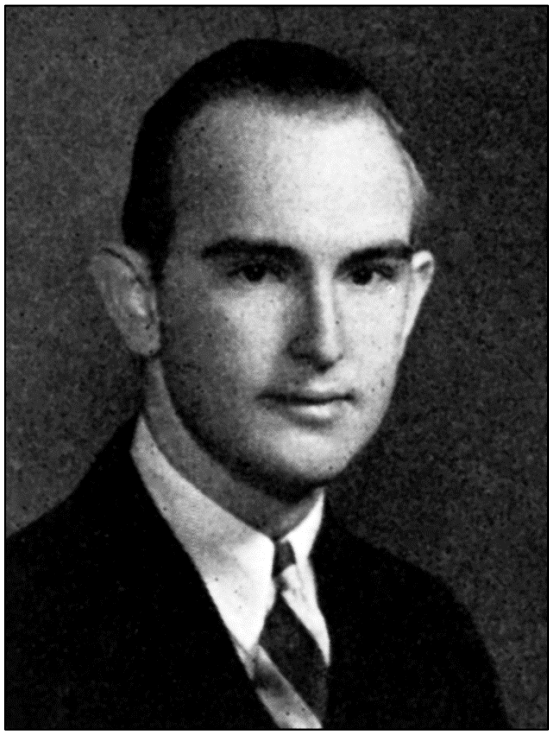

A.M.O. Smith's senior portrait
1936 *Big T* yearbook

APOLLO MILTON OLIN SMITH
(1911 – 1997)

INTERVIEWED BY
JENNIFER K. STINE

September 25, 1995

ARCHIVES
CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California

Subject area

Mechanical engineering; aeronautics.

Abstract

An interview in September 1995 with aerodynamicist Apollo M. O. (Amo) Smith. Smith received his BS (1936) and MS in mechanical and aeronautical engineering (1938) from Caltech.

In this brief interview, he recalls his early experience building and flying gliders with John R. Pierce; his undergraduate years at Caltech; the testing of various aircraft in the ten-foot wind tunnel at GALCIT [Guggenheim Aeronautical Laboratory of the California Institute of Technology] as a graduate student; working on rocketry with Frank J. Malina, Edward S. Forman, and John W. (Jack) Parsons; his employment at the Douglas Aircraft Company, beginning in 1938 in its El Segundo division; and his two years of work (on leave from Douglas) as

chief engineer of the newly formed Aerojet Engineering Corporation (1942-1944), developing the JATO [jet-assisted takeoff] rocket.

Administrative information

Access

The interview is unrestricted.

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Preferred citation

Smith, Apollo M. O. Interview by Jennifer K. Stine. Pasadena, California, September 25, 1995. Oral History Project, California Institute of Technology Archives. Retrieved [supply date of retrieval] from the World Wide Web: http://resolver.caltech.edu/CaltechOH:OH_Smith_A_M_O

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ORAL HISTORY PROJECT

INTERVIEW WITH APOLLO M. O. SMITH

BY JENNIFER K. STINE

PASADENA, CALIFORNIA

http://resolver.caltech.edu/CaltechOH:OH_Smith_A_M_O

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ORAL HISTORY PROJECT

Interview with Apollo M. O. Smith **by Jennifer K. Stine**

Pasadena, California

September 25, 1995

Begin Tape 1, Side 1

SMITH: I'm Amo Smith. I have three initials—A. M. O. My nickname is Amo; it was given to me by Bill [William Rees] Sears, my boss on the wind tunnel in GALCIT [Guggenheim Aeronautical Laboratory of the California Institute of Technology]. When I went to work at Douglas Aircraft Company [1938], there were quite a number of forms, one of them was called an AMO—Advance Material Order [laughter] for buying materials for the airplanes.

You asked about why I decided to go to Caltech. Well, at that time—this was 1929, my last semester in high school—I guess the main engineering school was USC, and UCLA was mostly a teachers' college. So Caltech was the obvious choice, unless you moved away, like to Berkeley. So several of us just decided to go to Caltech. I don't know if there was any reason other than that.

STINE: Your family had moved to Long Beach in 1927. Is that right?

SMITH: I think that's right.

STINE: So you'd been there for two years. Had you decided on engineering early on?

SMITH: My father [Orsino C. Smith] was a chemist—or a chemical engineer, and I decided that was a pretty good type of course to major in. So that's why I went to Caltech.

STINE: You entered Caltech as a chemistry major?

SMITH: Yes.

STINE: And then after your first year, you dropped out, to work?

SMITH: Yes, to work.

STINE: This was during the Depression.

SMITH: Yes. But I thought I'd mention first about the glider business and then get into Caltech.

Four of us fellows, in our senior year in high school, decided we wanted to build something. We first thought—being in Long Beach—that we'd build a sailboat. And then along came a magazine article—I think it was in *Modern Mechanics*—that showed how to build a glider. Well, a glider sounded more novel and more fun than building one more sailboat, so we started in. In fact, this first one was built in my father's garage. We got it done successfully and learned to fly. In fact, I could fly before I had a license to drive a car. This was in June 1929.

In September, there was a glider contest in San Diego. We went down there. The partner that stuck with me was John [R.] Pierce [professor of electrical engineering, d. 2002]. You probably have one of his memoirs here. He just recently won the Draper Prize, a kind of Nobel Prize for engineers. The two of us went down there and flew in this contest, and we cleaned up in the contest for training gliders. I won three cups. I brought this one along. I won this cup in an altitude contest. The launching was very powerful; you had about twenty navy men pull a rubber rope to launch it. And when I got launched—I was back in my seat, like this—the handle grip was a bicycle grip, and it came off in my hand! So there I was without any control and just going up and up and up. By the time I got control of the stick, I'd won the altitude contest.

And John Pierce won the spot-landing contest. They had a blanket out, about a mile away from the launch point, as a target, and the one who got the nose of the glider closest to the blanket was the winner. Well, he ended up with the nose four or five feet short of the blanket. Some other glider ended up right on top of the blanket, but the nose of his glider was maybe eight or ten feet from the edge of the blanket. So that's how John won the spot-landing contest. Well, so much for that. We cleaned up in the training class of gliders, winning all of the four cups.

Then I went to Caltech. I don't think I really knew how to study at that time. In fact, I was kind of proud that I had made all A's in my senior year of high school without taking a book home. Anyway, when we went into the classes, I didn't do very well. I made about a C average.

I don't remember any of the teachers—except there was one time when Arnold Beckman [then an assistant professor of chemistry] gave a lecture. The chemistry-class teacher was really no good. He was a graduate student working for his doctor's degree there in the chemistry department, and he really wasn't any good. And we all got together in our class—it had a section leader at the time, and he complained to whoever his boss was—and we got a new teacher. It was kind of sad, because this fellow was from South Africa, I remember, and he was aiming to be a teacher, so this wasn't very good for him. But that's about all I remember of the teachers in my freshman year.

Anyway, at the end of the year, I think one of the faculty people advised me to take a year off or so, which I did—actually, I took two years. We moved to Inglewood from Long Beach. And Compton Junior College—which I suppose has a very poor reputation now—was a perfectly good junior college. I especially brushed up on math there. So I was out for two years. But when I reapplied to Caltech, they seemed to be glad to have me. So that was it. Incidentally, I noticed that at Caltech it was kind of hard to kick somebody out. There were a number of people who I thought should have been disqualified, but they weren't.

So I came back for my sophomore year. That was in '32.

Incidentally, while I was out, my father and I built another glider—a real high-class sail plane. And it had way better performance than that simple training glider, which John Pierce did a lot of remodeling on. And in this high-class glider, on the fifth of July, 1932, we were flying down in back of Corona del Mar with a fellow, a mechanic who had helped us a lot on fittings and other metal work. He was making a fine flight, and suddenly he started diving about thirty degrees down, and for about the last 200 feet he dove straight in and killed himself. And that put me out of the glider business.

So when I went back to Caltech as a sophomore, I did a lot better. In fact, in the third term of my sophomore year, I made 214 grade points. The grading system here counts all the time you're supposed to spend on preparation and so forth—not just time in the classroom. And a normal course is about fifty hours or so. So if you make all A's for fifty hours, you can get 200 grade points. So I made 214, and that was my best. But generally I did fairly well. My average was about 180.

From my sophomore year, I remember two teachers. I often wondered what happened to one of them. He was a math major and a teaching fellow. His name was Lucas Avery Alden. A

lot of times, in math, you'll get hung up on some kind of a small detail—not some of the big theorems but some of the small details. And he was fresh enough from undergraduate work so that he would emphasize a lot of these small details. So I learned a lot from him. This was elementary calculus. He was one fellow, and the other fellow that comes to mind was Professor [William W.] Michael. He taught surveying. One reason he comes to mind is that his son is our next-door neighbor. [Laughter]

In my junior year, I don't remember anything special. We had regular engineering courses—heat engines, machine design, and other things like that.

STINE: Albert Einstein was on campus in the early thirties. Were the undergraduates aware of that visit at all?

SMITH: Yes. I saw him and old man Millikan [Robert Andrews Millikan, Caltech's head 1921-1945] walking around together sometimes.

STINE: What did you think when you saw them? Were you aware of his importance?

SMITH: Oh, yes. It was something special, like any famous person walking around the campus. There were a number of famous people. There was a famous British philosopher-scientist [Bertrand Russell] who came and gave a lecture one time. And it might have been in my sophomore year when Simon Ramo [Caltech PhD 1936] gave a violin solo in the auditorium. He was a virtuoso violinist.

STINE: Did the undergraduates attend that?

SMITH: The undergraduates? Yes. That was in old Culbertson Hall, a small auditorium they had at the time. I think we were supposed to attend once a week.

STINE: Were you aware, when you were an undergraduate, of the aeronautics testing going on at Caltech?

SMITH: Yes, I was. But when I went back to Caltech, I signed up for mechanical engineering.

They didn't have an undergraduate aeronautics option, so I signed up for mechanical engineering. Aeronautics was all graduate school, except for one undergraduate course, taught by Maj [Arthur L.] Klein. He was one of my better teachers. In this course, he really was just trying to instill in you a feeling of what doing design work on airplanes was like. He talked about all kinds of problems, and that was it. He was quite good that way. Incidentally, he was a fellow who had a phenomenal memory. He knew about everything. One day he got sidetracked and talked about ancient Greek naval tactics. [Laughter]

In my first year, I stayed in what was called the Old Dorm on the campus. At that time, the Athenaeum was being built. But later, after we moved to Inglewood, I commuted back and forth through my sophomore, junior, and senior years. Then when I was a graduate [student], I stayed on the campus again, once more in the Old Dorm.

One memory I have of the junior year was a humanities course in business law, economics, and accounting. In business law, I knew I was not doing very well; it didn't soak in. So I went to the teacher after the final—Professor Ray E. Untereiner—and he looked at the grade book and looked at me soberly and said, "A 'D' by the grace of God." [Laughter] It just didn't soak in. The middle term was more or less just theoretical economics, and that seemed to soak into me. In fact, I understand that I made the highest grade on the final of anybody in the entire class. And then there was accounting, and that, for some reason or other, didn't soak into me again, and I was back to my D. But all that time, even counting that, I was still making 180 grade points. I made it up in other courses.

STINE: Was the course with Maj Klein the point at which you decided to go on and do graduate work?

SMITH: Well, before I signed up for Maj Klein's course, I had decided to go on for graduate work in aeronautics, because of my glider experience. In fact, the Maj Klein stuff I kind of ate up, because of all this glider experience. He'd talk about things that I'd probably had to wrestle with in building the second glider. One thing that sticks in my mind about Maj Klein: In his design course in graduate school, he gave out two problems. One was to calculate the flow about a circular cylinder with lift—a standard classical problem. And then there was the final. And by golly, I made a hundred percent on that homework job, which was a pretty good-sized job, and a

hundred percent on the final. And I got a B. [Laughter] Later I went around to ask him why I got a B. He said, well, he hadn't given out enough work to be sure anybody deserved an A. [Laughter]

In my senior year, I had one course from John Pierce; he was a graduate student in electrical engineering at the time. Also I remember Professor Robert T. Knapp in hydraulics.

STINE: Shall we start talking about your first year of graduate work? I think that was 1936.

SMITH: Yes, I'm in the class of '36. That's when I got my bachelor's degree. And then I went on into aeronautics in the GALCIT building. My father supported all of us kids through university—there were four of us. He told me, "I've supported you through your bachelor's degree, but after that you're on your own." But he hoped that I'd go further—he had a master's degree himself.

So I had to get a job. I got one with the NYA—the National Youth Administration. And I was referred to [another graduate student,] Frank Malina, who was quite a good artist. He was handling the illustrations for a book by Theodore von Kármán and Maurice Biot. [*Mathematical Methods in Engineering* (New York: McGraw-Hill, 1940)] So I worked mostly making illustrations for that book. In fact, I made about three-quarters of the illustrations. Malina would talk to me about what to do, and then I would make the drawings. And once in a while I would see von Kármán, but von Kármán mostly dealt with PhD candidates, it seemed like. Anyway, while I was just sitting in Malina's office one time, he was talking to some people about rockets. And that sounded interesting, so I volunteered to help. We'd talk over theory of rocket motors and such stuff. He felt that the number-one problem at the time was to make a good rocket motor—not all kinds of fancy guidance systems like they have nowadays, just a good rocket motor. We analyzed the rocket motors; we'd go to his home and we'd talk more about them.

STINE: Had you been interested in rockets before you met Malina?

SMITH: Not a bit. [Laughter]

STINE: It was somewhat the stuff of science fiction in those days, right?

SMITH: Yes. In fact, at that time, "rocket" was a dirty word. It was wild, crazy stuff. And that's the reason it's the Jet Propulsion Lab. The technical magazine put out by the American Rocket Society was called *Jet Propulsion*. It was named that instead of, say, *Rocket Propulsion,* because "rocket" was a dirty word. And that's why it's JPL instead of RPL.

So we just talked about things and read whatever we could find. One thing I developed: I took the strongest acetylene torch tip—there are a number of different-size tips to an acetylene torch. And I made systematic tests on the various refractories, like carborundum—mullite was another one, various types like that—to see how well they stood up under all this suddenly applied heat. So we did that kind of testing; I was the one who did that.

Another test we did was to try some molybdenum. Molybdenum has a very high melting point. Malina wrote to the molybdenum company and they sent him a half-inch-cube sample. I remember that we tried our torch on it in kind of a darkened laboratory. It gets up to about 5,000 degrees Fahrenheit before it really melts. The flame was all over the piece of molybdenum, and it looked pretty good. Then we took the flame away, and oxygen could now get to it, and we watched that molybdenum cube just go up in smoke—kind of a heavy vapor. By the time it had cooled, it was down to about an eighth of an inch. So molybdenum wasn't any good.

We did a number of things like that. In fact, one time Malina and I went to a company where they made mullite. There's an island of Mull off Scotland. But these fellows were down in Huntington Park. They felt that they could synthesize mullite—just take a mixture of different minerals and melt them all together and make a better mineral than the natural one. So we went down there and talked to them some. They showed us what they did. There was a big cauldron—something like six feet high and about four feet wide—just a steel cylinder sitting on a dirt floor, with water running down all around the outside. And inside there were three graphite electrodes, about six inches in diameter—all in this boiling refractory-to-be. And here we saw the light. If those graphite electrodes could sit in this 3,000- or 4,000-degree cauldron of boiling stuff, that was the stuff we were interested in. So that's why we started using graphite nozzles.

STINE: Finding the right materials to make the rocket was a central problem.

SMITH: It sure was. The rocket is a little chamber, and all the burned gases flow out through the

nozzle. And if the nozzle can't resist the heat there, it'll just burn away. So it's a very critical problem.

And one more thing about that business. I happened to just try a little copper bar, about a half-inch thick, two inches wide, and eight or ten inches long. It was just lying around the lab, so I tried my torch on it. And by golly, I couldn't touch it with the blowtorch. What the copper does is carry the heat away so fast that it won't melt. So that was another finding. Some of the early rockets had copper nozzles, before we developed the graphite ones. It was just about a four-inch-diameter cylinder, all machined out inside—and being copper, it stood up against all the heat.

STINE: Was that something you and Malina started—the copper nozzle?

SMITH: I think so, yes. But copper is a very poor material for a rocket, because a hunk that size is quite heavy.

STINE: Now, the tests you were doing in the laboratory, was that after the rocket tests in the Arroyo Seco or before?

SMITH: The Arroyo tests? That was one of the first things I did—to join in and lug sandbags and oxygen cylinders and other stuff. The motor was pretty much designed by Jack [John W.] Parsons. That came first. Later Malina thought we should get into some kind of testing. We had designed a small rocket motor—I think it was only two or two-and-a-half inches in diameter and about eight inches long. It had a spark plug in it. And we burnt red fuming nitric acid—which is as noxious a stuff as you can imagine—and alcohol. And in Guggenheim, the west end was the hydrodynamics lab. It was all open, from the ceiling down to the basement, so we could make a long pendulum. We put all our apparatus on this pendulum. And by the deflection of the pendulum, you can find the thrust. So we did that, with piano-wire supports, and by golly, the thing wouldn't fire. We turned on the nitric acid and the alcohol, and it wouldn't fire. So here was this obnoxious mixture, which was squirting out into the room. Afterward our name was mud. It's about as corrosive as anything you can imagine. All the bright steelwork, such as steel scales, and all the micrometers and things like that turned a fairly bright red. [Laughter] This vapor permeated the whole building. So we were more or less kicked out. It didn't stop our

work, but they said, "You can't do any more of that kind of thing."

Then we designed a much better apparatus, and it was set up outside. I designed it. And about that time, I left school for Douglas [1938]. I'd graduated [MS]. I heard it blew up.

STINE: Yes, Malina talked about that.

SMITH: Yes, OK. So that was the end of that episode.

STINE: Could you talk a little bit about the personalities and the people involved: Malina, Parsons.

SMITH: Yes. Malina was a real nice guy. And Parsons I never knew too well. He was kind of a crazy fellow. As far as some of the teachers go, I thought Clark Millikan was probably the clearest lecturer I ever had. And Maj Klein was another one. The two more or less worked together. Clark did all the theoretical teaching, and Maj was more design work. And another fellow I had a lot of respect for was Fred [Frederick C.] Lindvall, who taught engineering math and physics.

In our sixth year, we had a project to design a light airplane—something like a four- or six-passenger airplane. A team of us would get together and do various calculations and make drawings and things. Well, there was a plane about the same size being built down in El Monte, or some place, called the Aeroneer—like "pioneer." It's nonsense to talk about this, but anyway we decided that a good name for our product would be the Errornear. And I guess it was Maj who discouraged this, because the company was giving GALCIT some money. [Laughter]

STINE: Was there a lot of interaction between the early airline industry and GALCIT at this time?

SMITH: Yes, there was. GALCIT had an arrangement, mostly with Douglas, for various specialists to come here and give an hour's talk or so about landing-gear design, or engine design, or oil-cooler design, or hydraulics—all the various specialties involved in airplane design. They would come up here from Santa Monica and give an hour's talk at the end of the day. In fact, later, when I was at El Segundo, I was involved in that, too.

STINE: You'd come back to Caltech?

SMITH: Yes. I'd come up late in the afternoon. I think my talk was about range and cruising—that was aerodynamics. I think it was probably in the late forties. Anyway, there was a lot of interaction. A. E. Raymond [chief engineer, Douglas Aircraft Co.] would come up once in a while. So there was very good interaction.

I mentioned that Bill Sears gave me my nickname. He was the boss of the GALCIT ten-foot wind tunnel, and when I showed up for work there, sometime in my fifth year, he looked at my name—"A. M. O. Smith. What do they call you? Amo?" I said, "Yes, I guess so." That was the first time I had ever been called that. I'd been called sometimes Amos, and sometimes Red, and often Apollo, which was my given name, but never had anybody thought of "Amo." And Bill has commented sometimes that that's what he's famous for. [Laughter]

The wind tunnel was a great experience. There weren't many high-speed wind tunnels at that time, and this was just a low-speed wind tunnel. The ten-foot tunnel was about 220 miles an hour at its top speed. But everybody would come and use it. It was the best tunnel around. I remember that Kelly [Clarence L.] Johnson, a big shot at Lockheed, came in with a wind-tunnel model of the Lockheed P-38 Lightning. He didn't like the wing-test results, so he took the model back home and rebuilt the wing. Most everybody who was designing airplanes used the tunnel. Consolidated—or General Dynamics, now. Lockheed. Both plants at Douglas—the El Segundo plant, where I would work—and other people. Curtiss-Wright, in St. Louis—McDonnell took it over, the old Curtiss-Wright plant. They all tested there. We saw what was wrong with the models, or what was right.

STINE: Were the graduate students involved in the testing? Did you, for instance, have much to do with these tests?

SMITH: Well, yes. The crew was mostly graduate students, like me. There would be a crew of four or five there, and we'd do various kinds of tests, running whatever test schedule they had—like different angles of attack, and sometimes rolling moments. We'd put the ailerons down—the flaps out at the wing tips that hold the airplane level or bank it. All kinds of adjustments were tested. Another part of the operation was reducing the data—the measurements—to standard coefficients. We used a Swedish calculating machine much like the well-known Friden.

One thing about this work was that you had a good look at various people's projects early in the game, and you could see whether their plane looked promising. You didn't know much about the project, because everything was really secret, but you still had the airplane model—something like an eight-foot scale model—and you could see what it was doing. In fact, that's half the reason I went to Douglas. They were testing what was called the DB-7 at the time. It was a twin-engine attack airplane. It looked pretty good to me, and that's partly why I went to work at Douglas.

The worst model, if I remember right, was Curtiss-Wright's C-46. It was a transport, and it just had all kinds of troubles, with poorly designed ailerons and elevators and everything else. They got it mostly fixed before they went back East and took the model back. You're in there typically about two weeks, and they got most of that fixed. But anyway, it had more troubles than any other airplane. It was enlightening work and quite interesting to see what people were doing at the time.

STINE: Was there any worry about sharing of secrets?

SMITH: No, we didn't transmit secrets at all. I don't think anybody did; they were all tight-mouthed. No, it was pretty good that way. The work was classified, and some was completely secret. The military had a "restricted," which was not very secret; then a "confidential," which was more so; and "real secret," and that's as far as we got in the kind of work there. You can go on up to "top secret," for atomic energy and things like that. No, I don't think there were any leaks—nothing that I ever heard of, anyway.

I was kind of favoring working for Lockheed. But Lockheed had a crazy system at the time. They had hired some psychologists, who got an upper hand there, and Lockheed couldn't offer any engineer—or anybody, I guess—a job until that person had passed a psychological test. I passed with flying colors and then I got an offer, but it was quite late in coming, because they couldn't make any offers until you passed the psychological tests. Actually, Maj Klein at one time remarked that a good mechanic is just by nature a very crotchety kind of a guy—he's going to be real finicky about what he does or he would not be doing a good job. So Maj said, Well, Douglas would find out which guys Lockheed had rejected and then hire them. [Laughter]

STINE: Did you ever think about continuing with the rocket research, or were you always ready

to go into aeronautics?

SMITH: GALCIT designed a powered boundary-layer control model—you suck off some of the air on the wing and you're supposed to get higher lift or some kind of improvement. And this boundary-layer control model had a little fan in the fuselage. That was my project—to test it—for my master's thesis. Then the war scare was coming on. Everybody wanted to test their models in preparation for it. Caltech pretty much acquiesced. And if I remember right, my model finally got into the wind tunnel the week of finals. So I did get it tested before I graduated, but just barely. And later Clark Millikan said, "You cross your heart and hope to die you'll get your thesis in?" I said, "Yes, Sir." [Laughter] I got it in about the end of July, I think; Caltech trusted me and I got my degree in June.[1]

You asked about the rockets. Well, because of the delay on that model, I had an alternate plan to write up something about rockets. But I didn't have to.

STINE: But you had co-authored one paper with Frank Malina?

SMITH: Yes, and that was my very first paper.[2] The theory of a rocket working in a vacuum is pretty well known, but nothing had been done where you added in air resistance. I did most of the calculations. I think it was during one summer, I sat with my slide rule on my folks' sofa and went to work, step by step by step, seeing how high it would go.

STINE: So you did the calculations. Did Malina write the paper up?

SMITH: Well, Malina wrote most of the paper, but I did most of the calculations. In fact, he gave that paper in New York.

STINE: Should we talk a little bit about Aerojet and your experiences there? You left Caltech for Douglas, and then you were asked to come to Aerojet and to take a leave of absence from Douglas [1942]?

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[1] Smith, A. M. O. (1938) *A preliminary study of the problem of boundary layer control.* Master's thesis, California Institute of Technology.
[2] Frank J. Malina & A.M.O. Smith, "Flight Analysis of the. Sounding Rocket," *Jour. Aero. Sci.* 5: 199-202 (1938).

SMITH: Yes, Douglas gave me a year-and-a-half leave of absence. And I was kind of unhappy about one thing: General Henry H. Arnold wrote Donald Douglas. One of Douglas's daughters was married to one of General Arnold's sons, so they knew each other well. And he wrote Douglas to ask for my services at Aerojet, because of my previous rocket experience at GALCIT. At that time, they didn't have Xerox machines, so getting a copy of something was pretty involved; either you just typed it over or photostated it, which was pretty expensive. So I never got a copy of that letter, and later I tried to find it and couldn't.

Anyway, that was the start of it. This was in the war days, and Malina had talked to me some about what he was doing. But Malina couldn't tell me much, because I wasn't cleared yet and everything was classified. But trusting Malina, I went to Aerojet, and I found out that the main thing they were working on was a liquid booster rocket—nitric acid and aniline. The two are what they call hypergolic. You get them together and they burst into a flame, so with them you never had to worry about some kind of ignition system. And this nitric acid, as I've already mentioned, was nasty stuff.

Malina pretty much felt that this booster rocket was a necessity for the war effort—to get shorter take-offs. Well, I felt, from my experience at Douglas, that it would be a lot easier just to get a bulldozer and lengthen the runway, or else put down some more of that tread plate that they used. It's stamped-out steel, which you can lay out along a runway and airplanes can run on it. I felt that what they were doing really wasn't practical or useful at all; it would be way later, after any war effort was all over with, before anything like that could be successful. So I felt kind of let down. But we had some conferences there, early in the game. And Jack Parsons mentioned that he had a 200-pound rocket motor, about so big and so wide, that was showing some signs of success. So we started pushing that approach, but we didn't stop the liquid-rocket work. In fact, the liquid unit was tested in the A-20—one of the airplanes I worked on; it was the successor to the DB-7 that I mentioned earlier, in connection with the wind-tunnel tests. Anyway, this A-20 was tested at Edwards Air Force Base, and it worked all right, but still it was a nasty kind of a thing to imagine putting into service in Europe.

So we started pushing the solid rockets. And they came along pretty well, pretty soon. After this 200-pound rocket, we had a 500-pound one, then 1,000-pound. Incidentally, I don't remember his name, but one fellow was a good stress-analysis man, and he saw the proper angle for a graphite insert into the nozzle. I mentioned the graphite earlier. If you have a nozzle, like

my hand here, the pressures will push on it and maybe break it. And if you get it like this, maybe it won't. But anyway, there is a correct angle, which doesn't put any stress or strain on the nozzle. And he saw the correct angle for the graphite insert, so away we went with that. Things went pretty well, you might say. When I went to work at Aerojet, there were six people in the engineering department, and by the time I left there were 400. [Laughter] So I was rather busy with the hiring and everything.

STINE: You were the chief engineer, is that right? Your job was to organize that department?

SMITH: Yes, I organized the department. It was rather interesting. At Douglas, I had been interested in design and manufacturing processes, and I gradually picked up what Douglas was doing and what its procedures were. At that time, I was interested to know how a company works. So I knew pretty well what to do at Aerojet. But now I realize that I don't have any idea at all about the proper organization. I just gradually got out of it. But at that time, I was interested in it, which was very good for the company.

The reason I went back to Douglas [March 1944] was that Aerojet was too crazy a place for me at the time. They'd make funny decisions; I could probably go on for the next hour about them. But I'll mention one example of being too crazy. In the war days, almost everybody in Pasadena showed up volunteering to work. Everybody was really quite loyal. And one day, a guy who was retired and living in Pasadena—a Dr. Dow, who had been chairman of the board of the Montana Power Company and had a doctor's degree from the University of Michigan in electrical engineering—came to talk to me. He had a lot of qualifications, and he wanted to know if he could do something for the war effort. And I thought, well, he should make a good administrative assistant. He knew procedures and processes, and he did make a good administrative assistant. Then, one day, Aerojet president Andrew Haley called me in and said, "You sure got a gem there." Those were his very words. And a week later he called me in and told me to fire this guy. And I got a lot of static like that, so I got tired of it. Just nonsense.

Anyway, the Aerojet products worked well, and pretty soon we were making JATO [jet-assisted takeoff] units, as they were called. Got into the war effort pretty good. JPL was supposed to do the basic development work, and Aerojet was to manufacture their developments. That was the organizational setup.

STINE: Was there any feeling that there was a conflict of interest? That Aerojet was making money off the research being done? Or was everything focused on helping the war effort?

SMITH: It was pretty much focused on helping the war effort. Well, another thing that griped me—but wasn't as bad as this other one—Malina and Parsons and [Martin] Summerfield and [Edward] Forman were basically working at JPL, but they were consultants to Aerojet, as you would expect. Well, they were able to authorize their own consulting time. And this just didn't seem right to me. [Laughter] It just seemed to me that—well, if they needed a little money, they could come in and consult whether it was wanted or not. So there was a bunch of funny stuff going on.

Incidentally, Malina became a millionaire artist in Paris. In fact, he told me this one time when I had supper with him in Brussels. What he had done was—no fault of his own, I guess—General Tire & Rubber took over Aerojet a couple of months after I went back to Douglas [1944]. Maybe if I'd known about it, I would have stayed. But anyway, General Tire & Rubber made an offer to the stockholders to buy their stock. And they all thought, well, that's a good deal; we'll all sell our stock back to General Tire & Rubber. Well, Malina told me he fully intended to, but he just didn't get around to it. So he ended up as a millionaire—an artist in Paris. [Laughter]

STINE: So you kept in touch with Malina over the years?

SMITH: Yes. Still get Christmas cards from his wife.

STINE: There was an effort on the part of Malina's family to rename JPL—to call it Malina JPL.

SMITH: Well, I made that effort, one time. I wrote to [Caltech] President [Thomas E.] Everhart, and I got an answer back, but I don't think everybody agreed with me. They said, basically, that it was too complicated—that JPL was too well established a name. But Robert Goddard gets his name on so much, and Goddard really didn't do very well; his line of work wasn't successful, really. The big work grew out of JPL. If Goddard gets his name on all kinds of labs and other things, Malina ought to have his on some.

STINE: Did you feel that Malina was the important force behind that?

SMITH: Yes, he was the first head of it. And I thought it should be the Malina Jet Propulsion Lab, or something like that.

STINE: And in 1954 you got the Robert H. Goddard Award from the American Rocket Society.

SMITH: Yes. I had a bunch of run-ins with Haley. He was quite an outspoken kind of lawyer. Nevertheless, Haley at one time told me that he put one condition on being elected president of the American Rocket Society. The condition was that I get the Goddard Award. The scuttlebutt around Aerojet was that the G. in Andrew G. Haley stood for God. [Laughter]

Another funny thing: Down on Madison Avenue and Colorado, there was a First Trust & Savings Bank. That was Aerojet's bank at the time, and the Aerojet common scuttlebutt was that we were the "First Thrust & Slavings Corporation." [Laughter]