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Oral history interview with Stanley Faber
[full name of interviewee]

about Flight ~~Simulation~~ equipment & Crew training; remote site network.
[main focus of interview]

Title: 1962- Flight Crew Operations Div, ASPO
[interviewee's current and/or former title and affiliation]
1968 - Chief Simulation Branch, Flight Crew Support Div, Dir of Flight Crew Oper

Interview conducted by Robert B. Merrifield, Staff Historian
[interviewer's name/position]

at MSC.
[location of interview]

Transcript and tape(s). [for inventory only: # pages 40; # tapes 2]

Master ~~2~~ 1

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Education -

Career Path - ~~LRC (flight research); STG~~

Topics - dev of STG; flight test & simulations; astronaut crew training at centrifuge Johnsville Naval Air Development Center; Control Center Simulation Group; Mission Control Center; mission simulation exercises; Kraft cigar signals mission success; destruction of MA-3; abort of 1st MR launch; remote site tracking & simulator network; 1st unmanned orbital mission & Hurricane Carla; Muchea, Australia remote site team work for Glenn flight; political squabble re Perth lights; negative reaction description of Houston site; Apollo Prog training equipment/simulators ~~from North American~~; decision to join Flight Crew Support at MSC; Gemini Simulators (McDonnell); astronaut Corps increases & training schedules; Translation & Docking Simulator; malfunction of stuck thruster (Armstrong). late delivery of Apollo training equipment; redesign of Command module; SIMCOM (Simulator Support Contractor); Apollo - MIT contract; out-the-window simulation capability; (over)

LMS visual system; Zero "g" water tank request; inter-division friction in early MSC days; Contractor evaluation ~~cycle~~ process too ~~complicated~~ involved.

1333

August 30, 1968

Stan,

The transcript of your interview, edited to remove extraneous material, is attached.

If you will, please read the statement and mark those sentences with brackets [ ] that you would not want alluded to in a Center history for reasons of embarrassment to an individual or the Center. As I mentioned during our recording session, this interview is to be part of the source material for the history, and it is doubtful that I will quote from it verbatim. Therefore, please don't worry about a sentence here or there which might not be as polished as would be desirable were it to receive public scrutiny.

If you want to add information feel free to do so. Just tack it on at the end of the statement, unless you prefer that it be inserted into the text.

After you return the transcript to me, I'll send you a copy for your personal file.

Thanks,

Bob

Code BN

<u>INTERVIEW WITH STANLEY FABER</u>

December 8, 1967

I joined STG early in the Mercury Program, and if the time cards are right I was employee number 80. ~~eight.~~ Previously, I had been at the Langley Research Center in Flight Research. During the period preceeding the formation of the Mercury group, Flight Research had suffered a severe cut back. A Headquarters Directive had come thru saying that such work should not be done.

When the Space Task Group was formed--a great many of the individuals in Flight Research Division, Chuck Mathews, Chris Kraft, Harold Johnson, Sig Sjoberg all were recruited by the Space Task Group. In fact, recruiting became so active that Langley Management had to put on severe restrictions to protect the rest of their organization. ~~Space Task Group was told not to recruit.~~ I had no desire to leave the Langley-Newport News area, but also I didn't see a heck of lot of work that was interesting in our own organization, expecially after so many of our good people went elsewhere. One day I happened to be home with a throat so sore I could hardly talk and received a phone call from Chris Kraft, asking me to come over and talk to them about a position. He could not officially ask me to come over but if I dropped over ~~there~~, they couldn't throw me out of the office. That was their agreement with Langley. So un-officially he was asking me to come over, and further he said there was one more day that the switch could be arranged.

I went ~~once and talked with him~~ and was offered an assignment in simulation and crew training under Harold Johnson. It was quite logical that I go into simulation work after being in flight test work. Flight

testing was fairly expensive activity, and ~~if~~ we ~~could~~ would supplement flight
49 hours with simulator hours ~~we could~~ to get much more data, ~~much~~ more effi-
56-2 ciently and at less cost. We had learned to develop simulators to repro-
duce the airplane and used the airplane ~~and~~ to correct our equations and
verify results.

My first assignment was in the development and acquisition of what was
known as the Mercury procedures trainer and the training flight crews in ~~of~~ the launch
49 56-2 and reentry phase of the mission on the centrifuge at the Johnsville
Naval Air Development Center. I ~~initially~~ set up the programs at Johns-
ville, and conducted the first programs. These ~~which~~ were overly-sophisticated due to our poor knowledge of what
was required. In the procedures simulator I worked with the initial de-
velopmental equations and became familiar with the spacecraft to ensure
that the simulator in truth duplicated the spacecraft properly. We
worked on developing crew procedures ~~and~~ in how to use the spacecraft systems,
~~in our functions~~ and in procedures to circumvent malfunctions.

Some of the first things that we tried to teach the crews (now con-
sidered a very simple task) was to handle a vehicle with an acceleration
49 control system. We spent many hours with the first seven astronauts. We
also attempted to develop the most economical control techniques in terms
of fuel usage.

My second major assignment with the Spacecraft Task Group was the
Control Center Simulation Group. In the evolution of the operational
56-2 team of the Mercury Program, the mission control center became the key
61 element. We had a large team in the Control Center and Mathews and Kraft
and others knew that this team was going to have to be trained to work
together and with the crew.

In preparing this controller training system, we updated the procedures trainer by adding a small analog computer. ~~The~~ Systems data was generated 56-2 in the simulator and was sent ~~out~~ to the control center ~~so~~ in a form that ~~it~~ appeared to be telemetry, we could animate all the displays in the control center, ~~and~~ the various A/G voice links were also utilized. The trajectory aspects 56 were basically canned. We knew exactly what the trajectory was going to be, we put it on a tape and then played the tape. The system was used to train the flight controllers and secondly, to test suitability of the operational characteristics of the control center. Just as we got the system rolling, we got a slight change in program. The Mission Control Center was originally planned to control only the later Atlas orbital 61 missions. Walt Williams ruled that rather than wait, we would use the Mission Control Center as soon as it was available, if possible, on the first manned Redstone mission.

One of my ~~new assignments~~ tasks was therefore to help to activate the Mission Control Center. The control center was being designed almost in real time. The 61 simulator would send out data and the control center would see how it 56-2 could use it, and if any design changes might be required. When we scheduled the first simulations, we found we didn't know what we were simulating. There was no procedures document, and no countdowns had been prepared. Knowing better than to complain, a couple of people from Kraft's immediate staff and myself with a couple of my team in the control simulation group, sat down and wrote the countdown for what was to be the first manned Redstone mission, and the procedures under which the control center would operate. There was a strong difference of philosophy among the members of the group. I represented one element that placed a high value on the potential of capable people. Another element believed in doing everything by the book, establishing rigid procedures and leaving all the decisions to the top man. We had to find a middle ground between these two rather diverse opinions and as a result came up with a workable system.

Once the procedures and the first countdown were prepared, we scheduled our first simulations. Simulation of a ~~countdown in a~~ Redstone
52-2 flight might last one to one and one-half hours, from crew insertion to recovery. The debriefings that would follow one of these short missions, would often last three to four hours. We simulation people would explain what we had done, what we thought the control people should have done, and
49 what we thought spacecraft pilot should have done. Then the other two parties, the control center and the astronauts would get into the act, and we would have quite a ring-a-round. The mission rules document were prepared almost in real time in these exercises. And as soon as someone
56 wrote a rule we would arrange a simulation to test it to see if we would agree with it. These series of exercises (and there was quite a series of
61 them) polished procedures to the point where, once the spacecraft was ready to fly--control center procedures and flight crew procedures were ready to fly.

At this time the question of whether we were ready for manned flight became a matter of active consideration in Washington. Did we have the capability to fly a manned spacecraft or were we going to shoot some guy
95 off into space and kill him? STG invited the PSAC down to watch a simulation. We wanted to put on a good show; we wanted to demonstrate our
56-2 capability. Kraft and I and several others got together and decided what type of simulation we wanted to run. We decided to run a real simulation

and not gimmic it up. If we gimmiced it up, it was going to look rehearsed. But if we didn't rehearse it, we couldn't be sure what was going to happen. We weren't that confident that any failure we could introduce would produce a safe conclusion, especially since the system itself introduced its own failures. After considering the alternatives we decided to run the normal mission. Our hardware left much to be desired insofar as being able to predict exactly what it was going to do. It was a system held together more by people than by basic design. My team consisted of McCafferty who joined us from McDonnell, Hal Miller, Art Hand, Glenn Lunney, Dick Koos, Dick Hoover, and briefly at an early stage, Jack Cohn. By bailing wire, tape, and lot of talking we kept the simulation together. We found out that a normal mission was the most difficult to run. Several interesting malfunctions were introduced by the crew and the flight control team. This committee watched the control center handle everyone of these things as if they had been thoroughly rehearsed, created the impression that in an actual mission malfunctions would be handled as run of the mill. Whether this overwhelmed the committee or not, it made an impression on them. We flew the manned mission on schedule.

During the actual missions, having been so actively involved in flight control work, and since there was not a heck of a lot that I could be assigned to do on the launch date, I fell to supporting the PAO people. Paul Haney and I occupied a little glass booth. In the course of this PAO work, I noted a factor that Paul ~~would then~~ used to find out how the things had been going. As mission success was assured, and we knew we could pick up the astronaut, Chris Kraft would light up a cigar. That was the key--as soon as Chris lit his cigar everyone would know that the mission was a success and could relax.

At this time, the first suborbital Atlas mission was launched. It was MA-3, our only mission in which we had to destroy the launch vehicle. Approximately 60 seconds into launch range safety destroyed the vehicle. The interesting part of this was the fact in watching this on our TV cameras inside the control center, we had no appreciation for the magnitude of what was taking place. My wife and children were on the beach. My wife said she could feel the heat of that launch vehicle blowing up ~~15~~ 7 to 10 ~~16~~ miles away. It was only after I got home and talked with her that I
61 realized the amount of energy that was involved. Our first MR launch was our shortest flight. The vehicle rose some 3/4-7/8" then sat back down on its tail. We didn't have all the automatic data systems we currently have, and I was to verbally transmit the lift-off time to Goddard (where our computer center was) so they could initialize their computation. They couldn't trust the signal that was coming up the line. The clock on the console in front of me just stopped at lift-off. I was probably the only one that didn't know that we had a program abort. My clock stopped I read off the time--I looked around and everybody was completely blank--just staring at their TV sets and wondering what the heck had happened. I've seen the film again and again and to see that thing sitting there with parachutes flipping out this way and that, it looks like one of the comic movies.

Most of the people in the Space Task Group had more than one assignment, especially those in the operational area. The additional assignment
52 for a good many of these people was as a flight controller to man the
56 various remote sites around the world. I feel that this dual assignment

was very desirable. Serving as both the engineer responsible for design of the system and the engineer responsible for operation of the system as part of the major team, we knew the compromises that has been made and why. I was the group leader of the simulation group and Dick Hoover was my assistant; we were also both flight controllers. Kraft guaranteed that we both wouldn't be assigned to the same mission. We would alternate--one would be assigned to a flight controller duty and the other would be able to carry the simulations at the control center. The first flight control activity to which I was assigned involved setting up the Bermuda 56-1 site. This site became operational several months after the MCC. I worked under John Hodge and was at Bermuda twice writing the countdowns and procedures that Bermuda was going to use--the procedures for the rest 56-2 of the network were evolved from a remote site simulator we had installed at Langley and was tied into our Mercury trainer ~~simulator also~~ at Langley. In working with the people at Bermuda and at the mission control center, the simulation people decided that the capability of the range was greater than estimated by ~~the capability of~~ the group managing the range, which was known as TAGIU, ~~out of Goddard~~. The contract technicians who manned these stations could do a lot in adding data that was not available to the flight controller. We worked closely with these people, especially in Florida and we got to appreciate their capabilities. The problem was how to simulate around the world. We developed the concept of taking our data from the simulator--which looked like telemetry for all intent and purpose--putting it on tape, cutting our tape in little segments like they were to be seen at each remote station and then we would send the flight control team with a roll of tape and a script out to the remote site. The simulation appeared to the world to be in real time but each site would merely play their pre-taped mission at a proper time. ~~It~~ They would send the data back to the control center and would receive instructions. ~~and~~ In this way we were training around the world. We wrote the little things into our scripts to require the back room to activate. That this capability was there and could be used was demonstrated in the Glenn flight--in which the back room was able to resolve an erroneous telemetry signal (the heat shield release signal). None of the displays to the flight controllers at their consoles could have indicated just what was wrong. The back room group with their additional capability was able to give us the readings necessary for the engineering people to evaluate the problem and say there was basically no problem.

My first mission assignment as a flight controller was the first
52-1 unmanned orbital mission. I was assigned as the capsule communicator at Corpus Christi. With me were Chuck Olasky and Dr. Fred Kelly The first time the mission aborted and we all came home.
52-2 The second time we were running through our simulations (and I might say that we took our unmanned simulations almost more seriously than the manned ones, because there was no guy on board to back you up, and the ground had to do everything right), and while we were waiting in Corpus Christi for the vehicle to be prepared in Florida, Hurricane Carla came across the Gulf, heading directly at Corpus Christi. The launch was scheduled for Tuesday, and the hurricane finally his us on a Sunday night. During Saturday and early Sunday the station was secured to the best of the capability of the team there. The station itself was at an abandoned Naval Air Station in a hangar. Over the weekend most of the men at the station under Mr. DeLong moved their families into this hangar which was a fair distance away from the water.

Here they could watch over their families and were ready for any emergency involving the station. Following the passage of Carla when the winds dropped back to 20-25 miles per hour, the maintenance and operation crew went to work putting antennas, rezeroing and bore-sighting their equipment, and checkout out all their equipment which had been subjected to winds of considerable force. We supported the launch on Tuesday morning and lost no data during any of the passes. My rental car had a window blown out and the front seat was soaking wet. The motel that I was staying at was located on Corpus Christi Bay, and the roof was peeled back so it leaked. My wife found out that I left my hurricane-damaged motel in my bathing suit and she was very excited about this. She thought I had to swim out---I didn't. It was just that a bathing suit was my normal clothing for a three day period. I just could not stay dry and there was just no sense doing anything else but wear a bathing suit.

The next orbital launch I was at the control center working on simulations. In the simulations we had a series of malfunctions, and even though these simulations were precanned, we tried to keep something in-
114 teresting in them for each station. We also attempted to incorporate a continuing problem that would build on itself. As luck would have it, in the last simulations we ran, we programmed almost the identical failure that the mission underwent. The simulation required a decision whether to retrofire at the end of the second orbit, and the decision would almost have to be made by the flight control team at California. If sufficient time was available after California had obtained telemetry lock on, to inform the control center and have Kraft make the decision. Come launch day, the program developed, the Hawaii site said something is going wrong.

The California station was properly primed, and Arnie Aldrich, the flight controller at the site said he was ready to push the button because he had been thru the simulation a few days before, and knew exactly what he was to do. We retrofired and brought the spacecraft down and completed a relatively successful flight. If we had not had a properly trained team of flight controllers we would have lost the mission because the fuel was being consumed at a high rate after the malfunction began in the stabilization system.

I was assigned to Muchea for Glenn's flight. Our communications between the States and Australia were poor. World wide communications
119 at that time depended on high-frequency radio lengths which are subject to known losses every sun rise or sunset and all sorts of other unknown losses--even the winds could effect the HF coverage. The Muchea team consisted of Gordon Cooper, Capsule Communicator; Capt. Beckman, the Navy Surgeon (supported by an Australian air force medical officer); a Philco systems monitor (whose name escapes me) and myself. In forming this particular team I learned thru the underground that there was some question in Kraft's mind about sending Faber and Cooper to the same site because they were a couple of strong-willed individuals who, if they ever got into an argument, could have brought on disaster. I heard about this going to Muchea and I imagine Gordo did too, and two people never worked better together. Our thought patterns seemed to mesh perfectly. As I sat beside him--more or less in communication with the control center and he in communications with the spacecraft, I would start to write a note and after five or six words would not have to write any further--he knew exactly what I wanted or what the control center wanted from the

spacecraft. The same was true if he wanted information from the control center. He just seemed to have to put down a key word and I knew the rest of his thought pattern. We were a real good team. The mission was extremely hard on most of the flight control teams for we went out for two weeks and spent two months. For the flight control people in Muchea, though, it was great. We were there in the summer near Perth, a city of about 400,000 people. They treated us royally. We spent our afternoons on the beach, sunning, swimming and enjoying ourselves and were entertained in private homes, or public activities almost every evening, except those few evenings when we had to go out to the site and participate in a world wide simulation. After the launch slip everybody at the Cape had gone home. After a new launch date was established and flight controllers were redeployed. Instead of flying to Florida a severe snow storm required everyone to take a train. The weather was lousy, and of course we knew it in Muchea. Now by this point in the program, the control center had evolved procedures to the point where a network check was conducted the first time a remote site came up on line, and this was several hours prior to the scheduled lift-off time. Each station would come on in sequence and say--"I'm here and I'm in good shape." I came on the line and said--"Muchea here, temperature 98°, sunny, spent the day on the beach." Each station in turn picked it up and of course as the distance to Florida decreased the weather got worse and worse--and the tone of the control center got more and more indignent till it finally got to the point where it requested curtly for each station to report its status--not the weather.

Our activities in preparing the Muchea site for the orbital mission

were simplified by virtue of the fact that the station had supported the
119 previous two missions. The Australians who operated the site were an excellent team. They did their job so well that we flight controllers could almost sit back and enjoy ourselves. They anticipated our needs.

When we first arrived in Australia we ran some simulations just by ourselves without tying into the network. The major purpose was to establish a communications--"dialogue"--with the back room people. These were the other people at the Muchea site participating in flight activity.
119 As the flight controller you sit looking at banks of dials and the rest of the world comes thru your ears. Accents and idioms are different whereever you go. You spend a period of time going thru your routine knowing the words this man is going to use. Following these type of simulations we tied in to the world wide network. Typically we would come in about four hours prior to simulated launch time. The station itself would have been working about 12 hours by this time checking out all maintenance and operations. The flight control team would then verify a few mid points and run thru their countdowns. It was really very uninterest-
119 ing because if the station was a good station there was absolutely nothing to do, and if the station was not a good station there was absolutely nothing to do but sit and tear your hair our wondering if they were going to get a problem fixed. We tied in with the world network about one hour before launch and participated in the world wide countdown. As the simulation progressed and the mission began, we followed the information that was sent out to us in the form of telegrams--summaries of telemetry status. We tried to pick up the astronauts on the radio as far out as we could to see if they had any information for us. Knowing that in simulations there

is always something to go wrong we tried to anticipate what the failures might be, what trends could be extrapolated from the data, and to form related questions to the crew when we finally got in radio contact with them. We also had to question our own displays so as to be able to rapidly analyze a problem. When contact is made, the station pass follows a programmed procedure. One of the controversies throughout the Mercury program was how much talk there should be between the ground and the astronauts. The astronaut fraternity wanted the ground to say almost nothing and the ground wanting to have an almost continuous flow verbage from air to ground and ground to air. The communications plan that was derived was a compromise that leaned toward the ground viewpoint, primarily because we didn't trust the telemetry. After we analyzed the situation, gave directions to the crew if required, or requested advice from the control center, our station pass was over and you have to wait for the next one. The simulation people knowing the lack of motivation of people always programmed something into each station pass to keep everyone on their toes, and we had to wait till the end of the mission to let simulation tell us if we had properly analyzed the problem. Then these two to three hour debriefings would be held where each site problems were discussed in terms of input and output and simulation would then tell us what it thought the procedures should have been. We would offer what we thought the procedures should have been and the crew would offer its opinion as to what he thought the procedures should have been. Then in a round table type discussion a conclusion was derived as to what the proper procedure was, which more often than not was a combination of the three rather than any one. We had a considerable amount of free time at Muchea. I visited a sheep ranch. It happened to be a poor time of the year for such a visit as in the summer things are hot and dry, but I really enjoyed it. It was a very welcome change to the hectic activity prior to the launch.

The mission itself, believe it or not, was almost anticlimatic. At Muchea, simulation lift-off time was about 11:00 p.m. At the end of the mission, about 2:30-3:30 a.m., we would go home. Most of my team had a problem trying to stay awake. During simulations, I had no problem staying awake, even though I may have been up all the previous day, because I was interested in what was going on. When the day of the mission rolled around we sat through the countdown and its many delays. During the delays we would stroll down to the Australian press tent. There wasn't a thing we could tell them--all of the official information had to come from the mission control in Florida. There were probably 20-25 reporters and other newspaper personnel there and we couldn't tell them anything about the progress of the mission. When we finally did get into the countdown and the vehicle was launched the tension was intense. A voice came on the line saying Goddard predicts seven plus orbits, which meant we had an excellent insertion. I relaxed to the point where I had to ask Dr. Beckman for a pep pill in order to stay awake for the rest of the mission. I had spent all the energy going thru the launch, and had nothing left. That was the only time in the two months of night training that I had to take a pill to stay awake. I knew the crew, I knew the spacecraft, I knew the flight controllers and I knew there was no problem. They could handle anything.

We had a little political squabble between the Governor of the state of Western Australia (in which Perth is the capital) and the Mayor of Perth during Glenn's flight over whether the lights be left on in Perth. Glenn's pass would be something in the neighborhood of 1:00 a.m. and we could get 117 in an unprogrammed test of what he could see on the ground. The suggestion 119 had been made by the local newspaper that the street lights be left burning at full brightness all night instead of turning them down at midnight. The mayor said the city didn't have the money to pay for the extra electricity that would be used. The Governor who evidently was of a different party, offered to pay the cost and they got into a bit of a hassle over who was going to advertise Perth. I don't know how that was resolved but Perth was well lit up for the launch and Glenn was able to see it and a refinery nearby that was burning off flares. It made the Australians extremely happy. They are very nationalistic and were thrilled and proud to have been able to participate in the Mercury program. They treated us even more royally after the flight--if that was possible.

The mission itself, as far as the flight team was concerned, was a hum-drum affair. There was very little in the way of contingency situations. Our station passes were almost uneventful and our communications were perfect that the three or four of us who had come from the states actually were not needed.

When we went to Australia we already knew of the selection of Houston as a site. Most of those who had been in Virginia with the Space Task 161 Group felt there weren't many worse places that could have been chosen. 163 The operationally-oriented people all strongly desired to have the site located close to the launch site. There was talk of Jacksonville, Orlando, outside of Tampa, and any of these we would have preferred because it would have made the conduct of our duties much easier. The people charged

with the spacecraft preparation and fabrication of course wanted to be close to the prime contractor because that would have made their work
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easier. Houston, which was close to nothing, made nobody happy. Soon after I got back from Muchea we came to Houston. I set up an office of five or six people here in Houston with the rest of my staff up in ~~Newport News.~~ Hampton. I came down initially every other week, and later I spent three days of the week in one place and two in the other. I looked over Houston every visit and liked it less each time. When I first drove by the site, a pile driver was working and it was late in the afternoon. We went over and talked to the pile driver crew. They were saying they had been driving test piles to see how much foundation there was. The crew told us that on one occasion they were driving a pile and figured that they had driven it about all it would do, but the boss said to give it one more hit. They did and the pile disappeared out of sight. That was the type of foundation that they were building the Center on. Then the opposite
165
could occur. They told me that they had been driving a pile and stopped for lunch and couldn't drive it afterward because the mud had locked it firmly in place. There were cows wandering where the main buildings are now located, and here and there were a couple of oil well structures. It was hardly an imposing location for the Center. My wife and I looked all over for a place to live and it was even more discouraging. Starting from where the site was going to be we searched in an ever widening circle for a place to build or buy. We ended up renting an apartment that was about an hour and a half in driving time from the site, figuring we would look more at a later date. Soon after we settled in the apartment, I was interviewed by a reporter for a local newspaper, who was a Houstonion--one of

the very few that I ever met that was born and brought up here. I don't think I made him too happy when he asked what I thought of Houston and I said that if it wasn't for the very interesting work I'm doing I would not be in this God forsaken place.

During 1962, our major function involved the definition of the training equipment to be delivered by North American. Harold Johnson, Keuhnel and myself prepared what we considered a reasonable family of training equipment needed for the Apollo program. We worked closely with our counterparts at North American. They presented most of our conversations to their own management embelished with their own thoughts. Where we wanted a $5000 item they recommended $500,000 but I guess that was not unexpected. We were also participating in defining the specification of the various facilities to house our simulation equipment. This definition of the Apollo training equipment preceeded our work in Gemini. Apollo was a more of a going program then than Gemini. Gemini was pretty much a Jim Chamberlin project and very other few people had much to do with it, and Apollo was getting all the publicity. We didn't ignore the Mercury program, but the preparation of the Mercury crews was moving along at a relatively easy pace.

With the move to Houston, operations split in two. The flight crew operations division was put under Warren North, and the Flight Operations Division under Chris Kraft. I was allowed to choose which I wished to be in, and I had been associated with flight crew training, training of the astronauts and the simulation and training of the flight control teams in the Mission Control Center. It appeared to me that the crew training was a more interesting experience than the flight control, and so I came with Flight Crew Support.

In working with North American on the definition of the Apollo training equipment my functional area was limited to the two major mission simulators--one for Houston and one for Florida. We also defined what was known as the part task trainer. This would be an adjunct facility, able to train a critical portion of the mission piece meal whereas the simulator could do training on a continuous basis. North American and ASPO made the decision that the major mission simulators would be contracted while North American could built the part task trainer internally. We agreed to abide by these guidelines in our evaluation. North American spent about six million dollars attempting to build the part task trainer before we urged that such work be discontinued. We conducted a review with Joe Shea while there was still better than a million dollars in funds remaining to complete the work on this simulator, and management decided that it would have been a waste of the million dollars to complete it. I think the decision was a correct one. The large expenditure was caused by many, many design changes to the command module from the start of definition of the program. We started out building an Apollo command module to land on the lunar surface, and of course that meant building comparable training equipment. So along with the rest of the people we started too soon and we spent a lot of money for hardware design that was never delivered. In our definition of the mission simulators, we were a bit behind schedule and as a result we didn't waste as much money. Our major effort was chasing spacecraft design changes. It underwent relatively major changes and the change traffic was so fast that we just could not keep current.

In this same time period we became involved in Gemini. The flight

crew division assumed responsibility for the development, acquisition and operation of the simulation equipment. McDonnell was to build the Gemini simulator in-house, so we didn't have to go thru a source selection. It
210 also was easier on us in that we let the McDonnell people write a detailed equipment spec that we modified to suit our desires as opposed to having to write a requirement document that they could answer. The relative me-
212 rits of buying a simulator from the prime contractor versus buying from a sub-contractor got quite a bit of kicking around within MSC. There were those who felt the training equipment manufacturer could do a better job for us, and opposing this viewpoint were those who maintained that in spacecraft design the data flow is a problem, and the solution was to keep communication lines as short as possible, and let the prime contractor build it. The Gemini experience seems to indicate that the first approach was the correct one--if the prime contractor has the capability of designing simulators, he can keep up with the change traffic much more easily than an independent contractor can.

In the definition of the Gemini training equipment during the time that Jim Chamberlin was project manager, Dick Carley was our interface in
252 the Program Office. We had to talk to Carley who talked to St. Louis. We worked very closely with the McDonnell people in building the mission simulators and had a very close knit working relationship, but our relationship with the project office was not. Every time the flight crew division said something was black the project office would say it was
210 white. We had many arguments with the project office that ranged from trivia to fairly important matters. Perhaps these arguments were beneficial, but at the time they seemed more destructive than helpful. One of

the biggest disagreements we had with the Gemini Program Office, and which was not resolved till after Chuck Mathews became the projact manager, was over the development of out-the-window simulation equipment for the Gemini mission simulator. The original contract with McDonnell did not include this, and Chamberlin did not think it was significant. We continued to fight for it, and finally got agreement from Mathews that he would fund the development and fabrication of a visual system but not thru McDonnell. We would go direct to our suppliers. I think our demonstrated rendezvous procedures using the out-the-window reference for most of the maneuvers served to justify our continuous effort to develop this image generation equipment. By the time the procurement action for this equipment had been generated, we already had it defined, and had already paid for much development work under the Apollo contract and resulted in a much shorter delivery time. We benefited from the mistakes made in Apollo equipment design.

Another big decision point made in the period prior to the arrival of the first simulators in Houston was how we would plan to operate--what would be the mix between civil service and contractor personnel. In meetings with management people like Walt Williams it became very clear that we were not going to get the civil service people we needed. We really didn't know exactly how many people we needed; the flight profile was every three months and supposedly there were not going to be any design changes from spacecraft to spacecraft according to the program office. We defined and obtained Center concurrence on a division of effort where we would use contract labor to maintain the simulators, and to design and develop the modifications necessary to keep the simulator in configuration. We would use civil service labor to operate the simulator, serve as the instructors and supervise the activities of the support contractors. This split in responsibilities still exists. We just added more contractors.

Like most of our programs, the Gemini spacecraft had tremendous num-
v70 ber of changes as they were building the spacecraft. McDonnell was developing all digital simulation. This was perhaps the first all digital simulation of its size to be developed. Programmers were not available to write real time programs in scientific language. The engineers could not write the necessary equations, as they had not been trained. Delivery of our simulators was very slow. In fact it ~~did~~ could not support the first
v72 Gemini manned mission. We made a decision with project office concurrence to ship one GMS to Houston without really accepting it. We left the second at the contractor's plant. We felt this gave us two teams to make the simulators work--a contractor team, consisting of McDonnell employees in St. Louis, and NASA-directed team working at the MSC site. These teams were very closely integrated and we had almost continuous cycling of people from Houston to St. Louis and from St. Louis to Houston. As would be expected, our biggest problem was data. Since McDonnell was doing all the hardware fabrication in St. Louis, the GMS located in St. Louis came up to speed first. We deployed instructors from Houston and from the Cape
343 to St. Louis and Grissom started his training at St. Louis. He would train for one shift, and then for the next two shifts the McDonnell people tried to make improvements, correct problems, etc., while we struggled to make the machine operational here in Houston.

Our facilities here in Houston were not completed at that time. ~~The decision had been to house the simulator separate from the offices~~. The plan called for constructing the simulator building a year after the office building. We therefore had to come up with temporary housing for the GMS and a lab area in Building 4 was assigned this task. It was a tight fit and the only real reason we were able to make it work was that we decided not to install the visual equipment in Building 4. After receiving the visual equipment, we found out that we could install it in Building 4 and did, until Building 5 was ready.

In our simulator evolution we and our contractor had ~~decided~~ to define the size of the computer complex. We would need so much computer capability to
338-✓ simulate this spacecraft. In the fabrication of the GMS and throughout
348 its life ~~lift~~ span in support of the 12 missions we better than tripled the computer capacity originally contemplated. In a course of the ~~other~~ Gemini programs, we and the contractor developed simulation techniques for simulating the IBM computer and for simulating the magnetic tape reload capability that this computer had on board. This was quite a step forward. The McDonnell people were to be congratulated. Our major internal effort was expended on the visual system and in particular the development of the method of simulating the earth scene. It was the key to the whole picture. Money was already beginning to dry up, and we were looking for the least expensive techniques that would meet our minimal requirements. We had cancelled the part task trainer by this time and began looking to it for whatever we could salvage. We were able to salvage some very expensive cost elements.

At this time the Cape flight crew training facility was still part
336 of my branch. When GMS 2 arrived at the Cape it was installed in a spe-
35✓ cially constructed annex to the old mission control center building. It was made operational and eventually supported Grissom's mission. This

operation was under the supervision of McCafferty.

The old Mercury simu-
lator (at that time we called it the procedures trainer) was eventually
333.4 given to the Langley Research Center where they used it as a crew station
for their various studies of spacecraft operations. The second Mercury
simulator, the one we had brought from Langley to Houston was modified to
a Gemini part task simulator in which the retrofire task and the rendez-
vous could be practiced. It was not a sophisticated crew station.
We went from seven to 14, then from 21 to about 35 astronauts in a
relatively short time. We could not give these men training in the mis-
343 sion simulators but we could give them time in the part task trainer.
They could learn some of the initial tasks of controlling a spacecraft~~.~~ and
~~the fact that there were no aerodynamics and no restoring of force, no~~
~~acceleration control system, etc. enabled~~ enabling them to learn some of the ren-
dezvous techniques. And we had a pretty good utilization with it--but it was
mainly by the unassigned crew members as opposed to the assigned members
who had use of the Gemini mission simulators. Training concept at this
time developed along the line that the active simulator training would
start at about six months before flight. Houston would concentrate on
the development of the systems and the more or less independent procedures.
At about minus three months the crew would go to Florida. Here they would
emphasize the development of mission procedures. The objective was to
have a fully trained crew on the flight date. We are more or less still
following this procedure although for Apollo we are trying to get more
and more into the mission configuration here in Houston. In flight plan-
ning you want to know how long it takes to do a paritcular task. There
is only one way to find out and that is to do it. The Houston simulator

in the Gemini program was not able to supply much of this data of the flight planning--or at least we could not supply as much as the flight planning people wanted. Under Warren North's urging we are changing our mode of operation as rapidly as we can in Apollo.

During the Gemini program we had what was then known as the docking trainer (what we call today the Translation and Docking Simulator). This
348 device had been sold by the Gemini Program Office people and McDonnel to Chamberlin and Mathews, primarily to evaluate the flight hardware, secondly as a device as a crew trainer. Much of the specification was done before the Flight Crew Division got in the act. ~~The piece of equipment is very good.~~ I was pretty much against it then as it was not one of the pieces of equipment I would have recommended as being mandatory for training. Even as a research piece of equipment I had my doubts. All in all it turned out to be a good piece of equipment. While McDonnel was developing this docking trainer for us, Langley had a very active
333-4 program going under Roy Bressington to develop another docking trainer. Concept of these two devices was somewhat different in that in the Langley device, the crew station was given 6° of freedom and the target vehicle was stationary. In the McDonnell device the six degrees of freedom was split two on the target and four on the crew station.

The training received by the crews in one docking trainer would have been somewhat more difficult to obtain in the mission simulator or even in the Langley docking trainer. When two vehicles are hurtling through
348 space at ~~3000'~~ 18,000 feet per second it is still possible to make a couple of foot
343 per second change in the velocity relative to the two vehicles. The training our crews received in such devices as the docking trainer made this task one of the things that could be crossed off the list as a cri-

tical item.

Our training philosophy was that the crew should be so well prepared that it would encounter no surprises in an actual mission. Now, we do
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not simulate those malfunctions for which there is no recovery. Every malfunction for which a unique action could be defined whether it was a high probability or low probability, if we could define it we attempted to show it to the crew. Of course we would emphasize those with the high probability and show them repeatedly.

The question has been raised as how we plan our simulations. We read the failure reports, we talk to the crews, we go through design
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logic, we pick elements ourselves that we think are weak links in the chain. Quite often we pick a link not because it has a high probability but because it has an interesting series of responses. We might disagree with the mission rules that have been written and we might like to prove that the mission rule is incorrect, or that it is correct, but under a given situation the mission rule might not apply. In Gemini there was really only one serious malfunction that came close to getting out of hand, that of course was Armstrong's stuck thruster. After it happened, the project
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office swooped down on the simulator. Was he trained in that? Even though we are not known to be the neatest record keepers, our records showed that we had considered that malfunction, ~~although the simulator is a static simulator.~~ Of course the pilot did not feel the rolling motion as the simulator is stationary. Acceleration of space flight is ordinarily below the kinetic sensing level--there is no motion associated insofar as the ear can sense, so that this stuck thruster was observable by the trainee looking at his Flight Director Attitude Indicator (eight ball) and looking out his window. The velocities that were built up in the stuck thruster case were such that there was a feeling of motion

on the part of the crewmen and as far as I am concerned the crewmen took the response that he was trained to take.

During the evolution of the mission control center there have been many suggestions by people both in mission control and in the various project offices to use the training simulators for real time mission support--to have the simulator configured as the spacecraft, so that if a problem develops in the spacecraft, it can be quickly simulated and a
348 corrected procedure can be devised and radioed to the crew men. Mission control itself could see no need for this as they knew the spacecraft well enough, the mission rules, they could see no possible situation that could come up where it would be required. Experience has shown this to
306-1 be a correct analysis. Also we generally don't regard the simulators as good tools to support real time flight analysis.

We were asked somewhere around Grissom's flight whether we could support two two-month launch centers. After a good deal of study we answered that this would be possible after we completed certain major changes such as after we had installed the visual system, and after we have taken care of the simulation on the on-board computer magnetic tape. In other words, after several missions following the first manned Gemini flight we could
348 support two-month launch centers, providing changes spacecraft to spacecraft were kept to a minimum. The answer came back in effect they didn't believe it, and that we would be expected to support after the first flight. We then had to change our planning and had to go through a rat race in attempting to convert to a two-month launch cycle. To squeeze in these major modifications was a real problem. The activation of the visual system probably required reprogramming of a good third of our computer

complex. The magnetic tape memory simulation probably required reprogramming of 10-15%. Of course the Agena failure, which delayed rendezvous and triggered the dual spacecraft rendezvous really upset our timetable. We were able though to train the two crews. The two spacecraft, while they had some significant differences--one of them having fuel cell the other having batteries--we had reached a level of sophistication that we were able to work out one reconfiguration. Every mission that is a success, simulation takes all the credit for it. We did it by working an awful lot of people very hard. The actual operations of the Gemini training equipment fell very heavily on my two section chiefs, Al Parker and McCafferty in Florida. My time and the time of most of the other section chiefs were very heavily committed to the acquisition of the Apollo training equipment. This was a full time task for most of us. I only got in Gemini when there were major problems and decision to be made.

Apollo training equipment slipped and slipped and slipped until actual delivery of the hardware to Houston was over two and on-half years after the original contract date and the equipment that was finally delivered represented no spacecraft at all. We had a spacecraft nine panel and a spacecraft six subsystems. At the time the first manned spacecraft was to be spacecraft 11. Nothing worked to put it mildly. The problem was that the contractor is not prepared to make compromises. He is given a specification and he tries to do his damnest to meet it. NASA personnel are prepared to make compromises. We worked diligently on the Apollo equipment after delivery. Certain major portion of it we had to put aside like the visual equipment. That was not mandatory for the 012 mission, although the crew station, the equations of motion, and the launch vehicle simulation all were. We concentrated on bringing these systems up to par. About three months after we shipped the simulator to Houston the second simulator was shipped to KSC and here again under NASA management we endeavored to bring this machine up to a satisfactory level of operation.

About this time we had our first major reorganization of the simulation activity since the division was formed. The Cape operation had grown from a small group that operated the one Gemini Simulator to where it was
313 responsible for a far more complex command module simulator, and a lunar module simulator. It was 1000 miles distant, and the directorate decided to set it up as a branch reporting to the assistant division chief. It was too large to handle as a section any longer.

We then had to ensure that configuration control would be formalized so that we wouldn't have the same problems that we had in Gemini where the
348 Cape did things one way and Houston another. So we started to work toward
347-2 formalizing a configuration control scheme. In Gemini the modification
347-3 contractor had been McDonnell. The purpose was to keep the data loop tight. We had McDonnell in order to take advantage of the fact that the people
333-4 who had built the machine knew most about it. In Apollo we went on an open bid to select the maintenance contractor, and later extended this bid to include modifications. We selected Link, a foreign party to the entire Mission. We had to formalize the relationship to ensure that Link was kept informed on design changes. We also had to contend with the problem of a much larger program office and a larger program.

Our biggest problem was the changes in the spacecraft. During the
348 time we were still on Block I, the command module probably underwent a 250% redesign in going thru the sequence 06-09-011-012, and this was as

nothing when compared to the change between 012 and what was then called the Block II spacecraft. The original contract that North American had for building the two AMS's had risen in slow steps from 10 million to about somewhere between 30 and 40 million dollars. Some of this represented overruns, but most representing spacecraft changes. When we looked at the changes from Block I to Block II it was evident that this would be an extremely large job, and beyond the capability of our modification contractor to handle on site. We went out on a sole source contract with
347-2 Link to update the two AMS' and came back with a 10 million dollar package, or about the original construction bid for the simulator. The required changes were so complete that we just about took our existing crew station, rolled it out the door and rolled in a new one. We did salvage a few items off the old crew station, but not many.

At this point we were told not to worry about any more change traffic. That was another mirage. The change traffic was so large under the ASPO management of Dr. Lanzskron, who was given the responsibility for managing
347-3 the simulators, that he made the decision to update in line and continue
347-4 to keep the spacecraft data flow to Link. I had recommended against this
348 as I felt we would not be able to buy anything. They would never have a finished product; we would continue to ship changes to Link and they would continue to try to put them in. Lanzkron finally agreed to a freeze on the Link installation far after the original agreed-to date and we were able to accept the Block II configured spacecraft, but of course by this time there was another big backlog of modifications necessary to bring the Block II spacecraft up to what 101 was supposed to look like. The change traffic in the Command Module had been extremely heavy since that

date. We did start training the 101 crew around July 1 last year, and as of that time we were probably in a 90% configuration. We had been thru many iterations in schedules by then. We had gone from a schedule that showed six launches a year, to a schedule that showed three launches a year and back again. At that time we dispensed with the part-time trainer--we were on a schedule that showed a maximum of four launches a year. We were pretty sure that we could support four launches a year, with three month launch centers and two mission simulators, one in Houston and one in Florida, but by 1966 we were back on a six month launch center. Rather than to reactivate a part-task trainer approach and the headaches that this would have entailed, the decision was made to add a third command module simulator to support this accelerated launch schedule. I concurred in that decision. A second decision also made at this time was to locate this third command module simulator at the Cape. I did not concur in this decision. It was my opinion that with the change traffic so heavy, and with what we knew was the level of effort required to maintain the configuration, the development of software, and the proof hardware, one simulator would be tied up doing just this and we ~~should~~ would really have only two simulators
333-4 available for training. Division management did not think that the update required a special simulator and the launch frequency was such that there would be two crews in Florida at a given time. Therefore there should be two simulators in Florida and therefore the third AMS was put there.

AMS three was also under the management of ASPO. The only difference
347-4 between it and AMS one and two was that ASPO made a direct procurement rather than going thru North American. AMS three was to be delivered in the 103 configuration with the capability of simulating the lunar flight.

Our original procurement specifications had included the capability to go to the moon, but to accept delivery of anything we had waived this, figuring we could add it later on. There were many who felt that Link had originally contracted to deliver such a simulator, and one was delivered that wouldn't, they wanted to penalize Link for this failure. Then we turned around and gave Link a contract to develop another simulator
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347-2 that would go to the moon. I stayed out of all these legal arguments. Actually, I don't think Link or Link's subcontractors have gotten rich on the Government. They have made a lot of money off of us, because they had a lot of contracts with us, but percentage profits have certainly not approached those of what they can do in the commercial industry, where their design basis is somewhat more rigid than NASA's design basis. The command module simulator here in Houston has been under the direction of one of my section chiefs, Dick Snyder, and he has been responsible for the update modification of all three simulators.

SIMCOM means simulator support contractor. The support team for the Gemini in Houston was something like 20 to 30 maintenance people and 50 engineering people. The
347-2 support team for the command module is like 30 to 35 maintenance people
345 with over 100 engineering, ~~people.~~ programming, administrative, etc. people.

One of the very interesting sidelights in the command module is the simulation of the MIT computer. In Gemini we had developed a method of
348 simulating the IBM onboard computer, ~~to be compatible with our hardware.~~ IBM issued ~~the~~ a math flow~~s~~ that we could pick up and program. Chuck Mathews was of the opinion that training was required and that he would not allow a math flow to fly until we could guarantee we could have it in the simulator early enough so that the crew could be trained on it. Each of these

math flows are uniquely different. The Apollo contract with MIT didn't require the publication of a similar level of data, and furthermore we were getting our data from MIT too late. It took us three to four months in Gemini to develop the simulation from the time we got the data, and this was about right; we got data minus one year, and we had the simulation developed and operational about minus six months. However, as we started looking at Apollo it was evident that wasn't enough time. To meet a mission we were going to have to push the freeze of the computer program to an earlier date which ASPO was opposed to. Shea would liked to have had the computer program flexible until minus two or three months. These incompatibilities led to the developing of an alternate simulation. We looked for alternate methods to simulate the onboard computer. We even considered getting a flight computer. At the time they were selling for four million dollars each and we needed two or three of them. ~~They are linked to something which is called translator.~~ ALTERNATES WERE ~~We had~~ an interpreter, OR A TRANSLATOR to utilize general purpose computers. ~~which is a similar type device but works slightly differently.~~ Interfacing with the actual computer was considered extremely difficult, ~~There was not a flight computer available,~~ so we desired to use ~~used~~ standard general purpose computers. ~~One would be linked to the interpreter, the other to the translator.~~ Each approach (interpretator and translator) had its adherants and it turned out that the biggest supported of the translator was MIT. Joe Loftus and I were working to try both techniques, at least initially. After we could evaluate the two we would try to use the best of both. The best suggestion that we had for doing the interpreter approach came from Jim Raney in Computation and Analysis Division. Shea decided to ignore the MIT translator approach because he felt they should commit every effort of their resources into the flight program, ~~and we wouldn't want them to divert any of their resources.~~ The fact that we would not be using people from the same area, and the fact that in the academic environment you quite often get prima donnas who want to work on one thing and won't work on something else were also considerations. ~~(We had one of our own prima donnas who wanted to work on the translator.)~~ A task team was formed composed of Raney, Geckler from Loftus' office, and Nelson from my office. These people have put in about one and one-half to two years of activity in developing the interpreter approach. ~~If you take a computer, program this computer~~ the interpreter is programmed so that it will read ~~the~~ a tape that is available from MIT (and this tape is produced from flight tapes), ~~the simulator~~ and will act as an onboard computer would act. We have developed it for both the CM and LM and we feel we have as good a simulation of the onboard computer as there exists. The mission simulator which was built primarily for training and for procedural checkout ~~of the hardware~~ is ~~also~~ now also being used for verification of the flight program. We are not out of the woods even yet, but we have made major progress. Six months ago if we got a flight tape and it didn't work, everybody blamed the interpreter. Today if it doesn't work, we blame the flight program. The latest program problems that were noted were the rendezvous program ~~recently~~ for 101 ~~and sun disk~~ were first detected in the simulator.

Our major problem today with the command module simulator is in the area of out-the-window capability. When we wrote the original specs with 39r:1 North American, back in 1962, we attempted to stay within what we considered the state-of-the-art and what we believed would meet requirements. It turned out we did stretch the state-of-the-art a little. Our out-of-the-window scene generator, which in a training simulator has an importance somewhat beyond what most people consider, was barely marginal in supporting 101. It is extremely complex and extremely difficult to maintain and it doesn't do everything that it is supposed to do when we specified it. This system takes almost a third of our computing capabilities. It's a major problem area and we're trying to fix it but we are constrained by time more than anything else. By the time we get it fixed we may be to the moon and back.

No single item of the simulator does more to create the impression of space flight environment, improve the attitude and motivate the trainee than what he sees out the window. This has been evident in all of our spacecraft flight programs to date. Anything out the window is good and
39v-1 of course the better you make the more they like it. Unfortunately once
38b-1 you give them something good you can't quit. They always want the best. In our development to date, we have produced what I consider tremendous simulation of stars. We produced by a variety of excellent simulations of rendezvous vehicle, but at the same time we have fallen almost flat on our face in producing simulation of the earth or lunar terrain. We've got crutches that will help us limp thru earth orbit mission, but all we have now is prayer to take us thru the lunar mission.

The task of simulation group is to maintain up-to-date configuration of our simulator. We obtain data from the contractor on the changes he makes to the simulator, and we reproduce this data into both software for
39r-1 the computer complex to define systems operation and hardware to put into our crew station. Both activities are extremely time consuming, in that
348 by the time we get the design of the hardware from North American or from McDonnell or Grumman, till we can process it into drawings from which the

local simulator fabricator can produce a hardware, we've killed three months. This is intolerable. We have spent considerable amount of energy in attempting to shorten this loop. In the Gemini program we shortened the loop by giving McDonnell the functional responsibility. McDonnell would identify a change to the spacecraft, and at the same time the itme was built for the spacecraft they would commence building an item for the simulator. Even more important was priority. Quite often for training purposes the simulator needed a particular hardware before the spacecraft did. We tried to start our training at six months before flight when the spacecraft was probably still in assembly. That was arranged with Mathews' blessing and proved to be a good scheme. We did not often get the first item, but we got the item before the second spacecraft did.

With North American, the Apollo program office did not see fit to give us this same flexibility. For one thing there was no trainer organization existing at North American. The organization that built the simu-
392-1 lator had disbanded after they sold it. Without this talent pool avail-
396 able, we have been struggling on alternate arrangements. Only in the past nine months have we been getting hardware from North American which will meet our needs. Unique CCA have been created to supply the hardware. The loop is operating rather satisfactorily today but it takes continuous
396-2 management of it. It is a non-spacecraft item and when someone wants to cut costs they try to cut in the non spacecraft area.

The LMS acquisition was handled somewhat differently than the AMS.
392-1 It was still handled thru the prime contractor, but the spirit of coopera-
396 tion between the project office and the FCSD was many, many times better
396-2 than it had been in the case of the command module. This was due to what

we had learned in the command module simulator and possibly to a much more cooperative environment that existed in Grumman than North American evidenced. Grumman felt at that time they were building a simulator for NASA and wanted to meet NASA requirements as opposed to North American who was going to give us what they wanted to give us. The interfaces were as before, with Lóftus and his people in the project office, Faber and his people in the simulator office, and we jointly chaired the meetings and shared the responsibility of getting Grumman started. Another major difference in the simulator acquisition was that North American gave a 100% contract to Link for the simulator whereas in the LMS case, to obtain early utilization the visual system was split off from the rest of the contract and Grumman supervised both. The second contract for the simulator included integration of the visual system. Grumman's plan, which NASA concurred in, was to utilize the high fidelity visual system with an engineering simulator for a one year period, which the schedule showed was available, prior to using it on the mission simulator. It was a good idea but didn't pan out in that the development of the visual system slipped well over that year's cushion and the delivered hardware still didn't work. Now we're trying to correct it approximately a year after we received the simulator. The visual equipment slipped almost two years--longer than for the rest of the simulator. As in building the command module, the major trouble that the contractor had (and again it was Link, Binghamton), was spacecraft data. At Grumman's suggestion, data flow format was grossly changed from what we gave North American. Instead of sending raw data, it was in a form they call a math model. Instead of shipping every change out as changes became available, these changes were held at Grumman, were polished, integrated with other changes and they went out almost as block updates every three months. The data flow was such that the net increase in cost of the Grumman contract for all these changes, was something on the order of only 10 or 15% of the original price whereas for the command module they were 100 to 115% of the original price. This savings accrued from the fact that the simulator contractor did not change his design quite as often. It did create a problem after delivery in that Grumman system of block updates was somewhat slower and at the delivery of the simulator and we had a somewhat larger backlog of outstanding work. The system was such though that our contractor on site could use the same format and the same data and was able to pick up the flow when he started developing the modifications. Today the command and lunar module simulator have about the same number of outstanding modifications~~, required.~~

The major defects of the LMS was the visual system. It did not de-
34a-1 liver the resolution required, and it did not operate in a fashion which
would allow NASA to run a reasonable acceptance test. Grumman and the
34b subcontractor have been allowed approximately a one year slip, and we are
approaching that right now. This fix will produce a satisfactory visual system for everything except the lunar landing--the final 10 to 15 thousand feet of the mission. NASA now is undertaking it as a direct NASA contract and various techniques are being evaluated in RFQ's. We hope to have that working by the time we need it.

When the Langley contingent from Mercury traveled to Houston to form the new Flight Crew Support Division, Johnson, Kuhnell, and Faber had prepared a list of what we thought was the necessary training equipment for

project Apollo. We had prepared this as an open list we thought NASA should acquire, not as any selfish list that we thought we ought to manage. The list included the major simulators, such as we now have, it included a water tank for zero "g" work, and it included a systems trainer for more dynamic crew briefings. We were laughed out of every office on the center, when we proposed this water tank for zero "g" work. We were told to go worry about your computers, but to forget about the water tank, as that was a stupid way to simulate zero "g". Approximately three to four years later, after the Martin Company and several others had demonstrated fairly
34r-1 good results using under the water techniques, we were instructed to start a crash program to build a water tank at MSC. The management made the wrong decision based probably on inadequate justification from the engineers. Our water tank, by the way, would have been built with the original facility, and would have been much bigger than the one we were able to stick in as an afterthought. It also would have been an allaround better piece of equipment than what we presently have. For building 35A, we have asked Congress for money to build a new building including a rather sophisticated water facility compared to the current tank. (The latter is relatively small for our hardware.)

On the Gemini system trainers, I was at odds with other division people. It was a battle over who would have the functional responsibility.
35v From the high degree of cooperation that we had in the Mercury program
34v-1 where we got suggestions from everybody and gave them, equally freely, it seemed that we experienced the attitude of everybody was to stay out of my corner--I'll do it all by myself. This attitude really rubbed most of us old Langley types wrong, and some people retreated into their shells.

Others adopted this the same type of philosophy as an answer. Over the next five years a lot of these frictions between working groups was eliminated. But it was extremely bad when we first came to Houston. People were trying to establish empires and didn't want anyone else interfering. Anyway the system trainers that were produced turned out to be pretty 770 much of a "flop." They received only limited utilization in the Gemini program. They tended to be over sophisticated for the task they were to be used for. This was corrected and the Apollo system trainers were much less expensive and much less sophisticated devices. They are good teaching aides and that is all they are meant to be. Gemini tried to make them dynamic simulators.

The world has suddenly decided that the way to get the most out of a contractor is by giving him incentives to do his best. I tend to agree 772-3 that in many instances incentive contracting does stimulate the contractor 347-4 to do a better, faster and cheaper job. They are real good when you can define your objectives. For example, in the Gemini program the contrac- 346-2 tor had as his objective to launch a spacecraft and get it back. In support contracts the situation is different. If there were a definitive work task that he is to do, it wouldn't be a support contract. He would deliver a product. But when we let a level of effort contract, it is very difficult to evaluate performance. We spend an average of 100 hours a month preparing an evaluation in our area for approximately a 250-man contractor effort. I don't think we gain a comparable increased performance out of the contractor for the amount of the evaluation time that we have to put into it. We have to justify our evaluations and our words are polished and repolished. I think its not so much a waste of time, because we have seen improvements in the contractor, but rather that the same ends could be obtained with a lot less work, if we were allowed to discuss these things we wanted to improve with the contractor directly. He could still have the incentive to improve his performance without going through the evolved evaluation cycle that includes a presentation to someone in upper management. Our contractors are earning in the high-good level, and if they weren't in the high-good level we would sure be driving them in that direction. We can't do our job if they don't do their jobs and I don't think we need all the paper work and this involved review process that goes with it. I would rather do an engineering job rather than a management job and that is why these evaluations don't seem like the ultimate to me and the people who work for me. They had rather complain directly. If they were civil service instead of contract personnel, they would be working directly for us and we would have a direct line of authority to tell them what we liked and what we didn't like. ~~We could get changes without having to go through this involved process.~~