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Oral history interview with Dennis E. Fielder
[full name of interviewee]

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Interview conducted by Robert B. Merrifield, Staff Historian
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Biographical - [date/place of birth; family background] _____

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Education - _____

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Career Path - AVRO, Canada; 1959 to STG

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Topics - ~~manned space flight network~~ Communications Support (RF); under Barry Graves; Western Electric contract; voice circuit vs. teletype Switching (mechanical); slow transmission over ocean cables; Communication carrier interface issues; Shellmax House (London) switching station; Tec Roberts + Cape Control Center; Apollo Unified S-band System; Mission Control Center; MIT Lincoln Lab Contract; pneumatic tubes for messages; flood at Langley destroyed records; 1962 move to Houston; Program Instrumentation Requirements Document (PIRD) (now Program Support Requirements Document (PSRD) for communications network; new Flight Suppt Div; Apollo Applications Prog (AAP); negotiating w/ Bell Telephone Co for MSC communications; MSC separate Control: operational ~~mainframe~~ Communications termination + administrative termination Channel Channeling

Interview with Dennis E. Fielder
3/21/68

In April 1959, I was hired by STG from AVRO, Canada, and began working for Howard Kyle, then responsible for RF systems on the spacecraft. There wasn't any ground network then to support the Mercury Program. Several months after I came, we began working with Barry Graves who had been given the responsibility for managing the instrumentation in what was to become the manned space flight network. Some of the people working for Barry at that time were Paul Vavra, Red Odenwalder, and Jim Satterfield, who are still in the organization.

We first participated in the evaluation of the proposals from industry for instrumentation of the network and this competition was won by Western Electric. Bell Telephone Labs was responsible for engineering design activity and Western Electric was the implementation contractor. From that point on, we got involved in the network communications requirements in depth.

Barry's job was to satisfy STG requirement with some kind of network support capability. Probably Johnny Mayer's people contributed tracking requirements that were necessary and we contributed telemetry, voice communications, and teletype communications requirements. Bill Boyer at Langley, later the project manager on lunar orbiting, was responsible for ground communications as part of the network.

We spent many many months working with Western Electric defining what the support requirements were. We had never before had a worldwide voice conferencing system. As a matter of fact, the first concept called for the operation by teletype alone. It didn't take too long to realize that there weren't any sophisticated computer capabilities in those days. To get information in and out of the

teletype receiving equipment onto a teletype line it all had to be done manually, including reading the display and transcribing the written text. The operator would cut that into a tape, the tape would be put into a transmitter, and then it would go over the lines. It was painfully slow. It soon turned out that teletype alone wasn't sufficient to run mission operations. We started promoting a voice circuit capability around the world. Although we insisted that this was the only way it could be done, I recall that Western Electric and Bell Telephone were extremely pessimistic about the long circuits involved and the very poor circuit quality to some of the locations we were going to be working with and that we were going to bridge these things together on a talk-listen basis. We wound up with all the voice circuits from 18 stations terminating in a switchboard at Goddard where they would be patched up as conference loops or sequential action loops, or whichever way the mission wanted it to be operated. They also would be interfaced with all the loops at the Cape. The Cape Control Center was also designed by Western Electric.

Voice circuit switching and teletype system switching were done at Goddard. We worked with some of the senior, experienced people in Bell Telephone and Western Electric systems which were then advanced state of the art teletype switching systems, but which today have been superseded by high speed data systems. We looked at some expensive commercial systems which were mainly put in by brokerage firms, central banks, and some of the major insurance companies. Those classes of organizations each had their own requirements for rapid communication response within their own organization. We started a model in our requirements and a systematic solution to those requirements against that class of the state of the art. We wound up putting in code name

the 2B2 system which was a massive conglomeration of electro mechanical switching gears. I can't remember the input output circuits, but it had about a total of 30 input output circuits and the system was designed so any one circuit could be switched to any other circuit or the control center could broadcast a message that would go out on all circuits. It was possible to multiple address any message. This system was able to manage that kind of switching.

There was a lot of negative attitude toward mechanical switching. There was a saying that whenever the mechanical switching system couldn't read the ID on the message or couldn't figure out what to do with it, it would send it to a lost message locale and it was then up to some operator to interpret the message and reinsert it into the right out-going circuit. In many of these existing organizations the busiest function in the operation of the system was that position. That was poor operator technique. However, even the Goddard people who were assisting us were very pessimistic about the success of our attempt to utilize mechanical switching. It was predicted that there would be a groove worn in the floor between the intercept position and the transmit gate. But our analysis showed that it was operating problems not equipment problems. To prove our point, we went to the Cape and got a bunch of military teletype operators. We created a lot of message traffic which was almost unintelligible as far as clear text was concerned--a lot of unusual words and in some cases just 5 letter groups. The idea

was to put this stuff in front of the operators and see how rapidly they could transmit it, what the error rates were, and whether the fact that the operator could understand and read the text made any contribution to the error rate. It usually turned out that after the initial few tries at this thing and the novelty had worn off, the operators went into their usual mode of operation which was strictly a machine. They had no concept of what the information content was or what the thing transmitted, they just were part of the closed loop. They saw a character and they punched a key and that was as much contribution as they made. But we found out that the error rate was lower when we went into that mode of operation. The result of that was that we put military caliber teletype operators throughout the network and they were the only people allowed to input data into the network. The flight control personnel or whoever was responsible for messages presented handwritten texts for these people and they transmitted it.

Soon a new calbe was laid between the West Coast and Australia, which was needed as the old cable wouldn't even work at standard teletype rates. It was extremely long, some 50 years old, and only a very slow rate of transmission was possible. There were some places we just couldn't acquire cables: South Africa was one. There we had to use HF radio circuits which have always been less reliable than cable. Bermuda didn't have a cable either, and relied entirely on HF to New York. I believe we had some influence in accelerating the cable-laying planning to Bermuda. In fact the presence of the space program on Bermuda was responsible for practically revamping Bermuda communications

systems, including their telephones. They were archaic; everytime it rained the telephone system went out of operation.

One of the things that we got started also very shortly after Western Electric got onboard was the design of the Control Center. Bill Lee was part of the Bell Telephone contingent. The Bell people served as consultants on the method of operation that should be adopted, the configuration, staffing, and organization. Colonel Abbott who is now in charge of the M&O activity for Philco was in the AFETC at the Cape as was also Pete Clements, who was then a 1st or 2nd Lt. They served as the interface between the Cape, the Air Force, and the NASA Manned Space Flight Program. I remember spending most of my time in New York during that era working with the Western Electric crew.

There always seemed to be some kind of controversy, such as who had the communications responsibility on the Cape site. The DOD essentially had total control of the cabling inside the Cape fences; the commercial carrier was responsible up to the fence. DOD gave the job to RCA, and here we were with Western Electric and BellCom and the Bell Telephone System. Some very strange interface problems occurred. I remember meeting in New York where they were still trying to formulate plans for this huge communications network which would extend around the world, mostly cables and some HF radio, and we were contemplating patching all the worldwide circuits together to get a voice conference circuit and a teletype switching system. It meant joining together the cables and facilities of different commercial carriers. This was in

violation of existing legislation in terms of carrier tariffs and franchises. I can remember George Vogel, AT&T representative, stating over and over again that AT&T would not knowingly interconnect their services with that of another carrier. Essentially what that meant was that they would wire up to a mainframe on one side of the room and any other carrier would wire up to their own mainframe on the other side of the room that AT&T would not knowlingly recognize that NASA was going to tie the two together. Paul Price at Headquarters of Office of Tracking Data Acquisition, was in the main responsible for resolving many of these interface problems.

The British Post Office is responsible for interconnecting and contract services on the HF circuits and the cable services to Africa and the Bermuda facilities. I remember one occasion when the British Post Office people came to Washington and met with us for 3-4 days discussing requirements and objectives for a communications network. They were very cooperative. Some of the social activities that followed that were by far the more responsible for the good working relationships, because all we were doing at that time was just routing through some of the terminal facilities in England. Now there is a fullblown switching station at Shellmax House in London which is operated by NASA. Very shortly after we had started defining and implementing that network, Jim McDowell was hired by Goddard as a communications supervisor for the facilities to support manned space flight. He and I worked very closely together for the next three years. When the switching system network and communications systems were located here, Jim moved to Houston, joined the Flight Support Division and continued to manage the facilities here. He had a heart attack several years ago, and left the

Center. He went back to Goddard and was sent to England to manage the switching at Shellmax House.

Tec Roberts should be mentioned in all this because the Control Center at the Cape was one of his responsibilities and he was also the first flight dynamics officer. He also was very much involved in the development of the operational capability associated with the first realtime computer complex, which was at Goddard.

Prior to when the Apollo Program was approved and made a national goal, some 6 months of definition analysis was required to see what implications such a program would have in terms of network operations. Our problem was recognizing what information flow requirements would be, so we wrote a statement of work for an information flow study. It was to be a contractor supported effort to look at Mercury and see how we would have to run the Apollo Program: what communications requirements would be and how we would provide flight control and flight management. I can't remember what happened to that statement of work but I know we had been working on it for awhile when the question arose as to what the Control Center would have to be like for Apollo. The next think I knew we were involved in writing a statement of work for a 1-year study on the requirements for an Apollo Control Center. It soon became evident that there wasn't time to do a year's study. The Control Center would have to be started almost immediately if it was to meet what was then the Apollo schedule. When the contractor showed up to do the information flow study, he was advised that he was doing a Control Center feasibility

study instead. The Group Manager of that MSC-Philco group was Maury Roffensberger, and the contract manager was Walter LeBerge. Maury is now working for Headquarters, in the Office of Advanced Planning.

A group under Dr. Herb Sherman at Lincoln Lab worked with Barry Graves as consultants on tracking and tracking acquisition systems. Later STG got them onboard in a contract associated with Apollo spacecraft communications concepts, and they came up with what became the Apollo Unified S-band system. They also worked with us and the JPL people in evaluating the range coding techniques and the random noise coding techniques. From that time on, Jack Arno who is still with Lincoln Labs worked extensively with us in the computer systems for both the network and the Control Center and we invariably asked them to support us in any of these classes of major procurement.

One of the mistakes MSC made once, but probably won't make a second time, was to have a very large computer complex run by one contractor, IBM, and the remainder of the facility--display, control, command, and communications, etc.,--the responsibility of another contractor. I guess the reason we got into that mess was because back in the era when we were starting these contracts for a realtime computer complex and we had the Control Center at the Cape, the RFP for the computer complex which went at Goddard came out 3 months before the RFP for the rest of the control systems. I've always believed that the way that system is designed, the way the configuration is arranged, and under our present contractor setup, -- all stem from the fact that we went out of context and launched two contracts in sequence separated by 4-5 months. In the procurement for the facility and implementation of

the Control Center, we had the audacity to make IBM a subcontractor. The word subcontractor later was changed to associate contractor.

In Barry Grave's career is a hiatus -- when he was away from Langley on a Sloan Fellowship, which he took after the Mercury network was essentially completed and had begun operation. His return to Langley was coincident with the evaluation of the RTCC. He looked around the various Centers and the best opportunity for major program endeavor was the creation of this control center. MSC offered the job to Barry. Barry came to the Center in January 1963. When FOD decided it didn't really have the engineering competence to manage the design aspects of control center implementation, Barry Graves picked it up, and Ground Systems Project Office was formed under Paul Vavra. As manager of that office, Vavra reported to Barry Graves, who was Assistant Director for Information and Control Systems. A large segment of people were taken from the Flight Control Division and some people came from other centers to staff this project office.

The responsibility of that Project Office was to build the Mission Control Center. It led to a long string of unfortunate interfaces because the Project Office had had nothing to do with the procurement cycle. It didn't write the statement of work, didn't participate in the evaluation; it was handed two contracts on a plate--the Mission Control Center and the Realtime Computer Contract. Two contractors had been trained and oriented in one certain approach for the last 18 months, the funding plan had been based on those approaches and now the project office was being asked when they could build it. With the integrity of any engineer the Project Office people decided what they should really do was to reexamine the design

philosophy from the ground up. This led to many many controversies on requirements and technical approach.

I worked for Tec Roberts while we were at Langley and amongst other things I wound up being the monitor for the MIT Lincoln Lab Contract. Tec was responsible for getting the design conceptualized to the point where statements of work could be written intelligently against some kind of objectives. The 1-year Philco study led us to a position where we could write a fairly definitive statement of work. We figured we knew what we wanted functionally. We wanted two control rooms, the computer complex, the communication switching system, a simulation capability, a command and control system, and an interface communication system with the Cape. The statement of work that was written was very detailed in terms of functional capability.

Teletype then, as had been previously, was the prime system for world-wide communication mainly because of its proven reliability. Although it was a relatively slow system, 60 words a minute (or roughly to 360 characters/minute) was the best to be expected around the world with any degree of reliability. For shorter haul internal systems, 100 words a minute could be expected. Any incoming message had information as to whom it was addressed and whether there was a priority or not, and the system in the control center was to route it electrically up to a printout machine near where the addressee was working. We had started using a high speed data circuit System to Bermuda and to the Cape. Since that time high speed data circuits have been established

almost everywhere. That was considered to be the most rapid and convenient method of getting printed material distributed from the network through the various control rooms, conference rooms, and the control center.

The noise of the teletype was a problem and I can recall we spent quite a bit of money searching for silent teletype printers. We failed in this respect, and, are still using the same basic machine. The only thing that's really been improved is the cabinet, which we had soundproofed.

We also looked for rapid transfer of messages throughout the control center. Despite quite a lot of looking around and it turned out that the pneumatic tube system, old and conventional as it was, was probably the best system around. The decision to go to the pneumatic tube was sound because the design team visited in hospitals and other such institutes that have a large amount of message traffic, and pneumatic tubes seemed to be the best system for transmitting copy.

It turned out that the contractor who put in the pneumatic tube system was used to putting them on ships. If you go around and look at the pneumatic tube installation you will find they are very substantially built with quarter inch steel plate cabinets. The only unfortunate thing about the pneumatic tube system is that the delivery system is a 3" diameter pipe which exits through the floor into a console and becomes an integral part of the console, making it very difficult to move consoles.

While we were still at Langley, MSC was adding more people to its staff, and in early 1966, my office was moved to the boiler house. That was a frantic place to work. As I remember there was a tremendous noise that used to come into that place because there were two huge pumps that ran periodically. They were monsterous things and could have been industrial air pumps. But space was at a premium and that's where we were.

Then came the day of the flood. I managed to get to the site and waded through slopping water in the corridors in one building but the boiler house was at a much lower elevation and there was about 3' of water in our offices. In fact, the water was up to the tops of the desks and all the files were floating. I remember swinging from the overhead pipes in the boiler house to get to my office to see if I could rescue anything. It was hopeless as all the files that we had on the information flow study and all the records of the work we had done with ~~the Mitre Corp.~~ MIT Lincoln Labs, all the communications systems development files, when we eventually got to them, were stuck together as if they had been glued--each page cemented to the next one. A wealth of history went down the drain right there although it wasn't evident that it was that historical at the time. I think there was at least 3" of mud after the water receded.

In June 1962, we moved to Houston and took up space in the Houston Petroleum Center. John Hodge was then Flight Control Division Chief. Howard Kyle worked as Operational Facilities Branch Head, and I was his assistant. Operational facilities at that time encompassed the networks

and the mission control center. Soon after taking residence up in the Houston Petroleum Center we moved to the 2nd floor of the Stahl Meyers Building. John Hodge had a magnificent mahogany office there complete with bar. From June 1962, to around November 1962, we wrote the statement of work for the Mission Control Center implementation. In January and February, the Ground System Project Office was formed and half of our branch, including Howard Kyle, was moved over to form the new project office. That left me to take over what was left of the branch. Our concern was predominantly with the network, and we started writing what was then called Program Instrumentation Requirements Document--PIRD's--for the Apollo Program. Since that time they have undergone a name change to--PSRD's-Program Support Requirements Document. Tec Roberts was running the Mission Control Center Branch and his responsibility was to work in conjunction with the newly formed Project Office to maintain the requirements for the Control Center. Tec Roberts stated what the requirements were and the Project Office designed to meet those requirements. For the next year or 18 months, the Project Office and FOD worked together in a sometimes strained relationship, but they created the mission control center on a turnkey contract basis. There was sufficient dissention between FOD as a directorate and the Ground Systems Project Office that a desire was expressed to discontinue the Project Office and establish a Flight Support Division which would be responsible for

managing and operating the facility. That was done by adding a fourth division to the Flight Operations Directorate. Pete Clements became the division chief. Prior to that time he had been a technical assistant to Chris Kraft for networks. In the evolution of this fourth division, the people in the Project Office were given the opportunity of joining the new division or returning to another division to be formed within E&D. That division is now the Instrumentation Systems Division under Paul Vavra. The Flight Support Division was created from personnel from the original Project Office and from the Operations Facilities Branch, Flight Control Division. I wound up as technical assistant to Pete Clements in the Flight Support Division. Pete Clements had quite a challenge because he had to create a division out of a conglomeration of two other divisions both of which had their integral line organizations, and none of whom were compatible with what he wanted in a support division. Apollo was fairly well established and new generations of programs were starting to appear on the scene. I remember the first one was called the Apollo Extension System, AEX. Advanced Planning Offices in Headquarters were generating conceptual schedules for activity in 1969-1970-1975 time frame. I handled the capability analysis of the Control Center to see if we could support these, or whether we should start looking to even more control systems in the future. That situation lasted for some 6 months at which time the Apollo Applications Program began to take shape and to involve a large number of organizations in some level of effort.

I moved over to the directorate office shortly after that, and since that time AAP became a reality. For awhile program planning was

a very significant endeavor and the amount of planning required the establishment of a small office at the staff level rather than just one person.

Immediately after the Houston site selection was announced, I came to Houston. The reason was that NASA Headquarters was concerned about communications access to the site. A problem was already looming because General Telephone Company ran the communications on the south side of what is now NASA 1, and Bell Telephone was responsible for the north side. A NASA Headquarters fellow came down to review what communications capabilities there were because there was the possibility that the contract would be let to the company with existing capability. NASA 1 was then just a narrow, rough, little lane, and the site was just a big open field with a hedge along one side of it. I believe that General Telephone had just run a 20 circuit cable along the south side of the road as part of the long range future expansion program. It was hopelessly inadequate for anything we were contemplating. We came down a couple of times after that to negotiate with the Southwestern Bell Telephone Company in Houston on what our operational communications circuit requirements would be to this site above and beyond the administrative communication circuits.

We had some pretty hectic meetings with Bell Telephone Company because it insisted on knowing what our requirements were and we weren't too sure ourselves.

Some of these meetings were frustrating. The Bell Telephone had not seen our kind of operation before. We were asking for 4 video tables and 2 diverse routes for cables, and I think the magnitude of

our requests took them back a little. I remember sitting in one meeting of about 4-5 NASA personnel and at least 25 senior Bell Telephone people. We were sitting at a very long conference table. Howard Kyle was sitting at one end of the table, as the chairman, and I was sitting at the other end as one of the participatns. The conversation got more and more strained and difficult and I guess, in an attempt to appeal for support, Howard from his end of the table said -- "Do you have anything to say, Dennis?" and I said, "I think it's coffee time." This relieved the situation. Bell Telephone really did us proud despite these anxious meetings, for they put cables in without any real commitment from us that we were going to use any thing like their total capacity. I think they resigned themselves to the fact that there was going to be a big demand and the community would grow, so they installed them. Two cables were run from Houston to this area. One ran down the side of the Gulf Freeway, and it's now responsible for the Hunter exchange support between Houston and Clear Lake. Another cable ran down Red Bluff Road and Highway 146 and cuts in on the north side of the property line. Those two cables (we insisted on diverse routing so if one was damaged we would still have an alternate), probably brought the Bell Telephone service in great strength to this area. I don't think that under normal circumstances that Bell Telephone would have put that much capability here in terms of heavy duty cables.

Tom Ulrich cooperated with us in defining our requirements. At one stage in the game, we had a disagreement amongst ourselves, Tom and me, as to whether the operational communications should not come under administrative management. I think once he understood the necessity for maintaining separate control, we had no more problems on that score. The Bell Telephone Building on site is actually two buildings in one. On one side is the operational main-frame termination channeling equipment. Then there is a wall and on the other side is the administrative termination channel. The administrative circuits are brought up to the 2nd floor of the Project Management Building where we have all our administrative switching system and the other cables are taken over to the Control Center with its switching system.