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## ORAL HISTORY INTERVIEW

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**Oral history interview with** Richard B. Hanrahan
[full name of interviewee]

**about** Mission Control Center, IBM-MSC relations; IBM set up in Houston.
[main focus of interview]

**Title:** 1965 IBM Gemini Group manager
[interviewee's current and/or former title and affiliation]

**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 15; # tapes 1]

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**CONTENTS:**

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

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**Education** - _____

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**Career Path** - Jan 1960 - IBM, Project Mercury GSFC Staff.
May 1965 IBM at MSC, Houston;

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**Topics** - experience at GSFC Computing Center; 1962 IBM Contract for Real Time Computer Complex (RTCC); ~~MSC~~ MSC prime computer center w/ Gemini 4; NASA-IBM interface w/ Flight Software Branch; program Verification; preparation for Gemini 6; Gemini 5; team relationship of MSC + IBM (weekly meetings); discrepancy forms to identify problems; Project Development Plan; ~~focus on~~ phase out 7000 series; System/360 phaseover; & re education IBM Mission Programming Dept; programming maneuvers; 1965 incentive award fee contract; IBM recruiting for ~~MSC~~ Houston; programming groups: Mission Systems, simulation Systems, Real Time Operating System; Maintenance + Operations Dept; IBM Federal Systems Division; IBM temporary Houston locations.

May 24, 1968

Mr. Richard B. Hanrahan
IBM Corporation
1322 Space Park Blvd.
Houston, Texas 77058

Dear Mr. Hanrahan:

At the request of NASA Headquarters, I am preparing a history of the Manned Spacecraft Center from its origins to the present. This effort is expected to complement NASA programmatic histories (such as This New Ocean), but will place primary emphasis on the Center as an institution--its general management philosophy, the evolution of its major organizational elements, growth and modifications of its staff, management of its financial resources and contracts, acquisition of its facilities, and its impact on the economy, culture and society of the community in which it exists.

This project is what can be termed a "contemporary history," and since many of the people who played key roles in the establishment and evolution of the Center are able to give credible witness to the events and decisions occurring in this period, it is vital that they be consulted. This pleasant duty is mine, as I have been commissioned to prepare this history. I am a professionally trained historian with considerable experience in research of this type.

It would indeed be a distorted history, that would fail to acknowledge the enormous contribution of industry to this Center's development and growth. Your Company, and you as an individual, have been major participants, particularly in the operational area. In view of this fact, I would appreciate the privilege of spending an hour or so with you in an interview, for the purpose of recording your personal recollection of significant details you are personally familiar with that have a bearing on the Center's past.

If you have no objection, I would like to use a tape recorder while I am with you, as it is a convenient way of obtaining a lot of information quickly and economically. I fully appreciate the fact that you have been involved in many major activities which have a bearing on the history of MSC. At the same time, I recognize that your time is valuable and limited,

and will leave to your discretion what you will want to comment on. I am interested in any information you consider to have been important to the establishment, growth, or maturation of the Center; and invite you to feel free to go into whatever depth of detail you feel advisable and within the limits of your available time. There will be no need to be concerned about grammar, structure, or repetition in this interview; I will consider the information as raw material, and as a consequence it need not be highly refined.

Many of us have difficulty remembering when some particular event occurred, and even more frustrating, it seems like recent events are among the most difficult to date. Therefore, if you have access to a concise record of things that you have been involved in here at the Center, it probably would be of assistance to you in such an interview. In case you do not, it is not vital, so please do not feel it necessary to prepare one.

I am looking forward to meeting you. May I call you in a few days to arrange for a time and place to meet that will be mutually convenient for us both?

Sincerely,

Robert B. Merrifield

# INTERVIEW WITH RICHARD B. HANRAHAN

June 19, 1968

In the fall of 1959 I heard of Project Mercury through a friend; and from a programming point of view it looked like a pretty fascinating place to work in those days. My friend left NSA and joined the IBM Space Computing Center at 615 Pennsylvania in Washington, D. C. and suggested that I have an interview, which I did in December 1959. At that time I was classed as a mathematician, not as a programmer. In January 1960 I joined IBM as part of the Project Mercury staff. We worked at 615 Pennsylvania until the computing center at GSFC was sufficiently completed in the fall of 1960 to allow occupancy. We began to support some of the early Mercury Redstone shots. After some training I began programming input-output from the missile guidance complex at the Cape. That was good experience because we were dealing with the interfaces between the Cape and GSFC and it was the type of work that hadn't been done before. We had a number of problems, and I was in great demand, as there was always the question of whether it was my program that was in error or an equipment malfunction. Because of that association, I got to know a good deal about the operation of the real time system at GSFC. In the middle of 1962 I became the manager of the programming group at Goddard. When MSC Houston issued an RFP for the RTCC (Real Time Computer Complex) we were very interested, and responded. In October 1962 the contract was awarded to IBM and the initial group of IBM people came to Houston and located on Broadway near the Airport.

The Mercury Program and the first several Gemini flights were to be supported out of GSFC, and MSC would not become the prime computer center until Gemini 6, the first rendezvous mission. After the first Gemini orbit mission in April 1965, I was reassigned to Houston.

In the meantime, there had been discussion between MSC and IBM about moving up the date for activation of the Control Center here in Houston. The original plan was to support the Gemini 6 mission out of Houston. That was advanced to support Gemini 4, which I believe took place in June, 1965. During 1965, IBM would have to deliver an on-board computer system, a rendezvous system, and on top of that, would have to prove out the interfaces of equipment and the software, verify the programs, and derive some kind of an operational readiness plan to support the schedule for the single vehicle GT-4 mission.

About that time, I was requested to come to Houston to manage the Gemini group, ready the programs, and follow the Gemini program until its completion late in 1966. In May, 1965, I came to Houston.

Our NASA interface at that time was with Lyn Dunseith's Flight Software Branch. It was his job to give us the specifications for the software programs, monitor their development, accept them, and employ them in support of Gemini missions. Looking back on that period, and the pressures and priorities, a person would easily decide we were off on the wrong foot as at our first meeting with Lyn we discussed what requirements we could delete from the programs. In a number of ways that sounds like a bad start for a contractor. But it must be remembered that our product is research and development. In other words, when we start on a program, we don't know all the answers. That would take the fascination from it if we did. What makes that risk variable is the contractor's belief in his own abilities and also his confidence in the customer's integrity. When two reasonable people try to solve a problem, they act rationally, and that is what took place in our dealings with MSC. MSC was particularly fortunate in the kind of people it had in the program.

In June, 1965, just after I got here, we did participate in the real time support of the Gemini 4 mission. It was a difficult mission, and we had many problems in supporting it. Luckily none of those problems had any effect on the mission, but we couldn't chalk them off or say we furnished perfect mission support. It pointed out that we had a lot of problems which we would have to solve and it gave us a full agenda for that summer. We concentrated on perfecting the primary computations of the system and we soon got them to operating successfully. Incidentally, during this period, we had backup from Goddard which was also running the system so that there was no possibility of a weak link in the chain destroying the chance of mission success. The Gemini 5 mission was conducted in August of that summer.

There were three things that we learned on that mission. One was that in order to prepare programming systems such as we were to supply, there had to be a fantastic amount of testing and preparation. To construct and operate programs which in those days ran up to 400,000 words, and with a machine which can execute them faster than you can think about them requires many options or paths, and they all must be verified. A fantastic amount of effort has to be applied to verification of the programs under the different conditions of use. In order to do that task, we would have to establish procedures which would allow both our management and the operating people to understand where they were. Those procedures would have to help the programmer get his job done, not just help the manager to report on it. It should theoretically be the same set of paper. Fortunately, our counterparts at NASA saw the problem in the same terms that we did. We pointed out our conclusions and got their agreement. We have always been proud of having solved the problem in this fashion, rather than having been directed to do a lot of things to control program development. It's true that's what we are paid for -- there's no question about it, but we were pleased that they approved our suggestions rather than giving us ultimatums.

That summer we had to begin preparations for the Gemini 6 rendezvous mission. That effort was an extremely difficult one for us. For Gemini 4 we delivered a system that did the job; then came Gemini 5 which was very similar and essentially required only a modification of the Gemini 4 program. But problems occurred in the Gemini 4 system and to prepare for Gemini 5 these had to be solved. It took manpower and considerable effort and ingenuity to correct those problems--all of which were needed for Gemini 6 which was waiting in the wings. After 5 was completed, we were not as far along on preparations for Gemini 6 as we had hoped to be. We were convinced that we could do it, although it was not obvious what set of reasons should have led us to that conclusion. Actually, we operated with a large number of people nearly 24 hours a day, seven days a week throughout the summer of 1965. The first launch attempt of Gemini 6 was in October 1965, and as you remember, the Agena vehicle blew up on that particular launch and the mission was rescheduled for December. At that point, we were far from certain that we had a good system. We thought it offered a reasonable chance of success and we knew the critical computations were acceptable. Yet, between the first attempt in October and the mission itself in December, we did not find a major problem--one that would have precluded success of Gemini 6 had it been launched in October. We were relieved to learn this, as we were not convinced of that before we started.

During the summer of 1965, we started working much more closely with our customer. It was an attitude we established while I was still at Goddard, that in this kind of an operation we had to join the customer--and although I think the word "team" may be trite, it's perhaps the only one that describes such a working relationship. In research and development, both customer and seller are trying to do a job which can't be done by putting together formulas read out of a cookbook. At this point we probably were writing the manual, and we didn't know but what we might be contributing some of

the bad instructions in addition to the good ones. We established a very close liaison with our NASA counterparts primarily through the medium of a weekly meeting at which we reviewed something that we called "The Project Development Plan" (the Mission Development Plan in those days). This development plan was a document of some 13 different parts or areas of reporting. It attempted to boil in one document everything we knew about the system that we were preparing. It told all of the functions which were to be added to the program to support a mission, with delivery dates that we intended to meet. There were three columns which pertained to the schedule: one of them was the original target date (our first guess), then the revised target date, and then the actual delivery date. We also began something new and potentially damaging to us, had the customer been unsophisticated: we reported on a weekly basis every problem which we had detected in the system. Usually the approach is to deliver a system as near to perfection as possible, and tell the customer more about accomplishments than problems. But our whole reporting scheme then, as now, was to bring problems into focus. In our kind of business we usually get only one chance; there is only the one mission. It wasn't a production-line atmosphere, and we couldn't afford to have many problems occur in that atmosphere for the first time. So we trained our people to talk about their problems, rather than their accomplishments, to write their problems down, to make people aware of them. Now implicit in this arrangement is the understanding that the customer is keenly aware of the job we were doing and who respected our candidness. The information he is given, if he chooses, he can use to our detriment, but that did not happen. The Project Development Plan listed things that we thought were wrong with the system, and after this discovery we assigned one of our managers to it. Each week the managers in each of the areas sat down and reviewed that list to find out what progress had been made in solving the problems. There was also a list of problems which were

corrected that week. So we and the customer focused our attention on that which truly concerned us--when would the program be ready and how are we going to be able to use it.

In another area, the documentation written in the computer room, we decided that we would ask the programmer to write down what tapes he used, what tests he was trying to run, etc. We gave him forms to take back to his desk and when he finds a problem we ask him to jot it down. We furnish him a piece of paper, which we call a discrepancy form, ask him to fill it out, keep the original and give us the copies, and we will do our administration from it. We avoid asking our programmer to do something additional for us and instead, simply ask him to record the information that's important to him in doing his job and we try to build the administrative system project around that information. It's been very successful, and has eliminated many of the ugly surprises. We feel that we know the systems when they go on the air, which means about a half million word program written by a group of 190 different people. We haven't been surprised by the systems, as we feel we control them, we know what they are, how they are going to perform, what their limitations are, and what their strong points are.

In 1965 there was also another activity in progress to analyze the current and future hardware requirements. Early in 1963, IBM installed its first 7094 computer at a temporary facility at 6702 Gulf Freeway. It was later replaced with a Mod II, which was a faster machine. We began with the assumption that the size of the auxiliary storage to house the library of programs would be on the order of 98,000 words. By the time we were providing rudimentary support for GT-2, and before we ever thought of becoming prime contractor, we were using something like 256,000 words of storage, and by the time of Gemini 5 sometime in 1965, we were up to 512,000 words of required auxiliary storage. Here we ran into a limitation on the expandability of the 7000's series of machines.

We proposed that a new series of IBM equipment, the System/360 should be used in the RTCC, and the 7000 series phased out. Late in 1965, we were given an extension to our initial contract to provide that reconfiguration of the RTCC, and this became our primary effort during 1966 and into 1967. It was a major transition. The initial idea had been that all of the Gemini series would be completed on the 7000 series equipment and the early Apollo missions notably AS-201, 202, and 203, would be supported on the 7000 series equipment and Apollo 204, the first manned mission, would be supported on the System/360. Our target date for that support would have been August, 1966. There were several problems which had to be faced. The schedule was very tight and the introduction of the System/360 made it even tighter. The model 75 series equipment became available around May, 1966, so we had only three or four months before we would be obliged to furnish mission support. That together with the difficulties in preparing a totally new control system made us recommend to NASA that the first 360 support be deferred to the Apollo 501 mission late in 1966, and that in fact the Apollo 201, 202, and 203 programs be modified to support 204. After a lot of discussion, that recommendation was approved. In late 1965 we began to work on the System/360 phaseover. Two groups were involved: the systems engineering group which was responsible for configuring the equipment and deciding how many tape drives, how many disks to use, what size cores, what size main memories and that sort of thing, and what would be the nature of the real time interface. The second group was composed of the people who were to design the software to be used in controlling input-output of the operational programs, the application programs, and sequencing the set of operations that take place.

During February, 1966, I believe, we supported AS-201, the first Apollo flight directed from the Control Center. That system used a 7000 series program. It was a difficult system for IBM because of a manning

problem. We had 100 or so people who were experienced in writing operational systems but the Gemini series commanded all of their attention. We chose from that group a number of key people who would form a nucleus of a group to write the Apollo programs. To complete the staffing of this effort, we recruited from within our Federal System Center and outside of the company a large group of young people who could write the Apollo 200 programs. Their work was completed in time for the support of 201 in February 1966. Early in 1966, we re-organized the project. Instead of having both a Gemini and an Apollo programming group with like talents, we formed a Mission Programming Department. Now the heart of the orbit system is an integration technique which both Apollo and Gemini had to have. There were really not that many people in the world who were experts on this kind of integration techniques and programmers. Therefore, it made sense to put them into the same organization. We also created sub-groups within the Mission Programming Department. The launch department, for example, was responsible for all the launch programs we wrote. This cut down a great deal on duplication of effort in deriving specs, etc. I became manager of what was then called Mission Systems. We set out to furnish the remaining four Gemini missions on the 94 and to start work on the System/360 programs.

It's hard to say whether difficulties we encountered on the 360 were more or less than we had anticipated. They certainly were challenging. First, there were problems connected with technology. This was new, complex, and very fast equipment -- orders of magnitude faster than the preceding generation. We ran into that set of problems first and this required a great deal of attention from all the departments on the project to straighten it out. We had to decide whether it was an equipment problem, a software problem, or an education problem.

If the flight controller puts in a request for a particular maneuver at a certain time, there are a set of program modules in the computer system which will compute those numbers for him. Our programmers write those modules to the specifications given to us by NASA. The flight controller's requirements are interpreted and flow charts are prepared showing how this particular thing will be accomplished. Code or a numonic interpretation of a set of instructions to the computer is then generated by the programmer, but that form is not acceptable to the computer and there must be translaters to transform the code into things which we call bits -- 1's and 0's -- which are capable of being interpreted by the computer. That translation is done by two kinds of programs; one of them called compilers and the other called assemblers and the only difference is that the compiler has a higher level of sophistication. It will take Fortran, for instance, which is more closely associated with normal mathematical expressions and it will do the translations from that, whereas the assembler works with a more technical and more specialized language. The operating system includes assemblers, compilers, and link editors. The Apollo 501 program had approximately 300 different program modules, or collections of instructions with a function which had to be put together to form a system, and it was the job of the link editor to put them together, to establish the communications between them, to establish the table references, etc. All of those operations become part of the operating system, and above that were the controls which sequenced the operations of the system in real time. Thus, we were able to respond to the things that were happening in the real world.

With the new system came a new set of problems. If the system is not operating correctly, there is a second level effect, a second set of problems. We also had to re-educate the approximately 350-400 programmers here in Houston to support the 360 series.

The first model 75 was installed in Building 30 in May, 1966. There were additional Model 75's added until at the support of Gemini 12 we had three model 75's and three model 94's. The 94's were still supporting Gemini and the 75's were taking care of Apollo. In January, 1967, the Apollo 204 accident occurred and we removed the remaining Model 94's and completed the installation of the 75's. By February, 1967, the conversion to the System/360 was completed.

Delivery of the initial 360 program, scheduled for January, 1967, didn't occur until May, 1967. The delay in delivery of the 360 program did not impact the MSC schedules. MSC management was, nevertheless, concerned and officially notified IBM management of this concern over the delay in phaseover to System/360. Toward the end of the second quarter of 1967, however, sufficient progress had been made in this regard that MSC management notified us that it was pleased with the progress being made.

A system selector unit is located in the RTCC which is primarily the interface between the computer system and the other systems of the building. The box was built by IBM as a special engineering assignment. It has more or less helped us to define the areas of interest. There are also some additional buffers which were built by IBM and perhaps fall outside of that unit. But in general the RTCC has become an entity which we have dealt with NASA directly. It is still a partnership.

Dealing directly with MSC personnel has some very desirable aspects. It brings with it a very clear responsibility for certain functions. It is a program with a well defined objective and goal, it's a program of national note, and it's a program which is going to accomplish things which have not been accomplished before. To be identified among the people who are actually doing this and to be dealing directly with the user, the flight controller and Flight Software Branch, we have found to be a valuable

incentive for each of us individually and also useful from a management point of view in defining objectives for our people and directing their efforts. For those reasons we have built a relationship with the Flight Software Branch, and deal with them very directly. They give us requirements for the system, monitor its development, take delivery of our systems.

The extension of our contract that began in 1965 was an incentive award fee contract. One part of the contract is a cost performance interdependency. We are graded quarterly by the Flight Software Branch and reviewed by MSC management up to and including Dr. Gilruth. We are evaluated in three areas of performance. First is development; how well we accept requirements, do the work, develop the programs, and deliver them. The second area is operations; how we contribute to flight controller training and support the missions. The last area is management; how we control the expenditure of resources which are allocated to the project. That kind of a contract is again much more satisfying -- to be rated in these areas by the customer directly and to feel that one's direct contribution is being measured.

There have been very few problems in dealing with the other contractors primarily because NASA has assumed the integration role. Everyone's primary interface is with MSC and I am sure each contractor feels he is getting a NASA assignment,which is what he is paid for.

The initial staffing of the project was done primarily by relocating people from the northeast. In that area we had done the Project Mercury work and the experienced people were there. The Federal Systems Center is also headquartered in Gaithersburg, Maryland, and the large majority of our people are located there. Housing was much cheaper than in the northeast so wives were very pleased with that. Husbands were pleased with the challenge of the job here. We began recruiting

in all parts of the country. The job itself was probably a very large selling point. The chance to be part of a project which was supporting Apollo was a powerful inducement, and IBM's reputation was also a major factor. To build a group of 30 - 40 people to an operating level of approximately 600 took concerted effort and continuing attention.

We have many different disciplines of people here. We have three different programming groups. One, the mission systems group, is responsible for delivering the systems which are used to support the actual missions themselves. In that group there are approximately 200 people. Most of the people have a background in one of the physical sciences, primarily mathematics, but with physics and engineering also well represented. Our second programming group is the simulation systems. It is responsible for generating an equally complex program for the ground system simulation computer. Its job is to provide data to the mission computer for the training of flight controllers. This group of programmers generates data which approximates that which would be received from the network during a real flight. It furnishes the data to the mission computer during simulations to train the flight controller in the use of the operational systems. There are approximately 130 people assigned to this second programming group. Its personnel have backgrounds very similar to those in the first group, with the physical sciences and mathematics being most representative. The third of our groups is called RTOS, Real Time Operating System, and its job is to construct the control system based upon the commercially available Operating System/360. There are approximately 60 people assigned to that effort. Their backgrounds are probably quite similar to the first group; however, there is a difference. The mission and the GSSC groups are more concerned with solving the customer's problem. They

are very skilled in the use of the computer and most of their conversation would probably revolve around some technical area, such as the propulsion system of the CSM or the expenditure of power of the LM. They get into the heart of the customer's problem. They are very much customer oriented. RTOS constructs an operating system which will allow the applications programmer to solve the customer's problem. They deal more in terms of the IBM equipment and software and its modification. In addition to those three departments, the project has a system engineering department composed of approximately 30 people. These people design the general purpose equipment configuration and the special purpose interface equipment in which the programs operate. These people are primarily electronic engineers. They come from many parts of IBM, but mostly from some of our engineering labs. Each of the major departments, for instance, the Mission Department with 190 programmers, is divided into many smaller departments. The usual department has eight to ten people. Each department is given complete responsibility for a subsystem of the program and we've attempted to parallel the organization of the applications programming group with the organization of the system which we are generating. They are responsible for the mathematical logic of that particular subsystem. They are responsible for programming its display logic, they are responsible for control functions, for using the control system. We have in this group a spirit we hope that brings a breath of familiarity to the many types of logic going into the system. We don't have just one group that does mathematical programming and isn't familiar with the technical system in which it operates. We try to get that familiarity through to all our people. For this reason we have had somewhat less trouble in hiring and maintaining a trained staff, because a man fits into several places in the organization and gets his training in several others.

We try to maintain a mathematical competence within each of these first line departments and have been more or less successful. Some of the problems which come up are certainly beyond the scope of training of the people assigned. For that purpose, we maintain a mathematical analysis group which contains about eight senior level mathematicians whose assignment is to supply a line department with a formulation which is beyond the scope of the training. They also advise project management on the mathematical integrity of the system and watch over its mathematical construction and suitability. It's a very small department, but it has played a very meaningful part in project development.

The last department is the Maintenance and Operations Department. Under the system management aspects of the contract, its 120 people operate and monitor the maintenance of the general purpose equipment, we maintain the special purpose equipment, and supply the keypunch services. The M&O people have a different background from the other departments. They are for the most part, junior people. The local universities have been a very fine recruiting area for these bright young people. In M&O we also have a large number of technicians who are very skilled in the maintenance of equipment.

There is one other department, and that's the project office itself. It consits of approximately 25 people and has two functions. One is the coordination of the technical planning of the project -- those plans which involve more than a single department. The second function is the management of the financial resources of the project - - budgeting, allocation of resources, recruiting and interpretation of commitments.

We are part of the Federal Systems Division of IBM. IBM is represented in Houston by two divisions. The other is the Data Processing Division. It has the responsibility for marketing IBM's commercial equipment in the Houston area. The Federal Systems Division people in Houston are all housed here in our building in Nassau Bay. We are interested

in growing in this part of the country and in doing the kind of work we have been able to do for NASA and for other customers, namely solving their data processing problems. The NASA project currently far outweights other applications in Houston.

The original contract was granted in October, 1962. Beginning in November, 1962, we had a small group located in a building on Broadway just a short distance from the airport. In December, 1962, we acquired a building at 6702 Gulf Freeway and moved into that particular building. In June, 1964, we moved 140 people from the 6702 address to the site -- to MSC proper. Late June, 1964, the first machine was installed at the site. During that month, we actually brought a machine in and 140 people to support it. Then in the remaining part of 1964, we acquired space in several buildings in Clear Lake City, such as the Alpha Building and the Beta Building, and we moved from the 6702 address as space became available. During 1965 and 1966, we were located in Alpha Building, Beta Building, and some of the metal temporary quarters near the railroad track across from Clear Lake Shopping Center. Later on we were located in the Nova Building which was behind Alpha and Beta and a small contingent was located in the GE Building here in Nassau Bay. Then in December, 1966, we all relocated to our current facility, and all Houston Operations is located at this facility at this time.