ORAL HISTORY: Arthur McComas

About Arthur McComas

Arthur McComas was born in Baltimore in 1921. After high school, he worked for over a year at the Glenn Martin factory, and then took a month long course in basic electronics at Johns Hopkins University. In 1943, McComas began working at Bendix Radio, starting in the test department then becoming a lab technician in microwave engineering. He was drafted into the Navy in about 1944, serving two years and participating in the electronic training Eddy program. McComas returned to Bendix after leaving the military and was re-hired as a junior engineer. During the course of his long career at Bendix, McComas was involved in many projects including ASR-3, SAGE, weather observation radar, ARIA, ATCRBS, MLS, Mark 15 and ADVENT, and became part of management. He was also active in the Radio Technical Commission for Aeronautics (RTCA), serving on many special committees for U.S. National Aviation Standards. McComas retired from Bendix in 1986 and holds eight patents.

In this interview, McComas talks about his long career at Bendix Radio. The many projects he worked on are discussed, along with the issues and challenges involved in avionics and aeronautics. Working with military and civilian customers – such as the Air Force, FAA and airlines – is also covered, along with the creation of standards and changes in air traffic control. McComas also talks about working with other Bendix divisions in Fort Lauderdale and Ann Arbor, the failure of certain projects, and the changes to the company in the 1980s. He also discusses how he saw himself more as an 'employed entrepreneur' than a manager, and mentions some of his colleagues such as Dick Abel, Fred Kitty and George Church.

About the Interview

ARTHUR McCOMAS: An Interview Conducted by Sheldon Hochheiser, IEEE History Center, 14 October 2010

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Interview

Interview: Arthur McComas

Interviewer: Sheldon Hochheiser

Date: 14 October 2010

Location: National Electronics Museum, Baltimore, Maryland

Background and Glenn Martin

Hochheiser:

Okay. It's October the 14th, 2010. This is Sheldon Hochheiser of the IEEE History Center. I am here at the National Electronics Museum in Baltimore, Maryland interviewing Art McComas, who is going to tell us about his career at Bendix.

Good afternoon.

McComas:

Good afternoon, Sheldon.

Hochheiser:

How are you today?

McComas:

I'm pretty good. Little wet but otherwise unscathed.

Hochheiser:

Yeah, it's wet out there. If we can start with a bit of background. When were you born?

McComas:

1921, July, in Baltimore.

Hochheiser:

Were you raised in Baltimore as well?

McComas:

Born and raised in Baltimore city, yes.

Hochheiser:

What did your parents do?

McComas:

My father was a building manager. Both my parents were very musical and had degrees in voice from the Peabody Institute and my mother also had a degree in piano. They had part time careers in churches, opera and other similar choral societies.

Hochheiser:

Were you interested in technology and gadgets or science as a youth?

McComas:

I was, but I had no inclination toward electronics until I was offered a job in that field.

Hochheiser:

What led you from high school to the Glenn L. Martin Aircraft company rather than some other opportunity?

McComas:

Well, I was fresh out of high school.

Hochheiser:

Right.

McComas:

And I had no experience or special training, I had only a high school diploma from Poly which as most Marylanders know is a very highly rated technical high school. When I got around to looking for a job that was the only job available. While it was not to my liking, I had to take it because my family was not situated to consider college or for me to sit around and do nothing. I worked the night shift in the factory at the Martin company for about a year and a half at 20 dollars a week. That was my starting salary, a magnificent sum in those days I guess.

Hochheiser:

Of course, you also have to figure out what things cost in 1940.

McComas:

Very true.

Hochheiser:

And then you were at Glenn Martin for about a year and a half?

McComas:

About a year and a half, yes.

Hochheiser:

And where did you go from there?

McComas:

Well I left Martin because there was no possibility for advancement except in the factory. The company absolutely refused to transfer me into the engineering department.

Hochheiser:

Which is what you wanted?

McComas:

Well, I felt I wanted to work in a more professionally oriented situation. I didn't have a profession, you understand. But the Martin factory just seemed like a dead end career path so I left.

Starting at Bendix, Radar, A.E. Abel

I soon found out that this was not a smart thing to do in the middle of a war and as an unemployed draft age teenager it was difficult to find work. Fortunately the Johns Hopkins University offered a course in basic electronics at the Homewood campus under the direction of Professor Ferdinand Hamburger. I think the objective was to train personnel to work in the Bendix plants. I took the course, which lasted about a month as I recall, and then Bendix Radio offered me a job.

Hochheiser:

That gave you the bit of experience, the bit of knowledge you needed to get the position at Bendix?

McComas:

Yes. As little as it was, it was what I needed because electronics was a very unknown subject I guess you'd say.

Hochheiser:

So when did you start at Bendix?

McComas:

I started Bendix in 1943, I'm not sure of the exact dates.

Hochheiser:

Well that's okay.

McComas:

I was hired at the Towson plant but I first worked in the test department at a plant located on Monument Street in Baltimore where they assembled communications equipment for the British. I was soon put in charge of testing and calibrating UHF direction finder antennas which were placed across Great Britain and performed an important air ground communications service during the war.

Hochheiser:

Was this part of the radar system?

McComas:

No, these weren't radars. These were communications systems including direction finders and command centers. Some of them were mobile and some were for fixed installations and those included portable plywood buildings. I worked there for about a year and then I requested a transfer to the Engineering Department at Towson

Hochheiser:

And you did this for about a year or so?

McComas:

I believe it was about a year or so and I began to feel the need for advancing a little bit beyond the test department. I applied to transfer to the radar- engineering department. The word radar was effectively classified during the war so it was called the microwave engineering department. They were developing several radar systems there and I was hired as a laboratory technician.

Hochheiser:

Okay. So as a laboratory technician what role did you play in the building of these radars?

McComas:

Well it varied, but I did more than just lab work. For example my boss, Sid Bainbridge, was having trouble getting drawings from the drafting department to put in the shop to have parts fabricated. So I said find me a drafting table which he did and I was able to help him in that way. I assembled and tested equipment and performed various functions like brazing waveguide and integrating the system in trailers, that sort of thing. Also I had a lot of microwave test equipment available to fool around with and I was able to learn a whole lot about things I would never have had the chance to fool with anywhere else. Also, I did some field work and systems integration tasks. One example of this happened when the engineers were busy getting their own pieces of gear ready to begin field-testing and someone happened to notice that the search antenna was not connected to the radar transmitter and receiver. So I was directed to figure out something quickly so field testing could begin. I designed and assembled a wave-guide run and showed it to the engineers who thought it was fine. Then the resident Navy officer came into the trailer took one look and said, oh no no - that won't do at all. It turned out that my waveguide assembly blocked the spot he had picked for the coffee pot. So I was redirected to add whatever bends and twists it took to unblock the coffee pot space. I had the feeling when I finished that radar performance took a severe hit.

Hochheiser:

Who was your boss?

McComas:

The chief engineer of that department was A.E. Abel - everyone called him Dick, a very interesting man. Very colorful.

Hochheiser:

Since he was colorful, can you tell me a bit about him?

McComas:

Oh, I could tell you all kinds of stories. [Laughter] We all held him in awe, I guess because he was quite volatile. If he liked you, you could tell. If he didn't like you, you'd better watch out because sooner or later you would have a problem. I got along with him pretty well, at least I never had a problem with him. He would say and do things that today I guess would not be tolerated. I recall one story that circulated about him involving an incident at the brazing bench. We used to store carbon tetrachloride, which was used extensively for cleaning circuitry and also for filling the fire extinguisher and lacquer thinner in the same kind of red safety cans. One day someone had a fire on the brazing bench and the extinguisher was used. The lab supervisor told one of the female lab assistants to refill it. Sometime later there was another little fire and, when somebody used the fire extinguisher, there was a big fire. She apparently had refilled the fire extinguisher with lacquer thinner. Later a very authoritative gentleman strode into the reception area and asked the receptionist to release the door into the secure area. She asked to see his badge and he responded that he was from the FBI and was investigating the arson and didn't need a clearance. Dick Abel observed this from his office and confronted the gentleman. A discussion ensued and Abel said it wasn't arson, it was just a simple mistake. To this the visitor responded "I'll be the judge of that," and again started to enter the secure area. Abel got in the guy's face and said, "Get out of here and don't come back without the proper clearance." He never came back as far as anyone knew.

Navy and Eddy Program

Hochheiser:

Was there a lot of pressure due to wartime needs to get things done quickly?

McComas:

Oh, yes. I primarily worked on a ground control approach system or GCA. It's comprised of two radars, one that provides search data, and the other that gives precise range, azimuth and altitude position of the aircraft relative to the approach path for aircraft on approach. Radar displays in the trailer provide this data to controllers who then gave voice commands to the aircraft by radio. Bendix built the first GCA for the Navy, the MPN1. It was just being delivered about the time I was drafted. What had happened was that when I left Martin they attempted to change my mind about leaving by threatening that I was going to be drafted. Apparently they made sure that happened. I had only remained out of the service as long as I did because my father was terminal with a heart condition and they deferred me until he passed on. In any event, the MPN1 was built and we tested it at what had been the Curtis Wright Airport on Smith Avenue.

Hochheiser:

Smith Avenue here in Baltimore?

McComas:

In Baltimore near Pikesville, yes.

Hochheiser:

So when did you get drafted?

McComas:

I believe it was 1944. Again, my dates are a little cloudy.

Hochheiser:

Well, just get in the ballpark. Somewhere in the middle of the war.

McComas:

What happened there was the Army was the logical place to go. I hoped for something a little better than what I expected to get from the Army and I learned that the Navy had launched a huge electronic training campaign. It was known as the Eddy program.

Hochheiser:

Right, several other people I've interviewed have mentioned that.

McComas:

I think the electronics industry after the war grew up around the Eddy people. It was a very interesting experience. I went through boot camp and then I was sent to various Navy schools. In the course of doing that, I contracted scarlet fever, and that led to viral pneumonia and extended stays in various Navy hospitals.

Hochheiser:

So you spent an awful lot of your time in the Navy in the hospital?

McComas:

A lot of it, yes. In those days, viral pneumonia was untreatable, they just put you to bed until it either got better or you died. I didn't see anybody die from it but I remember I had been going to a school, the Bliss Electrical School in Takoma Park, a suburb of Washington DC that the Navy took over as one of the primary schools in the Eddy program. I complained to the medical technician stationed there that I didn't feel well so he sent me over to the Bethesda Naval hospital. To get there I had to ride a public bus across Washington to get to Bethesda. They examined me and sent me back to the school on the bus. Two days later, I heard an ambulance siren and then these guys walk in with a stretcher. [Laughter] I was not allowed out of bed for 30 days.

Hochheiser:

That's quite a way to learn what the test results were. Did you manage to learn a good bit of electronics in the Navy?

McComas:

Oh yes. It was a repeat of much of what I'd had at Hopkins and learned the hard way at Bendix. A lot of it had to do with Navy-specific equipment, but it was a good education. It served me well because I was unable to complete college for various reasons and what I had gotten from my experience at Bendix and training in the Navy and so forth stood me well throughout my career. And also my Poly education, I don't want to leave Poly out of it. Also after the war, I attended the Johns Hopkins University at night for a number of years but did not graduate.

Hochheiser:

Certainly going to a good technically oriented high school was very useful. Now were you in the Navy for two years?

McComas:

I think it was about two years. As I say, much of it was spent in hospitals and classrooms.

Junior Engineer, Flightweight, Taxicab Radio

Hochheiser:

And then when you left the Navy you went back to Bendix?

McComas:

Yes.

Hochheiser:

Now I guess it was a standard procedure to rehire the veterans?

McComas:

Well after the war things were beginning to slow down from the heated pace during the war, when hiring people and taking on anybody who could spell engineer. I guess I'd made an impression on Dick Abel because he hired me back as a junior engineer and I really had no qualifications for that job other than what he knew about me. That was the start of my engineering career.

Hochheiser:

So in a sense, that's how you became an engineer?

McComas:

I probably couldn't spell the word, but I was one. [Laughter]

Hochheiser:

And what facility did you go back to at Bendix?

McComas:

Oh, I went back to the Towson facility and by that time the organization had changed a lot. It had evolved from multiple departments to one big engineering department under Abel. I was thrown into the midst of this reorganization. Many engineers who were there when I left for the Navy were gone when I returned and I never knew why.

Hochheiser:

What was your first assignment when you came back as a junior engineer?

McComas:

Oh, it was mostly factory follow up at first, but then I began to get into a little design work. The Bendix Corporation had somehow conceived the notion that everybody was going to have airplanes after the war and began things that didn't survive the post-war economy.

Hochheiser:

There were lots of predictions floating around at the end of the war.

McComas:

I understand this was one of Vincent Bendix's fixations. He was primarily an entrepreneur. He didn't spend much time doing anything. He just started these things on a whim and if they flourished, fine, if they didn't, he'd move onto the next thing like washing machines, whatever. In any event, I got caught up in that because Bendix Radio had launched a line of inexpensive avionics for use in small airplanes that they thought everybody was going to have. Just about the time I arrived back at Bendix they let go of the engineers who had done all the design work because they began to see the smoke was clearing and these things weren't selling as fast as they had anticipated. I was put in the midst of this and I had to pick up support for the whole product line which was named Flightweight. It consisted of air to ground communications gear. I also designed a couple of radios, some of which went into production. But due to the post war

economy and unrealistic expectations, the Flightweight product line was soon abandoned.

Hochheiser:

It stopped because it proved not to be something that was commercially viable.

McComas:

That's correct.

Hochheiser:

And what was your reaction to working on a program that ultimately did not succeed in the marketplace?

McComas:

Oh, I worked on a couple of them. Flightweight was the first one. Another had to do with taxicab radios. After the war, what was known as the King George transceiver, the SCR522, which had been built by the thousands by Bendix was put on the surplus market and being used by some cab companies. The SCR522 was about yay big, weighed probably 70 pounds, and provided four channel UHF tuning using a mechanical tuning device. Although they were cheap, around twenty-five dollars as I recall, they used a lot of 24-volt power and took up a lot of space so they were not what the cab market needed. So Bendix Radio launched a product line directed at capturing a large segment of this upcoming market. As it developed Bendix, unlike its usual practice of using engineers they already employed, hired an engineer from outside the company to develop this taxicab radio. I guess he knew what he was doing, but he designed this radio and then left Bendix. No one else had been privy to his work when I was assigned to work for him just a week or two before his exit. I never knew exactly why he departed but I remember that he told me that one of the senior engineers was out to get him and was spying on him. I concluded he was either paranoid or odd - I never quite figured him out. In any event, after he left I inherited this radio that didn't work very well.

Hochheiser:

So your job was then to get it to work.

McComas:

Yes, and that involved a lot of lab and field work. Bendix had arranged for a field evaluation program with a local company, the Diamond Cab company, which was located in the Waverly section of Baltimore. I think about 50 or 100 or so units were manufactured and installed in Diamond's cabs. Well, to make a long story short, they didn't work very well in the field. The failure pattern soon became obvious. After installation they'd work for a week or two and then die. So I spent much of my time at Diamond, the drivers all got to know me pretty well. After a while they'd pull in the shop, open the trunk and go get a cup of coffee.

Hochheiser:

And leave you to stare at the radio?

McComas:

Leave me to stare. Well I soon figured out what was wrong with the radio and that fix became routine. The IF transformer coils had been wound on very unstable material and they simply drifted as heat exposure shrank the coils. So it was just a matter of retuning the IF's and he's back on the street in five or ten minutes.

Hochheiser:

Did the project lead anywhere? Were you able to develop the radio so that it didn't need to be retuned every week?

McComas:

No. Actually, although the radio was an attractive package, the price was right and I think the market timing was such that a slightly better piece of equipment could have been very successful, no question about it. But Bendix simply threw in the towel. We were building railroad radios at the time which were very large, heavy and quite expensive to manufacture. Much more expensive than the cab market would have supported. I think Bendix considered possibly attempting to develop a better product but it never materialized. So that experience led nowhere. I worked briefly on the railroad radio project under Bob Edwards. It was a successful product line for many years.

Hochheiser:

But the taxi radios proved not to be?

McComas:

They proved not to be for Bendix. It was a case of where, it seemed to me, had they gone just a little bit further and improved product quality using tested materials and circuitry that they knew would work, the product line could have been highly successful. Instead, the market was abandoned and Motorola became the prime supplier for this type of commercial radio equipment.

ASR-3, ASR-4 and FAA

Hochheiser:

And what did you move onto after the taxicab radios?

McComas:

Oh, let's see. I think I was assigned to military communications projects after that. I'm not exactly sure. I worked on some command sets for the Air Force. Then I moved on to radar. I was assigned to a chap by the name of Fred Kitty who had several new projects under way. One was a portable search radar for the Swiss and another for a cloud height finding K band radar nomenclatured the TPQ6 for Fort Monmouth. The most interesting aspect of that program was the antenna. Bendix corporate headquarters listened to an antenna expert consultant from Bell Labs who insisted that the antenna should use stepped lens technology. What no one seemed to realize was that such an antenna did not lend itself well to physical design and manufacturing processes. It turned out to be a monstrosity that failed to approach its design objectives by a wide margin and had to be replaced with a parabolic dish. After that we developed the ASR-3 airport radar for the FAA. The first system was installed at Friendship, now called BWI. That was an interesting experience.

Hochheiser:

What was interesting about it?

McComas:

Well, Bendix had never been in the airport radar business and so we had to develop a new product. It went very well, actually. My assignments had to do with the indicator

design and associated system integration tasks. I encountered a severe problem in finding a way to meet the FAA design specification which required the radar display to be capable of off-centering the origin by a full diameter of the display CRT. The state of the display art in those days was that the radar display was generated using a mechanically rotated yoke that surrounded the neck of the cathode ray tube and was synchronized with the antenna rotation. To achieve off-centering another set of fixed coils surrounds the rotating coil and DC currents are applied to its four coils to displace the display origin. I searched the industry for suitable display components but found nothing suitable. So in desperation I conceived the idea of constructing an off-centering yoke that provided a more symmetrical magnetic field pattern by overlapping the four coils. For this idea, I was granted patents in the US, the UK, Germany, France and Australia. The ASR-3 program transformed itself into a product that the US Air Force needed for an entirely different purpose. They were developing a national air defense system at the time and they needed a radar that would fill in the gaps between long range radars, the L-band lower frequency radars. And they needed something like the ASR-3 to do this. We were already in the production phase so to make matters simple, we just simply manufactured more of them, painted them a different color, and the Air Force purchased them.

Hochheiser:

So this was at Friendship?

McComas:

Well, the first ASR-3 was installed there, yes.

Hochheiser:

Okay, but your customer was the Air Force, not the FAA?

McComas:

Sorry, the ASR-3 customer was the FAA. The US Air Force purchased essentially the same radar system, minus the display components and called it the FPS-14.

Hochheiser:

Okay, because then you were saying the Air Force. You just got me confused.

McComas:

Excuse me.

Hochheiser:

Certainly the Air Force and the FAA are -

McComas:

[Interposing] They are different entities.

Hochheiser:

But they are certainly both groups who need these sorts of radar systems.

McComas:

They both need radar systems.

Hochheiser:

You got me confused a bit.

McComas:

I apologize.

Hochheiser:

That's quite all right.

McComas:

Our contract was with the FAA for the ASR-3. And that led the Air Force to buy basically the same equipment, which they called the FPS-14. Subsequently, the Air Force decided these produced too much ground clutter. So, we were contracted to develop a traveling wave tube coherent radar, the FPS-18. The Air Force bought oodles of those to use as gap fillers for the National Air Defense System. Interesting[ly] enough, the FAA then came back to us later and wanted to buy the FPS-18 (in ASR form of course) to replace

all the existing ASRs. Bendix was willing to paint FPS-18s another color and sell them to the FAA as ASR-4s, but an interesting thing happened on the way to the bank. As a business strategy decision that turned out to be very bad, Bendix attempted to leverage its position on the ASR-4 for another purpose. I was talking earlier about the GCAs which the military used extensively throughout and after the war so naturally the FAA considered possible civil GCA service and they ordered several units which Bendix supplied and called them PAR-2s I believe. Some in the FAA, however, questioned the wisdom of taking on this operational responsibility, and possibly the liability of controlling airplanes to touchdown. So a huge battle went on within the government about whether they should do this or not. The technical elements in the FAA felt they needed better equipment to evaluate the operational application and so Bendix had been contracted to develop the PAR-2. It never quite met its specification so far as the antenna patterns were concerned. It had been specified right up to the theoretical limits. Bendix had delivered these systems but the FAA hadn't yet accepted them when the FAA made the decision to not provide GCA services. Bendix decided to apply a little strategy and said that they were not going to sell the FPS-18s unless the FAA accepted the PAR-2s. It was a pointless bluff because by that time the FAA couldn't go along. So they refused the offer and the FAA went out on a new contract for the ASR-4. We bid but lost and after that Bendix was effectively out of the airport radar business.

Hochheiser:

But still in the business with the Air Force?

McComas:

Well yes. They continued to manufacture those and of course, we built a lot of long range radars for the Air Force, which I had no part in. But I knew about it. It was part of the radar department.

Hochheiser:

Now you were in the radar engineering department at this point?

McComas:

Yes.

Hochheiser:

And reporting still to Dick Abel?

McComas:

Yes.

SAGE, Weather Radar

Hochheiser:

So after this fiasco with the FAA, what did you move onto in your own work?

McComas:

Let me think. I think after that, IBM under an Air Force contract, was building a huge control center for the National Air Defense System. They call it the SAGE system and it was huge.

Hochheiser:

Very famous.

McComas:

Very famous. Our exposure, I was told, came about because the Air Force felt IBM didn't understand radar technology and yet they had to deal with it in these computers. So I think they pressured IBM into giving Bendix a subcontract for parts of the computer system. Well, we couldn't spell digital at the time they did this but it was a cost plus contract. What we were tasked to do was to develop and build all the SAGE input equipment. This was quite extensive - it was handling the long range radar and gap-filler data plus some other things. The equipment was just unbelievably gigantic because this came before the availability of solid-state circuitry. In today's terms, you couldn't imagine something like that because everything was so huge, and consequently you had to deal with very high power levels because of the vacuum tube circuitry. These buildings were about a city block in size. They were huge reinforced concrete structures and had all kinds of gimmicks in them. I don't know whatever happened to them because after about a year I went on to other assignments. I think the SAGE system must have finally been buried because it was so huge and monstrous and they couldn't just hide it. I really don't know the history of what happened.

Hochheiser:

You had this small little piece and then -

McComas:

We had this small little piece, which was very challenging. But what I wanted to say about it, in the course of working with IBM, they educated us in the emerging digital world. That really proved to be very important to Bendix's future. I found through experience that, contrary to the Air Force's expectations, IBM had little regard for any ideas we attempted to give them.

Hochheiser:

Were you involved in weather observation radar?

McComas:

Well, yes. Later on.

Hochheiser:

That's later, though?

McComas:

Well actually, that had been earlier. I have discussed my work with Fred Kitty and the development of the ASR-3. Well, one day Fred came into the department, called us all who reported to him directly into his office. Then without opening any of the folders he handed each of us those papers associated with our assignments. Then with no further explanation, he said he was moving his office to another part of the building. We later learned that he had been indicted for a security charge, part of the aftermath of the McCarthy turmoil. After pleading guilty, Fred was sent to a federal prison. I later uncovered clear evidence that the violation he was charged with was a direct result of an error in the way that Bendix Radio processed security clearances and was certainly not due to any intentional fraud on Fred's part. But that is a whole other story for another day.

George Church, whom I had known for many years, replaced Fred and took us in a whole new direction. George was a pilot and had a great interest in aviation matters. The

military departments had been using weather radars on their aircraft for years, I guess starting during the war. I don't really know when it started. The technology was pretty well established, at least as far as the military was concerned. Bendix was heavily into the avionics field, having supplied about three quarters of all the avionic equipment in U.S. aircraft during the war and was trying to develop an entree to the commercial airline market, which it did ultimately with great success. Over time, Bendix became one of, if not the, biggest supplier of electronic equipment to the air transport industry. In any event, George Church, who had been an Air Force officer, conceived the idea of developing a weather radar product for the airline industry. The airlines were becoming interested because they could see how their schedules would benefit if they could fly around these weather disturbances and safety would be improved by not accidentally flying through them. So, George, Chuck Greenslit and others including myself launched an effort to try and sell the industry on this. It was a very interesting program.

What we actually did first was to examine the issue about what was the best frequency for this weather radar. There was a strong feeling in the industry, promoted mainly by United Airlines (UAL), in favor of C-band, which had been designated by the FCC for weather radar applications. C-band was no doubt well suited to ground weather observation, but Bendix identified several factors that favored the higher frequency X-band for aircraft application including higher resolution due to the limits imposed by the airframe on antenna size. Over time, Bendix became convinced that X-band was the better choice and participated in debates that were going on in Washington. The opposing view, maintained zealously by UAL and RCA, was that C-band provided greater penetration of the weather and thus permitted the pilot to see what was beyond the first heavy weather cells. This controversy went on for a year or two within the airline community, mainly through the Radio Technical Commission for Aeronautics or RTCA, which I later became deeply involved in.

In any event, George Church got us involved in a Navy supported flight test evaluation of the two frequencies. Bendix modified an X-band military weather radar that the Navy had installed in a four engine DC4 and I put together a monitor with a camera that allowed us to take time lapse photographs. RCA put together a C-band radar and installed it in a United Airlines four engine airplane. The nature of the program was to fly the two airplanes side by side and observe the same weather while simultaneously taking photographs which could later be compared. It was really very interesting because we would get together at United headquarters in Denver after each sortie and compare photographs. There is a lot of bad weather around Denver in the late summer where we did this. After I'd stay up all night developing our pictures in my hotel room, we'd project the pictures side by side on the wall. The first time we looked at them together we concluded there was really no contest, we won it cold. Well, it didn't quite

turn out that way. There still remained controversy, as often these kinds of things do, and the technical aspects get all twisted up in politics and personal feelings. Bendix wound up being very successful with its X-band in most of the airline industry. United Airlines never flinched and retained the C-band forever - as far as I know they may still be using it. Virtually every other airline selected X-band because of its benefits. The best rationale that United ever presented was that they could see beyond those first cells. The FAA contradicted this view following a few near disasters when UAL planes entered heavy weather cells and chastised UAL publicly saying they were not supposed to go beyond the first cells, they were supposed to avoid them. So that is the history of air weather radar. In any event, we developed the weather radar, the RDR-1 and it became a huge product for Bendix. Strangely enough there always remained a strong mutual dislike between Bendix and United Airlines.

Hochheiser:

So your customers were basically all the airlines in the country except United?

McComas:

Well, that included most foreign airlines.

Hochheiser:

Foreign airlines as well?

McComas:

Yeah. Even the parts of the military bought our commercial products I think to use for their transport aircraft.

Hochheiser:

Now once it gets into that kind of production stage, does it move elsewhere, and then you're no longer involved?

McComas:

Yes. The manufacturing phase became too big for Towson to handle. So they built a new plant in Fort Lauderdale and my boss, George Church, become its first general manager.

Hochheiser:

But you stayed here and moved on to other things?

McComas:

Yes. Church wanted me to go, but Abel wouldn't allow it. That's what I was told at any rate. I really didn't want to go.

Hochheiser:

I was going to say, born and raised native here.

McComas:

By that time I'd put down a lot of roots here.

Hochheiser:

That's what I was asking, I was suspecting that.

McComas:

I was never actually given a choice. But I mean, I would have turned it down for sure.

Hochheiser:

But since Dick didn't want you to go, then you didn't have to ever confront the decision.

McComas:

It never presented itself.

RTCA and Standards

Hochheiser:

Yes. So then, you're no longer involved with that particular program?

McComas:

No, that wasn't quite true.

Hochheiser:

Okay, then tell me about your continued involvement once they opened the plant in Fort Lauderdale.

McComas:

Well, once you get your feet wet in something it's hard to give it up. As I said earlier, I became involved in the activities of the RTCA, which formed many special committees. Eventually their main task turned out to be preparing national standards for aviation and that involved the military departments which Bendix Towson had a strong interest in. In preparing such standards, the government including those military branches that are impacted, the airline industry, and the manufacturers, had to come to agreement.

Hochheiser:

Were there representatives from all these groups on the RTCA?

McComas:

Oh, yes, including all our competitors. We all met together, hashed out the details.

Hochheiser:

The main function of the RTCA was standards then?

McComas:

I think it wound up that way. In the early days of the RTCA they were essentially doing that but it wasn't officially identified as a national standard. It was just sort of an agreement that was useful to the industry. I think there were some other things the airline industry agreed to. I don't remember what they were called at this time but they addressed certain problems that needed attention. I remember, for example, when I designed the cockpit indicator for the airborne weather unit, it was very densely packed. I put a pendant cable on it because that saved a little space within the cabinet itself but RTCA said, no, you can't do that. You must have a connector mounted on it. Well, the

connector took up maybe a half a cubic inch more space and that was important. I remember it because I had to go back and fix things like that.

Hochheiser:

Certainly when you're dealing with the confined space of an aircraft, any place you can save a little space.

McComas:

Yes. Well it involved more than just space. I think it was the fact that airplanes are wired by one party and the equipment is built by another party and somewhere there had to be an interconnect and they didn't want the installation to be constrained by the cable length. I participated in many RTCA special committees preparing U.S. National Aviation Standards. As a matter of fact, I was on a committee that was tasked to write the very first U.S. National Standard. It was the standard for air-ground communications equipment. The special committee was chaired by a British gentleman by the name of Featherstone. I don't know exactly why, but for some reason, he farmed out the main task – that of actually preparing the standard - to a subcommittee and RTCA appointed me the chairman of that subcommittee. It took a couple of years to get all the manufacturers, our competitors and so forth, to agree on everything. Eventually they did but Featherstone got all the credit for it. But that became the very first U.S. National Aviation Standard.

Hochheiser:

About when was this? Just ballpark is fine.

McComas:

Oh golly, I suppose it was in the late-50s I'd say.

ARIA

Hochheiser:

What was the ARIA program?

McComas:

I think the acronym stood for the Apollo Remote Instrumented Aircraft.

Hochheiser:

So now we're moving well into the 60s?

McComas:

Yes. I believe this was getting into the 60s.

Hochheiser:

Okay. Did I skip things?

McComas:

Oh, probably. But you know, they all sort of blend together over time.

Hochheiser:

Well, that's okay.

McComas:

At any rate, ARIA was part of the Apollo program. The Air Force was tasked to develop and operate KC-135 former tanker aircraft to do this. They were huge jet aircraft with seven-foot diameter steerable antennas mounted in the nose of the aircraft. The mission was to put these on station after each Apollo launch to fill in areas where the ground tracking stations might not have coverage. Well, the ARIA program had suffered a long political debate between NASA and the Air Force. The Air Force imposed a set of standards on the equipment that neither Bendix nor NASA felt was appropriate. At any rate, our contract was with the Air Force even though NASA played a part in it. We developed the instrumentation for these aircraft and got them operating. The problems that we had were mostly of a political nature. What happened at Bendix was that the project got off to a rocky start. The proposal had been prepared by a group of engineers who had been hired from outside the company because of their range oriented experience. When Bendix won the award the problem was that the proposal we won with was just nonsense. As a result, under the Air Force regulations, and even within the Bendix Radio organization, the program described in the proposal was unmanageable. The Air Force awarded the contract based on that original proposal and

I was assigned to a team that had to make some sense out of what to do with this thing. I think it was a 20 million dollar program, so it was sizeable. I think our Vice President and General Manager became petrified about the potential consequences of failure and cost overruns. We were actually subcontracting to Douglas Aircraft who did the aircraft modifications at Tulsa, Oklahoma but were really directed by the Air Force. We were really the prime in terms of the mission system development and had the real problem. I say difficult because the proposal didn't reflect any understanding of how to build the equipment. What they had written was largely fiction. Still, we had to develop hardware and my task was to redesign the system to make it realizable. I had to take the proposal and convert it into another proposal and then sell that to the Air Force.

Hochheiser:

Which the original proposal was not?

McComas:

Yes. And this was difficult because we went through cost negotiations and the Air Force officer who was directing the military side would ask a technical question based on the proposal we had submitted and I would answer from the document I had prepared and the answers often didn’t make sense. I never fully understood why the Air Force didn't just tell us to go away and forget about it, but they didn't. We wound up building it and it worked - eventually. But I think quite a few heads rolled in the wake of that program.

Hochheiser:

But eventually you were able to build something that worked?

McComas:

Yes. Well I was off of it by that time.

Hochheiser:

After you got it started and got the contract renegotiated, then you moved on?

McComas:

Yes.

Hochheiser:

Okay, I get the timing.

Air Traffic Control, Aircraft Collision

We can back up, I think we must have skipped over a bunch of things between the weather radar and -

McComas:

I think I'm talking too much already.

Hochheiser:

Well no!

McComas:

If you can remind me, what did I talk about?

Hochheiser:

Okay, we talked about the weather radar for civilian aviation.

McComas:

Yes, and the SAGE system.

Hochheiser:

The SAGE system. And then we skipped to ARIA and I think we must have jumped over a bunch of years there.

McComas:

Oh. One thing I wanted to talk about was air traffic control. I think that's what you were maybe driving at.

Hochheiser:

Okay.

McComas:

Air traffic control had become a huge problem after the war because the airlines transitioned to jet aircraft which had different performance capabilities and operated at higher altitudes and moved much faster and more often. Things were changing rapidly but the air traffic control system was essentially operated by hand, you might say. They used radar information but it was processed mainly by hand. I need to clarify that when the term radar data is used in connection with ATC it really is not data from the skin reflected radar signals but from another system called the Air Traffic Control Radar Beacon (ATCRBS) system. I expect to say more about ATCRBS later. Our experience with the SAGE got me interested in the automation of the air traffic control system. During the Eisenhower administration a task force was set up at the White House to address the matter. I think it was called Airways Modernization Board. They issued an RFP for advisories or proposals on what could be done to fix it. I thought Bendix was in an excellent position from our knowledge of the SAGE system and processing radar data and that RFP looked like a great opportunity.

At the corporate level it was decided to send in help [for] us to prepare our proposal. This help from headquarters in Detroit arrived in the form of a portly gentleman who had a fixation about railroads. His total contribution to the proposal effort consisted of his idea that the ATC system should be operated in the same way as the railroads. Well, those of us attempting to prepare our proposal capitalizing on our radar processing experience by adding substance and detail to radar processing could see little if any way to adopt railroad methodology. We tried in every way to tell him this but he was unmoved by our arguments. At any rate, I made myself so very unpopular with him that he threw me off the proposal team. That was good from my perspective because I had no idea about how to write such a proposal. Here was an opportunity that could have put Bendix way ahead of a lot of the industry in ATC affairs and we had what it took to win, but we just kicked it. It was a great disappointment to me personally, and an embarrassment to Bendix.

Hochheiser:

Anything else from that period between SAGE and the civilian aircraft radar and your work with Apollo?

McComas:

I'll have to tell you another story.

Hochheiser:

Please.

McComas:

This matter originated during the airborne weather radar program and wound up some 30 years later with the TCAS program. It began when our avionics competitor, Collins Radio Corporation, announced that they would modify their weather radar to also provide collision prevention information to the pilot. And they began to take orders for it. Bendix Radio had a physicist working in its research department, Dr. John S. Morrel, who said, they really can't do that. Management asked him if could he prove his contention and when he said he could he was put to work preparing a paper. He then wrote a historic treatise that he named, "The Fundamental Physics of the Aircraft Collision Problem." In this, he proved with irrefutable mathematical and scientific facts that the requirements were well beyond what any airborne radar would be capable of. In this paper, he also proposed a simple but elegant solution based on fundamental physical principles. Bendix Radio released this paper as a service to the aviation community and it pulled the rug out from under Collins Radio which was forced to withdraw its sales offer and cancel orders they had taken. Morrel simply showed that you needed more information and more precise information to predict a collision. You needed a lot of things that hadn't even been considered by Collins.

I got interested in the aircraft collision issue back in the weather radar era and this interest continued until my retirement. There was a great deal of discussion throughout the aviation community which continued for many years. It was fanned into flame by each accident or near miss. It seemed like everybody had a solution. There were all kinds of hare-brained ideas from supersonics to lasers. Bendix Avionics Division participated in an evaluation of a dedicated system using Doppler processing to derive collision probability data. I think it involved Bendix Avionics, RCA and United Airlines. Hardware was designed and tested and it worked. Bendix Radio did some flight-testing based on somehow deriving collision information using ground reflected signals The major fault with all of these schemes was that in order to implement such a system you had to equip every airplane in the fleet before there was any benefit. Well, anybody who has ever had anything to do with the industry knows you simply can't do that. Progress has to come progressively. The objective was to find a way to begin to do it and to provide some immediate benefits using what already existed and then to build on that. So as I

say, this argument about what can and can't be done technically went on for many years even though Morrel had shown the way back in the 1950's.

ATCRBS, Working with Airlines, TCAS

Through another assignment, associated with military IFF transponders, I got involved in the beacon system, generally called ATCRBS, which I referred to earlier. Beacon transponders are avionic devices that respond to signals from interrogators associated with the ground radars and provide the ATC system with the identity and altitude of aircraft in the system. The beacon system descended from military IFF systems of WWII and are required equipment for all aircraft operating within the ATC system worldwide. They respond to a signal from a special antenna that's mounted on (usually on top of) the ground radar antenna and rotates with it and sends its own interrogation signals to which the aircraft transponder replies and sends data about its identity and altitude back to the ground. The important thing is that the beacon system existed. So the name of the game became how to build a collision avoidance system around the beacon system. Dr. Morrel provided the theory and essential part of the methodology but the remaining challenge was how to implement it. His theory was based on the fact that two unaccelerated bodies moving on a collision course exhibit certain measurable physical characteristics. If one periodically measures the range between them and that range decreases at a linear rate or in other words has a first derivative equal to zero, they will collide. In a similar manner, if one also observes the angular bearing of each to the other, it also remains constant. So these two measurable physical parameters provide a measure of the probability of a collision. If either varies it indicates they are not on a collision course. Dr. Morrel felt that bearing measurement was at that time not within the state of the art but that range measurement was. He also showed that range difference measurements alone were adequate to support a collision avoidance system. In the mid 1970's the industry had pretty much agreed that extending the use of the radar beacon system was the way to move forward. But all elements of the industry had not yet accepted this strategy and there were obstacles, I'm leading to a point here -

Hochheiser:

I know you are.

McComas:

There were actually two problems that needed clarification. One involved the air traffic controllers who sensed an overlap and/or possible conflict with their activities. The answer to this concern was to demonstrate that the airborne detection worked well

within the time line of the ground ATC system and provided an independent but compatible back-up to their functions. The other issue was the position taken by airline pilots who were not interested in range information. They wanted to see the other airplane, and if they could not see it through the windshield, they wanted to know what direction it was coming from so they felt they needed that information from any collision avoidance system. Through their union, ALPA, they insisted on this and so the discussions had bogged down for several years. They simply refused to accept a range only solution even though it had been clearly established to be safe and adequate. A possible entry point as I saw it was to find a way to satisfy the pilots. I had listened carefully to their arguments and I felt that it was possible to construct an aircraft antenna that would be precise enough to display the bearing to the pilots and to also support collision avoidance processing. I began to consult with one of Bendix's antenna engineers, Allen Sinsky, an expert on phased array technology who suggested that an eight element array fed by a Butler matrix might do the job.

To make a long story short he built the antenna and I devised a system and through the RTCA primarily I promoted such a system to the industry. I applied for and was granted a patent for that system and we submitted an unsolicited proposal to the FAA based on the patent. That led the FAA to release an RFP for the development of a flight demonstration system. Bendix Radio won that award and a group of very bright youngsters led by Emory Reed developed the equipment which was installed in an FAA jet aircraft and demonstrated all over the world. It provided clear and convincing evidence that TCAS worked. However, the airlines and the FAA were convinced that the system could be safely simplified and so sometime later, under a separate contract, a simpler version - meeting the basic U. S. National Standard but lacking the precision antenna - was built by Bendix Avionics and installed on operational United Airlines aircraft. Operational evaluations were completed and that version became the model for the U.S. Standard for TCAS. Our original version still exists, at least on paper, in the National Standard, as an undeveloped super set of the U.S. National Standard and is identified as full or enhanced TCAS. The postscript to what I have talked about here is that subsequent to my retirement TCAS together with the Global Positioning System or GPS has opened up consideration of a whole new approach to ATC with shared responsibility for separation assurance. When this restructuring is fully implemented, the radar systems (that is the skin reflected radars) will likely cease to exist for ATC purposes although they may still be necessary to meet air defense needs.

Hochheiser:

Though ultimately it did not lead to a commercial product?

McComas:

Oh yes, that is true, but it provided clear evidence that the system worked.

Hochheiser:

I'm confused because you're saying the airlines -

McComas:

No, no, not exactly - what I am trying to say is that, in my opinion, this demonstration phase was arguably a form of bait and switch. What they saw and what the got in the TCAS Standard were not exactly the same, thanks mainly to the efforts of the airlines.

Hochheiser:

You're telling me you demonstrated this and the airlines didn't -

McComas:

Well when I said Bendix, I need to explain that there were two Bendixes - one in the airline business was in Fort Lauderdale and the other in Towson which is tasked to pursue research and development and military avionics objectives. In the end the Fort Lauderdale operation benefited directly from Towson's efforts and launched a huge new product line. And of course they had to go along with the airlines. I hope I have cleared up your confusion.

Hochheiser:

Okay.

McComas:

Of course, the manufacturing division in Fort Lauderdale was tasked to work with the airlines.

Hochheiser:

Okay. So you came up with this one proposal that had these eight to ten inch antennas that was a technologically excellent proposal. But the commercial system that was adopted and that Bendix was successful with?

McComas:

Well, you could call it a subset of our demonstration system. The airlines simply had no interest in the more precise antenna, they wanted the simplest and cheapest collision avoidance system solution so they substituted a less precise four element array which still could provide pilots with some crude sense of direction to threats but would not be accurate enough to support collision threat processing.

Hochheiser:

Now was the less precise antenna also developed here in Towson?

McComas:

No, it wasn't developed at Towson. It was suggested and promoted mainly by MIT Lincoln Laboratory in line with their support to the FAA. For the deliverable TCAS it was probably manufactured at the Fort Lauderdale facility. I was a member of the RTCA special committee that prepared the standard. Of course, I was pushing my idea but the airline industry fought it tooth and nail. Our point was that if you had two criteria, you should have less risk and greater confidence in the result of two assessments than one. But that was never really accepted. As my friend Frank White of the Air Transport Association said, better is the enemy of the good. At any rate, in the backwash of the demonstration phase Fort Lauderdale had to work with United Airlines to do an operational evaluation for the FAA. For whatever reason, which I think went back to the weather radar fiasco, Fort Lauderdale and United Airlines maintained a continuing level of mutual hostility. They didn't want to talk to each other. I got along with both so just before I retired I was asked to help them prepare their joint proposal to the FAA for the operational evaluation phase. I acted as a go-between [for] these two organizations and got a joint proposal ready to present to the FAA.

Hochheiser:

So you had to serve as a kind of intermediary between Bendix in Fort Lauderdale and the customer?

McComas:

Right, but I don’t think there was much of a customer relationship at stake. They didn’t like each other and I don’t think United bought much of anything from Bendix. Also neither one of them knew how to write a proposal.

Hochheiser:

You knew how to write proposals and could talk to both. About when was this?

McComas:

Oh my, this was probably in 1985. I can't remember dates very well.

Hochheiser:

Actually, that's quite sufficient. Over the years, how frequently did you work with the folks in Fort Lauderdale?

McComas:

I worked with them off and on through the years. I got along with them fine because George Church was a personal friend and I had other friends down there. We often disagreed on matters but the way I saw it they were right from their perspective because they looked at customer relationships in a different way that we didn't have to concern ourselves with.

Hochheiser:

You're looking at trying to find the optimal technical solution, which isn't necessarily the same as what will fly in the marketplace.

McComas:

Yes. There was another interesting sidelight to my efforts to sell my idea about TCAS. When ALPA (Airline Pilots Association) became interested in my concept they promoted it and asked me to do several things. First I was asked to meet with one of their technical committees in Miami, which I was able to do. Then they asked me to deliver a paper at their convention in Reno and also to testify before a congressional house committee. Bendix Radio management was apparently under pressure to curtail my activities in this area and would not approve my plans. I concluded that I had

inadvertently stumbled into the middle of an old labor dispute between ALPA and the airlines - this was popularly referred to as the “Third Man in the Cockpit” issue. I think that my efforts were perceived by the airlines as providing support to ALPA regarding their demands for an additional crew member in the cockpit.

Hochheiser:

How did you find Bendix as a place to work through the 50s and 70s?

McComas:

Excellent. It worked for me. I felt they missed some excellent opportunities as a result of corporate tinkering, but probably a lot of companies did similar things. Bendix Radio gave me a lot of freedom and support.

[End of tape 1, beginning of tape 2]

Hochheiser:

We just finished talking about the TCAS.

McComas:

TCAS is now installed on all transport aircraft.

Hochheiser:

So that certainly proved to be a very successful program.

McComas:

It did for the Bendix Fort Lauderdale division.

Change to Allied Signal and Honeywell

As you know the name Bendix has disappeared. Around 1982 the entire corporation transitioned first to Allied Signal and later, around 1989, to Honeywell when Bendix purchased controlling shares in Honeywell and then adopted the Honeywell name. Those of us retirees who still get together on occasion still use the name Bendix. I

should note here that many of the times in my discussion I may have referred [to] a Bendix that did not legally exist. Many of us took the first transition - that is to Allied Signal - in stride but resisted as far as possible using that name.

Hochheiser:

Right. Bendix had been bought by Allied. Which then became Allied Signal, which then merged with Honeywell and the combined corporation took the Honeywell name.

McComas:

Right, I get my pension check from - let's see - I get it from Honeywell, and I get my healthcare from Raytheon. I'm not going to try to explain that one, but it's very strange. That all went back to 1982 when one of the CEOs of Bendix - as you probably recall the great, what did they call it, PacMan war. Bendix bought controlling shares in Martin and Martin bought controlling shares in Bendix.

Hochheiser:

Yes, I certainly do know about that though I guess it's a bit outside.

McComas:

It's outside of technology certainly.

MLS and GPS, Mark 15

Hochheiser:

The next thing you suggested I ask you about was MLS system.

McComas:

The microwave landing system was another interesting experience for me. I forgot what activity I was winding up, but I was looking for something that we might pick up in the way of new business. A friend of mine in the Department of Transportation suggested we look into the microwave landing system, which was beginning to come into view as a possible replacement for the aging instrument landing system, ILS, that [had] been in use in the military and commercially throughout the world for years and years. ILS was not very precise and the equipment was huge because of the wavelengths that it used

and various other factors. There was some concern that it needed some sort of replacement. The idea was to develop a system similar to the old GCA's, except present the position data directly to the pilot so he remained in control of the airplane. The MLS program went through a number of stages. We started working with the FAA on it and oh, I don't remember exactly what happened, but we won a feasibility study. I was responsible for the proposal and the report in which we evaluated the available technology and chose some rudimentary equipment. I don't remember the exact program succession - I think it went through several stages at Bendix. I had moved on during the later phases but I remained on the RTCA Special Committee that prepared the MLS standard.

In the course of that activity it started to become evident to me that the MLS itself, even though it didn't yet exist, was dated because of the then emerging GPS system. GPS was beginning to make its way in a lot of fields. It occurred to me that the GPS could solve about 98 percent of the problems that the MLS was supposed to solve, the last two percent or so being that of automatically putting the rubber on the runway. I was aware that MLS was very hard pressed to do that. In addition, I also knew that pilots are very reluctant to give control at that stage of the flight to a machine. At any rate, GPS was making its inroads into a lot of applications and I could see it directly impacting the MLS. Notwithstanding, the FAA had launched a program, it had gone through evaluation phases, and had competitive equipments built. I began to tell our people that this program probably wasn't going to go to implementation. They didn't want to hear it because they'd already invested a great deal of time and money in it. I guess I made myself persona non grata to the MLS people because I went on to other things, that being the TCAS, among other things. I was also involved in the Mark 15, which was to replace military transponders, which had different requirements from the civil transponders.

Hochheiser:

About when was this MLS program?

McComas:

MLS I guess was in the 70s sometime and it went through a number of phases. It became a big, big thing for Bendix. Actually, the real tragedy occurred when Hazeltine, I think, won the final big production contract. They built, I don't know, many of these things but they never were accepted. I believe it was instrumental in putting Hazeltine out of business. I was thankful that we didn't win that phase. But you know, once you launch a program like that, it takes on a life of its own. There was no way that I could

have affected it. So it went to its fruition, which is to say it died and went away. I think there still may be some isolated applications for MLS where very precise data is needed. But that was my experience with the microwave landing system pretty much. It went through a lot of phases. I wrote many of the proposals.

Hochheiser:

You mentioned the Mark 15.

McComas:

The Mark 15 was the last military program that I worked on. It was a billion dollar contract to develop replacement transponders for the military departments which we were in competition [for] with Texas Instruments. It was an interesting program because we had to develop and test the systems with data that the government could look at and evaluate on an apples versus apples basis, which is not easy to do when you're working with a competitor. So as Program Test Director I spent a lot of time with Texas Instruments trying to figure out ways that we could do testing and evaluation on a comparable basis. Eventually, that program, for reasons I'm not savvy on, disappeared like a lot of other things. It went away. The biggest factor there being that it was a secure program. It had to be crypto-secure and that involved a lot of things that I don't really know anything about because I didn't have to deal with them myself. Cryptology is a different matter entirely.

FPS-85 and Phased Array

I want to mention another big program at Bendix Radio even though I had no part in it. [It] was a phased array radar, the FPS-85 which was constructed at Eglin Air Force Base in Florida to catalog space objects. I believe that system has operated, I am guessing now, for about thirty years, day and night, 24 hours a day 7 days a week. I can't think of any other piece of military equipment that ever did that and kept working. It's been operational from the day it was turned on. It went through two iterations. It was built and was tested and then burned to the ground. I happened to be with my boss who was the director of engineering at the time.

Hochheiser:

Who was?

McComas:

Ken Molz. We were playing cards when he got the word that it had burned down. This is like a 12 story building, all concrete, steel, aluminum, and so forth. Its phased array looks south toward Cape Canaveral. It spawned a lot of phased array expertise at Bendix, which I had several opportunities to capitalize on in my work. At any rate, it burned to the ground and it was in the process of acceptance testing. I think the documents showed that it technically had been accepted, so they were the Air Force's embers instead of ours. Bendix was given a second chance and as you might expect, they did a better job the second time. I think Bendix should take a huge amount of pride in that phased array technology. There were many other phased arrays built by the military in the course of the ballistic missile intercept programs. They operated for a period and then they went away. I don't know that any of them ever survived or what's being done today. I suppose that as long as that program keeps coming up on an international level, they'll keep trying to build these radars.

ADVENT System and Satellite Communications

Hochheiser:

What was the ADVENT system?

McComas:

I guess I didn't talk much about satellite communications.

Hochheiser:

No, you haven't, so I brought it up.

McComas:

That had an interesting history also. I had worked on command sets – radios - for some years, as I said, early on. My boss, the department head at the time, Bill Richardson, had a contract with the Wright Patterson Air Force Base to build a command set. There was a paragraph in that specification that required the radio to work with satellite communications systems. Well, this was at a time when nobody had satellite communications. The military departments were fighting a three way battle for which was going to get control and it was a huge political mess in Washington among the tri-service groups. Richardson called me in one day and said, I got this paragraph in my specification and I don't know what to do about it. I told him I have no idea either, but I

will try and find out. So he put me to work and sent me out to Wright Patterson to spend some time with his customer. I got to know the customer very well however he didn't know either. [Laughter] He had simply been told to put the requirement in his contract. And so, working with him, we began to establish some sort of a mutual understanding of what it might be and what it wouldn't be. And we established some of its limitations. These understandings were very crude at the time, of course, but through our helpful relationship we were given a contract by the Air Force to build a SATCOM ground station. This was interesting because nobody knew anything about what it was required to do. We had the contract. It was cost plus, it was fine.

However, I think some people in the corporation began to see that this could turn into something big having to do with satellite communications and maybe we ought to get interested in this. I was given a new boss by our division, George Sanner, a very talented engineer. He saw the potential of where this could go better than anybody else in the division. They simply saw it as business as usual. The project was named STEER by the Air Force and it allowed us to explore virtually all of the military departments as to their plans and objectives. Unfortunately STEER went away when DOD turned the responsibility for SATCOM ground stations over to the Army. I had contacts at Fort Monmouth who called me one day and asked me to come up and tell them what we knew about SATCOM because they knew we were working for the Air Force. Sometime after that the Army initiated a large SATCOM program which they code-named ADVENT. Bendix Radio was at that time in an excellent position to win a major contract under ADVENT and we went after it aggressively.

When an RFP was issued for the development of ground stations we prepared to respond, however the corporation took a different approach. Even as we were working with the Army on it at our division the corporation decided [to] set up a whole new division in Ann Arbor, Michigan they named the Bendix Systems Division. They staffed this with college professors, recent graduates and other academics who were able to spend a lot of money but they didn't know much about the real world, at least that is what I concluded. The result was they built a big space test facility there in Ann Arbor which never got used as far as I know, or got used very little. When the Army RFP came out headquarters directed that the new division would be responsible for the proposal and the Radio Division was to assist them. Under the program, the satellite was to be built by GE and Bendix Systems Division was to develop the satellite package while the Radio Division was to build all hardware. Philco was building the telemetry equipment. I got involved in a lot of the interface discussions and soon discovered that the equipment from these three companies wouldn’t work together. Within Bendix we at Towson had great difficulty determining what we had to build for the ground stations. I recall following the engineer responsible for the design all over Ann Arbor to get some

idea of the scope of our construction effort. When we finally cornered him he drew a block diagram on a bar napkin of the system showing “two flip flops and a NAN gate.” Subsequently this block diagram evolved into 19 full racks of equipment.

Hochheiser:

Oops.

McComas:

I got tangled up in that, but eventually we got these things solved. The equipment to be launched in the space vehicle was to be designed in Ann Arbor but Towson was to build it. After they designed this thing at Ann Arbor it didn't work so they sent it down to us and said, fix it. So we had the job of trying to fix something that was intrinsically [a] poor design. In the meantime, the launch schedule had been set up and everybody was working frantically to meet that. As it turned out, the launch vehicle - I think it was an Atlas Centaur Rocket - got scrapped or something. This let everybody off the hook. It was a great solution to most of these military screw-ups, you know?

Hochheiser:

So after all this work, then the project simply got cancelled?

McComas:

Yes well, ADVENT got canceled. But what happened next was that NASA, which was interested in satellite communications, had been working with the Hughes Corporation. Hughes, as you know, was one of the SATCOM pioneers and they came up with a brilliant scheme for a synchronous orbit satellite using single sideband technology, the name of the program was Syncom. The Army then came to the Bendix Radio Division and said, we want you to develop two transportable ground stations to work with the Hughes satellite. They made it clear that they did not want any part of the Bendix Systems Division involved in the new contract. It was a very interesting experience.

Hochheiser:

In what ways?

McComas:

It started out with the Air Force, and then with the Army, then with NASA and the Army. NASA couldn't understand why the Army specified certain things, such as the trailers having to pass the Munson road test. I don't know if you've ever heard of the Munson road test.

Hochheiser:

No.

McComas:

It's an Army test course at Aberdeen Proving Ground, or it used to be, I don't know what it is today. If, for an example, you took a commercial trailer and put it over that test course it would likely come out in pieces. It just destroyed anything you put on it. NASA couldn't understand why their equipment had to go through it. We didn't understand it either, but that was typical of what happened when the Army tried to put their stamp on anything. Hughes and NASA launched the first synchronous orbit satellite. As I recall it was placed in an inclined synchronous orbit - you know, it wasn't stationary like it is today because of the limitations of the propellant vehicles available at that time. We built two mobile stations with transportable 30-foot antennas. I was involved in that program. After that -

Hochheiser:

[Interposing] These were mobile ground stations?

McComas:

Yes, two were mobile, one in New Jersey and one in Camp Roberts, California.

Hochheiser:

Okay. So it then got repositioned for Syncom?

McComas:

Yes. Syncom was the first synchronous orbit satellite, a very successful program. As I say, my boss George Sanner could see where everything was going but the corporation saw it differently and took a different tack.

Ship Board Antenna, Management, 'Employed Entrepreneur'

I did win a later program - the Navy wanted a ship board antenna to work with tactical communications satellites.

Hochheiser:

These were ship board antennas to communicate with satellites?

McComas:

Yes, which at the time was a tough deal because Navy ship-board electronics testing is pretty brutal.

Hochheiser:

Yeah.

McComas:

So I got a contract to build this equipment and I set up a new department. Then the company immediately sent me away to a sensitivity training course and by the time I got back, the department was largely out of control because it was one of the few available charges that were active within the division. People were loading on to it and as a result, my customer canceled the contract. I did salvage the antenna design for the Navy but I have no information on what became of it. I mean, the antenna structure which was conceived to pass the Navy ship board test - popularly known as the hammer blow test to simulate heavy gunfire shock. I can't think of anything I've omitted here.

Hochheiser:

You just mentioned a group. At what point in your career did you start managing people?

McComas:

Well that was one of my weaknesses, I think. I was perhaps not very good at managing people.

Hochheiser:

But nonetheless, you did.

McComas:

I had the responsibility. I guess results often weren't very good, at least that must have been the management's view.

Hochheiser:

Why do you say that?

McComas:

Well, I never progressed in the management area even though I professed to want to at the time. In retrospect I'm glad it didn't work out because it probably would not have been wise since I have always been one who I guess would be characterized as telling it as it was. Not a desirable attribute for managers.

Hochheiser:

It's a different skill-set from being a good engineer.

McComas:

I wasn't really that good an engineer, to tell you the honest truth. I was more of an entrepreneur, I guess, an employed entrepreneur. I think that many of the really good engineers I came in contact with were great at design but often could not see beyond the details while I think that, at least in comparison to most, I had some ability and incentive to think "out of the box" and to see the bigger picture, as it were.

Hochheiser:

Good at finding? Can you expand on that - what do you mean by employed entrepreneur?

McComas:

Well, I took on the task of finding new business which function is normally conducted by marketing organizations. As an engineer I sniffed out where it was potentially and when

I couldn't prove to anybody it was there I just pursued it more on a personal level for a long time before I would get any acknowledgement or support from the company. It sometimes led to contracts, which I didn't become involved in, probably for good reason.

Hochheiser:

Any particular notable such contracts that come to mind that we haven't talked about?

McComas:

I'd have to go through my notes and I don't want to do that if I can spare you.

Hochheiser:

Then they don't come to mind?

McComas:

OK, maybe MLS and TCAS were examples.

Hochheiser:

I did and that's led to most of the questions I've asked you. What was the APX-10?

McComas:

The APX-10, I don't know. APX-10.

Hochheiser:

Am I reading correctly?

McComas:

Oh yes. I believe that was the Navy weather radar unit that we modified and used in the weather flight test evaluation.

Hochheiser:

Okay.

Allied, ATC and Surveillance

What effect if any did [the] Allied acquisition of Bendix in '82 have on your work or Towson in general?

McComas:

Well, I can't think of anything notable. There were probably shifts in management as a result of our continued conflict with some of the other divisions. For example, the corporation must have realized the futility of the Bendix Systems Division operation and decided to terminate it. In its death throes it was turned over to Bendix Radio to complete some weird projects that they had begun there, and I was part of that and I guess I felt good helping to finally drive a stake through its heart.

There is one other area I would like to talk about related to air traffic control. I got the idea of a different way to use the ATCRBS system to greatly enhance the ATC system in terms of surveillance data integrity, accuracy, interference, data rate and general effectiveness. I was granted a patent for this in 1977, it was my last patent. Based upon it I submitted an unsolicited proposal to the FAA for a smart surveillance system. The basic premise was to deploy multiple small non-rotating phased array antennas as smart interrogators. Whereas the existing ATC system simply accepts whatever the fixed rotation rate antennas are able to provide, these agile units would be controlled by a centralized computer system and the activities of each would be varied to best satisfy the current needs of the ATC system for each aircraft. Trilateration and triangulation of the data from multiple sites would be integral features to achieve these ends. This multiple site technology, which was conceived by Jerry Woodall of Bendix, had been proven in a demonstration we performed under a DOT contract on the surface of Boston's Logan Airport where we located targets with about a 10-foot accuracy. The conventional wisdom up to that time was that ATCRBS was limited to 400-foot accuracies. This plan would integrate the en-route, terminal and airport surface surveillance elements into a single system. Those responsible for FAA research planning at that time were greatly interested in this idea and attempted to fund it but apparently it was considered too much of a radical change from the direction they were going at that time and so nothing came out of my efforts. For many years I expected that this idea would eventually be developed but from what I have heard recently about future ATC planning, the role of surveillance now seems headed in an entirely new direction. The FAA, having been liberated from the requirement to insure safe separation of aircraft, an unanticipated consequence of TCAS, future surveillance is planned around

"dependant surveillance" where each aircraft will derive its own precise location from GPS and sends this to the ATC system.

IEEE, Bendix Evolution

Hochheiser:

To shift gears a bit, as you know, I'm from IEEE.

McComas:

Yes. I've been a member of the IRE since I was a junior engineer.

Hochheiser:

Yes, I know. Our records indicate that you joined back in 1947.

McComas:

Yes, that would have been about right.

Hochheiser:

And I'd like to ask about your involvement with IEEE over the years. Were you involved in any way in conferences, papers, sections, societies?

McComas:

I was active in display technology early on and went to several conferences. My interests transitioned to ATC and I presented a few papers. I remember one I gave in London on all-weather operations for the UK IEEE. There were many conferences I attended, but none of them stand out in my mind particularly. I was the local chairman for a Baltimore convention of the AIAA which eventually merged with the IEEE I believe.

Hochheiser:

In what ways did the Bendix operation in Towson evolve or change over your many years here?

McComas:

It's a little hard to characterize. My perspective, from the Radio Division which was founded around 1937, was that it went from primarily manufacturing to a more research and development slanted organization after WWII. Whereas money came in easily during the war it became necessary to work at acquiring new business after the war. As a result, the people who were running the division when I started there were factory oriented, it transitioned to greater and greater technical orientation. The management transitioned to people with technical backgrounds. The best example is perhaps that of the Division Vice President and General Manager when I retired, Joe McCormick, who had reported to me at one time. A brilliant manager, he had taken a tiny contract with the Naval Research Laboratory, NRL, and turned it into a major product line that sustained the Towson operation for a number of years. NRL had internally built a military transponder it wanted to put into production – but without changing anything. This was difficult because it required a lot of refinement without identifying it as such. Joe was able to lead NRL through this and we manufactured tens of thousands of them. And that led to improved transponder versions that are used by all of the services. Eventually after Joe became general manager, Bendix evolved towards management that was sufficiently technical to understand the businesses that we were in. Prior to that, many times we had to deal through sales departments with managers who only worried more about political consequences than business needs.

Hochheiser:

Oh, that's okay.

Career and Retirement

How would you characterize your career as a whole, looking back?

McComas:

I think I was successful in the sense that I'm happy with it. There are a lot of things that I wish I would have done differently, but in many cases I think if I had done so I probably wouldn't have had the subsequent experiences I had. So you've got to take the good with the bad. I guess I did very well for an engineer lacking a college degree. Later on, college degrees were necessary to even get in the door. I suppose in a sense I had to stay with Bendix because it had some knowledge of my value that others would not have seen had I decided to go elsewhere. In fact, I tried a couple times and I got discouraged because of various factors. Also, I had roots here and I didn't want to move

around. I don't know what else to say about it. I'm happy with it. I've been retired 25 years almost.

Hochheiser:

Now did you retire in 1986 simply because you reached retirement age or was there some other factor?

McComas:

No, there was really no other cause. I was happy with what I was doing at that time but I had other interests and I just wanted a change of pace. I had gotten into land development and community affairs which took a lot of my time. My wife and I liked to travel and I always loved to build things. I had expanded my home by many times and started more projects at home than I had time to complete while I was employed. I had a big piece of property and I wanted to complete some of my unfinished projects and have more time with my family. Bendix asked me to consult after I retired but after a few months I saw that consulting was not my cup of tea and I gave that up.

Hochheiser:

In what ways have you stayed active, kept yourself active?

McComas:

Oh, my farming, construction, traveling and woodworking days occupied my time for many years but now they are over. Mostly now I fool around with computers and photography. I'm living in a condominium where I have one small room which is stuffed full of books, computers and associated toys. My wife says she's happy because she can close the door to it and nobody sees it.

Hochheiser:

[Laughter] Well, I started out with a whole stack of cards face up, they're face down.

McComas:

Well you've done a good job, Sheldon.

Hochheiser:

Which means I've asked you everything that I could think to ask you. But at this point, is there anything that you would like to add that we didn't cover, that I didn't think to ask you?

McComas:

I can't think of anything except to note I have a total of eight patents, some of which I have talked about. Other than that we have about covered everything I could think of.

Hochheiser:

Well in that case, I would say we're finished. I thank you very much for coming in and sharing your recollections with us.

McComas:

Well you're quite welcome, Sheldon. I enjoyed your professionalism in putting the questions to me.

Hochheiser:

Well thank you.

McComas:

Good luck to you.

Hochheiser:

Likewise.