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Oral history interview with Joseph N. Kotanchik
[full name of interviewee]

about Structures + Mechanics Division - facilities
[main focus of interview]

and Subsystems.

Title: 1962 - ~~James J.~~ Spacecraft Integration - ~~Tech Anal~~ Branch Tech Anal Div), Spacecraft Research Div.
[interviewee's current and/or former title and affiliation]

1968 Chief, Structures + Mechanics Div, E+D

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

Historian **at** MSC
[location of interview]

Transcript and tape(s). [for inventory only: # pages 12; # tapes 1]

Master 1

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Education -

Career Path - Langley Research Laboratory; ~~Dec.~~ 1961 MSC ~~Space Task Group (STG) (now~~

Topics - Asst Div Chief for Systems Evaluation Dev Div (SEDD); first priority Space Environment Simulation Laboratory (SESL); group concept of Space Systems Evaluation Labs (SSEL); Chambers A + B; Thermochemical Test Area (TTA); Flight Acceleration Facility; Structures + Mechanics Division (SMD) retained: SESL, electric arc facilities, vibration + acoustic laboratory, structures + materials laboratories; building Chamber A: wall strength, man-rating, solar simulation, cold walls; Corps of Engineers - within + beyond capability for MSC contract; insufficient funds - SMD support from Brown + Root Northrop; sand/water impact drop test facilities; SMD subsystems: structures, thermal protection, earth landing, mechanical; Thermal Control Office.

challenges + problems

Oct. 3, 1967

Joe:

The attached memos outline the purpose of my research assignment and the general area of my interests. I am especially interested in your knowledge of <u>why</u> and <u>how</u> E&D facilities have evolved as they have, the justification for major design features, unique or unusual aspects of the capabilities of individual facilities as compared with others in use elsewhere, problems encountered during design, construction, and operation, and insight on any other factors, events or trends which will be useful in the preparation of a Center history.

I have been told that you have an excellent file of key documents pertaining to the evolution of E&D facilities. May I have access to this information?

Thanks,

Bob

Interview with Joseph N. Kotanchik
4/3/68

I had been associated with the Langley Research Laboratory doing research in support of the space projects, particularly Mercury Program up to late 1961. In the fall of that year, I asked Dr. Gilruth, head of STG, about joining his group. I felt that the Apollo program which had just recently been proposed was probably the single most important peacetime undertaking that the country would face for many years to come. Dr. Gilruth said he would be glad to have me and October 1961, he asked me to join his group. In December 1961, I officially transferred to the STG. By that time the name had changed to Manned Spacecraft Center and Houston had been selected as the site for the new Center.

When I joined the group it was in preparation for building the Manned Spacecraft Center and making the move to Texas. Under Dr. Faget I was assigned to the Systems Evaluation Development Division under Aleck Bond. Aleck Bond was to be division chief and I was to be assistant division chief. This division was placed in charge of planning the facilities at the Center, particularly those which would be involved in development and evaluation of spacecraft. At that time, Aleck was still with the Galovan Committee at Headquarters but was in process of phasing out and coming back to Houston which he did in a short time.

He and I both came to Houston early in 1962. Even while we were at Langley we began planning the various facilities. The one which we
148 gave first attention to was the Space Environment Simulation Laboratory because at that time neither the form nor scope of these laboratories had been planned. He and I were among the first to sit down and think about what these laboratories specifically would be like. We developed a concept of a complex of major space simulation facilities consisting of four chambers: Chamber A, B, C, and D. For budget reasons they were reduced to Chambers A, B, and several years later, Chamber D was added. Chamber C has never been funded and is not now planned to be added to the present space environment simulation capability of this Center. At the time the original budget for MSC was prepared, the facilities had not been planned in sufficient detail to identify them one by one but they were grouped together as the Space Systems Evaluation Laboratories. Only later were the separate ones broken out, identified, and built as separate facilities, but still as part of the overall plan of spacecraft systems evaluation. The major facilities that grew out of that group concept of spacecraft systems evaluation laboratory were the present Space Environment Simulation Laboratory, the electrical and electronics laboratories, the Flight Acceleration Facility, the Thermochemical Test Area, and the group of laboratories which now include the Structures Laboratory, Materials Laboratory, and the electric arc facilities. There were other facilities that were under Mr. Matthews - those which now are Building 16, G&C, simulation facilities, etc.

Because the SESL was such a long lead facility, so large in scope and cost in comparison with the other facilities that were being planned for the Center, it received a great deal of attention from us. After Kurt Strass joined us he took a leading role in the planning the SESL. Because of budget limitations, we had to consider only the two chambers, A and B in that complex and omitted Chamber C and D from the initial planning. The chambers which were eventually built were essentially about as Aleck and I had planned them originally, at least as to size and capability. Chamber A is now the only very large manrated chamber with solar simulation capability and cold walls now operational in this country. Chamber B has similar characteristics but it's smaller and there are a number of chambers of that type around the country, but I don't know that at this time they are as fully manrated as Chamber B.

The planning and building of thermochemical test area was largely the responsibility of Jesse Jones. For a time he was in charge of its operation. The Flight Acceleration facility was to be more advanced than that used in the Mercury and Gemini programs - - the Navy centrifuge at Johnsville, Pennsylvania. It would be capable of taking a crew of three and a simulated interior of a Command Module and of subjecting the crew to the kind of acceleration that would be experienced during launch or entry, that is an acceleration of 20 g's or less. When that work was in progress, Hinners joined MSC and was made responsible for following that project through to completion. He has remained in that capacity and is now responsible for its operation in the Crew Systems

Division. Responsibility for flight acceleration facility was moved to the Crew Systems Division about the time the facility neared completion as it was felt that since it involved many things associated with crew training that the CSD would be a more logical place for it to be placed. After the Propulsion and Power Division was formed the thermochemical test area was placed under its responsibility because much of its work is concerned with small size motors, their test and their development as well as other devices which are of a hazardous or semi-hazardous nature.

As the Center grew and the staffs increased in size and new divisions were formed, then the responsibility for all these facilities was assigned to these divisions, so that today the Structures and Mechanics Division has retained the SESL, the electric arc facilities, the vibration and acoustic laboratory, and the structures and materials laboratories. 236/245 The vibration and acoustic facility is part of the structures functions, because it's primarily concerned with vibrations in the spacecraft structure. These vibrations can be excited either by acoustical means, by engine vibrations, or aerodynamically induced vibrations. This facility is unique in that the acoustic part of the facility employs a method for subjecting a spacecraft to noise which to my knowledge hasn't been employed anywhere else. In most other facilities large volumes in the form of large rooms are used to generate noise and the object placed in these rooms is then excited into vibration. To follow this approach for a spacecraft would require immense energy generation. We avoided that problem and the inherent large costs by developing the noise in very small size channels immediately adjacent to the surface of the spacecraft structure. We had significant assistance from our outside consulting contractor in developing that technique. It wasn't original with us but its execution in the form of this large facility is unique. Today that acoustic laboratory is being used to subject a complete Apollo spacecraft to the noise level that it will experience from liftoff to peak noise levels in flight.

The electric arc facilities are also unique in that we can develop
236/245 a range of simulation that is the enthalpy (thermaldynamic potential at constant pressure) that can't be obtained by many other facilities in the country. Probably no other is as large as this one, as it has a 10 megawatt power supply, and has the capability of simulating vehicle entry characteristics. It can simulate not only a vehicle returning from earth orbit but also vehicles returning from lunar missions where the enthalpies of the boundary layer next to the spacecraft are substantially higher.

In the SESL, Chamber A was the more difficult to build. There were
236/240 many problems as one might guess when one starts building a facility that is the first of its type. It was to be the first large chamber to be manrated, to have solar simulation, and to have cold walls. Another big problem we had with that chamber was in obtaining solar simulation capability. This aspect required the development of carbon arc burners - the radiation from the arc constituting the simulation of the sun's radiation. Although a prototype of this type of burner had been built earlier by RCA and was the basis on which we decided to give the contract for the solar simulators to RCA, the ones we

needed were larger and more advanced than the ones RCA had built. Solving those problems was a long and painful process and Kurt Strass deserves major credit for his leading role in resolving the solar simulation problem and in dealing with RCA over a period of years.

Of all the various problems we had with the SESL, the solar simulation was our biggest, most troublesome, and lasted the longest. However, I guess it isn't the one which has received the most publicity, in that the problems associated with the structure of the chamber got the most coverage in the news media. When the contractor performed the acceptance test to demonstrate the capability of the chamber to achieve the desired level of vacuum the problem began to become evident as he began the pumpdown. As the pressure decreased, toward a very low pressure from one psi or lower, the people who were present near the chamber heard various noises coming from the chamber. This is not at all unusual because any chamber of appreciable size gives off various kinds of creaks, groans, and other noises as the pressure differential builds up. But in the case of Chamber A the poeple who were present thought there was too much of this kind of creaking and noise-making coming from the chamber, and at one stage they telephoned the designer of the chamber structure. The designer told them not to worry about it, to go ahead. They continued the pumpdown, and eventually got to the point where they felt they should stop because other things just didn't sound right. After the chamber was returned to ambient pressure it was found that the structure around the door had received a permanent set too large to be acceptable. There was no question about that, but many of the things that were said after that, such as -- we had a structural collapse of the chamber -- were not true. The fact was that the chamber structure around the door was not sufficiently stiff to preserve the chamber shape when it was evacuated. Whether it had the strength to do so I guess we will never know since we never pumped it down all the way and held it there long enough to find out. I can't say whether it would have collapsed, but the permanent set that took place in the pumpdown (although it was not down to the lowest pressure) was nearly equivalent to a collapse as far as structural effects were concerned. To correct this defect, it was necessary to stiffen the structure around the door. A great deal of effort was made to determine how and what kind of stiffening was to be applied to that structure. We employed a consultant firm and the Corps of Engineers also employed a consulting firm and eventually it was agreed how the chamber structure in the region near the door had to be strengthened and stiffened. After it was accomplished, we have had no trouble when we subsequently tested the chamber.

I am sure the Corps was entirely competent to build our office facilities and do other routine construction but most of the laboratories were not within their capability. They didn't have the design and construction experience or the appreciation for the complexity and sophistication of the technical equipment and systems that went into the SESL to make it a successfully operating system. Their inspection personnel just didn't have the background to make decisions on the appropriateness of the kinds of things that were to be built. The Corps had been authorized to compensate for that lack in their experience and background by employing suitable consultants or talent, but I don't think they ever did that or else they didn't do it on the scale that was necessary for the SESL. Many of the things that had to be tracked down and solved were done by MSC civil service personnel working with the contractors. They resolved the problems and made recommendations for appropriate acceptance tests on the facilities.

Col Blair was anxious to adhere to schedules; and although I know schedules were important, they should not be the primary consideration. Sometimes he would want to charge ahead without doing something we
145 felt was necessary to insure that the facility had the characteristics that we needed. In Building 13 we felt additional ducting in the floor was needed for power transmission cables to the various test sites in the laboratory. There was some delay in specifying the sizes and routes of these underground ducts. He threatened to go ahead and pour the floor without these ducts, which, of course, would have greatly diminished the usefulness of the laboratory. We were obliged to insist that he not do so until the ducts had been installed.

A continuing problem that we had in all of these facilities was
148 a lack of sufficient funds. As I recall, the initial budget for MSC
✓36 facilities was $60 million, of which about $30 million was allocated
✓40 to this group facility called the Systems Evaluation Laboratories. It was deemed essential that SESL be the first facility to be constructed

as part of that complex. When we went out for bids for Chambers A and B, we got back a bid of around $40 million - far more than had been allocated for this initial group of facilities. We had to do some very hard paring, eventually got the bid for the basic SESL down to about $19 million. Since then there have been additional fundings added but that $19 million was the base on which we started building. I would expect that the total capital investment in SESL is now in excess of $40 million but of course it has capabilities beyond that which were in the original basic contract with Bechtel Corporation.

We got some of our facilities at very reasonable costs. The contract for the electric arc facilities was about $$2\frac{1}{2}$ to 3 million for the
r36 vibration and acoustic laboratory was in the same range, something like 2.8 or 2.9 million. These two are both outstanding facilities and retained at an economical price. They were not huge sums of money. One contractor quoted a figure in excess of $10 million just for the construction of the acoustic lab alone. We obtained not only the acoustic lab but the vibration laboratory as well for less than one-fourth of that figure. The reason for this savings was the employment of the unique method, I mentioned earlier, of getting the noise input to the test article.

The principle support that Structures and Mechanics Division
345 obtains from support contractors is provided by Brown and Root Northrop combination and is in three areas. One is in the SESL where there are approximately 190 BRN people. Essentially the BRN people are responsible

for operation of the SESL as a facility -- to keep the facility in running condition and to operate it during tests. The other two areas of BRN support to this division comes from what are called engineering mechanics laboratory 1 and 2. The engineering mechanics lab number 1 is primarily the vibration and acoustics laboratory and about 50-52 BRN people are located there. Engineering mechanics laboratory 2 includes all of the different kinds of activities we have in Building 13 -- structures testing, materials testing, flammability testing, the Apollo docking equipment operation, and other small tests. In engineering laboratory 2 there are about 45 BRN people. BRN people are primarily experienced technicians with a scattering number of engineers usually in supervisory roles. The lead man in each of these three areas, that is SESL, engineering Mechanics Lab 1, and Engineering 2 is an engineer. Each of these may have engineer assistants but all of the operating groups are technicians with a wide variety of experience and skills - mechanical, electrical, electronic, materials, and others. They do many kinds of small tests, particularly in the area of materials flammability.

In the last two years we have added land impact and water impact drop test facilities beyond the thermochemical test area in the northwest
336 corner of MSC grounds. We have what's referred to as the swimming pool or the mud hole into which spacecraft modules including a full-size full-weight Apollo command modules are dropped to simulate landing of the Apollo on water. At the conclusion of the Gemini program, we obtained a drop test facility from McDonnell Aircraft Corporation which

had been built for the Gemini program. This facility is capable of launching a test article such as an Apollo command module at horizontal and vertical speeds to simulate impact forces that the command module could experience on landing as, for example, from an abort.

The SESL is the largest facility the Division is responsible for in terms of size and staff and support contractor staff. It is under the supervision of Mr. McLane, an assistant division chief.

The support of the Apollo spacecraft program which involves most of the effort of this division (I estimate at this time more than 90 per cent of the effort of the division is devoted directly to the support of Apollo), is provided through the subsystem managers organization. In this division we are responsible for the following subsystems: (1) Structures subsystem, which has the responsibility for all of the spacecraft structure including the command module, service module, the lunar module, the spacecraft LM adapter, and the launch escape tower. In addition to direct responsibility for this structure, we provide structural discipline support to other subsystems for Apollo such as the tanks and other pressure vessels. While the Propulsion and Power Division is directly responsible for the tanks which contain the fuels for the propulsion systems, we provide all the materials and structures support to the P&PD in connection with tank work. (2) The thermal protection subsystem, which has responsibility for development of the heatshield for the Apollo spacecraft. (3) The earth landing subsystem, which includes development of all parachute systems from the time of deployment of the first parachute all the way down to impact with the earth or water. (4) The Mechanical Subsystem, which includes responsibility for development of a large number of separate items on the Apollo spacecraft, such as the hatches, by which entry to the module is obtained; the docking device, by which the command module and LM are docked together; the command module uprighting system (the command module does have means for uprighting should it land upside down) a system of flotation bags which will upright the command module should it happen to land in the water in an inverted position; and the lunar module landing gears subsystem, involves the landing stability of the lunar module, taking into account the various kinds of irregularities that maybe encountered during the landing operation. The Structures and Mechanics Division has a group called the Thermal Control Office which coordinates all of the Apollo thermal control activities done by various groups throughout the Center and as such is similar to a subsystem. For example, the Crew Systems Division has a group that is responsible for thermal control work on the environmental control system. The Thermal Control Group in SMD takes the work of that group and reviews it in the larger context of thermal control of the whole spacecraft. The overall supervision of the SMD subsystems is exercised by the Project Support Office of the Division, and all the subsystem managers, their assistants and their support contractors are under the direction of the one manager in the Project Support Office. These subsystems people work directly with personnel of the Apollo Program Office and spacecraft contractors. The Subsystem Manager also draws support from the various branches, our Division which operates the test facilities.