as pretty much a standard but not quite to the extent that temperature, pressure and humidity are the air motion measurements. There were three velocity components that we could measure and that required the nose boom to measure the air motions in respect to the airplane and then we had the inertial navigation system that gave us the motions of the airplane and that had to be…all the output from that had to be recorded. Then back in those days it was all processed after

the fact to get the actual velocity measurements but at a minimum to do that you need to measure the three velocity components of the air in respect to the airplane, the three velocity components of the airplane in respect to the ground and the earth and the three altitude angles of the airplane. So, there was a total of nine variables right off the bat that you have to measure but it is actually more than that because sometimes you have to measure more than one plane to get that quantity. So, it is a fairly extensive system that required a lot of work and a lot of development because it was harder to do it in those days than it would be now. Neil Kelly spent a good probably two years or so with his group putting that system together making sure everything was working because he had to improvise and develop a lot of things along the way. That was a real state of the art system when it came out.

Alida: Was that initialized on the ground while the aircraft was static? How would that…what was the reference point for that?

Lenschow: The inertial navigation system, which was kind of the heart of that part of the system, you had to initialize while the airplane was parked, while it was not moving. In fact you didn't even want it out on a windy day because just the motions of the airplane responding to the wind was enough to cause the system to, let's say, not be as accurate as it might. What it has to do is it has to level itself with respect to the Earth and then it has to find more if it's got a gyro compass mode and then you have to put in initial coordinates and then once that's all done then it is ready to navigate. It estimates its position by measuring from where it starts to where it is going. So, if you don't get the right stuff in at the beginning there is no way you are going to be able to navigate accurately once you have left your starting point. That's still true but the systems are less finicky now. You don't have to be so quiet with the processing. The computers that they have now, of course, are so much faster and sophisticated that they can tolerate a lot more emotions and they don't take so long to initialize and so on. This was still in fairly early days of inertial navigation when systems were just beginning to be sort of operational at that point and time.

I could maybe sort of continue and tell you a little bit more about the AMTEX thing.

Rabson: Yes.

Lenschow: As I said, we came back to California and we didn't cancel because we were hoping that they could fix the airplane and we could go out before the program was over. So, we sat in California while the aviation facility folks tried to get it fixed and we waited and waited and waited and after something like a week or ten days or something it became obvious that it

wasn't going to happen in time for us to get there for the program in '74. So we finally gave up and went home while the airplane, I think, stayed out, I think, they went up to Seattle finally to get it fixed by a propeller company up there just to get that fixed. So, that was a big disappointment that we couldn't get out and get into the field for that first deployment of the Electra. But they did get it going and it did, of course, do a good job in GATE. The subsequent year we did go again to AMTEX the second stage of that experiment and we did make it and the aircraft did very well in the second 1975, February of 1975, experiment. It also did an experiment on the way back. I think it was called STREX, Storm Transfer and Response Experiment, if I haven't mixed that up with something else. That's the one where I didn't come back with the airplane because I had to get back here for something else and then I went up to Alaska doing some missions off in the western pacific in high wind conditions at the University of Washington for primary research institution for that.

Alida: What information were you gathering with AMTEX, Air Mass Transformation Experiment? Was it observations or gathering data?

Lenschow: Ok, what happens is on the east edge of big continents and Asia, of course, is the biggest continent, in the wintertime you get occasional extremely cold continental air coming off the coast from the northwest off the coast. It happens in this country off of the northern seaboard, Maine and _____ and even further south, as far south as Virginia, where you have a big high pressure cold air mass over the middle part of the country and then something will come along and push that out and you will get subzero temperatures out over the ocean. The ocean temperature in those areas, because there is also a warm ocean current on the east edge of continents and here it's the Gulf Stream, in the Pacific it's the Kuroshio by the Japan current. That's very warm water, it's like 70 degrees or something like that and you get really cold air coming off the coast and you have tremendous potential for development of mesoscale circulations, snow and it can develop into fairly deep convective systems, rapid psychogenesis where you get storms developing and this kind of thing. So, this program was aimed at looking at the initial stages of that. As the air just comes off the coast there is a tremendous amount of water and heat flux that comes off the ocean and we measured that, measured how much was coming up into the atmosphere and a little bit on how it kind of reorganizes things in the atmosphere and causes development of systems but we didn't get into the actual psychogenesis aspect this was more the transfer of energy from the ocean to the atmosphere.

Alida: Did you fly at different levels of pattern through…?

Lenschow: Yes. Our typical pattern was to fly out north and west of Okinawa up into the area where the cold air was coming off the coast and fly low in the

boundary layer, fly at maybe 500 ft. above the surface. We would go out at that level and then we would go up to a particular area that we'd _____ on the basis of satellite photos and other weather information and then fly series of flight planks at various levels from 100 ft. on up to maybe a few thousand feet, maybe 2,000-3,000-4,000 ft. or something like that. Then just do a series of those levels and then sometimes repeat them to get the character of the transformation, the modification of the air at that particular region. We actually measured the fluxes at various levels so we could get the structure for the function of height. These were typically six to seven hour flights.

Hosansky: When you talk about different levels, you've said 100 ft. to several thousand feet. Are you talking about like a 100 ft. above the surface of the water?

Lenschow: Yes.

Hosansky: So you were that low?

Lenschow: Yes.

Hosansky: Were you flying into storms at all?

Lenschow: No, we didn't fly in storms. We flew up stream of where storms may have developed later on. So, it was…this air is very cold but it is also subsiding, it's being pushed down so it can't really develop that much vertically. So, we were flying in conditions where there was a well-capped boundary layer, maybe at a couple thousand feet or something like that. Above that the air is very dry and quite warm especially in contrast with the cold air underneath. Down below that it is very turbulent but it is not developed, it can't develop into storms and it's cloudy. It's sort of a partly cloudy but you have a lot of stratus clouds and some cumulous clouds in this layer down below.

Alida: Were there other aircraft involved or was the Electra the only airplane?

Lenschow: There was one small Japanese airplane, I think a small engine airplane, involved and that was it.

Alida: Did you have any boats or ships?

Lenschow: Yes, there were ships. Again several Japanese ships. They had an array out there. They had one station that was Okinawa and then there was…this was the Ryukyu Islands, which go sort of in a southwest/northeast direction south of Japan, the Japanese Islands…

Rabson: Can you spell the name of that?

Lenschow: R…let me cheat…Ryukyu Islands.

Rabson: Ok.

Lenschow: There were a couple of island stations along that chain and then there were a couple of ships in the East China Sea that they had deployed up stream, or let's say up wind, of the islands…not really up wind of the islands, between the islands of the Asian coast.

Rabson: So, you were saying in that project you worked for a month at a time?

Lenschow: Yes, it was about a month when I moved to _____. I think actually in AMTEX it was a little less than a month, somewhere between two weeks and a month.

Rabson: Did the data end up at NCAR?

Lenschow: Oh yes. We got really good use out of the dataset. It turned out to be a kind of one-of-a-kind dataset because we had all of these hours of measurements of turbulence and of fluxes in fairly uniform very convective boundary layer, well kept so we had a well contained experimental domain, and because of this big temperature contrast lots and lots of turbulent activity. So everything was well mixed, well kept. So, we used that dataset to characterize in ways that hadn't been done before, kind of a generic convective boundary layer and that was very successful. It wasn't quite what the experiment was focused on, which was really more the process below that air-sea transfer plays in the development of weather systems further downstream. Other people used it for that but what we were primarily focused on was characterizing the convective process in a convective boundary layer, which had well-established uniform conditions. So there were a whole series of papers that came from…and in fact I still continue to work on that dataset doing various things as people came up with new ideas all the way up until about 2-3 years ago.

Rabson: Wow.

Lenschow: Maybe it's a little longer than that. Maybe more like five years.

Rabson: Ok.

Lenschow: But it's still here. It's still available if anyone wanted to take advantage of it. It would still provide interesting and sort of unique data. I don't think anyone else has done an experiment like that since then.

Rabson: Did it take a long time to do the data assimilation?

Lenschow: Yes. Back then we didn't really get a final dataset until maybe of the order of six months after the experiment. Again this was the first operational deployment of the airplane so there was a lot of software developed, a lot of tests to do trying various algorithms and that type of thing. So, it was a bit slow going but we were kind of the pioneers because this again was the first operational deployment and it wasn't really until GATE got underway that we were really able to take much of a look at what we got from AMTEX. We knew we got a good dataset just because we could make preliminary examination of the data but we really didn't know…we really couldn't do the detailed calculations until many months after the experiment itself. Then in subsequent experiments that got shorter because of the experience that we went through for that experiment.

Rabson: Do you have any other questions about AMTEX?

Alida: I was just curious whether there have been any subsequent studies to compare what you discovered off the coast of Asia say in the North Atlantic or somewhere to see if it's similar developments off the North American coast?

Lenschow: No. There hasn't been any _____ of that.

Alida: The nature of those air masses are similar or…

Lenschow: Actually there were some NASA experiments that used, I think a P3, which has got similar characteristics of the Electra but it wasn't as intensive an experiment and they were doing different things. They were testing, since this was NASA, they were testing remote instruments and that type of thing. Although they did do some in-situ flux measurements like we did and they were doing a lot of satellite observations simultaneously.

Alida: So the generic air mass model that you developed essentially applied everywhere.

Lenschow: Oh yes. It's still there. It worked. The mass experiment maybe added a little bit but they didn't really change anything.

Alida: They didn't reinvent anything.

Lenschow: They didn't reinvent anything. But NASA's interest is always more focused on testing satellite observations and that kind of thing so they were in a little different mode.

For AMTEX we made real good use of satellite information because already at that time there were good satellite _____ but it was pretty much photography images of the clouds but that gave us a lot of help and it was very useful after the fact because you could see cellular structures in the clouds and that kind of thing. That's again another thing that we were able to see in the data were these mesoscale cells that you could see in these convective outbursts from the continent over the ocean.

Hosansky: And the Electra performed fine once you were out there?

Lenschow: Yes. Once…the second time around it was very successful. We didn't have any serious maintenance problems at all. It turns out that if you want to go beyond that that over the years the Electra was a real workhorse in terms of being able to perform when it was needed. There wasn't a lot of problems keeping that airplane going.

Rabson: Let's hold that thought while I turn the tape over. (tape end)

So, at the end of the tape, side 1, you were talking about the Electra's performance as kind of a workhorse. Can you elaborate a little bit about that and how it did…?

Lenschow: Yes. I will have to kind of think back. I have been involved in many programs over the years with the Electra and I'm just trying to think. I don't know how extensive you want to go into all of these different programs but if you like I can jump to the latest one because I have the best and most recent memories and every little _____ is more accurate.

That was a program called BOREAS and it was Boreo Echosphere Atmosphere Study.

Rabson: I've heard of it.

Lenschow: That took place, I can't tell you the exact year but roughly five years ago, that would put it in '96…somewhere in 1995/96 somewhere in there. We deployed from Saskatoon, Saskatchewan up in Canada. It was to look at the impacts of the boreal forest from kind of a climate perspective, carbon dioxide exchange as well as energy budget but it was a climate focus. It had to do with the fact that there was kind of an unknown…I'm talking now about what was going on at that time. I think things have changed a little bit but at that time there was some inkling that there was a sink of carbon dioxide up in the boreal forest regions of the world both here and

in Europe and Asia and this was based on modeling and measurements, mean measurements of carbon dioxide that they couldn't explain. There seemed to be carbon dioxide, carbon being stored and sequestered up there and nobody really understood why so that was one of the motivations to this experiment. We were equipped to measure carbon dioxide fluxes as well as temperature and humidity fluxes so we could do energy budget and carbon dioxide budget measurements. This was primarily a NASA funded program with NSF and other agency support. We deployed up there three times during the summer from early to late…actually spring through fall to get the seasonal variation up there in the boreal forest, which extends from a little bit north of Saskatoon all the way up to the very far north of Saskatchewan and then on into the northwest territories. We flew…we had regular transects that we flew over this region and we actually flew all the way across the boreal forest up into the tundra area of northern Canada and just did these transects on a pretty high basis to get the seasonal variation as a function of time to summer.

Again for the most part the Electra did very well. We had one episode where we were…each time during the three deployments, the three seasonal deployments that we did, we'd fly up to Churchill, Manitoba and then they'd fly out of there and come back. So, we had one sort of overnight to Churchill and then we would come back. Something happened, I don't remember what it was, something happened to the airplane up there. We had to kind of limp into Churchill. We were not allowed…only the flight crew could take the airplane the rest of the way because I think they lost their engine. I don't know why whether it was propeller. Propellers have been kind of a problem with that airplane, propeller controllers. It might have been that. So, I think they had to fly on three engines back to Saskatoon then we had to go back by charter. They chartered an airplane for us to bring us back but that turned out not to be a serious problem. They got the airplane fixed and we were able to continue the program.

Rabson: Who fixed it in Saskatoon?

Lenschow: I wouldn't be able to tell you.

Rabson: Were they hired?

Lenschow: They may have had to go…I think they might have had to fly somewhere else. Maybe they went back to Seattle. I think they might have actually had to do that, fly to Seattle and get it fixed and come back.

Rabson: So, would they have the people from RAF come and fix it or would they hire people?

Lenschow: No, they had to go through a shop that would be able to fix that type of problem. RAF people can do routine readings and some even non-routine maintenance but if there is a serious problem they have to go somewhere else.

Hosansky: You had mentioned after that research mission that the Electra was designed to take carbon dioxide readings and I think you mentioned a couple of other measurements. Could you talk a little bit about how much time had to be spent getting the Electra ready for that type of mission and what was involved in that?

Lenschow: If it's a full-scale foreign deployment the lead-time for committing to something like that is at least a year. The actual time to get the airplane configured and so on might be as short as three months or something like that depending on what equipment has to go on the plane. As I was saying earlier there is a pretty much standard set of instrumentations that goes on the plane and that part of it is pretty straightforward. It still takes maybe a couple of months or something of that order to get it all on there and test it up to whatever completed the program but it's the special requirements that sometimes take longer than putting outside investigators on the plane or…

Hosansky: And the plane will be at Jeffco during that time it's being completed?

Lenschow: Oh yes.

Hosansky: Would you…what kind of role would you play in a configuration?

Lenschow: You mean like personally?

Hosansky: Right, or a scientist as opposed to a _____.

Lenschow: You see my role has changed over the years. At one time I was sort of the supervisor for that type of thing, putting new instruments on the plane and that kind of thing so at that point and time I was pretty heavily involved in terms of planning. I wasn't…there were people out there who actually did it in terms of planning and issues of where to put the instrument, how to configure it and that kind of thing. But then I moved on to that role and as a scientist, which I _____ BOREAS program I was mainly using it as a kind of an outside…NCAR scientist but outside RAF. In that role then it was more going to attending meetings and saying this is what we need, can you do that for us and then I'll come back and say, well this is the best we could do, was that good enough. Then participating in test flights as an investigator you have to…you want to go out and be on test flights and then look at the data for the test flight and iterate again, find out what can be done to fix various problems to optimize the measurements.

Hosansky: So, even after an initial test flight there will still be some optimizing of the instruments.

Lenschow: Oh yes. It's never…all the way through the program it's a never ending process. After a flight you look at what you have got and that's become easier in recent years mostly because of onboard computation or immediately after the flight you could do computations and you could look at data, processed data, after a flight and you can see what's working and what's not, how you can improve things. In AMTEX we were pretty much operating on the basis that the squiggly lines look pretty good, looks like we're ok but we didn't really know that until we got back and starting going through the data. Now you can watch squiggly lines during the flight…a nice presentations on the computer screen and you can see that things are working right. We couldn't do that back in those days.

Hosansky: Is that because of…I lost something…is that what you can do now? Is it actually on board or is it after the day's flight is done and you're back?

Lenschow: Both. We can see things onboard the plane and we can look at things in a little more detail then more precisely after the flight. Then after that when the airplane comes back and the program is over you can do like recalibrations of the data of the instruments based on post flight calibrations or post program calibrations and optimize everything and then come up with a final dataset the people use for the final product. All of these earlier things people use to kind of get a feel for how well things were working and to kind of establish what they want to do with the data after they get the final dataset because they'll know what day's are good, what instruments are working well and that kind of thing.

Hosansky: In what other ways has the process changed in the last 25 years or so?

Lenschow: We covered pretty much the fact that you can look at data easier and that kind of thing. There are other things that have changed. I would say that probably bureaucratically it's more difficult now than it was then. It just seems there is more things to do. When we went to AMTEX as I remember it was pretty straightforward. You didn't have to worry too much about getting clearances and all that kind of stuff. There were things that had to be done…part of that, of course, was the Japanese were very helpful because of their experiment in the Navy. We were flying into Okinawa, which was part of Japan so they cleared all that as much for us but it just seems that things do get more complicated but at the same time NCAR, let's say RAF has become more professional in dealing with these things over here, they've learned a lot from all of these deployments. In my opinion there handled more professionally and in a more organized way than when we were first learning how to do these international

deployments. I would say it's maybe not a lot easier but it's more institutionalized and the steps are pretty much available or _____ and there laid out and probably easier to implement than they were back then.

Also back then we pretty much we're able to operate out of military bases and that offered NCAR advantages. Military was very cooperative and they kind of I guess probably actually subsidized us in terms of providing the facilities. They don't do that so much anymore so there is no…nowadays probably not to take advantage in most cases _____ out of a U.S. military base and it's not done as often. So, that's another change that has occurred. Of course the organization has grown. There are more people available to handle different types of tasks. Back in those days one person probably had to do more different things in order to carry out programs.

Alida: What about the availability of real time information. You mentioned in the early projects, GATE and AMTEX that you used satellite photo?

Lenschow: Yes.

Alida: But now you would have really current satellite and other information.

Lenschow: Yes. It's easier to get current information. Now you can just log on to the wed, Internet, and get it for yourself. In AMTEX we set up a relationship with Kadena Air Force Base in Okinawa and we had a couple people who would go out to that base and use their facilities to get satellite pictures and then bring them over to us. We were on another base.

Alida: A paper copy?

Lenschow: Yes, that's right. It had to be done that way. Things were a little more complicated. None of that stuff was…there was no such thing as the Internet. We couldn't do anything like that then. There were places where you could get satellite information when we were there but we had a political situation in AMTEX. The Japanese didn't want us on the U.S. Air Force Base, Kadena, because there was friction between Okinawa and the U.S. and the Japanese. It was kind of a sensitive subject. The U.S. Air Force Base on Japanese soil and we wanted to downplay that. So, they put us onto the Naha commercial airplane site, or airport, but it turns out that the Naha International Airport, or whatever it is, also had a small U.S. Naval Air Station. So, they let us park exactly on the borderline between the U.S. Naval Air Station and the civilian facility. We had our own little parking place there. It was kind of straddled along the…we had the best of both. We had the civilian facilities available to us and the Naval Air Station facilities. It worked out very well.

Rabson: Great.

Lenschow: Everyone's happy conclusion.

Rabson: Right.

I was just curious about using Air Force bases particularly years ago. Did people have to have security clearances to even set foot?

Lenschow: Sometimes and sometimes not. It seems to kind of vary with location. I guess it depends on what the base is doing ____ high level of clearance or…mostly that hasn't been a problem. If they know we're coming and if they have a list…they need to have things like your citizenship, passport number and all that kind of stuff, which you give them in advance all that kind of stuff. They probably would issue us a pass in most places so we could get onto the base by using some card or something. It hasn't really been a serious problem once we give them all our information it seems to be pretty amenable to allowing us sort of free entry.

Rabson: Were you involving in the TOGA-COARE project?

Lenschow: I didn't go, no.

Rabson: Can you think of, I'm just curious, any projects that the Electra was deployed on whether you were there or not that might have been dangerous in some way?

Lenschow: I don't think anything really…not particularly dangerous. There are risks just flying from California to Hawaii turned out to be a problem.

Rabson: You're right.

Lenschow: So in that sense, yes there are risks. There are risks to flying low long distances for sure if your out over the ocean and that kind of thing but I don't recall anything particularly dangerous; not anything from my experience.

Rabson: Ok.

Alida: Who were the pilots involved with the BOREAS project? Were they NCAR pilots?

Lenschow: Yes, all NCAR pilots. Henry Boynton, Lowell Genslinger, Jerry _____, who is no longer there and one more…can't think of it. There are two crews that…

Alida: Did they alternate it or rotate it out?

Lenschow: I forgot who the fourth one was. I don't think it was…Jerry's gone I know that.

Alida: Ragni? Jim Ragni?

Lenschow: Oh, Jim Ragni. Yes, I forgot.

Rabson: Wasn't he on the Kuwait project?

Alida: Yes, he was in Kuwait with Cindy Tuohy.

Lenschow: He was the chief pilot and when he left, Henry was _____.

Alida: Were there other aircraft involved? It was a NASA project?

Lenschow: In BOREAS?

Alida: Yes.

Lenschow: Oh yes, there were quite a few airplanes. Wyoming King Air was another NSF kind of deployment and NASA had two or three other airplanes up there. They had a C-130 up there for a short time…what else.

Alida: _____?

Lenschow: No, I don't think so. I think that was it, maybe just the C-130. It was a remote sensing airplane, it didn't do any low level flights it was all going up high.

Hosansky: Was the data _____ that you collected in BOREAS?

Lenschow: Yes, in BOREAS we were sort of a small piece of a large experiment and a little bit different then AMTEX where we were a much larger piece of the total pie here. But in BOREAS the plan was to integrate all kinds of datasets together and come up with some symphysis of that in order to determine what the role of Boreal Forest was. It was energy budget and the carbon dioxide or carbon budget. I don't have as much purview of that but I do know that both the Wyoming King Air and the Electra, which kind of worked together in that experiment and kind of coordinated similar flights. Another airplane was the Canadian Twin Otter and the Long Easy, the NOAA Long Easy. The planes that worked together mostly in that experiment were the Electra, the King Air and the Long Easy and the Twin Otter, yes four of them. From all of those datasets I think it was very successful and I provided a lot of information for modeling the

contribution that the Boreal Forest makes but I wasn't so much involved in that part of it. I was more involved in just the collection of data and then the kind of parameterizing the fluxes that we measured and integrating that with the other airplanes.

Rabson: I have a non-Electra question because by the time NCAR acquired the craft we were no longer doing atmospheric testing of nuclear weapons in the United States in the Pacific. However I know that meteorologists used to go out there and do testing before and after explosions. Do you have any idea of anyone at NCAR who ever involved in that in the 60's or…?

Lenschow: Who is still at NCAR? I mean Ed Martell of course…

Rabson: Ed Martell? He was involved with that?

Lenschow: Yes, his kind of work was looking at what happens with radioactive byproducts of nuclear testing. But another one was Ed Danielsen, who was at NCAR several of those years. He was very much involved.

Rabson: He was a chemist, is that right?

Lenschow: He was really a meteorologist who got into chemistry.

Rabson: Ok.

Lenschow: Actually he considered himself an artist as well.

Rabson: Ok.

Lenschow: Yes, he was trained as an artist. He went to art school.

Hosansky: A painter?

Lenschow: Yes, as a painter or also just, what do you call it, sketching, that type of thing. In a lot of his science presentations he did some very nice artwork in terms of defending his scientific involvement.

Hosansky: I'm sorry I didn't catch his name.

Lenschow: Ed Danielsen. He's dead now. He died about 3-4 years ago. He was at NCAR for over ten years and left about maybe 2-3 years ago. Then Julian Shedlovsky, do you remember him? He was involved in that type of work too.

Rabson: Right.

Lenschow: I don't remember where he is now but he went to NSF.

Rabson: Right.

Lenschow: I don't know if he is still there. I haven't heard anything from him.

Rabson: He has a phone number in Estes Park.

Lenschow: Oh he does?

Rabson: The reason I know that is because he was one of the extras in the Woody Allen movie, Sleeper, and we thought he was the one who picked the nose up at the end that had been steamrolled, apparently it was somebody else but I called him to see if he would like to make a comment about it. He never called back so…

Lenschow: If wanted someone who is available now he would probably be the best bet because he is _____ both Ed's, Ed Martell and ____ ____ _____.

Rabson: Right and we do have an interview with Ed Martell that Tony Delany did locally.

Lenschow: Of course Tony Delany was known.

Rabson: That's true.

Lenschow: He is kind of peripherally in that area as well.

Rabson: Right.

I was just kind of curious how the measurements were done and what kind of aircraft were used.

Lenschow: I don't think we ever did _____ _____.

Rabson: Ok.

Lenschow: I think the VOE…but also the ER-2…

Rabson: The predecessor.

Lenschow: ER-2 of course was a NASA airplane or maybe Air Force, I guess Air Force also. The ER-2 was involved in stratospheric collections and bomb fallout. Ed Danielsen spent a lot of time ___ ____ ___.

Hosansky: Do you do that at all with conventional bombs or only nuclear?

Lenschow: Only nuclear. If the radioactive debris _____ _____…

Hosansky: Ok, so it's not other types of…

Lenschow: Not the chemical…no that's… if you're doing chemistry conventional bombs are such a small fraction of what goes up into the stratosphere from _____ ___ _____ _____. I don't know of anything in that _____.

Hosansky: I gather it's from experience.

Rabson: Was the Electra involved to your knowledge in any way with the Mount Pinatubo eruption in the Philippines? That was around 1991 during the Gulf War.

Lenschow: I don't remember but it was…we were involved with the St. Helens eruption and in fact I don't remember which airplane it was but one of them got damaged by flying through all the ash causing engine problems and wore down the engines. I wouldn't say it was the Electra. I'm not sure which airplane. They did some collections when they flew through it they did some sampling and as a result suffered some damage. The thing is you can fly through some dust without much problems to the airplane but if it gets too heavy then you start to, I think you just start to wear parts in the engine, which is too much grit.

Rabson: I don't have any more questions. Do you have any or?

Hosansky: I have just one question I will throw out. This kind of goes back to what we were talking about before with the differences with _____ and more recently. Is there perhaps an example that you could give us of some type of reading that you would have been able to take using instruments on the Electra in the late 90's that you compare to when you started working with the Electra? Can you give us sense of the increased _____?

Lenschow: Ok. I can give you several examples of that. One is, of course, the Electra played a major role in Eldora. NCAR made a big investment in putting that radar system on the Electra with a fancy tail rodo-dome or whatever it's called. That was a very unique development. It was focused just on the Electra. Of course now we're going through trying to work with the Navy in putting a similar kind of component off of the P-3, off a Navy P-3 but that sort of kept the Electra in the stables for a longer period of time than it would have if we wouldn't had made that commitment for putting Eldora in the _____. Of course the Eldora has really very unique capabilities in terms of looking at storm structure. So, that's one thing, that's one big thing. Another thing is Lidars, another remote sensing instrument. The Electra has been used several times to deploy Lidars. In

BOREAS we had on a German Lidar water vapor dial system so we could get water vapor measurements below us ____ _____ _____.

Hosansky: I guess if you could take those sorts of water vapor measurements in BOREAS would you not have been able to do that say 20 years earlier?

Lenschow: That's right. We would not have been able to do that. That technology has been available maybe in the last 10 years or something like that. Before that I don't think there were water vapor dials, at least not any that were deployed on an operational basis on the airplane especially.

We had that system and of course NCAR has it's own SABLE, Scanning Aerosol Backscatter Lidar, which is now deployed but now it is on the C-130 but it was deployed also on the Electra. That gives us profiles of Aerosol in the atmosphere, which can be used to look at the structure of the atmosphere. That's one big change but also over the years the Electra has increasingly been used for a whole spectrum, a whole suite of chemistry measurements. The chemistry community has taken advantage of the Electra. An early program there was called…Doug Davis' program…I'm trying to think of the name of that. It was kind of a prototype chemistry program. Does that ring any bells?

Rabson: No.

Lenschow: That was not long after GATE. I remember when we were planning for that and this was the first really big global chemistry program where we flew all over the Pacific…funny I can't remember it.

Rabson: Does it end in "EX", like Termex, Bomax?

Lenschow: I don't even remember that.

Alida: I have a list on my desk.

Rabson: That's right.

Lenschow: GAMETAG.

Rabson: GAMETAG, right.

Lenschow: That was a program to keep in mind because that was historical because as far as I know it was the first really big chemistry program that was flown and it was flown on the Electra. So, the Electra played a key role in chemistry, tropospheric chemistry. Again that was the limitation and has been a limitation of the Electra. It really doesn't get up to the stratosphere so you can only do tropospheric chemistry. That was probably the first

really full-scale deployment of a whole suite of chemistry measurements. It was the prototype for later chemistry measurements. Glad you brought that up otherwise I would have…that was a good program that should be in the archives one way or another.

Rabson: Oh definitely.

Lenschow: That's where the Electra, in later years, has been more and more used for chemistry climates. It has the advantage…again we have the C-130 now but you can put a lot in instruments on that plane, it has a big carrying capacity. It has more floor space than the C-130. So, in one way it even had an advantage, not a bit advantage but it did have more floor space and sometimes your limited by floor space before you're limited by weight and by volume. There is only so much room to walk around and to put instruments in and that can be a problem.

Rabson: A couple of months ago I got onto a B-17 that was parked at Jeffco and I was shocked. I had to literally crawl down this hallway in order to find a place to stand up. It was awful.

Lenschow: The C-130…I was in ACE-1 on the C-130 and that was one of the things I remember about that program. I was mostly a scientific observer. My role was to sit up in front and kind of direct the flight. I wasn't involved so much actually on the measurements as I was kind of direct emissions. When I had to go to the back of the plane, these were long flights, I remember it would take several minutes to get back there because of bodies lying on the floor fixing an instrument across the isle or somebody trying to work something, work on a problem, there just wasn't enough room in there and the floor space was a limitation.

Hosansky: When you flew with the Electra it was much easier to walk around?

Lenschow: It was easier generally. It was easier to walk up and down. There are tradeoffs. The Electra was kind of long and thin, I mean long and narrow I should say. The C-130 is kind of squat and broad. So, you could with the Electra…there can still be problems like with the isles if you had a big instrument you might just straddle the whole airplane whereas in the C-130 you might be able to make some room. But still the C-130 has less floor space so overall space available was less. Another thing about the C-130 is that is has a lot of room vertically but that doesn't do a lot of good for a lot of applications.

Alida: If you could mount your instruments on the ceiling or on the wall…

Lenschow: Yes, if you could do that…

ACE-1, by the way, is another example of a chemistry program, primarily chemistry but also dynamics. Of course that's the C-130 but that's kind of…the Electra played a role in the evolution in terms of the early deployment of these large scale chemistry and global chemistry programs and the C-130 is going to carry it on from there because it has longer range, which is important for these global chemistry programs and flies maybe a little bit higher and a little bit faster, not a lot, but the main thing is longer range.

Rabson: I would like to thank you very much for agreeing to talk with us today. It's fascinating. The only other question I have is do you have any photographs that you might like to share from any of these programs?

Lenschow: I could take a look. There not easily accessible but I could take a look.

Rabson: Ok.

Lenschow: What would you be most interested in?

Rabson: I'm thinking about maybe something for staff notes. What kinds of things would you want to see David?

Hosansky: I have not even though about it.

Lenschow: A person who used to keep lots and lots of photographic types of stuff and documentation of the airplane was Norm Zrubek.

Rabson: Yes, he has agreed to talk with us so.

Lenschow: Good. Whenever I wanted a picture of something I would ask Norm.

Rabson: Right.

Lenschow: So, if you're going to talk to him it would be a good thing to ask him about it.

Rabson: Of course Nicolle and I are interested in instruments, different kinds of instruments.

Lenschow: He used to routinely take pictures of the configurations of the airplane for different programs…

Rabson: Great. Excellent.

Lenschow: …just to provide that documentation.

Alida: When we first got the Electra it was yellow?

Lenschow: That's right.

Alida: Had you referred to it as Tweety Bird?

Lenschow: Yes, that's right.

Alida: I'm dying to see a picture of this.

Rabson: Yes, me too.

END OF TAPE