INTERVIEWER: Today is July 17th, 2007. This is the MIT 150 Oral History project. Today we are interviewing Joseph Gavin. My name is Brian Keegan. Thank you for taking the time to meet with us today Mr. Gavin.

GAVIN: It's my pleasure.

INTERVIEWER: As you know this is going to be a view of MIT history, but particularly your history and your intersections with MIT. So maybe we'll rewind the clock all the way back, start with your biographical background. Where did you grow up? What did your parents do? Do you have any brothers or sisters? What were you like as a child?

GAVIN: Well, let's see. I was an only child born in Somerville, but we spent most of my early days in Brighton. I went to the public schools through the sixth grade and I went to the public Latin School and graduated from there in '37.

INTERVIEWER: Did you know then that you wanted to go to college? Did your father [INAUDIBLE]?

GAVIN: Yes. I had been intrigued by airplanes early on because I had had a chance to see Lindbergh when he returned from his flight across the Atlantic in '27. And I was pretty sure I wanted to be an engineer. I was pretty sure I wanted to do something with flying machines. My father however was in the newspaper advertising business and his advice to me was don't get into that business. And he was a very interesting man, very supportive. He had had to leave school in the ninth grade to help support his family when his father was killed in an industrial accident. So I grew up in Brighton. Went to the Latin School. The Latin School was a big leg up, very demanding. By the time I finished there I knew how to study.

INTERVIEWER: Did you have any advisers or mentors who stood up for you or encouraged you?

GAVIN: No one teacher stood out but there were several who certainly conveyed the idea that if you're going to do something, do it well. And in my senior year I had a job putting together demonstration equipment for the physics department. So in addition to studying the required courses I had this hands-on putting together of things, which was educational in itself.

Latin School provided a couple of career paths. You could go all the way in math, which I did and I was not a great math student but I suffered through it. Or you could take Greek. I didn't take Greek. But it was a very demanding school and it paid off because entering MIT was fairly straightforward.

INTERVIEWER: How do you decide to come to MIT? Or was there anyone who recruited you or was there anything you had heard before?

GAVIN: Well MIT had a reputation in those days that was fairly local. Once you got beyond central Massachusetts I think the knowledge of MIT was less. It was before MIT was recognized as a national asset, but locally it was the place where science and engineering problems got solved. And I went there intending to go into what was then called aeronautics. But the way that worked in those days was that you had to go through the freshman year successfully and then Aeronautics would interview you to see whether you were acceptable. And one of the reasons they were being so cautious was that employment in the aircraft industry in those days-- this was pre-war, end of the Great Depression, '38, '39-- employment was not easy to get. So in our aeronautics group, in my class, there were perhaps, 28, 30 people. And that was it.

In those days MIT was sufficiently compartmentalized so that unless you met somebody through an extracurricular activity, as I did rowing, you could be pretty much within your own area of interest and the rest of the Institute was doing something else that you never heard about. But I was fortunate in getting into the Institute committee, as I mentioned, rowing. The people I rowed with were lifelong friends. I think there are only two of us that rowed together for four years that are still surviving, but it was a great experience.

INTERVIEWER: When you first arrived at MIT is there anything that struck you about the campus or about the students? Or how is it different from Boston Latin?

GAVIN: Well, you have to remember that in those days there were quite a number of commuting students. I lived at home, as did many others, and we had a thing called the 5:15 club, which was the home on the campus for the commuters. We would eat lunch there, we'd spend odd hours there, and I think that it no longer exists, but at the time it served a great purpose. I can't tell you how many hours I spent between classes at the 5:15 Club.

INTERVIEWER: Where was it on campus?

GAVIN: It was in the basement of Walker Memorial. Of course, in those days the campus was smaller. Walker was the only place where you could eat and there were a number of buildings that just didn't exist in those days. In fact, the buildings that were built during the war for the electronics enterprise didn't exist either. So the campus was really quite different. The aeronautics building did exist, that was the result of a Guggenheim Grant. So in those days, it was a relatively new building and of course, the last three or four years I spent a lot of time there.

INTERVIEWER: What was the surrounding neighborhood like? Did you go up to Harvard Square, did you venture into Boston?

GAVIN: See I grew up in Boston, so I knew the neighborhood to start with. I knew Central Square, I knew Kendall Square. I knew how what's now called the T, it wasn't called the T then. It was called the subway. And I knew how to get around Boston. I knew downtown Boston as it then existed quite well. As a youngster I'd have a lot of freedom doing errands on my own and so on, so it wasn't a matter of being in a strange place.

INTERVIEWER: Was the first year of classwork that you had a big shock for you in terms of what was expected for you or did you--

GAVIN: No, I had been pretty well indoctrinated into the idea of do your homework on time. I think I progressed fairly easily. Although, as I said, I was not a great math student and calculus was a challenge. It always was a challenge. I had to work at it.

INTERVIEWER: What kind of classes did you take your first year or two years?

GAVIN: Well, in those days there wasn't that much choice. There was one elective that had to do with, basically English or history. We had physics, we had calculus, we had chemistry, and we had physics lab. Seems to me that there wasn't that much choice. You took the basic requirements and it wasn't until sophomore year we got one more elective and then, I think, was the junior year I had a chance to take a liberal arts subject called Organic Evolution. And that's the extent of my exposure to the liberal arts at MIT. Having come from the Latin School I had had a pretty good grounding in the liberal arts. Shakespeare, the great novelists, poetry even, which I hated. But I can still quote some of it.

INTERVIEWER: Did you have a favorite professor or any particularly memorable experiences in the class or lab?

GAVIN: One of the professors that I remember best was a visiting professor from Princeton who taught a course called Military History of the United States and had to do basically with the Revolutionary War and how we almost lost it. And he was an inspirational teacher. Can't remember his name though.

INTERVIEWER: So you declared aeronautics as your major. Based on--

GAVIN: In sophomore year.

INTERVIEWER: Sophomore year. Who was your adviser? Did you have a mentor?

GAVIN: Well, the advising situation wasn't that big a deal then. We normally had an adviser. I can't recall any earth-shaking conversations, but we had some really good professors. I think of Otto Koppen, who was designing a little airplane at home on the side. Manfred Raucher who taught dynamics and who had come as an exchange professor from ETH in Switzerland and was marooned here by the war, so he stayed on a lot longer than he intended. But he was a great teacher. And even though he used some of his examples from the Swiss railway system, he did teach us what I would call applied mechanics and dynamics quite successfully.

INTERVIEWER: What was the atmosphere on campus like, it was 1939, 1940 before Pearl Harbor was, the sense of the war and--

GAVIN: Well, everybody sort of had the feeling that there was a blow going to fall. And the question was, when and how? A lot of us were concerned about the ability of the English to hold on after the fall of France. There had been, back in say, the freshman year, a few people who were actually enthusiastic about the German American Bund, which everybody has forgotten but which was fairly active on Long Island. Needless to say, that all disappeared very quickly. Rudy Hensel and I stayed on for a fifth year and we graduated in Walker Memorial with the blackout curtains drawn because the concern about the submarines off the East Coast was very much alive.

INTERVIEWER: Where were you when, for example, found out about Pearl Harbor and what was your reaction?

GAVIN: Well, actually Rudy and I were at my parents' apartment in Brighton and we were working on a wind tunnel wall effects analysis. He'd come out for dinner and we were in the middle of the afternoon, my father came from the other end of the house and said, hey you fellows better come and listen to the radio, Pearl Harbor has been attacked. And this was quite a shock because I think most of us had been thinking in terms of what was happening in the European theater. However, some of our classmates in the fifth year were naval officers. It's typical for the Navy to send people who had been out in the fleet eight or 10 years back to either Caltech or MIT to get advanced degrees. And one of those officers, who was then a senior grade lieutenant named Thomas Connelly effectively recruited me for the Navy. And of course they were out of the loop being at MIT and so they immediately went to Washington to find out where they were going to be assigned and what they should do. They were told to finish their year and then be assigned. Well, to make a long story short Tom Connelly and I crossed paths about every three to five years for the rest of his life.

He became deputy chief of naval operations in his final assignment. And he was one who was quite convinced that the Navy should have a role in going into space, so he kept in touch with me even when we were off into Apollo.

INTERVIEWER: You sort of received your bachelors in 1941, but you stayed on for a fifth year to get your Master's, right?

GAVIN: Yeah, right.

INTERVIEWER: Was there anything involved with having to deal with drafting or enlistment or receiving commissions that you worried about?

GAVIN: In my case I finished the fourth year underage. The ROTC could not snatch me immediately. And Connelly saw to it that the Navy provided me with the proper application papers and in the spring of my fifth year I in fact, signed up with the Navy. I never was sent to indoctrination school. I reported to the Bureau of Aeronautics, I think, three days after I had figured out how to put the uniform on. I was very, very fortunate. I was assigned to the fighter design branch. I met several very competent mentors. The head of the branch at the time I came in was Commander Jack Pearson. And he saw to it that I became the one who became the fighter branches expert on the new jet engine. And he also saw to it that I met some very interesting people, like Orville Wright who came to the Navy one time. Let's see. I met the people who were in the jet engine business at Westinghouse. Also, when Pratt and Whitney got involved with their license from the British and I met some of the original British investigators of the jet engine. And through a series of circumstances I became the Navy's project officer on their first jet airplane. And I've never been sure whether that was because the other guys felt their wasn't any future for the jets in the Navy or what because there were a number of people who figured they'll never operate off a carrier deck successfully. Well, of course, that was wrong. Through a fluke of weather-- I was then I think a senior grade lieutenant toward the end of the war. I actually ran a mock up board on McDonnell's second jet fighter for the Navy. And that was an experience that you couldn't have thought of getting, ever. See, here I was, a senior grade lieutenant, running a meeting where I was almost the junior officer present. And the reason was that the weather had closed down in Washington and my boss couldn't get out. It was one of those fluke things.

INTERVIEWER: At MIT had you worked at jet engines at all or had there been any--

GAVIN: Jet engines hadn't really been even whispered about at MIT. Maybe there were some people thinking about it, but we never heard about it. As a matter of fact, I think we spent all of one week contemplating the unlikely event that anything would go faster than the speed of sound. Well, you know it wasn't too much longer-- what was is? '47 that the X-1 went faster than the speed of sound. So things were moving fast in those days and it was very stimulating to be part of it.

INTERVIEWER: So after you were demobilized where were you and what did you move onto?

GAVIN: Well, as soon as I had enough points I got out of the Navy, although I did get an offer to stay in the Navy and go to flight training. And I thought about that and I decided that I really wanted to build something. So I applied for a job at Grumman, who at the time was a very successful manufacturer for the Navy who understood the Navy's requirements, probably as well or better than the Navy themselves. And so I went to Grumman and they said, well let's see. The first thing we want you to do is to learn how to make a drawing and this is a drafting table and you use this device to make everything parallel and perpendicular. And we're going to teach you how to make a drawing. And fortunately again, I fell into the hands of a wonderful mentor who pushed me along pretty fast and then because I was the only one in the company who had really had any experience with jet engines, I very soon got moved into preliminary design, which lead to being part of a team that developed the F9F-6. Well first, the F9F-2 and then the F9F-6, which was the swept-back version of the 9F. Again, I was very fortunate in the people I worked for. The head of preliminary design at that time was a chap named Richard Hutton, who was an extraordinary natural engineer. Not sure how much education he'd had, but he was a natural and he seemed to be able to put the right combination of things together almost intuitively. And of course, being in preliminary design I got to deal with the various departments in the engineering floor and developed connections and some of those connections became lifelong friends.

INTERVIEWER: What was it like working in the design industry that it was kind of a tumultuous time-- that the projects had really quick turnarounds. The plane might only be--

GAVIN: The thing was that you could work on three projects in 10 years, which you don't do anymore. In those days we still worked with slide rules and then we had a electrical adding machine that we did computation on. And basically, a lot of it was take column a, multiply it by column b, add column c and so on. And you marched across the paper until you got an answer. We still in that era-- well, there were no desktops, let alone Laptops. It wasn't until just before the Apollo Program that we really got the big IBM mainframes. In the middle of the Apollo Program I think we had five big mainframes going. Three for engineering purposes and two for vehicle check out purposes.

INTERVIEWER: What kind of programs were running on the computers? What were they simulating?

GAVIN: Don't ask me. In those days the engineer formulated the problem and he'd turn it over to the monks who ran the computer. And they would convert it into a computer language. If you're a little lucky you'd get the answer back the next morning. So I managed to completely miss the introduction to programming. I was much better at figuring out where the loads went through a structure or what the functions of an electronic device were. But I completely missed the introduction to programming. And in a sense that was a handicap because you see, it wasn't too long before I became a project engineer. And a project engineer in those days did what today is called program management. He worried about everything, including the budget. The company had an interesting way of doing things. On the F11F they appointed two of us as co-project engineers. My counterpart, Larry Mead had been with the company a lot longer than I had, all through the war, and he was an expert on stress analysis. I knew more about aerodynamics and propulsion than he did. And despite the fact that our personalities were not a perfect match we did a good job and that turned out to be, for its time, a very successful airplane. But it was before the requirements for big radars in airplanes came along. And it wasn't until later that Grumman did a fighter, the F14 that really had a huge radar and therefore, changed the whole nature of aerial warfare.

INTERVIEWER: So you went from being a project engineer-- you were then named the chief experimental projects engineer--

GAVIN: Well, that's because they didn't know quite what to do with me at that point. The first thing we did for NASA was a canister for Echo. And then we did a thing called the Orbiting Astronomical Observatory for Goddard. And it was that background, plus the electronics aircraft background-- see in the meantime we had brought along the E2C which was an aircraft early warning machine. And the F14. And those airplanes were basically electronic systems. The aerodynamics were interesting, but not as vital as the systems. That systems experience, plus the OAO qualified us to do something about Apollo.

When

we first got interested in Apollo our management talked to the management of General Electric and we wound up being a member of the GE team that bid on the command and service module. Well, they didn't win it. It wasn't until after that, that lunar orbit rendezvous came into sight. John Houbalt went around his superiors to some degree, I think, he got the ear of Bob Seamans, who was then at NASA headquarters. There was a period where there was quite a debate, which we were not part of directly, although we did one of the studies led by Tom Kelly that validated the importance of lunar orbit rendezvous and finally, that decision was made-- I think it was 10 months after the command and service module was started. The lunar module was late getting started and furthermore, NASA didn't ask for the design in their request for proposals. They said, here are 20 questions, use 100 pages with margins thus and so, and type not smaller than a certain size and answer our questions and we'll see if you know what you're doing. Well, that was quite an editing job to get it to fit, but we did. I think the senior management was surprised when they called up and said, hey, we want to talk to you.

INERVIEWER: If you could rewind the clock a little bit, what was your reaction in the end of the 50s, 1957 Sputnik launches? Did that catch you by surprise?

GAVIN: I was a little surprised that they got there first, but I have to tell you that back at the end of my tour in the Navy we had written a report at the request of Senator Truman about where the Navy should go in the future. And one of the things that our group, our office stuck in there was that the Navy should be interested in navigating outside of the atmosphere. So the idea of doing something outside the atmosphere was not a new idea. It was a little shocking to see that the Soviets had gotten there so conclusively first. And of course, it stimulated a lot of interest and that interested extended nationwide.

INTERVIEWER: What kind of engineering systems, infrastructure had been laid between Sputnik in 1957 and Kennedy's speech in 1961? You mentioned Eisenhower's decision that the program be open.

GAVIN: There were some funded studies which we didn't get one of. We did our own on reentry bodies. It turned out that this business of orbital navigation was related mathematically to some of the work we had done on optimizing the climb of jet airplanes. With a jet airplane you don't just climb right from the beginning. You pick up speed at low altitude and then go up, and some of that mathematics used in finding the optimum flight path-- not too different from what you do in looking at orbits. So we had a beginning of understanding there. And of course, when we began to talk to people like the Draper Group who had gotten the NASA commitment to build the navigation and guidance system, we were able to talk reasonably the same language.

INTERVIEWER: Doc Draper was your thesis adviser.

GAVIN: Yeah, so that was interesting. I think we had one major meeting where we told him what we were going to do and he said, fine. Go do it. He was so busy building lead computing guns sites in the basement for the Navy that we didn't get a lot of oversight. And what we did was we put an airfoil into the old four foot open return wind tunnel and we vibrated it to determine the damping provided by the air flow. We learned fundamentally that it's a mistake to look for a small difference between two very large numbers. But at least it got us our degree.

INTERVIEWER: So Kennedy gave his man on the moon speech in May 1961 and you were at a position to kind of evaluate how realistic was it. Was is bold, was it realistic, was it just a crash program?

GAVIN: The thing that happened here was that we were convinced after Kelly had done the moon orbit rendezvous study that that was the way to do it. The feeling in the company-- it kind of split the company in that the really confirmed aircraft people thought you guys are going off gambling greatly on something that-- if it's a disaster, it's a disaster.

The idea was that we were gambling the company. There are a bunch of us who were still young enough and eager enough, we said, hey, this is where the future of engineering really is. And I think we turned out to be right because later on a group that had worked on Apollo kind of took over the company management. It was really a question of how adventuresome you wanted to be and some of us were more adventuresome than others I guess you'd say.

INTERVIEWER: Did you ever have a hard time, like wrapping your head around the idea of sending a man to the moon?

GAVIN: Well, I'm an incurable optimist. And furthermore I knew I had a great team of people because the team-- you see, immediately we had to recruit from the company at large and I was fortunate to get a really great team of people. And the core were a group of people that I had worked with 10 or 15 years. We were pretty well calibrated, so we understood each other. And of course, over a period of time we brought in a lot of new recruits. But having that core really was what made it successful. And I have to explain to you that Grumman was a strange company in that the employees regarded it as our company. You know, we tolerate the management, but we're the ones that really make it work. And it was also a company where nobody hesitated to pick up the phone and call anybody else. The idea of going through channels was unheard of. Now that leads to a certain level of confusion, but you'd be surprised how well it works when you have instant communication like that. And consequently, as an organization it was much flatter than the chart would indicate. And I spent a lot of time with our subcontractors because about half of the dollar value went to subcontractors. We purchased effectively the ascent and descent engines. We purchased all the radio gear. MIT was purchased-- their gear was purchased by NASA. But we're the ones responsible for integrating it, making sure everything worked. So I spent a lot of time on the road or in the air, I guess you'd say better. And it was always an engineering program.

In other words, it was very clear early on that successful operation and safety was number one priority, everything came after that. And then the second priority was the schedule because you had these other people around the country, the booster people, the command and service module people and we're trying to fit our schedule in with theirs. And the third priority was what it cost. I've been quoted many times, but fundamentally if you're doing something truly novel it's impossible to know precisely what the schedules going to be or what the cost is going to be. And if you took into account that you had a certain amount of direction from the purchasing agency, in the long run, at the end of the program I think we could say that well there was about a 15 percent overrun. It was not twice or three times. And as much as the lunar module worked every time, there wasn't much the government could criticize. Although success does not necessarily mean you get the next job working for the federal government.

INTERVIEWER: Well maybe you can tell me what the bidding process for the lunar module program was like. Were you director before that or named director as a result of that?

GAVIN: To do that, even though they said answer 20 questions-- to do that you had to hypothesize a design, which we did. It was probably only 60 percent of the size of the eventual vehicle, so it was smaller. And we had estimation methods that said, well, we have this many pounds of structure, it's going to cost so much per pound. You could guess how long it would take. Also, the original contract only called for, I think, six vehicles. So there was an add-on later and then later the second group of vehicles were for extended stay times-- stay times on the moon, so they had some major modifications. They had more batteries, more oxygen, and were heavier. So really there was the A model and the B model. But when you shook it all out, somewhere between 12 and 15 percent overrun, was about it.

INTERVIEWER: Did you work at all with Werner Von Braun or other former Nazi scientists? Were you at all conflicted working with them in the programming, or was that collegial?

GAVIN: I met Werner Von Braun early on and I visited at Huntsville occasionally. He was a very interesting person, extremely charismatic. I took him for a tour through the Grumman shop one time. And typically he would speak to a machinist and say, what are you doing here and the machinist would explain what kind of a cut he was making and they'd chat for maybe a minute. And when he left the machinist would be standing there with his jaw hanging down saying, "what a wonderful guy." What a wonderful guy because he's interested in what I'm doing. But the one that we dealt with at Huntsville most was Eberhard Rees. And in my view Eberhard Rees was one of the unsung heroes of the Apollo Program. A wonderful engineer. He'd had a lot of experience. He seemed to intuitively know when to ask the right question. He'd assembled a team that was completely loyal. I don't think he ever got credit for what he did. But basically, our dealings were with Houston and there was no question, but between Bob Gilruth at Houston and Werner Von Braun there was never an easy meeting of the minds. They worked together, but there was always that uneasiness at least, visible.

INTERVIEWER: You mentioned the three priorities you have in designing the module. I wondered if you could go in more into what kind of design considerations you had to-- was there a most critical module? How did you go about testing?

GAVIN: Well, there were two things that caused us a tremendous amount of extra hours. One was the introduction of bomb testing for combustion stability in the rocket engines. That doubled the time required really, to prove that the engines were flight worthy. The other thing had to do with leaks in designing the propulsion tank and plumbing system for the lunar module. Obviously we were trying to make it as lightweight as possible. For example, on ordinary tubing we would chem-mill the outside of the tubing except at the ends where the connections went to try to save weight. Weight was almost worth a million bucks a pound and we did a lot of chem mill we did a lot of redesign. But in doing this we also got into levels of flexibility, which led to leaks in the propulsion system. We had a terrible time with curing that because the obvious thing was to beef something up and we didn't want to beef it up any more than we had to. And part of it was aggravated by the fact that the oxidizer was nitrogen tetroxide. And when you have a leak with nitrogen tetroxide it very soon becomes a bigger leak because it's corrosive. We had a test article in the chamber at White Sands where we actually started a fire. We spent a lot of time beefing things up very carefully. We spent a lot of time measuring leaks. We never got to the point where we could say there's absolutely no leak. And you say, well, why didn't you?

And the answer is we didn't want to spend the weight. We got the leak down to being so insignificant that everybody agreed that it wasn't a problem anymore. But we burned up a lot of bad hours, a lot of test time, a lot of test articles to prove that the final configuration was adequate. It was aggravating and slow and in hindsight you could say well, you guys should have been smarter and done it quicker. But I think our motivation was correct, but we really suffered through it. Then of course when you have a system where there's much electronics in it as the LEM had-- first day, realizing that the computer was trivial by comparison to what you're carrying with you or anything else. You worry about cross talk and uninformed, unintentional signals being sent. And so we spent a lot of time testing a vehicle that had been thoroughly wired and set up.

And there's an anecdote I should tell you about one young engineer whose name I've forgotten unfortunately. But we're using the standard miniature toggle switches in the cockpit, the standard switch that had been used for years in military aircraft. And one of our young engineers said, you know, I don't really know what goes on inside that case and he had one of the mechanics in the shop open about a dozen of these and believe it or not, in about a third of them there was a little ball of solid that was free to move around. Now in one G flight, presumably it's at the bottom of the case, probably not cause a problem. In zero G it could go anywhere. Now this was fairly well along in the program, so what do we do? Don't have time to design qualifying new switches. So we devised a test to show which ones had the solid balls and we threw those away. And in looking back at some of our aircraft experience, there are one or two crashes where I personally suspect that that phenomenon was involved. I can't prove it, but this was the kind of taking nothing for granted. That it was the byword that we had everybody working toward. Of course, after we put out that slogan, "take nothing for granted," in two days it had been converted to "take nothing for gravity." Now don't tell me why that happened, but it happened and it served the purpose anyhow.

INTERVIEWER: There's another motto that seemed to emanate from Grumman is, "there's no such thing as random failure."

GAVIN: Well, we got into this business of trying to compute reliability. In short order we convinced ourselves that none of the analyses were likely to give you an answer you could hang your hat on, let alone risk your life on. So we did a lot of testing. In fact, we had a vehicle that you couldn't flight test before the mission, so we did a lot of ground testing at various levels of integration. We sort of came to that conclusion. I can't remember who said it first, but there's no such thing as a random failure. If something fails, if you're patient enough you can usually find out why it failed and do something about it. And in looking over the program afterwards, I think we had throughout all of the testing at every level, we had something like 14,000 anomaly reports. And I think there are only about 13 that defied analysis and test. And what we did there, we changed something anyhow. This all led to another expression, "turning over every rock on the beach." You know, this is something that only works when you have a really good team where when they say I've done something, you can believe it.

INTERVIEWER: How much contact during your 10 year- shift as director of the lunar module program did you keep with MIT? Were you talking a lot with Doc Draper still? Were you working with the instrumentation level?

GAVIN: Well, I worked principally with some of the people that worked for him, Davy Hoag. Of course, I met a number of their people, still see them from time to time. We got into a little bit of a confrontation with them right in the beginning because we questioned the accuracies they were talking about. And that forced them to reveal some of the work they had done for the Air Force, which was classified. It was a little embarrassing. I remember one meeting where I had to apologize and eat crow at the end of the meeting, but basically, once we got past that beginning we worked very well together.

INTERVIEWER: How much did you feel like you were operating under a national or international spotlight? Did you have to interact a lot with the press corps or did you have any restrictions-- national security restrictions?

GAVIN: Well, the Apollo was a very open program so there wasn't too much of a problem with talking about it. NASA did most of the talking with the press, we didn't. Although, one thing we did think about was who speaks for the company if there is a catastrophe? We had worked that out. I drew the short straw and I know my wife quizzed me about this way back, said well, what happens if? And I said, well, we've thought about it. We know what has to be done. It won't be pleasant, but having been in the aircraft business for quite a number of years we had faced disaster before. The first F14 crash landed and the pilot escaped in a parachute. And fortunately, we knew what happened and could fix it, but it was the sort of thing where when you're dealing with flying machines, when you're defying gravity you have to know that sometime you're going to have a problem. I think we had grown up with that understanding and I think we had a team at Grumman who thoroughly understood this. We had problems with people on the day shift staying extra hours off the time clock to make sure that the night shift was doing the right thing. So the spirit was there. And there were cases where we had to send people home to rest up. We put in a lot of long weeks-- 80, 90 hours a week. It was tough on the families.

INTERVIEWER: How much did you interact with the astronauts in the program?

GAVIN: Well, the astronauts became our friends because NASA very wisely saw to it that one or two of them would be in the plant every month. They became acquainted with the people who were doing the vehicle check out. They became acquainted with the lead engineers and it created the feeling that we were building this machine for somebody we know, not just some-- you know, put in a package and send it somewhere. I have to tell you that the astronauts wound up knowing more about the machine than we did. The principal example I think of this is Freddie Haise, who I've known for a long time since and who I talked to, I think, about 18 months ago. He knew that machine better than we did. So the visit to the plant was extraordinarily important.

INTERVIEWER: You're only a few years older than a lot of the astronauts in the CORPS. Were you at all envious or are you relieved that you weren't in the position that they were?

GAVIN: You see, if you have designed flying machines-- doesn't make any difference what kind of a flying machine it is. I think as a designer you'll always have the feeling that I can fly this thing, no question. I know it so well that I could fly it. But I never held a pilot's license and one never should unless you're willing to put in a couple of hours a week maintaining proficiency. So while I had the urge I never really did anything about it, so it wasn't a question of-- by the time we were working on Apollo I was accustomed to saying to somebody, it's okay to go fly it. That's something you don't say without thinking about it.

INTERVIEWER: Where would you be during missions?

GAVIN: Well, the way it worked was that there'd be a major review at Grumman before the machine was shipped to the Cape. And then after almost rebuilding it at the Cape and checking it out, there'd be a three day before flight meeting where all the principals from various companies would come and the question would be subject to what is left on the check-off list, are you ready to go? And fortunately I was always in the position of being able to say yes, we're ready to go. And I never saw a launch myself because I was always in the instrument room where the NASA crew was keeping track of evidence of life in the LEM. And we would stay at the Cape until it was safely in earth orbit. And then a few of us would get in the airplane and go to Houston where we already had a team that had been training with the Houston crew to support the flight. And basically, immediately outside the mission control, what everybody has seen on TV, there was a small room where about four people from Grumman and four people from Rockwell monitored what was going on and they were the first level of assistance. And on an open line back to another building there was another dozen or a dozen that was the second line of assistance. And that group had an open line back to Bethpage where there were another dozen. So you could get an answer on almost anything in a matter of maybe a minute or two.

Now those of us who were responsible leaders got to sit in the VIP lounge and watch all this happen. And fortunately the first bank of NASA instruments were close enough and my eyesight was good enough so that I could keep track of things like the pressure on the propellants and some of the other things that were interesting. For the routine missions I did nothing but sit there. When we got to Apollo 13 it was a little different because there we had the problem of how do we shut things off in order to save electrical energy? But how do we shut them off in a safe sequence so that we can turn it back on? And so this didn't happen all at once. It had to be done carefully. In hindsight the initial concern was that we wouldn't have enough oxygen to carry the crew around and of course that was worked on. But as I think I mentioned to you earlier, the real problem with that mission was the times that just had to go by with nothing expected to happen. And where you hoped that nothing would happen. And when they finally got down in the water, George Low beckoned through the windows and invited me into mission control, the only time I had been in there. And of course, they'd all broken out their cigars and little American flags. And I never smoked, so it was pretty bad. But there was a level of emotion in that group that was-- you could almost cut it with a knife because the odds of it being a successful retrieval were pretty small. In fact, if the accident hadn't occurred at just the right point the options to go around the moon and return wouldn't have worked. A lot of us got pretty exhausted. But it was a good feeling to get them back on the carrier.

From our point of view, my point of view, the critical time in Apollo 11 was the take-off from the moon because the astronaut had to push a button and several things had to happen all at once. Ascent engine had to ignite, the guillotine that cut the electrical connection between the ascent and descent stages had to work and the explosive bolts that held the two stages together had to blow. It's something that we had never found a way to demonstrate here on earth because of two factors: gravity and the fact that it's hard to get a vacuum when you're firing a rocket engine. So we really didn't know what happened until the very last flight when the TV camera was pointed at the take-off. So from my point of view that take-off was critical and it was a relief of course when it did take-off. It was an interesting aspect of it. By the time they got back into the command module and cast-- the ascent stays loose, our business is essentially over. And at that point I decided that I needed a sandwich and a cup of coffee and I walked out from the viewing room with Tiger Teague who was a representative from Texas up in the Austin area-- great supporter of the program whom I'd gotten to know quite well because he kept tabs on what we were doing in the whole 10 years. And as we went to get a sandwich he put his arm around my shoulder and he said, Joe, I'm glad it worked. You know, you've been telling me for years how it was going to work, but in my heart I wasn't really sure. I thought, well, that's quite a compliment. But he was a wonderful individual. He got put into the naval hospital in Bethesda because of his diabetes. And he'd been wounded, I think, at Anzio in the Italian campaign and had a leg that probably should have been amputated. But anyhow, he wound up in the hospital and what does he do? He arranges one of the staff to bring him corn beef sandwiches and a bottle of beer. And I think he probably drove the medics wild. But a great guy.

INTERVIEWER: What was going through your mind when the Eagle was landing? There's this anecdote that the computer was aiming them into a crater--

GAVIN: The computer got overloaded and it was just a matter of letting it clear. But you see you could always have aborted from any point on the descent, so that's why it wasn't as critical. And furthermore the landing had been practiced in simulators so much, and they had worked out a very good scheme for handling it. Which wasn't obvious when we started, but what they did for the landing was to set the vertical rate of descent on the autopilot and they flew it manually in the horizontal plane. So I had great confidence that they'd put it down gently in the right place. It just wasn't as critical to me as the take-off. Because when Armstrong had to stretch the landing due to the fact that he missed the aim point, we had to worry about running out of fuel.

Let's see, after Apollo I got to be president of the company. Mostly because the then president had a heart attack and died. In a weak moment I agreed to become head of the Alumni Association the year after I retired. I retired in '85 so '86 was the year. And that got me involved. And one of my classmates, one of the people I rowed with was Carl Mueller who was already a member of the Executive Committee and member of the Corporation so it wasn't too long before I became a member of the Corporation.

INTERVIEWER: What year did that happen?

GAVIN: I have to look it up. Offhand, don't remember. But then I became a member of the Executive Committee. I think the highlight of that was the meeting which led to the investigation and the book, *Made in America*. At that time there was great fear the Japanese were going to take all of our high technology manufacturing away from us and at that time John Deutch was the provost and I think at that time Paul Gray was-- not too sure whether it was Paul Gray or David Saxon, but anyhow, Deutsch picked it up immediately and said, we have all the necessary elements here to explore that and do something useful. So he and Professor Lester--

INTERVIEWER: Lester Thoreau?

GAVIN: Hmm?

INTERVIEWER: Lester Thoreau?

GAVIN: No, this was Richard K. Lester. And others of course. Got busy and it made-- I think it made an interesting impact at the time. Being on the Executive Committee you learned about the financing of the institution, the budget. You learned something about how the various departments either worked together or how the centers worked with the departments and for me it was very educational. I think I contributed something.

INTERVIEWER: Maybe you could explain what the Corporation does.

GAVIN: Well, the Corporation is a board of trustees that oversees the running on the Institute. And the president is the chief executive. The chairman presides over the meetings of the Executive Committee. And almost everything that happens of any significance gets handled by that committee because they meet monthly whereas the entire board of trustees in the Corporation only meets four times a year. Now the Corporation also is the one that approves all the visiting committee reports that are generated by MIT's numerous visiting committees. Which incidentally is a system that I've seen nowhere else. And it's certainly not in the same impressive fashion. The visiting committees are extraordinarily important because they involve some graduates, alumni. They involve people from other institutions. They involve appropriate people from industry. And every second year they take the pulse of a particular department and make recommendations as to what should be done. As you well imagine, floor space and dollars come at the top of the list. But there are many other things about emphasis, where do you put the priority and so on. How do you renew the faculty if they're all going to retire shortly? So there are many questions that get handled at the visiting committee level that eventually get finally approved and discussed by the board of trustees, which is the Corporation. Massachusetts apparently is unique in calling boards of trustees corporations.

INTERVIEWER: What visiting committees did you serve on or what did you do on the Executive Committee? What capacities?

GAVIN: Well, see now I'm old enough so I'm an invited guest. You become an emeritus Corporation member the month in which you reach your 75th birthday. Well that's long gone. So after that the visiting committees can invite you if they wish as an invited guest. And currently I am an invited guest in aero and astro-- which is my home department-- mechanical engineering, sponsored research, music in the theater arts. I think that's it. Anyhow, it's been a wonderful way to understand what goes on at MIT. But it's an even more wonderful way to meet so many extraordinary people that MIT gets to work on these committees. Committee meets for a day and a half and they talk to the leadership of the departments, the senior faculty, separately, the junior faculty separately, and the students separately. In a day and a half you get a pretty good picture of what really is going on. As you might expect, in most cases, things are quite good. There are some cases where something obviously needs more emphasis and the chairman of the committee writes a report that goes after that need. So I think it's a great way to be on the cutting edge all the time. It's hard to do that. So easy to get complacent. It's one way of doing it.

INTERVIEWER: You spoke of MIT as being a great national asset, but it's also a very well-known university internationally and has a very large international student body. Sometimes there's conflicts that come up with regard to classified research on campus or anything like this. How should MIT kind of balance its obligations as a world class university with serving the nation?

GAVIN: This gets debated from time to time. There are people in the government whose profession is to hide things and I think MIT has a pretty good balance. There's no question in my mind that the international involvement is really a national asset. And I've been in Europe often enough, I've been in Japan several times, been once in China and there's just no question about it that this place has produced people who have carried the reputation abroad in a fashion that has made a tremendous impact. It's hard to measure. I don't know how to measure it, but it's important and I think we have to-- well, we've got several things going. We've got Singapore, Cambridge, there are other smaller things. But I think that's something we need to explore because I'm sure one size doesn't fit all cases. I read of course, in the periodicals that not enough Americans are going into science and engineering at the graduate level and my answer to that is over the years I've heard this business of shortage over and over again, and there is no shortage. There may be a shortage of real good ones, but there's no shortage. If you had the funds to start going to Mars tomorrow you'd have more applicants at your door than you can imagine. I had a considerable debate with one of the deans of engineering on this subject. We never did agree, but I think at the National Science Foundation level they say that we only award-- I've forgotten-- a small percentage of grants compared to the number of really good applications. And therefore, there aren't enough people. Well, no. There's not enough money. As I said at lunch, I think I'm a contrarian in some respects.

INTERVIEWER: The engineering fields are kind of in a state of change. In the past decade or so you're seeing the emergence of like biotechnology and information technology and nanotechnology-- all these kind of new fields, but the old kind of traditional fields like mechanical engineering or aerospace engineering, they're faced with challenges about what their identity is or what their role is.

GAVIN: Well, I could comment on that. First of all, I think that aerospace engineering is a little bit different. And the reason it's different is because the margins are less and you're defying gravity every day. And the results if you fail are quite notable. If you look at the margins of safety in a bridge compared to an airplane it's really a different game. However, the problem-solving aspect of engineering is universal. I don't think it makes any difference whether it says nano or info or bio, the basic idea of how to approach a problem, how not to take the first obvious solution. I remember one professor said, well it's like climbing a mountain. First of all, you ought to go all the way around before you pick one route up because it's much easier if you pick the right route. You might get there eventually, but picking the right route is half the battle. So I think the basic approach in understanding a problem, finding a way to solve it, and then actually doing something and making it work is fundamental. It doesn't make any difference what kind of engineering it is. And I also think that being an aeronautical engineer myself, I take the somewhat arrogant position that we live more dangerously and therefore we were more careful. Some of that carefulness needs to go into places that build tunnels. I'm brought to mind by the tragedy of the Big Dig. Incredible. That should never have happened. So I suppose engineering has broadened in the schemes to which the art is applied. But the fundamental problem of finding out what problem needs to be solved and then solving it and then making it work is there. And I have to tell you that if I were entering as a freshman today I wouldn't know which one to pick. It's just they're all interesting.

INTERVIEWER: How aware were you during the 1960s that the kind of social changes that were going on around-- were you so engrossed in the development that you weren't aware?

GAVIN: Well, I had a first-hand experience with social change. Two of our lead engineers of which you might say within the top 20 were blacks. Ozzie Williams and George Henderson. When we first went to Houston there was only one hotel that would take the whole team, so we went to that hotel and commuted out to where NASA was at the time. This was before all the big buildings got built. But you know, in hindsight that was the smartest thing we ever did because it welded the team together. Of course, a lot of the NASA people were southerners to start with and so this meant that in some respects I was backing up these two guys more than once. And fortunately, Grumman, from early on, from the founders had had a very modern view of treating everybody alike. So it was easy to do within the Grumman organization. And then of course later on we had visits by equal opportunity committees from I guess the Department of Labor and all of us went through interviews, kept records on minorities and women. One of the problems we had was that we had very few women in engineering at Grumman despite the fact that during World War II a number had been trained to do elementary engineering, crafting and so on. But most of them had gotten married and disappeared by 10 years later. So there was always a struggle to satisfy these committees that came to see how we were doing. So I've been very aware of the social changes.

INTERVIEWER: The spring of 1969 was a particularly kind of explosive time, but by July we were landing on the moon and the space program is seen as being this unifying humanity around everyone and then the pictures that came back, the famous blue marble picture of Apollo 17-- that these pictures, these images, this program influenced the environmental and other political movements by showing the earth as this item hanging in space. But on the other hand you also had people saying the space program was just a waste of money given all the social issues you had on Earth.

GAVIN: Absolutely. Spent all that money and brought back a bag of rocks. And then there were people who said it was all a TV show. In fact, there's a whole group of people in Europe that still exist that have a website that denies that we ever went there and it was all a TV show. I gave a lecture almost 20 years ago now in Munich area sponsored by one of the German societies and one of the things that I was asked was, what can we do to answer those people who deny that it ever happened? This is like trying to convert somebody who truly believes that the Earth is flat. There is a flat earth society. I'm not sure exactly who belongs to it, but when people are set up-- there was one person interviewed in New York City who said, well, if those astronauts didn't go through our temple they never reached the moon. She had a certain conviction that that was the route to heaven and that's all there was to it. Reason has nothing to do with it.

INTERVIEWER: What do you feel that your project, that the LEM, the LEM that's featured in all the television images of Neil Armstrong walking down the ladder, of the guys playing golf on the moon, but that this object that you designed is in all these historical photographs would be always part of human culture.

GAVIN: Well, yes it is. That for the 60s that was the place to be. That was the program to be involved with. I don't see too many of my colleagues here in recent years. Tom Kelly died. I do talk to his widow occasionally. I got a letter from one of the guys just a few days ago. I think everyone of us would say that as tough as it was, as demanding as it was, we would not have chosen not to be there. For an engineer it was a great, challenging experience.

INTERVIEWER: We'll get back to MIT a little bit. What about MIT makes it so unique? Why is it that other universities can't imitate the success that MIT's had? What sets MIT apart so much?

GAVIN: That's a tough question to answer. But I think it's had exceptional leadership. You know, Jerry Wiesner said we should be getting into molecular biology back when most of us didn't know what that was. And he hired a couple of people and everything has grown from there. The things that Draper did were not so much gross invention as mini inventions. How to make things that were understood, how to make them work perfectly. Some of the work he did on gyros was considered impossible until he did it. There's always been a few people sort of out in front. I'm acquainted with Phil Sharp and Tyler Jacks and I don't speak their language, but they're doing something quite remarkable, and they're doing it well enough to have world class recognition. And as much as we don't have a medical school that is indeed doubly remarkable. You can go and pick other people out that have done certain things that make a difference. But I think you have to look at it that we've been very fortunate in the leadership because I believe that management and leadership overlap. And not necessarily congruent. And you can have leaders that are outstanding who need help when it comes to the management. And you can have managers that are outstanding who have as much leadership charisma as an inanimate object. I think we've been fortunate in having a good balance in the leadership. And I think we've been willing to do things that looked a bit risky. There probably were a lot of naysayers about getting involved in Singapore or for that matter, Cambridge. However, I have to say that I speak with some bias. And furthermore, I have very little acquaintance with other institutions of learning, although I've learned quite a bit about UMass the last 15 years since we've been here in Amherst. And the great leaders aren't just the president and the provost. As you look down at say Bob Silbey, who's the head of science, Magnanti, there always seems somehow to be the right person at the right time. Phil Sharp, John Hynes.

INTERVIEWER: Maybe you can tell me a little bit about-- right when Chuck Vest came onboard MIT was kind of going through a crisis. We were just coming off of these congressional investigations of research misconduct. There were these accusations you mentioned about the Japanese were going to take all our high technology, that MIT was somehow complicit in that. And then there was having to do with student financial aid about this anti-trust suit. Was it a time of crisis or was it like--

GAVIN: Well, there are two or three separate things you mentioned. One, the business of student aid. I was on the Executive Committee at the time and we took a unanimous position that we were not going to cave in like the other guys did. Because we felt that frankly, we were being persecuted. And we got away with it. Now that was a gamble. But it was unanimous. Then there was the case of David Baltimore who I had talked to before he went before the Congressional Committee and said, now you have to understand that logic has nothing to do this. That those guys are shooting for a headline and you're the goat-- having had some experience with Congressional Committees myself. It was unfortunate to say the least, but I have to tell you that the Institute was solid in its support. It didn't run, didn't run away. At least that's the way I remember it. You mentioned one other thing, what was that?

INTERVIEWER: MIT being involved with Japanese companies. But my theme is this theme that MIT doesn't run away from problems. You know, it kind of is willing to tackle the big problems. Do you see that?

GAVIN: I'm not too familiar with that case. A more recent case is the controversy about Professor Postol and the missile defense scheme. Now I don't fully agree with Postol, but I'm not sure I know everything about that problem. But I also am a firm believer that we're wasting a lot of money in that area. So somewhere in between the government's position and his there is a better place to be. The results of the first war in Iraq clearly indicated that missile defenses were no damn good. Because I personally looked into that a bit. Talked to a few people here and there that could tell me what really happened.

INTERVIEWER: Having seen MIT, how much it's changed since you were an undergraduate-- when you served on the Corporation, all those changes.

GAVIN: Well look, everything has changed. It isn't just MIT. Everything's changed. When I come to the city of Boston the skyline is different. When I was a student only the Custom House Tower stuck up. And now you can't find it. The city has changed. The suburbs have changed. Everything has changed. The computer has revolutionized things. I even had to learn how to use a cell phone. I don't understand why all these students go around with one glued to their ear all the time, but I don't think MIT has changed any more than the world around us.

INTERVIEWER: When Eisenhower was leaving office, his famous closing speech and his warning against the military industrial complex, given your experience in the defense industry, as well as in academia, is it really a problem what should be or what shouldn't be done?

GAVIN: I think it is as varied with administrations. And that it is varied with time. I don't think it was until the 50s that congress began to recognize how much money was involved in military affairs. And their involvement politicized it. When the Shuttle contract was awarded Mr. Nixon was certain it was going to go to California because he had a reelection coming up. So I would say that the whole system has become so complicated and with so many people involved-- when I was a senior grade lieutenant at the end of the war I canceled a program just by sending a telegram. It took a little bit to get the telegram out of the bureau, but there were fewer people running things quite responsibly and now you've got layer upon layer all in the act and it's far more complicated than it used to be. This business of shutting down a base gets to be pretty complicated because everyone is in somebody's district. So I would say that yes, over the years we have been progressively politicized.

INTERVIEWER: Okay, just a few wrap up questions. If you saw yourself 25, 50 years ago and based on all your experience since, what advice would you give to other MIT students? What advice would you give to other aeronautics engineers?

GAVIN: Well, the most important thing is to be doing that about which you are enthusiastic. The thing that you would rather do than anything else. It doesn't really make too much difference what it is. I happened to get hung up on flying machines, so it was obvious what I was going to do. At least it was obvious to me. I have a son-in-law who is an expert on Shakespeare. Years ago my wife said to him, but Peter, hasn't just about everything been written about Shakespeare that could be written? And he said, no I think I have a point of view that's important. And he's been writing books ever since. But he's enthusiastic about it and that's what counts.

INTERVIEWER: Who do you still keep in touch with at MIT?

GAVIN: Who?

INTERVIEWER: Who do you still keep in touch with at MIT?

GAVIN: Well, the key person to keep in touch with is Susan Lester because she is involved with all of the visiting committees and she knows what's happening everywhere in the Institute. I've had a little bit of interaction with the committee that's pursuing the matter of energy. I have friends in a number of places. Richard K. Lester I consider a very interesting friend. David Mindell is, I think, a very interesting guy. INTERVIEWER: You wrote a piece in 1998 advocating that we should return to Mars. Do you feel like NASA's plan at this Orion project-- do you feel that's setting its sights too low? Do you think we should be giving ourselves higher?

GAVIN: I am a critic of the current plans. I've spent too much time thinking about how to do it and not enough thinking about why is it important. Why would it have priority? I think we're going to have a major crisis in this country on two counts. One is basically bankruptcy because of the fact that even though the administration tries to hold the cost of the war separate from the regular budget, the fact is we're overspent. And it's going to take years to dig out of that. The other thing is that we have every likelihood of being in an energy crunch because even if we do nothing about the atmosphere the growth in China and India is going to cause them to buy a greater share of the energy that's available. We're going to get pinched. And I just wrote a thing which I gave president Susan Hockfield a copy of that says, "How to Commit Political Suicide or Save the Nation." And what happened was I was talking to a local state representative, brought up the energy question, which it turns out she understood very clearly. But she said you know, to talk about that frankly, is political suicide. And that inspired me with a title. You haven't heard any of the presidential candidates really address this problem. I think the press is deficient in not forcing it.

INTERVIEWER: If we had kept up the intensity of the Apollo advances where would space exploration be now or where should it have been by now? If the Apollo mission had gone forward--

GAVIN: Well, the Apollo did one great thing in my view and that is it showed us how to make something reliable. And I'm not so sure how many really got that message, but it was done and it was reliable. And I would hope that the younger generation would be smart enough to learn some of the lessons that we found the hard way. We spent a lot of hours, much to the consternation of the contracts people-- making things reliable and it can be done. It's not easy. Well.

INTERVIEWER: Thank you very much.

GAVIN: Okay.