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ORAL HISTORY INTERVIEW

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Oral history interview with Riley D. McCafferty
[full name of interviewee]
about Spacecraft Flight Simulators and training; MSC + KSC
[main focus of interview]
Simulation facilities; technical support

Title: 1968
[interviewee's current and/or former title and affiliation]

Interview conducted by Robert B. Merrifield
[interviewer's name/position]
Staff Historian at _____
[location of interview]

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Biographical - [date/place of birth; family background] _____

Education - _____

Career Path - _____ 1960 - Contracted by MSC

from Mc Donnell Aircraft, St. Louis

1961 - STG / MSC

Topics - 1st Simulator from Mc Donnell Aircraft to Langley;
 Mercury Simulator ^{Trainer} at Cape; flight control simulation;
 Gemini mission simulator; Trajectory tapes from
 Goddard Computers; Mc Donnell - Link Division Computers
 Software (drum machine); IBM Math Flow;

MSC Mission Control Center; GT-4 support;
 window image displays & star ball; ~~early~~ ^{engineering info at MSC} ~~work~~ Apollo mission simulator; Mission Training ^{at} ~~MSC~~ ^{simulators} ~~MSC~~
 Cape Simulator; Gemini, onboard Stewage for
 practice; KSC facility & initial construction
 delays; problems with ^{KSC} technical support;
 problem w/ ~~MSC management~~ ^{promotion ratings} for KSC personnel
 done by MSC; disadvantage of ^{have} distance between
 MSC & KSC; brand budget; Summary of
 growth of simulator staff & equipment; food ^{astronaut} ^{quarters}
 service, & security measures against contamination

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2:00

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FCTB
Bldg

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15060

BN

October 30, 1969

Mr. Riley D. McCafferty
Chief, Flight Crew Operations Branch
Mail Code CFK
John F. Kennedy Space Center, NASA
Kennedy Space Center, Florida 32899

as convenient
on Thurs aft.
or Fri aft.

Dear Mr. McCafferty:

At the request of Dr. Eugene M. Emme, the NASA Historian, this Center has agreed to assume responsibility for the preparation of an MSC history, and I have been specifically detailed to this task. I am a professionally trained historian and a long-time Center employee.

This history will emphasize the ongoing, institutional aspects of MSC's past from Space Task Group origins through the Apollo 11 landing with particular attention to the development of management philosophy and practices, evolution of major organizational elements, growth and modification of the staff, management of financial resources and contracts, acquisition of facilities, and the impact on the economy, culture, and society of the larger community in which it exists.

Your relationship to MSC has been somewhat different than many other organizations at the Cape in that you have always been "ours," whereas most of the former MSC Cape complement is now a part of the KSC structure. I am interested in the role you and your group have played at the Cape from the early days to the present, the problems inherent in a 1,000 mile separation from "Headquarters," and your analysis of the advantages and disadvantages of being a tenant at KSC. I would appreciate any help that you can give me in reaching a better understanding of functional relationships between the MSC Cape element and the Air Force, KSC, and MSC Langley-Houston and its contractors. The insight you can give me on this aspect of the MSC story should be of great value in the preparation of my history.

I will be at the Cape for the Apollo 12 launch, and would greatly appreciate it if you could allow me an hour or so of your time for an interview either the afternoon before the launch or the following afternoon. A tour of our present facilities, if it could be arranged, also would be extremely helpful in getting a "feel" for your work.

Sincerely,

Robert B. Merrifield

Bob

I took you at your word and only struck
out the things I thought really hit me hard. I am
depending on you to clean up and butter up the rest

Phox
McAfferty
7/6/20

Interview with Riley D. McCafferty
11/14/69

In July 1960, I was ~~hired~~ ^{contracted} by MSC from McDonnell Aircraft, St Louis.

At that time, I was the McD tech rep for the maintenance and modification.

The instruction was also contracted to me from NASA which at that time was part of Langley Research Center, but known as STG. The first simulator from StLouis went ~~through~~ ^{to} Langley and was integrated with the computer to give ^a live control ~~or the capability of that to control~~ ^{stick only} which the Mercury had. I came ~~down~~ ^{to Cape Canaveral} with the second Mercury Procedures Trainer and it was not anticipated that the one at the Cape would have the need to have a ~~large~~ ^{live} control stick or hand controller for attitude control. When we got down here we were about the only complex on schedule and we spent a great deal of time helping and working with the other agencies and contractors in the area putting their equipment in. The room we had allocated to us was in the mission control center. Telemetry Building No. 3 was its designation and later on it was changed to MCC. We had a room about 20x34 of which ~~the~~ 20x20 was allocated to the Mercury simulator, which contained the crew station and the three consoles in a u-shape which made up the ~~control~~ ^{instructor operated} station. After the control center and a few of the early unmanned launches, it was pretty apparent we had a need to activate the hand controller, so under contract to McDonnell, we bought a 221 ^{EAI} computer made by ~~EIA~~. We developed the interface and the software program here on site to accomplish the control task which was added to the control. Mercury had no thrust control or maneuverable capability as far as changing the ~~plane~~ ^{attitude} of the spacecraft.

We found in setting up the equipment that the flight controller or the network

simulation was being conceived at this time and they asked ~~me~~^{us} what it would take to bring voltages or signals out of the simulator from the various points - ~~which~~^{we} I told them it was about an eight to twelve weeks job with very little cost except ~~for my~~^{local} manpower. At the time there was myself and one part-time ~~individual~~^{technician}. The STG contracted to Bendix and Stromberg Carlson combined to build a signal conditioner for all of ~~my~~^{our} signal output which represented telemetry. Their job was to build a conditioner that would take ~~my~~^{our} analog voltages and change into another analog voltage which was similar to the spacecraft PAM, an analog measurement system. That system would interface with the control center, the control room, and was integrated with the telemetry in the backroom of Telemetry 3. Through Al Shepard and Gus Grissom's launches which I had the pleasure of training both of them. I remained with McDonnald and in December 1, 1961, I changed over and went to work for NASA in the STG. Almost simultaneously the MSC was formed and shortly thereafter, the decision had been made to locate the center in Houston. ~~By the time~~^{had} John Glenn orbited 3 times and splashdown ~~up to this~~³⁰⁰⁻ time, we had gone through 3-500 modifications on the simulator and also ~~including~~^{getting} we put the computer and the telemetry ~~in and got~~^{the} prepared for these training sessions, ~~and when~~^{At this time} we changed it from Mercury Part Task Trainer to ~~a~~^{The} Mercury Flight Simulator ~~because~~^{as} we now simulated a flight with the exception of trajectory information. We continue on through Glenn, Carpenter, Schirra, and Cooper with the Mercury trainer.

In the meantime, I began to work on the Gemini mission simulator and we knew from the experience in Mercury that the thing to do was to design the simulator with trajectory capability ~~as~~^{well as} the telemetry capability.

In Mercury we used what we called trajectory tapes. We were using Goddard computers for our computations here. Goddard would generate some magnetic tapes and put the trajectory on these tapes. We would play our sequence times and our systems times against these tapes and invariably we had a second here and a second there of miscounts because of starts. ^{was with} The human error of everybody starting on one hack with 5-6 people pushing different buttons we always had a second or two error. We found in Gemini program the only thing to do was to go ahead and just make all this into trajectory and telemetry, everything in the simulator itself - so we would push one button and start the others simultaneously. This got to be quite a software and hardware development problem, which was a great deal beyond the state of the art.

We started looking for computer equipment and McDonnell Aircraft had the contract to build the Gemini mission simulator. We really began to look for a software contractor and computers that could do our job and this was what we first worked with - the Link Division which built the airplane trainers. They sold us the computer and our basic software which was a Mark I digital and analog combined. It was a drum machine - you put your instructions onto magnetic bands or a drum which turns at a 40 cycle rate and your heads would read off these magnetic bands the instructions for operations. This would control the basic trajectory. In the Gemini mission simulator we still designed mostly special purpose systems to do the electrical and environmental control. The computers were used for the spacecraft control systems and for trajectory work and of course for the onboard computer work. Later on we had to add two

additional computers which were DDPO24's built by Computer Control Corporation which has since been bought by Honeywell. We had to go to these because of the increase in scope of the simulation. We had to do a more sophisticated , a complete functional type simulation of the onboard computer because it was found that the telemetry or the onboard computer words put on ~~Mercury~~^{memory} were very important and we could be of great value to the flight controllers by doing a more sophisticated and better simulation. We did in this particular case - we took an IBM ~~who~~^{math model and} built the actual flight computer - and took their math flows and went down through and built a math flow point by point identical to the IBM math flow system. We simplified it by using 24 bit computer in the O24 and in the IBM onboard spacecraft computer, it was a 36 bit computer. In a couple of areas where the trajectory calculations and predictions needed extreme accuracy we did a double iteration - we would do more accurate computation by program techniques. Our telemetry system got complicated from the standpoint of output in telemetry for all spacecraft systems. We had between 300 and 350 different parameters which needed to be outputed. Our concept was to take the simulated systems, the developed system, internal to the electronics of the simulator and feed them into an actual onboard flight hardware PCM gear (Pulse Code Modulator Telemetry). We actually took the early qualification test hardware and used them as our PCM equipment output.

GT-4 was when we first moved into Mission Control Center at Houston with the Operations and as a result of the first mission which we used the Mission Control Center at Houston realtime computer complex.

Prior to that, we were still using a Goddard complex and by hardware were piping the information to Goddard, getting the solutions back and control back to the control center. At GT-4 we did this through Houston. One of the things I will never forget and will always use as a yardstick for myself. We were scheduled to meet GT-5 in Houston and do GT-4 out of Goddard, but Kraft asked if we could support GT-4 in Houston rather than 5. We went through an exercise trying to show why we couldn't make GT-4 in Houston/^{on}the schedule. I went to Houston and sat down with Mr. Kraft, went through my reasons and after about 10 minutes of exploiting all these things, Chris told me - look McCafferty, I didn't ask you to come in and tell me how you can not make GT-4. I asked you to come in and tell me how you can make GT-4 and what my tradeoffs are as mission director. That was quite an experience because every since then, I have always approached problems in that manner. I went back and went through GT-4 and told Mr. Kraft how with the simulator we could make mission control center Houston. It ended up we had about 80% capability and he was willing to sacrifice ^{the remaining} a 20% ~~capability~~. Basically, through the conceptual phase of the Gemini simulator, Hal Parker in Houston pretty well managed all the software, the contract, and that type of integration and I managed the operational end - the structure station, and this type of thing. It was a dual effort between Hal Parker and myself although he would have been the single point of contact for anyone who wanted to talk about the Gemini mission simulator. After we had the simulator

operating about 1 year, we had decided it had become important enough to also provide image display out the windows. So Houston primarily developed and designed a visual display system which electronically generated a spiral-type image of the Agena. In the background we used an artist conception type filmstrip with a photo multiplier to bring the images film on the TV tube out the window. We had integrated a star ball. On Gemini, we did have 1000 star capability, earth-horizon capability, and a simulator Agena target vehicle to rendezvous and docking with. During this Gemini time we trained a lot of pilots, they had a lot of hours, and we had a very good reliability factor. We also began to work on the Apollo mission simulator which at that time was called and later changed to CM simulator and LM simulator. Link won the contract award from NR who was the prime spacecraft contractor for Apollo to build the CM simulators. Later, Link won the award from GAC who was the LM spacecraft prime contractor to build the Lunar Module Simulator. In the process, we went through almost in parallel the Gemini Simulator - about 2/3's the way through the CM simulator and about 2/3's the way a LM simulator.

From the standpoint of being 1000 miles from home, it sometimes makes operations pretty difficult. There are many freedoms we have that the person at Houstonn wouldn't have, but there are also many restrictions. For example, being 1000 miles from home, your fellow

engineer that you work with day by day, side by side, doesn't always think you have the big picture. In the final mission training phase the astronauts are with us, and we feel that people in Houston don't know what the pilots need to train with in a full mission capability. This always gives a real interesting set of circumstances, especially when you start talking modifications or systems changes, or systems validations.

Theoretically the command module simulators - the three of them are identical except for some minor spacecraft configurations. However, Houston's position in training is to get the astronauts started in briefings, systems, and do what they can in tying in an integration of systems. Our job is to start with a crew that has been trained in this system from an engineering depth of knowledge, to exercise in this spacecraft or this mission totally and fully integrated. Houston responds to generalized systems training and we are responsible for final mission profile or mission training. The machines are 90% alike in both locations. *There is a need to* We feel ~~we~~ keep ours to a higher fidelity because there is more of a requirement due to the total integration of doing a mission simulation. Houston could get by with two or three windows out of 5 working (which displayed the outside views to the astronauts). We would not be able to get by with this type of thing and we would have to have all five windows operating. We have to have the simulator in a full up condition all the time, where they can do part-test training. From that standpoint, we feel like our job is a little tougher. On the other hand, they do the basic design and modifications. From a modification design standpoint, they feel their job is a little tougher. It is complicated by 1000 miles between us.

There is no help to either side from the standpoint of the astronauts who publically state they get better training here than they do at Houston. They will fly from Houston to the Cape to train when they could have a simulator available there to train. They feel that we give that much better training. These are the types of things that are difficult to handle.

The experience we had in Gemini in making a long lines work, the trajectory line between here and Houston - this was carried over to the CM and the ^{module} module simulators. The visual display experience, all the true mission simulation experience, the checklist work, the flight plan, the onboard data profile work, all is very compatible with Gemini CM and LM simulators. In Mercury we did not do much onboard stowage work. In Gemini, we did start providing almost all onboard stowage capability and then the CM-LM simulator we continued to supply about 85-90% of the onboard storage: Capability of stowing food, cameras, the waterguns, the ear receptacles, medical kits - anything that is considered a loose item on the spacecraft that the Government is usually responsible for rather than purchased as part of the spacecraft. All kinds of things - the exerciser, the ear receptacles, various lenses, camera mounting brackets, food, defecation bags, etc. This is in our area because when you go through a full mission simulation, they are training with the flight controllers in Houston and you are going through a period of time, say during rendezvous - a man is supposed to also take a picture like right now. They would practice getting the TV camera out of the stowage, set in place on the brackets, like they would in real time in the simulator. They do that here at the Cape most all the time and do it seldom in Houston.

At KSC, we built the basic part of this building, the Flight Crew Training Building, in 1965, and moved the first simulator in 1965 (CM Simulator #2), then the LM simulator in 1966 or early 1967, we brought the CM #3 in middle '67 to late '67 which meant that we had to approximately double the size of the building some time in late '66. We actually made additions to the building to house the personnel. Then we've been operating the CM #3 now for nearly 2 years. We interchange between the two CM simulators. Simulator #2 (CM) supported Apollo 7, #3, Apollo 8, #2, Apollo 9, #3, Apollo 11, etc. The first mission the LM simulator supported was Apollo 9 and then each subsequent mission.

A few other things about being 1000 miles from home. The facilities here are a good example of some of the problems you get. Although our bosses back in Houston were always right there on our side and behind us, it still left most of the job up to us to sell the facilities, to get the facilities built, to coordinate with KSC and Headquarters facility personnel to get the money transferred, to get the contract let, to monitor the contract and construction. I remember specifically having several meetings with them. It seemed like there was a certain faction of people in KSC that just did not want to build the building at all. I didn't understand this for a long time, then I realized what had happened. We had budgeted \$1,600,000 to build the building and when it came right down to it, we only needed \$1,200,000.

These people put up all kinds of objections and screamed and hollered and went through all kinds of shenanigans and then we found out at Headquarters that they had diverted about 3/4 million dollars from our facility budget into Pad 39A and in fact, the money was not there, ~~just like they said it was not because they had stolen it.~~ Some good friends of ours in headquarters came down here and said, ^{to KSC personnel} Gee, boys, you got a problem. You took the money from this Flight Crew Training budget and you put it in 39A last fiscal year. Now we suggest you go to 39A and get that 5-600,000 dollars back and give it back to these people. With that meeting, we got our money and built our building.

Then we had another problem. It seems like every so often certain people take on a job to make life difficult for other people. The head of the program office at KSC really gave us a hard time. When it came time to activate the simulators, not being familiar with KSC activation procedures, we didn't do the job right for CMS #2, so therefore, the KSC said sorry there is a 6-month activation leadtime to do the job and your simulator can sit in storage for 6 months. That went over like a lead balloon. ~~We went into Gilruth's office and Headquarters and forced them into activating the facilities and brought the simulators onboard in a timely fashion.~~ For CSM #3 and LMS #2, we went strictly by their rules and regulations and played their game. Internally they figured we wouldn't make the schedule we were giving them and they built three to four months leadtime or pad into them and sure enough when we delivered on time, the facilities weren't ready. Here again,

they told us to activate, and we could just store the facilities again.
 So when ~~IM#3~~ ^{CMZ} came we went through the same cotton pickin' thing
 again. I never did quite understand all this. There never was a
 reason that I could find except later on I had a visit from one of the
 fellows who was in the office at the time and he said our problem in
 the Flight Crew Support area, was that certain persons at KSC were
 spoon feeding us and that they were going to see to it that this
 spoon feeding stopped. We were going to act just like everybody else,
 take orders like everybody else, and if we didn't like it - that was
 just tough. This didn't go over too well and the fellow eventually
 had all kinds of problems because when it came time for us to support
 a simulation and KSC had not supported us, he got in trouble. I guess
 you can say we are back to "getting spoon fed" again. ^{whatever that means.} The fellow
 brought his boss over. We went through this and I explained to his
 boss very slowly what our problems were, why they were short term
 notice and not 2 months or 6 months in advance, and why we needed
 the airconditioning, the power, etc., and his boss after listening for
 about 45 minutes turned around and said - Bill obviously these people
 need special consideration, special support, and they cannot fit the
 run of the mill schedule plan you have. That was the end of it,
 and we've been ^{supported} "spoon fed" every since. For some reason, these
 two particular individuals - one in the program office and the other
 in technical support, seem to want to make it quite difficult for us.
 Those two people have since been removed - one was removed completely
 and the other one ^{has} ~~is~~ resigned to supporting us - we've had virtually
 no support problems. Also, Sam Beddingfield has been made the key point

of contact for me at KSC and he is chief of systems engineering office, and I was made the point of contact for the Flight Crew Operations Directorate. This was done about $2\frac{1}{2}$ years ago and there has been a real good Beddingfield-McCafferty relationship ever since.

The other thing that's real tough about working 1000 miles from home is our people are rated for promotion with the fellows who are back at home. If I have a man who is really outstanding, then being 1000 miles from home he ~~makes out like a real bear back there~~ ^{does very well} because everybody knows him. If I have a mediocre man or fair man, then he makes out very badly back there, because nobody knows him.

My technicians, especially, have a very tough time. They do a lot of reliability control and facility work and the people don't get to know them like they do the operations personnel or the astronaut training people. Also another thing that is tough on the people is even though we are rated back there, the civil service regulations ~~state that if~~ ^{are not clear} ~~by chance there ever would be a RIF that they would be competing with~~ ^{as to how my people would be handled in case of a RIF} ~~the people in their region.~~ My people feel this gives them a big

disadvantage from the standpoint that if they ever got riffed, they would have a heck of a time bumping somebody in KSC because they would have a heck of a time finding out what job to even bump over there. ^{if that were the case} ^{also they are not all that familiar with MSC} I'm not real clear on all these regulations and it could be there isn't the problem there seems to be.

On the other hand, decisions out of Houston appear to be arbitrary, and ^{to my people} they don't appear to have a lot of reason behind them because the people are not out there day by day and seeing the way

events evolve. All they see is the way a decision comes out, and they don't understand why. The definite advantage of being 1000 miles away is that there are times we can ~~play the game on the rules.~~ *work to cleaner rules.* MSC has some rules in Houston that are contrary to rules at KSC and if MSC has a good rule we tell KSC we are going by MSC regulations. *or* Vice versa, ~~tell MSC that KSC does it this way.~~

From the standpoint of travel, it is a disadvantage because I have to be there every 2-3 weeks ~~so people won't forget me and my people.~~ *lastly am.* That means travel for me and my people to stay current and technically competent in some of these areas. In travel and overtime costs, there is the advantage of being 1000 miles away. Our expenditures compared to MSC total are so small, that when KSC sends them a bill every 3 months, it is a small bill and nobody pays much attention to it.

We are unusual from the standpoint in that I put in a budget each year to KSC. Here I am a branch chief level submitting to KSC a budget in the neighborhood of \$400,000 a year. KSC provides facility maintenance and supplies all of our common spare parts. Although I am at branch level, I ~~am~~ *not far* at extremely high level in comparison to other branches. I run my own budget, am involved with KSC's support contractors, MSFC representatives at the Cape, and have worked with Ames, LRC, Patrick AFB. Patrick, for example, was to support the LLTV training. It was out of *misc* Algranti's Division, being here on the site, I was the coordinator for the facility and did the engineering, the reviews, and coordinated it with

Joe and his people as required. In the case of LRC, I got involved with them in several ways. One, was we gave them the Mercury simulator, so had to go up and set it up, get it running and give them some courses on maintenance and operations, etc. Also, they were supporting a Houston program doing some docking studies. I had to get some IM docking targets from here to Langley and install them. They were radioactive, and were in bonded storage and I had to send a man along who was qualified to handle radioactive materials and go through quite a bit of high level center operations at both ends to get him in and out. Ames, ^{were}asked to do some human relations pilot activity studies especially in control tasks. They sent a couple of representatives down here at first a high level and then later on at branch level for me to fetch some parameters on the computer and to put some brush recordings out showing the hand control of motion and attitudes and the various control tasks of the pilot. I had to deliver them to Ames when they were finished. With MSFC I've gotten involved in two areas--one was the AAP. They came down to look at the simulators. We went through a complete set of briefings, and then I went there and looked at theirs. They also have here a resident office so I get involved with them periodically on tours, briefings, of people at MSFC who want to know more about what the program involves. MSFC has been more of an informal tie than a formal tie whereas Langley and Ames have been semiformal. With contractors, it has been technical--NR for the design review of egress trainer, etc. KSC always has to approve the paperwork, local facility support contracting, but when it gets down to doing the job we end up dealing with TWA, Bendix or other contractor doing a specific job. There are also

a multitude of other contractors we have to work with for various reasons.

Regarding the contractors and their different natures, I can't help but go back and think about Mercury where there was myself as McDonnell Tech Rep and a parttime technician. Later/^{as}we got into the program, by the time John Glenn flew, there was myself and two civil service personnel. I was civil service at the time for I had changed over. There were five fulltime McDonnell people on the simulators. In the telemetry gear operations done by Bendix and RCA, there were about four or five people there. The Mercury simulation area nevertheless remained quite small. When Gemini came along we decided to go out on a maintenance contract and we ended up having a dual contract. McDonnell Aircraft won the contract portion for all the system engineering and programming. Link won the contract for hardware maintenance. So we actually had two contractors onboard. McDonnell kept from 9-11 systems engineers working with us at the Cape and Link had anywhere from 13-19 hardware technicians and engineers. Then came the Apollo Program and we have gradually increased in size to where today we have about 230 Link people onboard and I have 43 civil service people. We don't have any other contractors in direct support of us. Local TRW people support the ASPO office in Houston; GE technical advisory comes under the ASPO support contract in Houston. At one point I did hire about 30 IBM personnel to do a specific software programming task, but all the rest of the people were support contractors of different natures and most locally belong to KSC.

I spoke of the 43 civil service people - the operations of the astronaut quarters, the food, lodging, etc., is also under my branch. I have a mission support office with three civil service people and I have a contract with Automatic Retailers Association, who are food vendors throughout the country. They supply us a Chef, a cook, and steward to help feed, and run the quarters from a food preparation standpoint. That's quite a job though one doesn't think of it. We went through several chefs. For one thing he has to be able to keep his mouth shut. Some guys talk too much; he has to know when the guys want to talk and when they don't. Actually the biggest problem we had with chefs was ~~post nasal~~ ^{medial} drips. ~~This particular fellow has virtually no postnasal drip so he is a big asset to us.~~ In operating the quarters, we get the food shipped in from various places all under complete secrecy so nobody can contaminate it. We buy locally eggs, bread, milk, etc. The chef on a completely uncoordinated schedule has to go out to a random store in a random city and buy the staples - eggs, bacon, etc. It is quite interesting to try to run an operation like this where we are not allowed to get any habits. We are not allowed to take advantage of sales; and even if we found a guy who always has fresh eggs, we couldn't buy all our eggs from him because somebody could conceivably contaminate them. It becomes quite an ordeal.

In maintaining the quarters themselves, we have several maids furnished by the TWA to clean them and wipe them down with disenfectant. Everyday, we wipe down areas that they touch like doorknobs, etc. The other areas the walls, moldings, baseboards, are wiped down on a weekly to bi-weekly basis with a disenfectant. We clean everything daily. It involves several different contractors.