[NOTE: This transcript consolidates the audio content of three MP3 files]

Lou Boezi: I am Lou Boezi. And I ended up as the Deputy Assistant Administrator for Modernization of the National Weather Service. That was about the 1990 time frame. I began work in the Federal Government at the National Bureau of Standards, or the National Institute of Standards and Technology in 1959. And I was at the Bureau of Standards until 1966, at which time I transferred to the National Weather Service. While at the Bureau of Standards, I was involved in the Computer Division. And at that time of course, computer development was in its infancy. We did a lot of computer system design and development work with a particular emphasis on the man/machine interface.

We had also a number of jobs with other Federal Agencies in the application of computer technology. So we had built some expertise in not only how to design a computer, but also how to use it, and then how to introduce them into various Agencies. We did work for NASA, for the Census Bureau, for FEMA [Federal Emergency Management Administration], and we did a lot of data acquisition work for the Bureau of Standards itself, we prototyped a modern linear accelerator. This was sort of the poor man's version back then. And we built at that time one of the most advanced computers in existence. There weren't too many computers that you could go buy then.

Barry Reichenbaugh: Right.

Lou Boezi: Sperry was making some, and IBM of course had some. But the interface was all through punched cards or tapes, a very crude kind of interface by today's standards. But the aspect of the man/machine interface was particularly interesting to me. A number of us at the Bureau of Standards in the middle 1960's then transferred to the Weather Service, because we also did a job for them. And that was with the Upper Air Program, to show whether or not a computer could be used to reduce an Upper Air sounding.

When we came to the Weather Service, it was with a purpose of beginning to deploy computer technology in its engineering and operations of the systems and data acquisition kind of functions. I came in 1967 into the Upper Air Program. And that is the program where we simultaneously across the Country launched balloons that carry electronic packages up to an altitude of about a hundred thousand feet. And during the ascent, information of pressure, temperature, and humidity is telemetered back to ground tracking equipment. And the ground tracking equipment looks like a small radar. In fact it was. It was a World War II type of technology, military green, etcetera. That information is then manually analyzed by technicians in the Weather Offices, and we get the temperature profiles and the humidity profiles. By tracking the balloons during the ascent in azimuth and range, we can deduce wind information. Now the computer technology at that time took some eleven hours to reduce one sounding. That is how slow it was.

3:50 The introduction of the Upper Air computer technology in field operations was of course a first in the National Weather Service. And it demonstrated some very profound dimensions of subsequent technologies that were useful to study and to know, and were quite frankly a benefit to me in my evolution in the Agency over a course of time. In a broad sweep, I went from an Upper Air Program Engineer to a Branch Chief, at the Systems Engineering Branch in the Engineering

Division. I worked on a special project with the new Deputy Director of the Weather Service, who at that that time was Richard Hallgren.

That program that we dealt with was the NOAA Weather Radio Program. It was the first expansion of that, and there were a lot of political issues surrounding it. Dick and I worked quite well. That then at a later time led to him to appointing me to head up a Recovery Program for a System that the Agency wanted to deploy called AFOS, which I will talk a little bit more about in a moment.

After AFOS, I began to work in the Systems Development Office for the advanced technologies that would become a part of the Modernization of the Agency. And in each of those technologies, their life cycles, and deployment to field operations, built a knowledge base that prepared not only me, but quite frankly prepared the Agency for ultimately grappling with this complex problem of Modernization.

I think it is useful to discuss the Weather Service in two contexts, Pre-Modernization and Post Modernization, and then the transition between those two generations of operations and services. First let me say that "service" in the Weather Service connotation is "the delivery of timely and accurate warnings to the public." It is as simple as that. In the Meteorological field, a warning is derived from a complex set of analysis that deals with a global dimension, and then scales down to a large regional scale dimension, and then to an area perhaps the size of a state. At that point, you are able to issue forecasts for states. But warnings are issued for very small-scale phenomenon. And you can only understand the development and evolution of a small-scale phenomenon by studying the large-scale phenomenon.

So, the issuances of forecasts are kind of free when you issue a warning, because they come along as a part of the process. The public of course depends on the weather, and I might add flood warnings, because that is the most life threatening, and short-fused, and complex phenomenon to study.

In the Pre-Modernization Era, the amount of data and information and the actual processes were quite crude that we used in comparison to the Post-Modernization Era. The Agency had a Distribution System for its data, products, and information that was basically nothing more than teletypewriter and facsimile circuits. And facsimile products are just paper charts, graphic products as we call them today. The products or the data were manually typed into the teletypewriter, and then were issued over these circuits that were called NOAA Weather Wire Circuits. The whole infrastructure of the Nation had access to those, the Emergency Management Offices, the local communities. There were very few television stations back at that time, but they were starting. The radio stations were a big outlet to the public, of course, and everybody had access to teletypewriter circuits.

8:58 The field structure at that time included two categories of forecasts and warning offices and river forecast centers. We had Weather Service Forecast Offices totaling about fifty-two I think was the number. It was roughly speaking one per state. And they had forecasting responsibilities for the whole state, and warning responsibilities for a small area within their sphere of knowledge, namely where they got their most important local data.

Associated with each Weather Service Forecast Office, or WSFO as we call it, were a series of smaller offices called Weather Service Offices, WSO's. And the WSO's, many were only part-time operation. Many were full-time, but they were typically one person per shift. The preponderance of the work done there was the collection of data, the surface data, the surface parameters, the launching of the upper air balloons, and also the issuances of warnings. The issuance of warnings at the local scale up until quite frankly fairly recently was absolutely mandated to be done on a small scale, because you had to be where the data was. And you had to have a considerable history of the geography and the terrain that were forecasting for that region. It was only later with the advent of the modernized observing technologies that it would become a part of the National Weather Service that you could broaden the concept of the warning operations.

10:46 The workforce in the Agency in the Pre-Modernized Era was one that was principally made up of Meteorological Technicians. There were degreed Meteorologists, but they were outnumbered about two to one. Roughly there was about two thousand Meteorological Technicians staffing the Offices, and about a thousand professional Meteorologists. In the Post-Modernized Era, those numbers would be reversed.

The operations as I said before in the Weather Offices were virtually all manual. There was no degree of automation. A forecaster would come on duty and look at all the facsimile charts on the walls, and those facsimile charts were products that were issued from the National Meteorological Center [NMC] by analog circuits. And they contained the forecasts that were prepared for very large-scaled parts of the Country at NMC. And they also contained some information on analysis and model outputs. They would look at the large-scale weather patterns on the wall. They would then read the forecast prepared by the previous shift. They would then look at all the surface data that were being collected almost continuously, and use that information to prepare their outlook for the next period of time while they were on shift. The amount of data that was coming into the Office comparatively speaking was very, very small. There were temperature readings, pressure readings; these are small amounts of information.

12;47 We had radar data at that time coming from a World War II type of radar. It was called the WSR57. WSR was Weather Search Radar, and 57 was the year in which it was acquired. It was strictly a World War II vintage piece of equipment with vacuum tubes. It had a Planned Position Indicator, PPI, type of scope where the radar would sweep around in a circle, and you would see these fuzzy blobs on it. The fuzzy blob in the weather world was weather. When those radars were used in the military during the war, they took steps to eliminate the weather, because that was noise. The signal they were looking for was aircraft, and weather could obliterate the aircraft signature.

That technology, although it was World War II, was pursued by a small group of scientists in the country, in the DOD, as well as the other parts of the Federal Government and a few Universities. The Doppler technology was the very interesting approach that was being pursued. It was first discovered and understood during the War, but the utility of the Doppler to detecting weather phenomenon and precursor atmospheric signatures that would lead to the full scale development of weather phenomenon was very exciting to those few people. And that was the beginning then of the modernized technology called NEXRAD.

So Research and Development on the NEXRAD type technology actually began underway in the '40's and 1950's in a very crude way, you couldn't go and buy a Doppler radar to study its' application, you had to build one. So it was a slow and tedious process. But the atmospheric scientists that pursued that were dogged. A head of steam was built, the Severe Storms Lab, in Norman, Oklahoma, and became a real force in the development of that technology, which subsequently led to the writing of specifications and the acquisition of NEXRAD.

15:28 Prior to the deployment of NEXRAD, the Weather Service had nothing more than the WSR57, which was deployed along the coastline after a major hurricane hit in the Massachusetts area. That caused Congress then to give money to the Agency to deploy some more. And, they hand-built these things and then acquired a bunch of them. We then spread them out across the Country. But initially, it was part of the Coastal Warning System.

As I said before, the acquisition of most of the data in a Weather Office was done locally, but not all of the data that was needed for that Office was generated locally. It came from some other places. The analysis of the data was all done manually with paper and pencil. And the preparation of the products and the subsequent transmission of the products was all manual. Lead times for a severe storm like a tornado for example, was usually measured in seconds and very few minutes [if at all], simply because we had no way of detecting any precursor activities. The actual phenomena itself was detected, almost always by someone on the ground someplace, who just got hit or almost got hit by the tornado or saw one, and they would call it in and the Weather Service would then immediately issue a warning.

[Pause in recording]

So the Weather Service was intimately tied to a local community in order to protect the local community. It was a community effort to do that. And that is a long and deep part of the history of the National Weather Service across this Country, which subsequently during the transition to the Modernized Era, proved to be a very large stumbling block, because of this local community relationship.

17:38 So the strong relationship was vital between the local community, and the Weather Service operation proved to enhance our services. And it subsequently proved to be problematic to a certain degree, because ultimately a large number of local offices were to be closed. That put an increased emphasis on the Weather Service to show that there would be no degradation in our service operations.

We also collected in the Weather Offices hydrologic data from river gages for flash flooding, but the ability to predict the flooding phenomenon was somewhat limited because of lack of instrumentation throughout the river basins and the major water sheds. But by and large, we had a River Forecast Center associated with the major watersheds in the Country. And through close affiliations with other Government Agencies in the Federal level, and the State and local communities, the River Forecast Center acquired data that was shared and distributed amongst all interested parties. That information was also provided to the forecasters in the Forecast Offices. But in that era the River Forecast Centers most of them were in separate locations. Subsequently in the Modernized Era, they were co-located with the future Weather Forecast Offices.

19:15 The NOAA Weather Radio Program that I mentioned earlier was again a coastal system, whereby a person would manually record a warning or a forecast or a series of forecasts and sea-surface conditions like wave heights and major storm systems, and were principally used and sent out over a VHF Radio link to mariner's along the coastline. The coverage was not very long, twenty or thirty miles out to sea, but that's where most of the shipping routes were anyhow. The recreational boaters, the fishing fleets -- it was a very popular program that grew in terms of deployment through the tornado belt in the country. It was just another way of getting information to the public.

In the middle 1970's, the Weather Service wanted to expand that program, and that is when I met Dick Hallgren. It turns out that the telephone company thought they wanted to provide us NOAA Weather Radio transmitters. Of course it had nothing to do with their telephone business, but they thought
it was a neat way of getting further into the Federal coffers, and they pulled some political strings. We were almost at the point of being directed by the Office of Management Budget that we were going to acquire this -- future transmitters from the phone company. And for a protracted period of time we resisted that and subsequently we got approval to go acquire those systems apart from the telephone company. Some three hundred transmitters were then deployed. The deployment and upgrade of that System grew throughout the '70's, '80's, and 90's, and still goes on today. Again, it is very closely coupled to local community needs. And today many of the transmitters are provided to us by the local communities. We maintain them and then use them to transmit the signals.

21:54 If you are in a severe weather prone area, you know about NOAA Weather Radio. If you are not, you don't know about it. It is the nature of the beast, but as time goes by, perhaps its life will be measured in some few number of decades, because iPads, iPods, Smart Phones, and every other kind of technology. Many, many cars today have NOAA Weather Radios in them. They serve a useful purpose; I have one in my house. We rely on it, because we are doing other things and that sends a signal out that turns on the radio and you get the warning issued, then it turns itself off and goes to sleep and waits until the Weather Service sends another signal out for the next storm. So it has a very useful purpose. It is a very simple technology, but it's a close tie to local communities, which further strengthen the Weather Service relationships.

23:04 The first Polar Orbiting Satellites were launched in the 1970's. And subsequently the Geostationary Satellites were launched in the 1980's. .. Since then, there has been a constant constellation of satellites covering the United States. But the Weather Service in the Pre-Modernized Era had access to virtually none of that data or information. A small system was deployed in the '80's called SWIS, Satellite Weather Information System. And basically it was a monitor that would show some of the satellite coverage's. It had very little if any of the soundings, the measurements that were available. It was a sad commentary that the Weather Service did not have the techniques and the systems to use this information, but nonetheless they were there. They (satellite data and information) would subsequently prove to be a very powerful tool in the concept of operation for the future Weather Service. And were very much in the planning and development stages coincident with the evolution of the Modernization.

In the late 1970's, the Weather Service began the development of a replacement for the teletypewriter system. And it was a system that was started again by Dick Hallgren called AFOS, A – F – O – S. Automation of Field Operations and Services, that's what AFOS stood for. The intent of that System was to begin to acquire some of the data and information that was available to the local forecasters, but not all of it. For example, it was not intended to integrate radar data. But it was intended to acquire the guidance products out of the National Meteorological Center; the Surface Observations that were all being collected manually was going to automate some of that. And it was going to replace the teletypewriter. So at that time, it was not used as a transition to any other future technology, but a realistic attempt to acquire and automate some of the manually intensive processes that were underway in the Weather Service.

The acquisition of that technology was done in two parts. The computer consoles were to be built by Ford Aerospace out in Palo Alto, California. The software development, the meteorological application software, was to be done in-house by software engineers in the Weather Service who really were new to the Weather Service, and did not have much Agency experience. Some did have some Meteorological experience in the military, but by and large it was to be a classic development process where
requirements were written down, usually by some engineer and reviewed by some Meteorologist. And then those requirements were given to the software developers and they would try and satisfy those requirements. And that model of technology development would always be a surprise to the end user, because they had very little involvement with it. It was the "aha moment" when the truck pulled up and this was going to be your system and you are going to be happy with it. That was a process that was followed many, many times. Now in most applications you could do that, but in the forecasting business it is not so easy, simply because the meteorological understanding, the meteorological science, is not all that great of the phenomena that you are trying to forecast. Forecasters use their own mental models of what dynamic is occurring. And by looking at data, information, and model projections, they get a mental picture of what the weather is that is evolving and how it might evolve. And how it might ultimately get down to the small-scale life threatening phenomena, the severe storms and tornado.

As you start to add more data and information to this mental process, the data either simply helps or hinders the forecaster. If it is presented in two much quantity without a whole lot of thought and quality to it, it will be discarded. There is not enough time to assimilate it, to discern what information is in that data. And in the press of time, there is very little that can be assimilated if it is nothing but raw, bulk format. As you have the opportunity through new technologies like a new Doppler radar or a Satellite System, you have the opportunity to get a large amount of information, and it is incumbent upon the designers then of the AFOS System, or an AWIP System in later years, to understand how the forecaster can use that.

29:50 A good example is the number of mouse clicks that are required to get through a menu to display a set of analysis or a set of products, be it a satellite images or radar images or forecast products that were generated by some algorithm running. If you are dealing in minutes and seconds, in terms of it being life threatening, you can't spend ten or fifteen seconds clicking the mouse to get the information up on the screen. And we learned that through a whole series of risk reduction activities that were begun, but they had not begun for AFOS. They had begun later after AFOS was deployed. It was one of the lessons that we learned in the development process.

AFOS ultimately proved at the time of its first scheduled deployment to be a failure. The software simply did not work, and what little did work was not useful to the field forecaster. That posed a big problem to the Agency of course; it was a System that was forty million dollars as budgeted. And it was the first major piece of technology, aside from the Upper Air System, which by comparison was only two or three million dollars, but it proved to be quite an embarrassing situation for the Agency. Because, prior to the delivery date there had to be a lot of facilities work done to accommodate this like raise*d* floors, air conditioning had to be added, and cabling had to be brought in. That sort of thing. In order to make room in the forecast offices across the country, you had to take all the teletypewriters out and shove them in the halls and in the back rooms. People did their work sitting in the halls and sitting in the back rooms where the teletypes were while this brand new floor was there waiting for the consoles to come, which subsequently they did. Ford Aerospace delivered the consoles, but they could not be used because the software was not developed. When the software was put onto the computers, it was not very useful, and it was not very reliable. And the System sat there and the forecasters worked in the back rooms and in the closets, and the teletypewriters continued to clank and bang. It was a very bad work environment. It was another lesson learned. You had to understand how to introduce the technology. We did not know that beforehand, but we learned that as a hard lesson. And subsequently we learned that the end user had to be intimately involved in the development of the system.

In the late 1970's I was asked by Dick Hallgren to lead a recovery team to try to salvage the AFOS technology. I assembled a group of about a hundred or so people here in the headquarters, developers and engineers. And we set a whole series of plans out to improve the development and to get something working. I made a series of trips around the country, because the field operations were pretty disheartened that we could not deploy this equipment. And their work environment was so bad because of the anticipated use of this new workspace, which was not usable to them. I would venture to say that virtually none of the developers in the Washington area had any idea of the plight of Forecast Operations. That was quite an eye opener to me, and subsequently it proved to be a valuable bit of learning on my part, which we used then in the development of the Modernization Program.

I remember a visit to the Forecast Office down in Suitland, Maryland, where I was explaining to the staff on duty what we were going to do with AFOS to try and make it work. I had all these nice charts and I was giving all this engineering talk and the forecaster's heads were nodding off. One of them at one point said, "This will fail as it has before." That was Randy Racer, the meteorologist forecaster who predicted that failure, and I inquired as to why? He flat out said, "You have no earthly idea what we are living through here while you people are over there in headquarters developing the System." He then proceeded to give me a lecture, which was quite an eye opener. I subsequently brought him into headquarters and we made contact with a number of people in the Weather Service Field Operations who were struggling with trying to get some value out of the workstations that were sitting in their Offices. Sandy MacDonald was out in the [NWS] Western Region, and Denny Walts was in the Central Region, and Gary Grice was in the Southern Region. They were all trying to improve the situation in the Forecast offices. They were not afraid of technology, but they had little capability to use it. But, use it they tried. They were very keen on making it a useful tool for the Forecaster's, because they saw potential.

When we asked for regional help, they quickly volunteered. We had an understanding that they carried as much weight in any decision on what was to be deployed and when it was acceptable to be deployed. They carried as much weight to make those decisions as any developer here in Washington. They gleefully accepted that responsibility. They were able to go back home and convince the local regional staffs that something was going to be delivered, and that the field was going to have a say as to what it would do and how it would do it. That was honestly the key to the subsequent successful deployment of AFOS.

37:46 Now because the system failed and because it costs so much money, that created a furor in the bureaucracy in Washington. The oversight committees and Congress wanted to know what was happening, and why it was not working. There were a number of hearings, and Congress sent out the technologists from the General Accounting Office to do a study as to what is wrong with this system. The GAO folks were running around the building just about the time that we had formulated our recovery plans and were setting out to make the system usable. And it was their opinion that we ought to stop. Not that we might not get it to work, but that even if it did work, there was more information that was going to be available that the system couldn't handle. There were no plans to integrate satellite information into it. We had this little workstation called SWIS as I mentioned earlier. There were no plans to integrate the WSR57 Radar into it. And yet it was already clear that there was NEXRAD-like development underway that was in the future. The geostationary satellites were being deployed, and that was also in the future. They were real and they were coming. So their logic was, "You ought to stop the development of AFOS and to develop another
System that would actually meet your needs." Well it was easy for them to say. It was not easy for an Executive Branch department to say, "Okay, we will just trash that and go build another one." We could never get the money. Not only was it not a plausible thing for us to do, but Denny Walts in the Central Region had made enough progress and had seen enough progress in the development work that we were doing that he was convinced that this was going to be a useful tool. Of course the reality of the situation is that if we decided to defer AFOS to some successor system, that would be perhaps a decade or so away. And the plight of the forecast office was back to the teletypes for another decade. Untenable. We had to make it work.

There was a series of actual debates that we had up on the floor of the Congress with the technologists in the GAO before the Committee Staff. They would assert something or other, and we would assert something contrary to that. And it got to the point where we had to publicly demonstrate that what we were saying in fact was true. And we did that. We actually had a demonstration, subsequently, of AFOS doing its thing, and the service operations of the Weather Service not being degraded. And Randy Racer again, was a key figure in identifying what is it that we could demonstrate…that was not so overbearing and likely to fail. It had to be something that was meaningful and something that we could handle in a relatively short period of time. He argued quite successfully that, "Look, the principal service that we provide is the issuance of warnings in a timely manner over teletype circuits. They get out to all of the local communities in a way in which they can use them. So why don't we demonstrate that a cluster of local offices could do exactly the same thing. Issue warnings over a period of time while using AFOS and its communication system. And we should be able to demonstrate that we could do that without degradation." Which is what we did.

42:30 We were able to demonstrate that, we used the Central Region Circuit. AFOS communications is what was called a store and forward type of logic, where information, products, warnings, came out of a Weather Office and went in two directions. It went to the next office, if you can envision a communications circuit that ringed the county, and then data would go left and right when it came out of a Weather Office. And it would meet on the other side of the circle at some point in time. And the reason why it was sent bi-directionally was for reliability purposes. The teletypewriter circuits were built that way. If there were a break in a circuit, the data would get all the way around the circuit to that break. And everybody prior to the break would get that product. The Office that was down would not get it, but everybody else in the country would.

That store and forward concept is not used much nowadays, but at the time that was kind of novel and it worked. And the Central Region had such a circuit, and that is what we used to demonstrate that AFOS was useful. The demonstration was a success, and we were allowed to continue and encouraged strongly to get on also with the next system, which Dick Hallgren had already been scheming on that dimension. Sandy MacDonald, Don Beran and the people in the Atmospheric Research Labs of NOAA out in Boulder, had a prototyping activity [PROFS – Prototype Regional Observing and Forecasting System] began out there in the 1980s I guess it was. My mind is wandering. I think it was around the '80s to begin to experiment with the application of all of these futuristic, very complex data sets. Many of which were provided by the National Centers for Atmospheric Research, NCAR. They had some Doppler radar that they had hand-built. They had access to the satellite information. So a series of systems were prototyped, and the advanced data sets were examined and analytical tools and techniques were experimented with. Then we began to transition field forecasters into their office [in Boulder] to expose them to this new technology. That was sort of the infant period of the subsequent AWIPS System that would eventually replace AFOS.

45:44 -AWIPS was the Advanced Weather Interactive Processing System- And over a period of a decade or so with ever-increasing complexity that proved to be a very innovative and useful approach to developing a complex system. They pioneered a rapid prototyping methodology in this process that was really unheard of. However, to this day, is more practiced than any other approach. Not only within the Weather Service, but in industry as well. It is far easier and less risky to evolve a system in a piece meal fashion, and take advantage of what you can build and what you can use as rapidly as you can build it. And not wait for some tremendous moment in the future when everything is working and all the bells and whistles are there before trying to improve them. The systems of this type are very, very complicated. You will never get to a day when everything is working perfectly and there is nothing else to do. There is always an evolution required. So if your scientific understanding is evolving and the data sets and data sources are evolving, the information handling system has to evolve as well. So test a little bit, build a little bit, operate a little bit, and test a little bit. This incremental approach to, evolutionary approach- was begun out at the Boulder Labs and is still in use to this day.

47:56 In the modernized era, the concept of service is still exactly the same -- with one caveat. The lead-time for the warnings is substantially improved. And it is substantially improved because of the sophistication of the radar technology and the satellite technology to detect the precursor atmospheric conditions that will subsequently yield tens of minutes time lead to the development of a tornado. So service in the modernized era is the same concept it's just improved.

The Distribution System in the modernized era has to be something other than the old store and forward circuit that had bandwidth problems and finite limitations. And of course society has evolved and the industry has evolved. The Internet concept was growing through the '80's, and actually began in the '60's. Some of the work we did at the Bureau of Standards was a part of the DARPA, that's D – A – R – P – A, and I forgot what the acronym stands for [Defense Advanced Research Project Agency] but they built it, initially and we had some involvement with it so we were aware of the evolution in that regard. So the industry and marketplace was providing opportunities for a distribution system for these data sets that was quite useful to the Weather Service. And AWIPS and its mechanism called NOAAPORT would be the Distribution System in the modernized era.

50:02 The Field Office structure would change dramatically because we had a concept of operation that dealt with the environmental coverage that was provided through the use of satellites and radar and Automated Surface Observing Systems and networks and sources of data from outside agencies and departments and universities and industries. We had the onslaught of an enormous amount of data and information, and it had been fielded, tested, and demonstrated that we could provide an equivalent level of service from a fewer number of offices. [So long as the technology was available, the data sources were available and AWIPS were available.] The projections were that we would consolidate the fifty-two Forecast Offices and some round number, a hundred and fifty WSO's of the previous era into a hundred and twenty super Forecast Offices. Weather Forecast Offices, WFOs is what we called them.

The River Forecast Centers would still be aligned with the major watersheds in the country, but they would now be physically co-located in the WFOs. As I said earlier, the workforce would transform to a makeup that could best understand the advances in the science that was rapidly happening. And also to best utilize the advanced data and information that was coming. So there were tradeoffs between how much a person could do and assimilate, and how much the technology could do to assist. And judgments were made. And subsequently we tested those concepts prior to finishing the Modernization, and did so successfully.

52:27 The Operations in the Modernized Era was to be highly automated. AWIPS was at the hub, acquiring all of the information from the satellites, and the radars, and surface equipments and any source real time. Now a single satellite generates an enormous amount of data. It is constantly sending through very large bandwidth telemetry links, enormous amounts of imagery and measurement data, the sounding data. Then additional products are added to that data stream. One radar will generate the equivalent of one satellite. And we were going to deploy roughly a hundred and sixty-five Doppler radars. We had an extraordinary amount of information now coming in. And as I said before, it had to be presented in such a way that a forecaster in a warning type environment could receive, assimilate it, analyze it, and make a decision as to what the weather was going to be like in the next few minutes. This highly-automated assisted process also allowed us to restrain the number of employees that we needed, because if the human couldn't deal with this, then you had to have more humans to deal with the information. So if you wanted to consolidate the number of field offices, you couldn't offset that by adding more staff to accommodate the equipment with what the equipment couldn't do. So again there were tradeoffs between what people can do and what systems could do and how many people you needed in the offices that you needed.

54:30 The data sources that were planned all were in this concept of coverage that I mentioned earlier. They included the automation of the surface observations, ASOS. We still had the upper air soundings, the balloons were still going up, but we had automated that data collection process. We anticipated a hundred and sixty-five Doppler radar's, two geostationary satellites, and a constellation of polar orbiting satellites. Hydrologic data throughout the country, through the Corps of Engineers and other agencies was being automated, so there was a wealth of hydrologic data that was being collected in real time. All of this data was going through a very sophisticated process of assimilation and analysis and data reduction to make it most useful.

Now the transition then between the Pre-Modernized Era and the Post-Modernized Era has to deal with people, places, and things. The workforce needed to be transformed from one that was principally para professional in the beginning period to one that was mostly professional. That meant we had to anticipate hiring a large number of college graduates. They had to be trained in the new science. They had to be exposed to the new data and information over the period of the development of the technologies through the '80s and '90s and subsequent to that. Universities of course were beginning acquire similar kind of data sets. They knew what was going on in the government laboratories. Many of them had participated in some degree and fashion. So as time went by, the training and education was greatly assisted by the university community. So the students that we were hiring already had some familiarity with this approach. They did not know much about Weather Service operations, but that was a part of the training activity. So there was a fairly elaborate human transition that had to take place in the workforce of the agency. Concurrent with that then of course was a fairly extensive training activity that was required, not only in the science, but also in the technology. It was a very sophisticated suite of equipment. The use of the systems themselves, AWIPS in particular, needed to be anticipated.

The Modernization and Associated Restructuring, that name was carefully chosen, again by Dick Hallgren. The term modernization is synonymous with the introduction of the new technologies, , the NEXRADs, the ASOSs, the AWIPSs, and the satellites. The Associated Restructuring dealt with the transformation of the workforce, the construction and consolidation of field offices, and the training of all of the employees, and the subsequent certification that we were -- would be required to demonstrate no degradation of service. While there was prototyping work going on in the Boulder Labs, there were many unanswered questions that would be encountered in the transition of the workforce and the adaptation of the new hires to field operations and in the transformation of operations during the transition period. There was no method available to answer those questions, so we started on that series of activities that I called Risk Reduction. In part, this was an attempt to utilize the field operations, the field personnel to help us to make this equipment, this technology useful. And in part it was an attempt to head off any major calamity. This was a massive undertaking that was being planned. It had to be done 24/7 in real time. We couldn't afford to shut down an office and then five months later start up the new one.

1:00:15 Forecasts and Warnings had to go out whenever a storm happened, or by the clock. The Risk Reduction activities proved to be a real Godsend in that they were designed and conducted by the Regions in operating forecast offices. They convinced themselves that they could make the necessary changes in operations. They convinced themselves that the new technologies were

advantageous to them, and would be useful in a warning environment. That was the underlying strategy that we had always hoped for. We felt in the early development exposure that we had that this new equipment would be really quite useful. Remembering AFOS, you can't just have a few people, developers, forecast that it was going to be useful. We tried to create what we call today a sort of a "Demand Pull." We wanted an environment where everybody in the field was clamoring for this, because if they thought it was useful for the delivery of their services, then they would make it work and they would make it happen. And subsequently, that turned out to be the case.

[End of recording segment]

Part 2 Begins

Counter re-set to 00:00

00:00 Lou Boezi: The transition was a process that occurred in real time 24/7 over a multi-year period, and it occurred throughout the country. And it involved a series of processes of building new facilities, hiring new people, introducing all the new technologies that were coming from different contractors under different contracts over different periods of time, and going through formal commissioning processes to make sure that those technologies were workable and working and could be supported, etcetera. The agency had a lot of history in the commissioning of equipment, decommissioning the old systems when they were no longer needed, and then aiding and assisting our user community as we made this transformation.

Now, this is the same user community that in the past we relied heavily on to deliver services. We lived in those communities. And our kids went to those schools. And some number of those communities were going to lose a Weather Office, because we didn't need two hundred and thirty Weather Offices any longer. We could get by with something on the order of magnitude of a hundred and twenty and still provide the same level of services, we felt, but it was not a universally accepted opinion in the country. You don't close a Weather Office and you don't close a Post Office without an awful lot of flack from the Congress. And we anticipated that, we knew that, but the transition process allocated a lot of time to cultivating community acceptance of this change. The responsibility for that was at the local level.

If the forecaster's believed that these sets of tools would improve their ability to deliver service, they could best and most convincingly sell that promise to the local community. The local community knew them, for decades had trusted them. These were the same people who enthusiastically were saying, "Man, have I got something neat to show you. This is what we can do with it, and this is what it means to you. And this is how we are going to make these series of changes. We are going to be with you every step of the way. In the end, you're going to be better off if you're an Emergency Manager, or you're a Chief of Police, or whatever the local infrastructure that exists is, this is how you are going to be affected, and when and why. And I'll be here to help you. Now my office might be across the state, but with the new communications and etcetera etcetera - but we are not going to make a change, and we're not going to shut down that old office unless you are happy."

That went a long way to ultimately making the country sanguine about these sets of changes. And it also helped the Congress if they knew that their local constituents were intimately involved and aware of what was going on, and knew that they could confront the local forecasters with "I am not happy with this." And he would do something to fix whatever they were unhappy with. That relived the pressure on the Congress. These series of changes were accompanied by public law and oversight. And that in a legalistic way satisfied the country's demand that there would be no degradation in services. I'll mention more about that in just a minute.

4:20 The transition of course included the acquisition then of the equipments, and those went along in a reasonable fashion. Each technology would have hiccups and bumps along the way, but ultimately proved to be quite successful. There was a point in time when the NEXRAD deployment had been delayed, because there was difficulty in getting the prototypes working. And there were in fact discussions in the Department of Commerce about terminating that project. And as it turned out the very day that there was to be one of those meetings, the Director of the Weather Service at that time was Joe Friday, was able to walk into that meeting with a series of images that had been overnighted to us from Norman, Oklahoma, where the first prototype was installed. And that night, a series of tornadoes went running over Norman, Oklahoma, and NEXRAD detected every one of them and showed them on the images. The warnings were issued in a timely fashion. And while the "suits" in Washington were talking about terminating the Program, Joe was able to lay out these charts and said, "This is what we've got." And that was the end of that discussion.

The Company [the NEXRAD contractor] was delayed for a variety of reasons. These are complex systems. They were not derelict in their responsibilities. They are just complex systems, and they were able to deploy them.

06:13 The ASOS System, the Automation of Surface Observations was also a complex piece of technology. It measured in real time things like pressure, temperature, humidity, runway visibility, sky conditions, and precipitation types and amounts. These are things that were done manually before. We worked closely in the Weather Service with the FAA to support flight operations in this country. And these surface parameters were also generated by FAA personnel and DOD personnel, the Air Force, and whatnot, Navy. The notion of automating them meant first and foremost the loss of a human. And the human observer was a long tradition in this country for a hundred years we had observers. And the cooperative weather observer was a very prominent position across the country in towns. We shared their data. They gave us their data, and it was a badge of honor to be a cooperative observer. It is a two way street. We needed them and they needed us.

07:35 So the notion of automating this to an engineer sounds rather straightforward. It is a very complicated set of measurements and observations unfortunately. And the human acceptance, that dimension of this automated system, was something that would have been very difficult internal to the Weather Service, but even more difficult when you had to deal with other agencies, especially in the case of the FAA. That is their lifeblood- observations. They either have them, or planes don't fly. That was the nature of the business at that time. Now other information like radar data and satellite information is available in the cockpits. But at the time with the planning phases here, the notion of having the surface observation replaced by a piece of equipment and the person would not be there, was very unsettling to our sister agencies.

However, it was necessary for economy of scale for the Agencies to get together, in the Federal Government, to acquire that ASOS System, as it was with NEXRAD. There were applications for NEXRAD in the Air Force, as well as the FAA. When I mentioned a hundred and sixty-five Doppler Radars that was through a tri-agency acquisition process. The Project Office was hosted in the Weather Service. The ASOS Project Office then for the three agencies was going to be hosted in the FAA, who were undergoing a major modernization in their tower operations as well. That went on for decades in the FAA.

And the surface observations, the loss of employees at that time in the FAA, had the added dimension of the Unions - PATCO, or whatever they called in the FAA. They were very influential. And the notion that one of their employees, whose sole function was taking observations, would be replaced by a piece of equipment would die-hard. So that was another twist that would cause that acquisition to get delayed. The Weather Service subsequently took over the lead of that acquisition and brought that in-house.

The satellites were of course developed by National Environmental [Satellite] Data, and Information Service, a part of NOAA. And that went reasonably well. Those were major acquisitions with very complex technologies. Very keen competitions in the industry to build them for us. They had some problems as well, technological problems, which all of these major systems run into.

Each of these systems had a life cycle unto itself. The acquisitions involve multiple years. And then the fabrication and deployment and activation and operational commissioning of each of the equipments went on for many months. And it varied by systems. ASOS for example, took about four months to fully commission it. NEXRAD took like nine months. It took several years, but this was done centrally in the case of satellites to commission them, because they had to go through an elaborate testing processes and validations. But once they were operating, then the data were available to everybody. A facilities project would take forty-four months from the initial acquisition of land, permits, the design, construction, and government acceptance and turning it over. Each of these pieces of elements of the modernization had a sort of a life cycle and a time line unto itself.

The turnover in the workforce had a natural rhythm to it, because you had employees who were always coming of age for retirement and being replaced. So you needed to work in the new hires. You also needed to anticipate the location where the new hires were to show up for work. Were they to be in the new offices or in the old offices, and a part of the physical transformation? A very complicated set of schedules as you can imagine now are evolving here, conceptually. And we had a planning scheme that was put together to organize all this activity. And it had dimensions at the national level, the regional level, and the local office level.

13:05 Regions play a very key role in the operations of the Weather Offices. Regions insure the continuity of services, should a given office have a major catastrophe, a major failure. Regions would invoke the backup arrangements and the temporary reassignments of personnel from one office to another, or the reallocation of service responsibilities from one office to another set of offices. So the regions had a key -- of course did the hiring of the staff. So at the national level we had all these major contracts, all the facilities projects being organized and handled. At the regional level, they had a set of responsibilities for the office transitions, to the service transitions, for the

continuity of services. And then at the local level, the MIC, the Meteorologist In Charge, had the ultimate responsibility to make it happen on his watch, at his location. A substantial part of that local responsibility was bringing the local community along with them.

We had as I said before, a series of risk reductions activities in each of the regions. They addressed many of the dimensions that I just talked about in terms of the phasing, and the execution of the transition at the local level. They were run locally and were successful in every case, because the people locally wanted to solve these problems; they were affecting their own personal lives in this process. And they had to confront the user community, or were confronted by the user community.

15:11 I mentioned before that to get government acceptance of AFOS, we had to run the test. We knew that we had to demonstrate not only to ourselves, but also subsequently to the nation at large, that the modernized concept would work. We had risk reduction activities. We had the systems under development and test. We knew all the pieces worked separately. We knew how to do it. But you had to get public acceptance that this in fact would work. We knew our people knew that they would work. They knew how to make it work, but we had to set up a process for a national demonstration. We had always anticipated this internally. It was a lesson from AFOS.

But the overall scale of the modernization became more and more apparent to the policy people in the Government, the Executive branch, and to the Congress. Because the evolution of each of the technologies came along at its own pace, the origins were different in time. NEXRAD, as I said before, was under development and in various pieces back in the ‘50s and ‘60s and ‘70s. So the talk as it were in the Budget Offices in Congress went along through that period. ASOS came along at a later time.

AWIPS came along yet later. And pretty soon we had this massive facilities project that was looming. Now the budget folks saw the dimensions of this and we had a whole series of briefings to the Congress as to how this was going to work. Congress felt then they had to set into legislation some conditions for us to meet. And along came Public Law 100-685, which said in essence that through this transition there should be no degradation in service. And that the Secretary of Commerce before he made any change in a local office to close it or relocate it, he had to certify that there was no degradation in service. And that had to be done for each and every office that you were to close, or even some of the equipment that you wanted to decommission. You had to go through this elaborate process.

18:13 We had always planned a national set of implementation plans. At the national level they dealt with the major acquisitions and the major contracts and procurement. At the regional level they dealt with the human transitions, the hiring of people, the training of people, the availability of people at the new offices and manning the old offices while the equipment was being transitioned. At the local level the workforce was in a state of flux. Some were retiring, and many people decided they were not going to get involved in this new technology. On the other hand, you would bring in new kids out of college who had no idea how a Weather Service operated, but boy they knew how a computer operated. So you had this exciting dimension. Then you had this apprehensive user community.

So our planning then was a hierarchy of documents. One of the conditions of the Public Law was that we had to report yearly on the condition of each of these transitions of each office in the country. We developed the National Transition Database, as it were, and a set of planning documents at each of the levels. And the field offices, the Regional Offices, and the major program acquisition offices would input the state of their affairs into this national database. We automatically assimilated this and prepared a report for Congress that told them what was going to happen in each office in their area of concern, their district, or their state, when it was going to happen, how it was going to happen, to whom it was going to happen, who was going to execute it, and how would they know that it was done successfully. And, how did we interact with their constituents in this process.

This one set of unified documents in the National Database then was a repository for all this information. At any point in time, you could make a complete runoff of the status of the modernization across the entire Country. And of course then Congress picked up on this notion of this demonstration project that we had anticipated, and they insisted we formalize that as well. So again we proposed a very dramatic test. We took tornado alley and we proposed that we would install AWIPS, the NEXRADs would be there, the ASOSs would be there, the staff would be there, trained, and ready to go. We would operate for a projected period of time handling each and every weather situation that came, and we would improve our service. The same service, the same issuance of warnings, but we would improve the timeliness and accuracy. It sounded like a big risk, but we had so much risk reduction activities, we had so much prototyping in Boulder labs and Norman, Oklahoma, we were quite confident and our field was confident. They were happy to have this technology. They knew they could make it work. We then ran this whole demonstration period and it was successful, which then allowed us to proceed with the national deployment and the national transformation of the National Weather Service.

[pause in recording]

21:52 Lou Boezi: Technology changes. You always find new ways of improving things. Some equipment becomes obsolete. Each of the technologies in the modernization was thought about and designed to continue to evolve. In previous eras, you built radar and it would in concept never change. In the current modern era, the technology, the information processing, the computer application software is always changing. And if you channel it properly, then it is always changing for the better. And if the people who are using it understand better the atmospheric phenomena that they are trying to use this information to detect and discern, then they'll provide you insights on how their job could be better done. So the evolution, the modernization, was always thought internally in the Weather Service, to be a continual evolutionary process. No more stand-alone, one-step fits all kind of a thing.

NEXRAD was designed with evolution in mind. And ASOS always had the ability to incorporate new sensor technologies as the techniques and the processes could be acquired. And of course AWIPS was key to subsequent evolution. As the current iPads demonstrate, you know the workstation of ten years ago is now held in your hand essentially. And while a large agency is ponderous in some regard, the Weather Service, the modernization, positioned the agency to evolve, and in effect continues to do that to this day.

24:06 The Public Law was satisfied. One aspect of that Public Law that turned out to be quite beneficial was the use of the National Academy of Sciences to provide an independent oversight. And we had them under contract for many years. We would meet with them and brief them, and they would take tours and visits all around the country. When it came time for certification, they looked at all of our criteria. And in each and every case for each and every site, they would review those performances that we said we had met, they would review our database. They were available to any community in the country who was concerned.

They would go out and hold hearings as warranted. And they always followed the same process. Someone in the country would write to their Congressmen, who would divert the letter to the Academy, questioning the modernization at such and such a location. And we would set up a public meeting there. And the local MIC, the Meteorologist In Charge, would come in with his whole set of plans and his whole set of tests that he ran and the whole set of coordination activities that he ran. And he would present, he or she would present, the government's argument for making the transition at this point in time. The public would hear that and would counter. The MIC would offer further arguments, and then the public would be satisfied. Now it sounds kind of simple, but that is in fact what would happen time and again. The public where there was concern almost wanted to be sure that it wasn't some suits in Washington that was dictating this change. When the local Meteorologist in Charge led the whole discussion, and he had the whole Academy of Science sitting there enthralled with what they were saying and applauding the results, you couldn't deny the results, that the community was then satisfied that this was a useful thing. And then word would get back to the Congressmen that everything was okay.

26:53 In a few cases we had an AFOS delay, because the user committee couldn't accommodate the changes. Back in the teletype era, in the AFOS period when AFOS was going in, and we were trying to pull out the teletype circuits, that took years and years and years to happen, because all of the local offices just used teletypes. We have an analogous situation today in the medical profession. The vast majority of doctor's medical offices communicate by facsimile. They don't use the Internet. And there are still medical offices that don't have even fax machines unfortunately. But that exists today in this day and age. Well back in the '70s and '80s getting rid of a teletype circuit was a big deal.

Barry Reichenbaugh: You were talking about the user community?

Lou Boezi: Yeah, getting their aspect.

Barry Reichenbaugh: That was all they had.

Lou Boezi: It was one thing for us to make a change.

Barry Reichenbaugh: Right.

Lou Boezi: But you could not say now we are going to cut this umbilical cord, and you have got to do the best you can.

Barry Reichenbaugh: Yeah.

Lou Boezi: No way in the World. That wasn't fair to them of course. And our forecasters and our operators out in the field knew that. They lived there. They knew what the circumstances were. So they would never try to go any faster than their user community could adapt. And many times, some of the operations like Emergency Management Offices were involved in statewide changes of their own that were going on. So we had to kind of mesh the local transition to the condition that existed outside the agency. So that would cause us to delay commissioning or decertification of some system or circuit. And we would accommodate them in that regard. It was nothing that was a surprise. It was always known, but nonetheless, there is always a fear in the country that people in Washington would do dumb things and over rule a local meteorologist.

Barry Reichenbaugh: Yeah.

Lou Boezi: So the Academy was quite helpful in that regard. And of course they were critical of the technologies and the science. They were very interested in that and helpful in the case of the satellites when there were problems with some of the satellites development activities. A number of the members of the Academy Committee were world renowned experts in satellite applications and were set aside to go help NASA in the development of those troubled spots. They were a very useful tool. There was another thought that I wanted to mention. Perhaps it will come to me.

Barry Reichenbaugh: Did it have to do again with the satisfying and no degradation?

Lou Boezi: Yes.

Barry Reichenbaugh: One thing that occurred to me, maybe while you are on that?

Lou Boezi: Yeah, go ahead.

Barry Reichenbaugh: I went on a service assessment following the Palm Sunday tornado strike in Alabama and Georgia.

Lou Boezi: Yes.

Barry Reichenbaugh: The difference between County Emergency Management assets was incredible. We walked into the one near Huntsville and they were state-of-the-art. And then you had other people who didn't even have a computer.

Lou Boezi: That's right.

Barry Reichenbaugh: I don't know if you want to go down that road, but EMWIN kind of came up in a sense as a way to try and bridge that teletype gap with those Emergency Managers who couldn't afford anything else.

Lou Boezi: We tried, it varied around the Country as what we might be able to do to help a number of the local services, cooperators, emergency managers, in the predominant number of

cases to make transitions. We couldn't legally buy equipments for them, but we could introduce pieces of technology that would help them in some way or another. NOAA Weather Radio was a big issue, because in many places all they had was a radio receiver. They didn't have teletype. They had a radio.

Barry Reichenbaugh: Right.

Lou Boezi: They would listen to that. So if we were going to shut that off and move the transmitter that was a major problem. So even in this day and age, the emergency management community in a broader sense across the country is far from homogeneous. And the Weather Service Operations has always been very sensitive to that, and tried to accommodate through the use of technologies, ways to help them. Push comes to shove, a local manager always has the personal phone number of the local meteorologists. And that proved to be invaluable time and time again. I led a survey team after Hurricane Gilbert ran into Mexico and the Brownsville, Texas area. The Mayor of Brownsville made it known to me in no uncertain terms that if the local WSO Chief was not in his office counseling him at every step of the way, he said we would have directed people to their death, because what had happened was the Hurricane went into Mexico to the mountains and then got picked up on the upper air flow that was bringing the residual, small tornadoes up into Texas. And they were directing people to evacuate right in the face of the flow. The local people were saying, "You don't want to set the evacuation that way. You want to set it this way in different directions. Now is the time to pull the plug. And now is the time to wait."

This hand holding goes on today in a big way. It is not really to be unexpected. A person runs for a local office, what does he know about emergency management operations? Nine times out of ten, they are totally unaware of what goes on in that community. They learn of course when they get in office. And to have somebody knowledgeable from the Federal government is a big deal in a small town. Brownsville, Texas for example, was not a big place. So across the country you will find that the relationship is still intimate, even though the offices may have moved, there is still a direct phone connection there. And our forecasters do visit. We set up special staffs in the future offices. A Science and Operations Officer that was to help the introduction of the new sciences and technologies in the training programs. We had staff to deal with the emergency management community. They were dedicated for that purpose. That was a principal job, to make this transition happen. We didn't have those positions in the past, but as part of this total design concept; you had to anticipate how your services would be disrupted. And it would be disrupted if you had a client that didn't know what the devil you were sending them.

Barry Reichenbaugh: Right.

Lou Boezi: It is no good sending them a very complicated picture. You did not want them to have a complicated image that they couldn't understand. Everybody today likes to look at the radar and say, "Oh yeah, it's raining there." But many times it is not raining on the ground, it is only raining up in the atmosphere, and the radar can't tell the difference. A trained meteorologist, a trained observer knows the difference. Everybody wants to be a local weather forecaster, but it is a complicated thing and will remain so. All right. What didn't I cover? How about in your section there?

Barry Reichenbaugh: I don't know if you want to spend any time, I know you spoke about NOAA Weather Radio and expansion. I mentioned the Palm Sunday tornado, which got Vice Presidential notice. Vice President Gore asked what could be done and another expansion occurred.

Lou Boezi: Yeah, right.

Barry Reichenbaugh: And kind of simultaneously, I know I'm getting into real detail here, but the SAME technology was developed again by some regional ingenuity.

Lou Boezi: Central Region?

Barry Reichenbaugh: Yes.

Lou Boezi: Larry Krudwig.

Barry Reichenbaugh: Yeah.

Lou Boezi: Exactly. Well, the evolution of the NOAA Weather Radio is in many regards symptomatic of the evolution of a lot of that technology in the Weather Service. There is a local need. If there is a lack of response on the headquarters part to satisfy that need, the local people will attempt to do something about it.

Barry Reichenbaugh: Sometimes budget driven?

Lou Boezi: Of course, yeah. It's not that there is a hate, you know, [laughter] attitude.

Barry Reichenbaugh: Right, yeah.

Lou Boezi: There are all kinds of complications, and sometimes timing. Projects are scheduled to go, but if the budgets don't show up, they are delayed, or procurement can't start. And time and time again, changes would be introduced in the field because of slowness out of Washington. Sometimes that turned out to be problematic, because occasionally they would be getting in a little over their heads. Then headquarters would have to kind of help them fix up the maintenance and logistics, because we didn't know what this thing was that they were building, or how it worked, or what components it used. They were happy that they had it, but now they didn't know what to do with it to keep it running you see. Over the years, that was always a source of contention. But if you sat back, you had to admire the ingenuity of the field to satisfy a local need. NOAA Weather Radio in that regard evolved. I mentioned earlier that many of the communities would actually buy transmitters for us. We didn't have the money for them. Always after a major weather event if there is a disastrous result, that there is impetus given to whatever technology can best help. As I said earlier, the first radars were deployed when a hurricane hit in Massachusetts. NOAA Weather Radio enjoyed some expansion with the Palm Sunday break out, Al Gores interest in helping that.

38:32 The idea of the government setting off a radio in somebody's home has a couple of subtle dimensions to it, "Is Big Brother listening to me? Why are they turning my radio on? I know what you are saying you are going to do with it." There that aspect was very serious. And there were a

number of Congressmen that did not like that idea, that we would remotely turn on. Subsequently, they acquiesced. But on the other hand, if a local office has a responsibility for fifty counties, and weather is happening in a number of them, do you want the NOAA Weather Radios always going off if something is happening in a county that is eighty miles away from you and not likely to come? So that was always sort of a down side in the concept of NOAA Weather Radio. And Larry [Krudwig] came up with this idea of compartmentalizing the warning to basically counties or major towns, and developed the technology to do that and demonstrated it. So now when you buy a radio, you can tell it which county warnings you want to hear, and it will then operate that way.

Barry Reichenbaugh: Yeah.

Lou Boezi: That was a wonderful example of an initiative taken by somebody in the field, and was dogged in his pursuit. He had other jobs to do, but he knew that this was going to work and that it was useful, and that they needed it and that we couldn't get it for them in time to satisfy him. That is not the only example; we have other cases like that.

Barry Reichenbaugh: Sure.

Lou Boezi: Right today, I do not know the full scale of the NOAA Weather Radio Program. I don't know how many, I have been out of the agency too long.

Barry Reichenbaugh: They are up about a thousand now.

Lou Boezi: Are there that many? Okay, I was going to say I lost count around seven, eight hundred. So, it all worked out.

Barry Reichenbaugh: Yeah. Just last year or the year before, it went over a thousand.

Lou Boezi: Is that right?

Barry Reichenbaugh: Yeah.

Lou Boezi: And I said that that is going away, but apparently you see it still has local interest. I said it should be going away because of these other things. But, it is a big Country.

Barry Reichenbaugh: Again, I suppose you could set your smart phone to wake you up in the middle of night, but...

Lou Boezi: Yeah, it's not the same as that thing blasting.

Barry Reichenbaugh: Right.

Lou Boezi: It wakes us up, I know.

Barry Reichenbaugh: Another thing I wanted to try and ask you about. We didn't get into at all before I think. When you lay out the intricate number of plans and systems and processes that had to

happen simultaneously, you're holding about a forty page document that just sort of lays that all out, it was a four and a half billion dollar program overall.

Lou Boezi: Yes.

Barry Reichenbaugh: But you still had trade offs. You still had to take some things off the wish list I think initially or subsequently. Hydrology I've heard was something when you talked about the river gages for instance. I think they still depend on gages from local, state, and other federal agencies?

Lou Boezi: Absolutely, yes.

Barry Reichenbaugh: Were their things like that if you had had an unlimited budget you would have done somewhat differently?

Lou Boezi: Sure, absolutely. Yeah.

Barry Reichenbaugh: Does anything come to mind?

Lou Boezi: We would have had more NOAA Weather Radios for example if we had our druthers.

Barry Reichenbaugh: Sure.

Lou Boezi: But these are just another item on a wish list.

Barry Reichenbaugh: Yeah.

Lou Boezi: And sometimes the decisions were made for us. And other times we made those decisions ourselves. In the case of Hydrology, we were never the big player in the number of river gages. It was always local communities. They needed it, and they could afford to buy them. They were relatively inexpensive. Fortunately they would share the data with us. But in terms of the major technologies, I guess anything that we envisioned we got.

Barry Reichenbaugh: That's pretty good.

Lou Boezi: Yeah.

Barry Reichenbaugh: I mean I remember seeing that map of the interlocking radar coverage areas.

Lou Boezi: Yeah.

Barry Reichenbaugh: You basically got everything except some remote mountaintop areas that would have been challenging.

Lou Boezi: Well, nobody lived there either.

Barry Reichenbaugh: Right.

Lou Boezi: In the spine of the Rockies, there aren't too many people living up there. So it would be hard to justify a million dollar radar which you can't maintain. The mountain top maintenance is a horrendous problem. So there are logistic considerations. But this whole concept of coverage that we had where you had a satellite looking down and blanketing the area, and then you had a radar, a principal radar associated with each office that scanned out so many miles from the surface up to a certain altitude. And then within that cylinder, you had all the various surface instruments and river gages and other alternate sources of data. All of that information came into that AWIPS. That was the first in the history of the agency. That is a pretty convincing argument, because all of these equipments are running continuously.

Barry Reichenbaugh: Yeah.

Lou Boezi: And you have people sitting there watching continuously. And that is why we are able to get the lead times, because of this concept of coverage of the atmospheric dynamics. There are smaller scaled phenomena yet that probably a different kind of radar would be better suited for.

[pause in recording]

One other -- in terms of the planning and the management of the transition, we used the latest engineering techniques, work break down structures, PERT [Program Evaluation and Review Technique] charts and Gantt charts, and all those kinds of decision tools. This is a foreign language to the Weather Service. They didn't know what a work break down structure was or what a PERT chart or Gantt chart was, or why they would ever use it. They never had any need for it. But they had to manage their own transition, and we offered them a process that was amenable. And we maintained the database for them. All they had to do is to enter pertinent information that they only possessed. They owned that data. They relied on other people who had certain data to enter that data, so there was a shared responsibility. So it was a user acceptance that quite frankly grew very easily.

Barry Reichenbaugh: User from the point of view of the local office?

Lou Boezi: Local Office.

Barry Reichenbaugh: Yeah.

Lou Boezi: Yeah, sure. They knew in an instant and their Regional Directors would know or I would know or a member of Congress would know what was going to happen and when and how, and what was the date. And, did it happen? Because when it was executed, that was always entered locally. Not a whole lot of information, but when you aggregate it, it turned out to be a lot across the Country. You could talk for days on the management structure that we invoked. It was really quite good.

The briefings we gave were endless, but always success oriented. We had all kinds of services, marine, aviation, agriculture, fire, weather, always some unique user community who had some dimension. You had training of the new staff. You had to be sensitive to that. You had training on the systems. Then you had interns that were coming in. So the training program was really quite dramatic. We were at the forefront in distance learning techniques. We provided a whole course on a disc.

Barry Reichenbaugh: Right.

Lou Boezi: Now it is just downloaded as an evolution.

Barry Reichenbaugh: Yeah.

Lou Boezi: But at the time, that was really quite unique and very successful, because we would get somebody at a university who was an educator, and who had a knowledge about that piece of science or piece of data and radar or satellite on a broad scale. And we would put together a course that would go on for a number of weeks, very sophisticated stuff. It was the kind of thing that a forecaster could use on their job tomorrow morning. Take the course today - you can use that bit of knowledge tomorrow. So it was very helpful and innovative approaches.

This chart here is not much good for your recording.

Barry Reichenbaugh: Audio, yeah.

Lou Boezi: It shows the AFOS. You had the radar and the SWISS. The Marine consoles, you were getting data from there. And then you had all the other data sources like the hydro operator manually.

Barry Reichenbaugh: Before - pre AWIPS, a forecaster had to move around the Office?

Lou Boezi: Physically go look.

Barry Reichenbaugh: Yeah.

Lou Boezi: Now they thought while they were doing that.

Barry Reichenbaugh: Sure.

Lou Boezi: I mean it wasn't wasted effort. They were thinking as they were reading. I would watch them. They would come in and they would scan the charts on the wall, and then they would go look at this instrument readout or that instrument readout. Then they would read their previous forecast, and get a picture of what has changed.

[pause in recording]

The verification of our services, the quality, timeliness, and accuracy of our services, has been a long-standing tradition in the Weather Service. And we know how the quality of the products coming out of each and every office. In the '90s, sometime in the time frame, there was a fad in performance plans amongst the Federal Workforce. And how do you know that you are doing as well as you can. The Weather Service had a no brainer. We knew exactly what the quality of our service was. We were a model. I gave lectures around the government on how to set up performance-based plans, because we have metrics. It's not easy for some agencies to do that.

Barry Reichenbaugh: Sure.

Lou Boezi: But then you talk about the certification, no degradation of service, that was a complicated – in a site, in a site plan, each and every dimension of service that that site rendered, be it to a marine desk in a harbor or a local airport's tower, whatever user community that local office dealt with, every aspect of their interaction on a day-by-day basis was measured before and after the certification. It is a very long list. It is an impressive list. Some of these things you might say, "Well it doesn't amount to much." No, but if you were the person on the other end for that message or that information, it was a big deal to you. So we have these performance measures.

50:58 The Academy looked at the way we did the verification, because some people were saying, "Those are all kind of hokeyed up numbers." They were not. The Academy could come up with no better way of verifying our operations than what we were using. They stood legitimate tests. I might say parenthetically contrary to a number of the private meteorological services who claim all kinds of performance where they have no scientific basis to demonstrate that anecdotal information.

Barry Reichenbaugh: They would open their books and show it.

Lou Boezi: Yeah. The strategic plan that we issued for the modernization and associated restructuring of the National Weather Service, I think was really quite a document. It foretold what and why we were going to do, and what the promise that this modernization held out for the country. And how we were going to deliver that and subsequently we did exactly what was forecasted.

52:00 And the cover [of the NWS Modernization and Associated Restructuring Strategic Plan] I might say is of a very large wall cloud of a very, very severe storm that developed a number of tornadoes. The quality of the image on the document is nowhere near as good as the original photograph. I saw that out on the wall out at NCAR one day. And I said, "That is the most dramatic thing I could ever imagine." I mean I'd never saw a storm that big. And the original quality showed a telephone pole going horizontally into the base of this thing. It was being sucked up in this wall cloud. And when we had to put this [strategic plan] together, I said I got exactly the -- I called Sandy out there and said, "Would you find this?" He found it and sent me the slide. It was a thirty-five millimeter slide that they had.

Barry Reichenbaugh: Yeah.

Lou Boezi: You can see the scale. There is the telephone pole.

Barry Reichenbaugh: You're right.

Lou Boezi: You can actually see the rotation, the striations in the wall cloud of this thing. It is really dramatic. But, it is an excellent document that describes this modernization.

[pause in recording]

53:08 Barry Reichenbaugh: In terms of the Public Law that pretty much governed the oversight of the modernization process, closures, and what have you, is there anything else that you might want to touch on with that?

Lou Boezi: Yeah, you know it's an interesting thing. At first blush you might think that it proved to be an imposition that we had to go through all of these various steps and formal processes to report back to the Congress. But if you think on the other hand that this modernization took place over a number of decades beginning with the early development processes, then the system acquisition processes, then the transformation in the field offices, and the transition of operations and services to the new era to the new concept. In the Executive Branch, we went through many, many Administrations. And each Administration comes in with their own agenda. Most of them come in with some agendas. There were a few over the years that had no clue what they were going to do once they got here. They were happy to be elected. Then they discovered what they were going to do. I say that with the tongue in cheek.

So the fact that there was a Public Law that was guiding this expenditure of federal monies, protected the agency from rather random whims of a new Administration -- "I would rather use that money to do something else." Many times that happens when a change is made in the Government projects are killed, and money is diverted to other projects that are more important to the new Administration. The Public Law gave cover, as it were, to the modernization. A key area was in the handling of the staffing.

Each Administration wants to improve the performance of the government operations. And at first blush if you say, "I've got an Agency here that has five thousand employees, certainly I can take four of five hundred employees off that payroll and you wouldn't know the difference." So at first blush it sounds like a reasonable thing to do. So there is always pressure to cut back on the Federal payrolls. That is where the bulk of the expenditures go.

But, if you are in a local Weather Office -- a WSO that we used to have, that is one person on shift. It takes five people in a Weather Office to have a shift 24/7. If you take one person off and weather occurs at that time, the community suffers. There are an irreducible number of people necessary to conduct weather services pre-modernization and post modernization. The use of technology helped us curtail the amount of employment that we had. But it is designed at the lowest possible level. You have to have enough people on shift to do the work that is required of that office.

As different Administrations would come in and try to cut back on the Federal payroll, there would always be an attack on – I use the word attack -- for the Weather Service to give up more personnel. And we were constrained by the Public Law that if you made a change of any type in your operation, you had to certify there would be no degradation of service. And when push comes to

shove with something like that, you could run afoul of a new President or his Administration if you say, "I can't do that. We are not permitted to do that." People can get fired because they think they are being viewed as obstinate and not going along. But there is a Public Law that protected this country in that regard. So, it had a useful purpose. It was a certain amount of baggage to us, but on the other hand, it provided the continuity of this whole entire transition.

Barry Reichenbaugh: Right.

Lou Boezi: It is a two-edge sword I guess, is the best way of saying that. There was a period, an episode when a number of us in key positions decided that the proposed cuts were excessive and in fact would have a degradation of service. There was a letter that we wrote to the NOAA Administrator. It was a private letter, unfortunately it got out and of course, it was a cause celebre for a few days or so around the country, you know. A few civil servants were objecting to cuts because of a threat for degradation of service. And it always sounds kind of phony when the country reads it, but local managers were very, very concerned about that. Local users of the Weather Service knew what the consequences would be to them. So while it was an unpleasant environment, it was necessary to take a stand that we could not certify. If somebody else wanted to certify no degradation, fine. Go ahead. But we would not do it. You know, one of the unintended consequence of a Law like that, but it was beneficial.

Barry Reichenbaugh: Yeah. Anything else you would like to cover?

Lou Boezi: No, I would say that in thinking about this, I think it is a useful thing that you are doing. Probably it would have been something that we should have as we evolved the modernization plan to do ourselves. I know I personally ran out of energy.

Barry Reichenbaugh: Sure.

Lou Boezi: [laughter] When we had the first thirty of so offices certified, I ran out of steam.

Barry Reichenbaugh: Yeah.

Lou Boezi: It was long hours and long days. The idea of trying to document this whole thing was not… I think it is a useful piece of history to have. I know in my case as I look back into my files, I didn't keep a lot of stuff, but it brought back enormous memories that were almost always satisfying. You know, I mean you sort of block out the misery.

Barry Reichenbaugh: Yeah, the sacrifices and everything.

Lou Boezi: Yeah. But it was exciting. It still is exciting. I watch the results. I go out and visit the local forecast office periodically, and am just delighted to see the enthusiasm they have and the advances they've made. And getting on the Internet and get access to all this data that NOAA Port is piping all over the World. We all have access to it. It is a marvel. You go to England for example, you buy a forecast if you want one. [laughter] They are not issued randomly like we do around this Country.

Barry Reichenbaugh: Yeah.

Lou Boezi: We take it for granted, but it's not that case, all around the country. The dedication of the staff was the strength, is the strength of the Weather Service. It's the local responsibility. It is the local sense of responsibility. This was a time when you saw an entire Agency from the lowest level to the highest level intimately coupled in a task of joint interest. You know we had organized national meetings of all the managers of the Weather Service. Never in the history did we ever do that. We laid out these plans and we said, "This is what your responsibility and authority is going to be. And this is our obligation to you and your obligation to us. We do this for the good of the country." And this is the benefit to the country. You know what you see locally and we had cost benefit studies done and all that kind of thing. So this was a smart thing to do for the taxpayers. There was a sense of pride and can-do and we can get this done, because they knew that these tools were helpful to them. And once that was the case, the demand-pull was just fantastic.

Barry Reichenbaugh: Yeah.

Lou Boezi: It wasn't so obvious in the case of AFOS, because it was to not introduce anything new. It was supposed to make your life easier, but for such a long period of time, their life was worse because they did not have it.

Barry Reichenbaugh: Gosh.

Lou Boezi: [laughter] Subsequently it turned out to be okay in use. It survived until it was replaced by AWIPS.

Barry Reichenbaugh: Yeah.

Lou Boezi: They made do with it. We made do with it. We improved it, and it worked well. But it [the Modernization and Associated Restructuring] was an enormously complicated program. I have to say that. And the fact that it went on day and night, most of the World didn't know what was happening, and no office missed a beat. No forecast was lost.

Barry Reichenbaugh: Right.

Lou Boezi: No warning failed to issue. That is an enormous testament to the quality of people that are serving in the Weather Service of this Country.

END of March 15, 2011 recording session

Part 3 Begins

Counter re-set to 00:00

Following are excerpts from an earlier recording session in May 2010

00:00 Barry Reichenbaugh: Is there anything looking back that you might have down differently, knowing what you know now? And that is a very broad question, I know.

Lou Boezi: There was no glaring thing. If we were a bigger agency you would do things on a bigger scale. Uhm...we had very, very small staffs doing – many of them doing things that they had no prior experience at. Some of this stuff you can't get experience. You have to do it. That's the only way you will get experience. The second time around, it's easier, okay? Uhm...but we had – if we had a better prepared staff to plan and oversee...we might have made a lot of people's jobs easier. But it worked out reasonably well, anyhow. I don't have any deep regrets over that. There was nothing we could do we were the size that we were. NOAA wasn't going to get any bigger...

Barry Reichenbaugh: Yeah.

Lou Boezi: I mean they didn't have much relief in that regard. By and large, NOAA was very supportive. You know...we always had trouble with financing...it's a lot of money of course. We are a small agency the Weather Services is small. Congress was never used to big projects [in the NWS], so they were always worried. I am sure this will record nicely. [Laughter]

Barry Reichenbaugh: That's okay, posterity.

[Laughter]

01:34 Lou Boezi: Uhm...the thing that I always felt badly about was the AFOS experience. That was really traumatic. We turned it around to a positive...we always could point to it as the example that we never going to follow and promise everybody that. And they believe that because they knew that we were in there trying to prevent that from happening. So, there was no – there was no major thing that I was dissatisfied with. I had enough authority you know...that I could have done something if I felt it necessary. I was really pleased with this notion of risk reduction, because it went well. The field accepted that much better than I thought was going to happen. I thought that was going to be complicated. But there again, we had a few people that made it work, you know? Forecasters with credibility saw the value in this and uhm...so that turned out to be a very worthwhile activity. It didn't cost much. It didn't cost us any, maybe some travel time or whatnot for people to go spend some time there. But the Regions wanted to make it happen at that point, so whatever money was necessary they handled it and the equipment was always – by and large was always reliable enough that they could use it you see. So, even if it had faults, they could over look it and they were happy to get debriefed and get the next software upgrade, uhm...because it would be better the next time...the next storm. That was really kind of rewarding.

03:19 I think that the development activities...uhm...for NEXRAD...even to this day could be better funded. It is limping along on a nickel and a dime. And so much more could be done. People down in Oklahoma really have a good handle on what can be done – a lot of academics are involved in it now, as well. And you can make bigger strides faster with some more support to it. But when you balance the thing, it is going as fast as it could. But there is an areas, in terms of public service...and the warning dimension...you could put more effort into it...into the R&D. And I think

the work-out at the Boulder labs in general could be better funded, although they are very creative guys out there. They would go get money from other places, if they needed it. You know...the Air Force would cough up something or they would strike a local arrangement and then we would help in anyway we possibly could, you know.

Barry Reichenbaugh: The background research that went into NEXRAD,. AWIPS, and some of the other technologies...

Lou Boezi: Yep.

Barry Reichenbaugh: ...my limited knowledge of it – it doesn't seem like there were too many eureka moments where great breakthroughs were necessarily made in one step...it sounds like it was really incremental over many years.

04:49 Lou Boezi: Yeah. It began during WWII. It was the first deployed radars that began seeing things on the radar that they didn't understand. So, they had a couple of – a couple of scientists looking at it, "What is that?" "Oh, that's not noise that's real signal." [laughter] They were throwing out the good stuff, man. And then – so then the creative minds that were working – 'gee can we measure this and could we do that and how would we do this?' It was always little pieces...and you get a little success and that led to some better insights. So there is a certain pace that you make...there's a certain rapidity that you can achieve, but not more than that. Just more money doesn't do it, you have to have some basic understanding of what is accomplishable, potentially anyway. There are some very, very dedicated people in the radar field, you know?

05:49 Probably half a dozen around the country that go back to WWII. One fellow passed away and I can't think – I can't recall his name. But I would listen to, he would come to some of the Academy meetings and met frequently with the Academy to review progress and you know...prepare them for the next public outcry and whatever. And then they would bring in some of the deep scientists to explain – you know...what's on the horizon. And it was great to see these people. They didn't require a lot. Okay? In fact, at one point I gave them down in Norman – I gave them a half of a NEXRAD radar that we had in a maintenance depot. They just desperately needed to get their hands on a digital radar, they didn't have one, you know? Be someone...and they were so happy. [laughter] They just didn't even...but they were inefficient because they didn't have enough to work with you know? And that's why I said they could use more money and things like that. They would have to build something in order to then run the test. The test was to make certain measurements and they'd have to build all this other apparatus before they could even begin to build the measurement. Well, it wasn't necessary, you could buy stuff, but they didn't have the money. They didn't have that sort of thing...you know we would help whenever we could and then the other agencies NESDIS and OAR would always try to help.

07:25 Dick Hallgren I give a lot of credit for the organizational steering. Getting the modernization sold was not an easy thing. We had the misery of AFOS. That did not sit well – bad press. Uhm...the thought of spending a couple of billion dollars – when we couldn't handle forty million? You know...it just was not something that Washington wanted to give to NOAA or the Department of Commerce, it was such a small agency, you know? I can't put a year on it when I – it was after we had gotten through the AFOS dilemma and that was being deployed...that's when I

was asked to put some "lessons learned" together and get involved in the modernization. We had the transition office...I was subsequently put in charge of that and we began the planning…

08:35 I went out to Boulder during the summer experiments and happened to be at the Forecast Office [in Denver], they had brought the workstation down and actually put it into the forecast operation. It took a few years – a few cycles for that office to get acclimated to this thing. Although they liked it, it wasn't really working that well, and that solid and the guys at Boulder labs would run back and forth and try to keep it working, well everyone was trying and everyone was very tolerant. I happened to be out there on one occasion and I was waiting for the evening shift to come on. I happened to be looking at the early AWIPS screen...there were – it was a typical summer day. There is always the chance of thunderstorms late in the afternoon. You could see the cloud build-ups occurring. And I noticed – we had just gotten some lightning data in. They had the radar arrangements with some small little – small network that had been put together...I was watching these lightning strikes occur, just east of the mountains. And there was nothing else visible on the radar and on the AWIPS workstation, other than they had some lightning strikes. Within twenty minutes, thunderstorms started developing. You could actually see the build-up occurring on the radar and you could then see them on satellite imagery. And the notion of a lightning strike preceding was really fascinating to me. And I thought – I took that data set – actually I made one, it was an artificial one. And we started a series of briefings on the Hill to meet with the staff up there...what the heck is all this stuff about...I had a data set like that together where I could actually show. I said, now you watch this situation. Twenty minutes from now on the screen you are going to see a thunderstorm and it's going to go from the very first signs on the radar to a full sixty thousand foot storm in – I forgot how many minutes, it was literally just a few minutes. That thing just exploded. And that sells everybody, you know? I had this suitcase with stuff that I would bring up...I would sit and I would this thing, you know?

That was – that was very useful in convincing the staff that we knew what we were doing. They knew it was big and they knew that we were small, but nonetheless you couldn't deny.

11:15 The other thing, I remember an incident – we would give a lot talks – I would give a lot of talks and as soon as we could get any kind of data from NEXRAD down in Norman or whatnot that I could use as part of the talks...I would always have on the Power point presentation you know?

[pause in recording]

11:31 Barry Reichenbaugh: I guess for the Weather Service...at least everybody involved had the same...everybody did tend to agree on the end focus.

Lou Boezi: No, see the difference – eventually, yes. But the AFOS experiment failed because the developers had no concept of the service operation. Oh they thought they did. You know...they had been to a few offices and they had looked around at the teletypes...'well hell we can replace the teletypes.' And they saw all the charts on the wall...'well we're not going to deal with that stuff...that's going to be there.' So, they had it already in their mind what they were going to build and you were just going to like it. 'Sit back and take it. You're going to give it...you're going to love it.' So, the development community didn't understand that. And, the greater Washington – NOAA didn't understand that and Congress didn't understand that and the Hill staffers didn't

understand that a human being in a real-time environment had to make decisions and this stuff either helped or it didn't help. Okay? So when we want money for risk reduction, there's a reason for it. You can't force this down their throat. So, you had to – we had to take the "development side" of activities in the Weather Service and make them appreciate that this stuff had a place and a purpose out in the country somewhere. Now, the guys in the field offices, the regional headquarters, like Sandy and Denny Walts, and some of the others...played a big part in giving feedback to that. Because when they would come in for these technical meetings and whatnot...they would always say, "Well you cannot do that, because we have this and that and this to contend with and that has nothing to do with these things and this is how we work." Okay? Well, it was easy for me to always side with them, because I trusted them. I mean I had already been through AFOS. And then we come to the AWIPS situation...it was easy to say we have to make those people happy. If they are happy, you know...each region had a thousand people...you convince one and they'll sell it to the other thousand. [Laughter] You don't have to do that.

14:03 Okay? So the notion of service...is not easily understood here in Washington. Even for people who come back in from the field, they get wrapped up in the Washington environment for ten or fifteen or twenty years...you know...we will budget this...we will budget that...it's just all a monopoly kind of stuff. And the sensitivity then to the user acceptance is lost or never – or was never had. And once we got that the overall transition plans that we set up it became very obvious then to the development community that this wasn't going to go any faster than the user could accept it. Okay? And they were going to fail if the user didn't accept it. So, you had these checks and counter checks and counter balances always in play. And it was wide open, it was not deceitful you know? They had an equal share. The user had a responsibility to make this stuff happen, but they had the authority to insist that it be satisfactory before they accepted it. And the developer then had the understanding that they designed it and created it, but they had to accept input from the user.

15:23 And they could not force it... I can't tell you that during the AFOS period...I didn't know what I was doing prior to getting called in on AFOS, but I was observing what was going on and I knew they had a major failure on their hands. It was a bitter pill you know...for Dick Hallgren to accept and he was sort of steering this. He was at the time spending half his time at NOAA, as they were going through administrators and vacancies and all that kind of stuff. It was easier then selling NOAA. He was a real craftsman in getting this thing sold. We could never start off selling the big picture...a small agency, you know? NOAA is a small agency, Commerce is a small agency...

16:13 Commerce could never go up to the Hill and say, "Ah, we need three or four billion dollars and go through this grand thing," you know? We needed to replace the old WSR 57 radar...the WSR-57 radars were falling apart. We had cannibalized every piece we could find. We had got all of the casting molds to make the bull gears. We couldn't even find people to make them for us anymore...there were vacuum tubes...you couldn't find the vacuum tubes anymore. We were getting them from Russia. I mean, it was a nightmare... it was falling apart and everybody knew that it was important. So, NEXRAD was sold in a large part on the obsolescence of the AFOS.

16:54 ASOS in selling it... was not easy. We wanted to believe in that technology. We hadn't demonstrated it adequately and we didn't have a good appreciation, I believe, for the intricacies of an observation and a meaning to the user community.

17:14 I mean enormously important. A lot of commercial weather offices are one and two and three-person operations and the owner is up all night long waiting for the observations, because he's got to get a forecast to his clients. Now, if they don't have the forecast in the morning – you know spraying operations are supposed to start and they don't know if it is going to frost or not...frost and the observation is missing...you can't have a missing observation. It doesn't miss when a person is there. Now we're going to say a person is gone and a machine is gonna do it..."uh-huh"...[Laughter] So, it was not, ASOS was not an easy thing to sell. First you had to demonstrate – you spent a lot of time. There was a lot of R&D on that...mostly out in Sterling [Virginia]. But then getting user acceptance for it took forever, and maybe it still is not fully accepted yet, who knows...although it is and people are gone. [Laughter]

Barry Reichenbaugh: Anything else you would like to talk about before we wrap up?

Lou Boezi: Ah I don't think so. I – I thought that it was a grand experiment honestly. I remember a phone call from a Congressman, who was getting some heat from his District...I had never met the man before. I don't recall where he was now from...and he said "How you going to do this?" And I gave him a thumbnail sketch of what process and risk reduction and user acceptance and all that kind of stuff. And he said, "You know that all sounds great, but I can't go home with that. That's not enough credibility." I said, "Well, I have just contracted with the Academy of Science to oversee this." We had just gotten the contract. "Oh!," he said..."That's great! That's great!" There was an independent body vouching for what we were saying or not saying and they could go directly to them if necessary and get them to testify. That was an interesting dimension. We had a credible body overseeing what we were doing and passing or not passing.

[pause in recording]

19:22 Of course, they were all supportive people, I mean half of the guys in the Academy committee had some historical involvement in the modernization and in the research projects and funding support around the country...this lab...that office...whatever the heck, so. But when they sat in that setting, they were really quite autonomous and you know...true to the callings of the Academy. So, that was...and the political dynamic was very fascinating.

19:58 Lots of facilities projects. We had facilities projects all across the country, contracting, different contractors all over the place. That went very well. Real professionals working that. Engineers that had done this sort of thing. Work force transition was something that the regional people handled. So, much the idea of training and scientific training was a real winner. We had a lot of employees that decided that they were going to retire. They weren't going to ride this one out. And that in part, helped us transition from the paraprofessional to the predominantly professional. You got kids out of college who were very adept at workstations and didn't know anything about operations, but they could come in and explain the science...they were energetic...they could run little demonstration projects out of their office and training and then so that was a very nice... The service realignment activities with local communities...I remember lots of troubles with field offices, but they all handled it because they knew that they were doing the right things. So, they made it work...they just stuck to it.

21:02 We had a lot of productivity improvements in the Agency. I still think that – as I recall they – we had a Bureau of Standards Study done on the cost benefit of doing a modernization. As I recall, it was like eight to one. Current operations was about five to one. Modernization would result in eight to one benefit. And I would always say that the modernization cost the taxpayer a Big Mac, an order of fries, and a Coke...five buck per person. I remember one time we had a change over in the Secretary of Commerce's Office and I got a call from one of the staffers down there. And, "We've heard you talk about this Big Mac and a hamburger...how do you arrive at that?" I said, well, there are two hundred and fifty million people, we have a two billion dollar project, and I gave him the raw numbers and you can divide it out, dada dada...$4.58 per person in this country...whatever it was, like a lunch. [Laughter] That's about a Big Mac and a hamburger..."OK, fine he said, that's great." I never had any trouble using that anymore. [Laughter]

[pause in recording]

22:11 Lou Boezi: When I left the Bureau of Standards...I had done...I had developed a light pen. I didn't think a mouse was very good. I thought that was a poor method. We were actually working with the light pen – it looked like that. I actually made it in a machine shop. And it had a little wire coming out of the back of it. You could point it on the screen, you could draw on the screen, you could – and we were using vacuum tubes, old time radar vacuum tubes. The face was that thick...glass. I mean it was terrible. You couldn't aim the darn thing, you know? The computer had a sense where you were looking at it – it would flash one of the pixels on the screen. This is the one you want? Is this the one you want? [Laughter] It was crude, but it was very effective. So, you went from that to tablets and NEXRAD has a tablet – an electronic tablet – that was big stuff then. I mean that never saw it's way commercially. That was a piece of technology that got swept over quickly, you know? The mouse is still with us, you know? And light pens aren't around anymore. So, there was a lot of technology and software development – computer technology – equipment themselves was evolving tremendously. The science was evolving as the data was coming. Lots of universities now studying it. They made their own radar and contributing. Model evolution was exploding because now the data was improving. You could actually improve the resolution of the models, the accuracy of the models. The regional models. So, the workforce was turning over and the technology...the science was changing. The public environment was changing. Enormously fascinating.

Barry Reichenbaugh: Yeah, you had the internet come up.

Lou Boezi: Yeah, yeah.

Barry Reichenbaugh: You had the whole pipeline of how you were going to move all that data from...

Lou Boezi: Yeah, yeah.

Barry Reichenbaugh: ...satellites and radar...

1:007:19 Lou Boezi: We had no way in the beginning, you know? That's why the satellite data never got used in the forecast office. You couldn't get it there. You couldn't get in the forms that

you could use. It was bad enough to go look at the NMC [National Meteorological Center] graphics on the walls, you know? That is what the forecaster would do coming on duty. He would kind of walk around the wall and scan the charts and then go sit down and look at the surface observations come in you know...and then he'd have – he would draw out his forecast, you know? And then he would go over to a typewriter and teletype...you know pound away, you know? That's how he would generate his forecast. You think of that environment and then over a twenty-year time period...all the evolution that took place and we never missed a forecast. Never, ever missed forecast because of our modernization. Improved most of them, but never missed one. You know? People knew where they were supposed to be and when they were supposed to be there and they were prepared to do what they were supposed to do and they got there. That was really remarkable how that all of that happened. And that was some dedicated people, who saw this technology as a way of improving their service...that's what motivated them and drove them enormously.

Barry Reichenbaugh: Uhm, hmm. And they sold it.

Lou Boezi: They made it happen. That was the demand pull. 'We want this.' They knew how they were going to use it once they got it. Once you were given half a chance, then it would function. That sort of thing.

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