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ORAL HISTORY INTERVIEW

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SUBJECT OF DOCUMENT: [use relevant bold-face introductory terms]

Oral history interview with Ralph S. Sawyer  
[full name of interviewee]

about Instrumentation & Electronic Systems  
[main focus of interview]

Division - facilities, equipment & development

Title: 1962 - Electronic Systems Branch,  
[interviewee's current and/or former title and affiliation]

1968- Chief, Instrumentation & Electronic Systems Div,  
Dir of Eng & Dev

Interview conducted by Robert B. Merrifield -  
[interviewer's name/position]

Staff Historian at MSC  
[location of interview]

Transcript and tape(s). [for inventory only: # pages 15; # tapes 1]

Master 1

**CONTENTS:****Biographical** - [date/place of birth; family background] \_\_\_\_\_**Education** - \_\_\_\_\_**Career Path** -*Exterior Ballistics Instrumentation Branch,  
Naval Weapons Lab, Dahlgren, VA;***Topics** -

<sup>1959</sup> *Robert* Initial STG Contact w/ Gilruth; early STG Quarters, Polaris experience. Work w/ Faget in Flight Data Systems Branch; <sup>Rich Building</sup> temporary quarters in Houston; Houston Chamber of Commerce; facilities for electronics effort; acoustic chamber; vibration ~~facility~~; nuclear facility; Anechoic Chamber; EMI tests; rotisserie positioners; bore sight tests; micro-miniaturized circuits; integrated circuits; labs - telemetry, instrument, RF communication, radar; in-house study of contractor progress; office facilities at Ellington; Calibration & Development Flight instrumentation; Corona problems; aircraft natural resources program; synthetic aperture radar; passive microwave radiometer; infrared systems; scatterometer. Loss of personnel to industry (higher salary)

UNITED STATES GOVERNMENT

# Memorandum

TO : EE/Ralph S. Sawyer

DATE: March 8, 1968

FROM : BN5/Dr. Robert B. Merrifield

SUBJECT: Preparation of a History of the Manned Spacecraft Center

As is pointed out in the cover memorandum, I have been commissioned to prepare a history of the Center. There is a large volume of information (memoranda, blue prints, sketches, etc.) available in the official files and, of course, I plan on exploiting it. However, such information is only the bare bones of history; I will also need intimate detail and personal insight from major participants and informed observers. It is especially vital that I have the benefit of the personal recollection of our key personnel who shaped the management philosophy of the Center during its early formative years. It is for this reason that I would like to have the privilege of spending a few hours with you, to help you put together a statement reflecting your knowledge of the Center's history.

If you have no objection, I will plan on using a tape recorder while I am with you, as it is a convenient way of obtaining a lot of information quickly and economically. I fully appreciate the fact that you have been involved in a seemingly infinite number of major activities, all of which are complex and of such significance that they cannot be disregarded in a Center history. At the same time, I recognize that your time is valuable and limited, and will leave to your discretion what you should put into your statement. I am interested in any information you consider to have been important in the establishment, growth, or maturation of the Center, and invite you to feel free to go into whatever depth of detail you feel advisable and within the limits of your available time. There will be no need to be concerned about grammar, structure, or repetition at this point. I will plan on submitting a transcript of this recording to you as soon as I can get it typed; if you wish, you may then amend or add to it.

I am keenly interested in those minor details that will add vividness and vitality to a historical narrative. For example, a key management decision may have been reached in one of those drab, crowded, stuffy conference rooms of the "Dolly Madison House" (rather than "at OMSF"); or the wisecrack or joke that relieved the tension or boredom or weariness of an important meeting; or the unprepossessing appearance of the Carla-battered Clear Lake Site. Although such details may seem trivial, their judicious use will make the difference between dull and interesting reading.



*Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan*

Because of your position and long association with the Center, it is quite likely that you are familiar with events where personality clashes, conflicts in judgment or other human failings have played a considerable role. The natural tendency in dealing with such sensitive issues is to avoid them or to gloss over them with generalities. Obviously, any history based on this type of treatment will be bland, innocuous, and superficial. On the other hand, if potentially explosive information were to be incorporated into a history, it would certainly lead to embarrassment or more serious consequences to the Center. As an alternative to these two extremes may I suggest the following: I would like to have your statement to be completely candid; I will consider it to be personal and confidential, and will safeguard it accordingly. After typing your narrative, I will return it to you for verification. At this time, I will ask you to indicate those portions of your statement which you regard as "privileged information." They would never be alluded to in any way in the Center history, and would have the sole purpose of giving me the necessary background information I need to write a factual and objective history.

May I call you in a few days to make arrangements that will be mutually convenient for me to see you?

Robert B. Merrifield



UNITED STATES GOVERNMENT

# Memorandum

TO : EE/Ralph S. Sawyer

DATE: March 8, 1968

FROM : AC/Special Assistant to the Director

SUBJECT: Preparation of a History of Manned Spacecraft Center

At the request of Dr. Eugene M. Emme, the NASA Historian, we have agreed to assume responsibility for the preparation of an MSC history. This effort is expected to complement programmatic histories (Projects Mercury, Gemini, and Apollo) which are either in preparation or complete. The MSC history will place primary emphasis on the Center as an institution--its general management philosophy, the evolution of its major organizational elements, growth and modifications of its staff, management of its financial resources and contracts, acquisition of its facilities, and its impact on the economy, culture and society of the community in which it exists.

Dr. Robert B. Merrifield, a professionally trained historian, has been asked to prepare this record of our progress from Langley origins to the present. Since he has been with the Center for over five years, Dr. Merrifield is familiar with many key decisions, events, and trends in the Center's past. However, he will need help from all of us who have been major participants in the life of the Center, particularly in interpreting why and how various forces have influenced the development of the Center as an institution. Your aid and cooperation in this undertaking are vitally important to its successful completion and will be appreciated.

  
Paul E. Purser



Interview with Ralph Sawyer  
4/10/68

32  
Prior to coming to STG, I was at the Naval Weapons Lab in Dalgren, Virginia, as head of the Exterior Ballistics Instrumentation Branch. We had quite a large danger area there where we were firing various types of rockets, and dropping various shapes from aircraft. The advent of the jet airplane meant the planes from Washington would stack up over our danger area occasionally even though it was well labeled danger area. It was only a matter of time until we shot one down or the FAA put us out of business so we wouldn't. We had rather an astute management there, and we volunteered to get out of that business. There were several other jobs open and a couple of them were in the category of promotions. I started looking around. I was well aware of Goddard, of course. I did not know too much about the Space Task Group; however, I had heard about it. I guess it was June of 1959, when I went down to ~~Hogshead~~ <sup>Nags Head</sup>, N. C. to spend a week fishing, and then decided to use the last several days staying with my wife's sister's family in Norfolk, Va. ~~While there~~, I called the only name I knew with STG (and I knew it from Aviation Week, etc), Robert Gilruth, and I gave him <sup>a</sup> short resume of my background. It so happened that I was a consultant on Polaris in regard to onboard instrumentation as a second job when I was at Dalgren, which turned out to be a useful link with STG. He said, why don't you come and talk to us, and so I did. I went into the lobby of the STG building and asked for the only name I knew, and it was Gilruth. That got me in, and I talked with Gilruth, Faget, and Harry Ricker, who went back to Langley before MSC moved to Houston. I also talked to K. Johnson. As I was getting ready to leave, I

I went to Norfolk to fresh water just in back Bay, but the wind turned to the North and blew the water out of the bay. The fishing was useless, therefore I had time on my hands.

went back through K. Johnson, and he wanted to know when I could come to work. I could hardly believe they had made up their minds so quickly. This kind of scared me because I felt like there must be something wrong with the Government agency - they didn't mull it over for 6 months. I told him that I needed a letter and he should state in writing that STG would move my furniture. He should also state in writing where I was going to work as I didn't want to be interviewed for one job and get into another.

38 I guess it was two weeks later, I got a letter from NASA Headquarters that offered me a job in the wrong division, doing the wrong things, and didn't say anything about moving my furniture. I just ignored it. Then about two weeks later I had a call from Kemble Johnson. He asked me if I was going to come or not. I told him I had a letter, but it said all of the wrong things. He had a few choice words to say about Headquarters, and a couple of days later I got a letter from Kemble, and it said everything I wanted to hear, so I went to work July 19, 1959.

52 Of course, there were very few people at STG compared to what we now have at MSC. We were in two brick buildings in the east area of Langley Research Center. I happened to be in the same building as Gilruth about mid-way in the building, whereas his office was up front. Two days after I arrived, we had about a 6-month program slip. I had worked as consultant on Polaris where if anybody talked about a two-day slip, he was in deep trouble. I figured with this announcement of a 6-month slip, my office was well situated to enable me to watch the heads roll down the hall. Well of course, the nature of the program was a little different, there wasn't quite such a to-do about slips in the program, which was probably good, and no lopped heads rolled by my door.

52 When I was interviewed by Gilruth and Faget, Faget also had been working on Polaris. I had worked for NACA (previous to working with the Navy) so knew him vaguely from that period. Then when I attended the Lockheed Coordination Meetings on Polaris, I noticed the NACA rep was Faget. I wondered what he was doing on the project, and I found out later that he had had a lot to do with putting the skirt on the reentry body. He was pretty well acquainted with some of the people in Polaris program's Special Projects Office in Washington, and after interviewing me he called Cmdr Rod Middleton (now Admiral Rod Middleton down at the Cape) and checked me out before offering me a job. They did things a little bit faster in those days.

25 I guess it was the same week that I came to work, that I got sent to McDonnell Aircraft as an expert in communications on Mercury. Of course, I was just beginning to learn what the whole program was about, but it was either swim or sink. I was working under Max in the Flight Data Systems Branch. In those days there were three divisions: one headed by Max, one headed by Chuck Matthews, and one headed by Jim Chamberlin. The character of Max's division is fundamentally the same as that of the E&D Directorate. The character of Jim Chamberlin's division was essentially comparable to a program office. Chuck Matthews' division was equivalent to the two operations directorates and it included the Cape in those days.

45-1 We had quite a few GS-7 engineers, who had graduated in that June of 1959, and a large number of them are still here, and some are still in my division. They, like everyone else, got thrown in the pool, and also were expected to swim or sink. They sure did an excellent job

for young kids right out of school.

I guess it was in the fall of that year when I became head of the Communications Section in Max's Division. Then in a later organization, I became head of the Electrical Systems Branch. This was about the time we came to Houston. Around this time we hired ~~Lynn~~ <sup>Lem</sup> Packham, who was then working under Chuck Matthews.

128 Speaking of coming to Houston, I was on TDY down here for a period of time prior to moving permanently. Various MSC divisions had sent reps to look at the prospective rental facilities, and for their personal needs looked into apartment renting, house renting, house building costs, school systems, etc. I remember we talked to the superintendent of schools at Clear Lake on that trip. Bob Bailey, now Executive Engineer in the Apollo Office, was one of the fellows in that group. Others were Jack Kinzler, Bill Kincaide, Norm Smith, and possibly others, although I can't think of all of them. The MSC Site Manager was Marty Byrnes. We went through the Rich Bldg, and I remember Phil Rich walking along behind us. He didn't know who was who, and for all he knew I was James Webb. I remember every other step I took, he would say, "You make this building anyway you want it - anyway you want it."

128 One of the things that was scarce in the Houston area was the work area. The Rich Bldg was the only building we saw with a high bay. I believe that the reason you see so many big barns attached to the office buildings at the site today is because of that scarcity of high bay buildings we encountered when we came down here. Everybody felt he needed a high bay area and there was a lot of competition for the Rich Bldg.



At the same time we were laying out the concepts for our permanent quarters and I think everybody designed a building with a high bay attached, just to be sure he would have one if he needed it in the future.

156 The Chamber of Commerce treated us real well, of course. They sent representatives to Langley and showed movies. I remember we were told that everything was wonderful about Houston except the weather. They said it was lousy - terrible weather--it rains, it's humid, and it's hot. But since I've been here one of the things I like about Houston is the weather. It isn't as cold and miserable as it was in Hampton, Va. 163 We had our own hot, humid summers in Tidewater, Va., so Houston was not a real bad shock.

163 Our TDY in Houston was right after hurrican<sup>e</sup> Carla, and we saw a lot of the effects of that. The area of the Site had cattle grazing on it; - I recall matted grass (I guess from the result of heavy rains). We tried to visualize where the buildings would be. It was then just an open prairie and it was kinda hard to imagine a center complex there. 1 Marty, of course, had a better handle on the Site plan than any of the rest of us, and tried to tell us where everything would be. At that time MSC was located in temporary offices in the Gulfgate Shopping Center.

146 Some of the planning that we had to do was for new buildings. This Bldg, Bldg 15, houses a large part of our electronics effort which is the main concern of our division. And at that time, the large vibration facility was also under us and we designed a complex unit consisting of the vibration facility, the Anechoic Chamber, each with a high bay and a

246-7

and a common erection area between them. But we had a change in organization, and Barry Graves came in the summer of 1962, I guess. The Electrical Systems Branch became the Instrumentation Electronic Systems Division, and the big vibration facilities we had planned, and our development program for thrusters were relocated due to the change in organization. Later this division was to have a nuclear facility, for instrumentation purposes. (We created the technology for measuring the char ablation of Apollo vehicle). During a reorganization, the nuclear facility was moved over to ASTD, and in subsequent moves came under the Experiments Office and the Science and Applications Directorate. We also had planned a small acoustic chamber. That got transferred when we went into the directorate under Barry Graves. Our division thus can claim a couple of facilities, other than the one we now have as the acoustic chamber, vibration facility, and nuclear facility all were started here.

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Our Anechoic Chamber, as far as I know, is the biggest facility of that type in the world. We take antenna patterns there of astronauts and the antennas on astronauts used to communicate with other astronauts; we have suited up <sup>pseudo</sup> astronauts and put them on a boom up in what we call the quiet area of the Anechoic Chamber, taking patterns, and also taking electromagnetic interference measurements. The reason the chamber is the biggest in the world is that our vehicles are very large. They have to be large, of course, in order to house three men for a long period of time. And we can put in our Anechoic Chamber both the Lunar Module and the Command and Service Module. As a matter of fact, we have them in there right now along with the back-pack communications running EMI tests.

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The Anechoic Chamber can also serve as one end of the antenna range if per chance we should have interference in the area for some reason. We can use the Anechoic Chamber Building to shield one end of the antenna range, and utilize it in making patterns. Normally the patterns are made out on the range which is entirely outdoors. I have a sheet of paper that I will send you that gives its characteristics. The chamber is roughly 55 feet by 100 odd feet long, and the whole end the building opens up so as we can use it as one end of the antenna range, and so we can get these very large vehicles in.

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We also developed positioners, or what I call rotisseries. These are the mounts where we put mockups of the spacecraft out on the antenna range. The "rotisserie" is programmed to rotate so we can get a full set of antenna patterns. The tower at the far end of the range doesn't look very large, but it is 80 feet high. We had a need for boresight tests on the landing and rendezvous radar so we put another building to house that equipment with another large positioner that turns the spacecraft models. We have uncovered many problems in using this equipment. The boresight enables us to look for interference patterns caused by structure. We have modified the structure and modified the antenna to take care of these interferences. In Building 15, we have several labs, but one of the most significant is our micro-min laboratory. At the time we were designing it we were at the threshold of research in micro-miniaturized circuits. We put in a thin film capability, and now we have a full integrated circuit capability there. The work we do in this laboratory has allowed us to remain on the threshold of the state-of-the-art in electronics. Electronics is advancing most rapidly in this micro-min area. The transistor was a big step from the vacuum

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tube and going to integrated circuitry is an even higher step. We have 15 transistors impregnated along with their circuitry in one chip about an inch square, which, of course, enables us to effect great economy in weight and size. Our other laboratories housed in this building include the telemetry lab, instrument labs, RF communication labs, and radar labs. I might mention that one of the first activities that we got in for Apollo was an inhouse study on instrumentation, communications, and tracking. We set up a panel (I guess there were a total of about 10 panels at STG) on communications, instrumentation, and tracking. Throughout the study ~~pahse~~ <sup>phase</sup>, we went as a group on periodic visits to the contractor plants, and of course, periodically we had the study contractors make presentations to us. At these presentations, we brought in outside people. In the communication tracking area, we brought in the Lincoln Laboratory of MIT and JPL, and after hearing the contractor's presentation we would break up into splinter meetings and interrogate the contractor more closely, and then the people from the other Centers and JPL and MIT, as I mentioned, would come up with some critiques. It was then up to the chairman of these subpanels to go to the contractors and get the answers as to methodology and other questions of a technical nature that had been raised. Then we would put out a report explaining to the members of the committee what the answers were.

338-3  
When Building 15 was finished we moved directly from the Rich Bldg to Clear Lake; however, our building was not large enough to house us all, so some of our division was housed at Ellington. As time went on we became more and more compressed in Bldg 15. Later we did get Bldg 14; however, it was designed as the Anechoic Chamber and the antenna range

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and this was really only able to house one section as far as office space was concerned. I presently have two branches in that building, and thus it is overcrowded. We are now housed in about eight buildings at Ellington. One area that has grown quite rapidly since we moved from the Rich Bldg is the area of calibration. We got into calibration because back in Virginia we started working on what was then called the R&D Instrumentation, and has since been redesignated Development Flight Instrumentation (DFI). One reason for changing it from R&D Instrumentation to DFI was Headquarter's fixation over the use of the term "research" by a development facility, so it was called Development Flight Instrumentation. The purpose of this instrumentation is to prove that the vehicle systems will function properly in space. The reason that the prime contractor is not providing this instrumentation is that he didn't have the time to do it. Use of instrumentation of this type is a problem as ~~during~~ <sup>after</sup> a flight, certain organizations want more information, and only so much <sup>on the next flight</sup> information can be carried on the transmitters that are available, so something has to give. If this problem had to be negotiated with the prime contractors each time, it would be a very lengthy process. We started using shelf items, and at one time for one vehicle we had about 43 vendors. We provided the sensors, the modulation, and the transmitters as well as completely designing, checking out, and calibrating the system. That is how we got into calibration. We had to calibrate all of our test instruments and all the measuring systems that would be flying on these early development vehicles. They required such a lot of calibration equipment, and at that time, we were the only electronic people at the Center able to provide this service. When we



347-2  
345

moved here from Virginia, we had a Mercury Ground Station plus a few other accoutrements and it was the data reduction facility for the whole Center. Of course now we have an entire division to handle that sort of thing. As the Center grew, electronics shops sprang up in many other places and the calibration requirement grew to include physical measurements. There were physical measurements that had to be performed on the spacecraft, such as pressure, temperature, and vibration, and we calibrated the instruments. We provided calibration for the whole Center, and when the prime contractors began to use the large chambers at MSC, it increased the load on calibration tremendously. We are also doing such work as gas analysis - largely oxygen purity, which has become a Center requirement since the fire. We have people on call 24 hours a day who spend a great deal of time in this calibration area and as a function, it has gone from what was largely electronics to where it now includes torque wrenches, load cells, various other things that we are asked to calibrate. This work is done primarily by the support contractor, which at present happens to be Philco-Ford, the subcontractor to Lockheed. Lockheed is our principal non-personal services contractor here in this Division. The civil service billets certainly couldn't keep up with the load and a great majority of the calibration work is being done by the contractor. We manage this effort, but we never got any building space for it. We had to accommodate it in the space ~~craft~~ <sup>3</sup> electronic building.

191

During the time we were at Langley, all the technicians were in a pool under Kinzler, but about the time we came to Houston there was a change, and the technicians who were assigned to Kinzler but working in this division and other divisions were reassigned to the divisions in which they

worked. And I guess there were mixed emotions about this decision-- some were for it and some were against. Favoring it, I guess was the fact that the people who really know what the technicians are doing, are in an organization other than the organization that put the technicians up for promotion. We had an excellent relationship with Kinzler and his supervisors of technicians, and had no great problem operating under the pool arrangements and when technicians got transferred to us, we had no problem with that arrangement either. In my opinion the technicians probably preferred being in the Division using their services. Also, when you have a pool of technicians, you have to have supervisors for them. The supervisor is able to get a higher grade than is normally possible for a technician but prevented a needless pyramiding of supervisors.

405  
Fairly recently we have gotten some help from Goddard and JPL in regard to some corona problems. JPL had had the same problem. After their equipment was built, they discovered corona. Our equipment is built and we too are getting a corona effect. *I can sometimes be alleviated by putting the electronics in plastic, however, the plastic also moves with temperature changes and it is not a permanent solution.* To prevent it such as plastic inserts can be used. To ~~prevent~~ *prevent* it, it is necessary to put the box under pressure. For assistance in various technical problem solving, we have relied on consultants from JPL and Goddard along with other Center elements and the contractor chain. For instance, we had some worries about the landing radar operating properly *due to flame characteristics of the motor* on the lunar surface, and some tests were run by *MSC's* the Propulsion Division *(here at MSC)*. At Arnold AFB, we arranged for Langley Research Center to make measurements of the plume effect of the *on* ~~S~~ *X-* Band radar. This test was done on the actual motor, however it was done in the atmosphere vs the vacuum of space. We have borrowed equipment from various Centers, Langley Center primarily, and they

have borrowed some from us. For example, they borrowed a belt pack communication system for some tests they were doing. For a laser tracking experiment on Gemini we built a station at White Sands Proving Ground. We planned to track and receive from there. Actually we were planning to talk on a laser beam. The whole experiment did not work too well, and one reason was that we changed the geometry of Gemini 6 and Gemini 7. Originally we were to have a zenith pass over White Sands at about a maximum of  $30^\circ$  from the horizon. Headquarters learned of the experiment and it wanted to expand it, so a station was set up at Accension Island, and in Hawaii, which we were asked to manage. We told them we didn't have the people, so Langley and Ames came in and manned these other stations. We provided them with drawings of our stations, and gave them certain equipment we already had. Then the flight path changed and also the weather at White Sands. Normally the weather is clear but I guess it rained all during that mission. Then we had a lot of sad things happen during that experiment which are probably best forgotten. We were using a laser as a tracking light on the ground and we had very few of these. One burned out in Hawaii, and as we had a spare here, we had one of our people handcarry it to Hawaii. As he got off the plane in Hawaii, he dropped it on the runway.

We are running the <sup>aircraft</sup> natural resources program technically for the S&AD Directorate. At the present time, we have a Martin 240, which I believe is going to be replaced. We also have a P-3A in which we are now installing equipment. We are providing about 50 people for this effort. Most of these people are employed under the non-personal services contract with Lockheed. We are managing their efforts and have several



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257-1  
247

of our own technical people in each area. As part of the earth resources program, in the radar area, we are <sup>making use of</sup> ~~developing~~ a synthetic aperture radar, which <sup>compares in complexity with</sup> ~~is~~ probably more complicated than the whole guidance system in Apollo, including the guidance and stabilization system and the rendezvous radar and the landing radar. We also have responsibility for the passive microwave radiometer, which is in the early development stage. We are associated with JPL in this development program. In addition, we are working on a number of infrared systems and of course we have various types of cameras under development. Before the earth resources program began at MSC, we were working on a scatterometer for the landing radar. We are now using them for the Apollo program and the natural resources program. We already have a scatterometer radar installed on the airplane.

243  
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And speaking of airplanes we do quite a lot of work with airplanes. During Gemini we ran extensive tests at White Sands requiring the use of airplanes. We had to have a large area flattened out to a certain levelness. We emplaced the Gemini spacecraft in the ground, put absorbing material around it to avoid RF reflection and then we flew the transponder on aircraft and helicopters. We used White Sands because the range is instrumented. Now we <sup>are</sup> ~~were~~ using the same site for testing the Apollo landing radar and the Apollo rendezvous radar. We have been using White Sands for Apollo tests nearly a year and a half now. Hence, working with airplanes was one of the standard things we were doing prior to getting into the natural resources program.

Since our division offers an opportunity to work in advanced state-of-the-art, we have lost a number of people to industry, primarily because of the ~~inducement~~ of more money. One fellow who came to us with a PhD, then got called in service, we arranged to have transferred to us. He stayed for two years, and then after being discharged from the service stayed on with the Division. I believe he stayed with us at that time because we were putting in an integrated circuit capability and he wanted to see it thru into the operation phase. He was a GS-13 when he left, and a section head. We would have had no problem eventually bringing him up to the GS-14 level which I am sure he understood, but he took a job in industry, at a salary over \$20,000 at a time when he was earning \$14-15,000 here. Another individual came to us from Georgia Tech with a PhD and no real experience. He worked in our radar area, particularly in the development of the scatterometer for the landing radar. He had a great deal of contact with two or three radar vendors due to the nature of our work. He too went into service, and when he completed his service obligation, he had at least three offers, all over \$20,000 from industry. He worked for us as a GS-13. Generally speaking, the people that we have the greatest difficulty hanging onto are those with RF experience. There is apparently quite a shortage of these people. We have had our greatest turnover in the Electromagnetic Systems Branch and Tracking Techniques Branch which are in the RF area. Our work on Apollo has given our people rather good experience in rendezvous radar and landing radar. We have two radar experiments that have been funded the last two years

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that we are making good progress on and are advancing the state-of-the art in certain aspects of radar, so I guess maybe that is one reason industry is interested in these people. Of course, many other people, in addition to the two PhD's I have mentioned, have left us (and they don't have to be PhD's), and they left us for rather a substantial increase in salary. I had a Branch Head leave about a month ago who was a GS-15. A company starting a new division in the Houston area hired this man. *His previous job was as* ~~He was also~~ the chief electronics engineer with Baylor Research Institute, Baylor Medical School. He left a GS-15 job (and he was probably in the 5 or 6 step) to go to industry at a substantial salary increase and a stock option.