THE AEROSPACE CORPORATION

Interview with Joseph Wambolt
Vandenberg Air Force Base, California
August 2, 2001

Joseph. F. Wambolt, Principal Director of the Western Range Directorate at Vandenberg Air Force Base, joined The Aerospace Corporation in 1960, the same year the company was founded. During his long career at Aerospace, Wambolt has worked on some of the nation's pioneering space programs, including NASA's Mercury and Gemini programs and the Air Force's Manned Orbiting Laboratory program. His work today—managing Aerospace activities in support of Department of Defense Space Launch Programs at Vandenberg—places him in contact with the most recent developments in space technology.

Wambolt has received many corporate awards over the years in recognition of his important contributions. In 2000, the company awarded him its highest honor—the Aerospace Trustees' Distinguished Achievement Award for Management and Technical Leadership—for his "sustained, outstanding management and technical leadership of the highly successful Medium Launch Vehicle programs."

Steven R. Strom interviewed Joseph Wambolt on August 2, 2001, at Vandenberg, where they discussed the Gemini program. A version of this interview appeared in Quest: The History of Spaceflight Quarterly.

***Strom:** First of all Mr. Wambolt, could you start by telling me something about your educational background and how you came to Aerospace in the first place?*

Wambolt: Well I was working at Rocketdyne in Canoga Park, and that was my first job out of college after graduating from Northeastern University in Boston. I wanted to get involved in the space program, so my first job was with Rocketdyne working on the Atlas engines, and from that I developed some friends and working relationships with people from Space Technology Laboratories (STL). We worked together on the early days of Atlas, and when Aerospace was formed in 1960, the Director of Operations in Florida at Cape Kennedy, or Cape Canaveral at that time, asked me if I would come and work for Aerospace as a propulsion engineer on the Mercury Project. Tim Hanrahan was the Director who has since retired. Tim and I had worked together previously on Atlas development and we developed a rapport. He decided that I could provide some value to Aerospace, since I came from Rocketdyne where the engines were developed. So I did, I went down there for an interview and they hired me. I went to work in Florida for a short time when Ben Hohmann, who was the director of Mercury and eventually director of Gemini [for Aerospace], asked me to work on the West Coast, since I lived on the West Coast at that time. So I worked for a short time in Florida, but I eventually came directly

to Los Angeles and went to work for Aerospace at the end of 1960 and joined the Mercury Program Office, which later became the Gemini Program Office.

Strom: *So most of the personnel associated with the Mercury Program went directly over to the Gemini Program when it began. Is that correct?*

Wambolt: Yes, for the most part, all of us on Mercury became members of the Gemini Program. At that time, the Titan was being developed and there was another organization at Aerospace responsible for developing the Titan. So since they were in the leading edge, or front end, of the Gemini Program because of the use of the Titan, while we were launching Mercury, the Aerospace program office that was responsible for Titan was starting to get involved in the early planning days of Gemini. But as soon as Mercury was over, the Mercury management team as well as all the engineers moved into the Gemini launch vehicle program and took over that activity and Titan went and split off and became a separate program office, Titan Development. So we established our own Titan capability at that time and hired certain people from industry, as well the rest of Aerospace, and we built a new team of Titan people.

Strom: *I noticed in an Orbiter article that the formal announcement for the Gemini Program Office was announced in January 1962 before Project Mercury was actually completed. I wondered if you were ever aware of actually working on two programs simultaneously, or was there some sort of clear demarcation between the two?*

Wambolt: No, they basically had us finish up the Mercury Program. They didn't want to defocus until the last launch, which I think was Gordon Cooper's mission on Mercury [Mercury-Atlas 9]. And until that flight was over and successful most of us stayed devoted to the Mercury Program, and then we transitioned into the Gemini Program.

Strom: *Once Aerospace began working on Gemini Program, all of the literature emphasizes that there was a strong desire to maintain the Pilot Safety Program that had been so successful during the Mercury Project. Could you tell me specific modifications that might have been needed for the Pilot Safety Program when transitioning over to Gemini?*

Wambolt: Well, we took the concepts that we developed for the Pilot Safety Program on Mercury. But then we had to apply those concepts to a brand new set of contractors because the Titan contractor was Martin Co. versus General Dynamics, who had built the Atlas for Mercury. They were not familiar with the pilot safety concept so they had to be indoctrinated into what the pilot safety principles were of putting together a component pedigree program. NASA wanted contractors to put together an abort system that could be used to protect astronauts against malfunctions in early flight and adapt that concept to the Titan rocket and look at redundancy, things where we could improve the reliability of the Titan. And putting together working teams for every one of the subsystems for Titan was a brand new undertaking for Aerospace because we had to convince and educate Martin Co. on what that was all about. NASA was already familiar

with the Safety Program because they had lived with it. But Aerojet, who built the engines, and the Martin Co. in Baltimore, who built the Titan, had to be oriented to what the Pilot Safety Program was supposed to accomplish.

Strom: *Did you have to go on site to Martin Baltimore, was that any part of your work?*

Wambolt: We established a field office at Martin Baltimore and we had just a very small office, but we had a contact office in Baltimore and also one at Aerojet, where the engines were being built. The Martin Baltimore plant was used for Titan production and was devoted to Gemini. The actual Titan production was still being conducted in Denver for the weapons systems. So an entire launch vehicle checkout and assembly and delivery system had to be created in Martin Baltimore for the Gemini Program. One of the unique concepts at that time was to incentivize Martin Baltimore to deliver on schedule and deliver a reliable booster. So Martin Co. had to have all of their incentive money, and I've forgotten now how much they earned but it was several million dollars, riding on the last booster. So Gemini 12 [the final Gemini mission] being a success meant that Martin Baltimore would realize the maximum amount of profit at the end of the program. And they did a beautiful job obviously to make all the following missions successful, but it kept pressure on the contractors to do good work right up until the very last rocket was fired. And that also was a reliability aspect of the Pilot Safety, to make sure we had sound work crews and worked best practices.

Strom: *Can you tell me a little bit of how the task of man-rating the Titan II compared with man-rating the Atlas D for the Mercury Program?*

Wambolt: I think it was probably easier. The Titan II was a pretty robust design as opposed to the Atlas. We were dealing with later technology. We weren't dealing with the structural problems that Atlas could encounter with a thin skin, and we had some working knowledge now of an abort system. We knew how to build an abort system, and we knew how to engineer an abort system that would detect malfunctions during ascent. So the task of getting a malfunction detection system into the Titan rocket was, I believe, simpler and we learned a lot from the Mercury Program so it made the job a little easier. We found some vulnerabilities in the Titan by going back, and we reviewed every Titan flight that had ever flown. And at that time, I can't remember the numbers, but there were many, many dozens of Titan failures that had occurred. We went through every Titan failure and made a determination whether the failure had been identified and been fixed on the Titan weapons systems fleet. If it hadn't, we carried that problem to the Gemini Program and then a review board looked at every single flight failure that hadn't been fixed or explained to see if there was something we should do to the Gemini rocket to make it more reliable. And one of things we discovered is that we needed to put in a redundant first stage flight control hydraulic actuator system. We had dual actuators steering engines as a result of hydraulic failures that had occurred previously. So we made a lot of modifications to the Titan II rocket to make it more reliable based on that flight history.

Strom: *So was the absence of an escape tower on the Titan II actually the result of improved technology?*

Wambolt: The mission malfunction detection system that was used on the Gemini was different in that we had no escape tower like you said. But we had developed a malfunction display panel in the satellite itself, or in the spacecraft, and the crew had the ability to shut down the rocket, eject, or abort. Or they could switch back to our flight control system if it turned out that our system malfunctioned early in flight and was corrected. And if it corrected itself and they switched back to the primary mode, they had an ability to switch over to a backup mode. So we had a much more sophisticated abort protection system, or malfunction detection system, for Gemini than we did for Mercury.

The crew became, as I remember now, much more integrated into the process of whether or not they would abort the mission. It was almost out of their control on Mercury. It was pretty much in the control of the ground NASA mission operational people whether they should abort on Mercury. But on Gemini the crew had enough onboard instrumentation to make their own determination where they were in trouble during booster ascent with the data provided, and they could decide whether or not the situation was critical [enough] to abort or whether to continue with the mission.

Strom: *From a systems engineering standpoint, can you describe any major differences between the Mercury and Gemini programs?*

Wambolt: Well, from an integration viewpoint I guess it was much more complex because we had to deal with not only a new launch vehicle, a new spacecraft, a new launch pad, and a new production line, but we also had to coordinate with an Atlas program and an Agena program, which was going to eventually become the rendezvous target. So the complexity of the management system and systems engineering that went into making sure that all those pieces were integrated in a manner that would come together at the right time was probably our greatest challenge. We had to make sure that we had an Atlas-Agena ready to launch in time to support a Gemini-Titan launch. And we had to make sure that the two countdowns were integrated and the problems for both launch vehicles were resolved before launch, to allow the rendezvous to take place. We were also dealing with a brand new, targeting rendezvous adapter that had never been built or even test flown before, which the contractors designed and built and flew. And that had to be, as I recall, a pretty complex endeavor because we had to deal with delivering that target docking adapter in time for the Gemini Program to make sure it could dock safely and back away from it [the Agena] once it was docked. So a lot of those responsibilities fell on Aerospace and the Air Force to make sure that hardware was acceptable even though NASA was ultimately the user. So working with that complex set of industry teams was probably our biggest challenge from an engineering standpoint.

Strom: *You mentioned the issue of rendezvous being one of the principal goals of the Gemini Program. I read that very early on it was proposed that Gemini craft actually conduct landings on the Earth, on land as opposed to just water. Do you recall that or was that already quashed by the time you were working with the program?*

Wambolt: By the time we had arrived at the first manned flight that issue had been closed. It was decided to stay with the water recovery.

Strom: *In organizational terms, as far as The Aerospace Corporation is concerned, do you remember how the transition between the Mercury and Gemini programs went? For instance, did the Gemini Program Office greatly increase in size or did you generally just continue to work with the same people?*

Wambolt: No, we added. I think we added from Mercury to Gemini. We stepped up from probably 35 people to 100 people on the Gemini Program. And we had to find new people because we were dealing with new technology and new hardware. The Mercury folks were pretty much Atlas-oriented. We had to find Titan specialists and we had to find them in a hurry because we didn't realize there was not that much overlap between Mercury and Titan. So we drew from industry and we hired people from industry that had Titan background. Fortunately, Aerospace and STL had some Titan people hat were used in the development of Titan itself, so we had a pool to draw from. But we greatly increased the size of our program.

Strom: *Are there any Gemini missions in particular that stand out in your mind?*

Wambolt: Yes, well the one that stands out in my mind the most is Gemini 6, which was piloted by Wally Schirra and Tom Stafford. That first mission attempt was in October of '65, and it was supposed to be a rendezvous mission with a Gemini target vehicle, which was made into an Agena vehicle. Well the Agena blew up before the Gemini-Titan mission was launched. The Atlas-Agena mission had taken place already and during the Agena burn to the right altitude the Agena exploded from propulsion problems that were associated with the Agena itself. For that reason there was an abort of the Gemini-Titan and that mission was put on hold until December of that same year. That mission that was [now] attempted was called [Gemini] 6A and there was a lot of pressure to put that mission back in the air because they wanted to rendezvous. And one of the things that happened, that I remember being a propulsion person, was that engine when that Titan first stage shut down before liftoff prematurely [December 12, 1965]. And Wally Schirra, being a clever engineer, knew right away what had happened before we were able to determine what had happened. He told us our engine umbilical had fallen out, and we weren't sure he was right until after we looked at the data and we realized that we had lost a ground connector on the engine. But there was an interesting byproduct of that story because when we looked at the data … we noticed that the other engine had a very strange appearance in its gas generator. It didn't look normal, so we looked further

at the data and determined that there was something blocking the gas generator oxidizer line of the other engine on that Gemini mission. So it was serendipitous that we shut down because the other engine was not going to thrust. And it turned out that somebody had left a dust cap in one of the oxidizer lines—the gas generator. When we took the gas generator all apart to find restrictions, we found a plastic dust cap lodged in the line that was feeding oxidizer to the gas generator.

Strom: *Was this something that should have been found in the procedures?*

Wambolt: It should never have been in there. It had somehow become lodged in there during the fabrication of the engine. So it was a double miracle that we aborted that mission. And it was a tribute to Aerospace because we had looked at the data—even though it was just a few seconds of data—we were convinced there was something wrong with the profile of that data. This was a lesson we learned and we've kept to this day—that part of our whole process of launch verification is to look at every single bit of data after a launch to see if there are any malfunctions that had taken place on a mission that didn't cause a flight failure, but maybe a near miss. And this was certainly a near miss because we had a clogged engine. Postflight analysis is probably one of the cornerstones of our launch vehicle readiness process that we have today for Atlases and Titans.

Strom: *So that's a lesson learned from the Gemini Program that's carried on to this day then?*

Wambolt: Absolutely, look at your data after you've launched. Don't just assume because you've got the orbit that it was a success, because there are a lot of small telltale indications of impending problems on these rocket engines and these rocket flights.

Strom: *Could you please share some of your thoughts on the Gemini Program and its overall role in the U.S. space program?*

Wambolt: In terms of the U.S. space program, I would have to yield to NASA on that because I know NASA, the people that we worked with, felt that Gemini was a necessary stepping-stone to Apollo. There were too many unanswered questions about whether EVA [extravehicular activity] was going to be safe. Whether or not Gemini could rendezvous safely with another vehicle in space. Whether or not they could penetrate the altitude in the long duration necessary for some of these future missions. As I recall, the Gemini Program was the first to come up with 14 days in orbit, and the nature of the medical effects on the astronauts was unknown at that time. The ability to think and provide reasonable conclusions if they encountered an on-orbit malfunction—could the crew in the space environment continue to operate and think properly under those conditions? Was the mission control concept of having a mission control in Houston watching and overseeing the flight, was that network ready to take on a mission like the mission to the Moon and the duration of the crews and so forth? Because the time

between the earth and the moon essentially was what a Gemini mission was. It was tailored to be a mission to the moon.

So a lot of knowledge needed to be obtained by the spacecraft community. It didn't affect the booster folks ourselves. We didn't notice the difference as far as Gemini versus Mercury. It was strictly a stepping-stone in space for us, going from one rocket to another. But it was a huge step for NASA to make. I don't think NASA would have ever made that step from a one-man capsule to a three-man module for the Moon without Gemini. I really think Gemini was vital to the whole Moon program. I would doubt you would find anyone at NASA who would disagree with that.

Strom: *In a similar vein, how do you see Gemini fitting in to the overall corporate history of The Aerospace Corporation?*

Wambolt: Oh well, that's just part of our legacy as a space program. I think I'm very proud to have been a part of that because to me it was evidence that Aerospace was here to stay. We could provide solid technical value to a new program. We could work with contractors and Air Force and NASA folks very, very well and I felt a huge amount of pride working in the program. Especially that NASA would have enough trust in us to ensure the readiness of these rockets to carry men to a company like us, which had only been formed less than five years to ensure the readiness of those rockets to carry men, Yes, I think it became part of our legacy with the partnership and trust with the Air Force and NASA.

Strom: *I wanted to ask you something on a more personal level. During the 1960s, particularly during the first half of that decade and all the way up to the moon landing, there was an amazing amount of technological history that, in hindsight, seems like it was compressed into a very fast time. Since you were involved in the midst of these space programs, were you aware that you were part of the history-making process?*

Wambolt: I have to answer that we were proud of what we were doing but we really didn't give it thought that we were part of anything historical, because we were basically the trucking company that was putting up the satellites and the spacecraft for NASA. And our thoughts were on safety and doing a good job, and the public relations and the historical aspects of it were really not foremost in our minds at that time. Probably we were too scared to make a mistake to worry whether we were history. The thing I remember most about that whole program was the fact that we had to face the astronauts on a personal basis and answer their questions. Why did the piece of equipment behave the way it did and was it okay to fly, and frankly that takes away the edge of being a part of history because all you want to do is be right and do a good job for these guys. Their lives were basically in your hands in the final analysis.

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Strom: *Do you remember, after the successful conclusion of the Gemini 12 flight, how you were transitioned to the MOL [Manned Orbiting Laboratory] Program? Was there an interim period between your work in MOL and the end of Gemini?*

Wambolt: Well we were pretty much cut loose after the last Gemini flight and absorbed into the program called MOL. And that program had already been established and was an Air Force version of NASA's manned spaceflight program. So when it became obvious that we were not going to get involved in Apollo, because of a totally different approach and a totally different set of contractors, the Air Force captured us. They told us that we had probably a tremendous amount of experience and value to the MOL Program, since we were familiar with the Titan and were also familiar with the interfaces between the satellites or the spacecraft that were going to be used. If you look at the MOL model [model spacecraft in office] you'll notice that the laboratory module and spacecraft look very much like the front end of the Titan-Gemini. So it was a natural evolution for us to get involved in the MOL. It was really an exciting program for a while until we realized that it was going to be so expensive that it ran into funding problems and we eventually lost it.

Strom: *Can you give me any final thoughts that you might have had on the Gemini Program after you concluded your work with it?*

Wambolt: Well, first of all I was very happy with the success of it. The boosters were all successful. The Titan weapons system was still having troubles and the Titan development program was still having problems, but somehow we managed to squeak by with 12 completely successful Titan launches. So I felt good about our record, and I felt good about our team because we felt that we were sort of cut loose and separate from the rest of the company for a while during those years. We were basically looked upon as an experimental bunch of folks that were supporting NASA. I think we developed a set of principles of operating that have been very successful over the years in putting together what's now called the verification process for Atlases and Titans and Deltas that are boosting very, very expensive high-priority payloads for the government. And if you'd look today at a briefing on the launch readiness or launch verification process that Aerospace provides as a core function—just about every step of that process was used by our Gemini and Mercury team to develop a readiness posture for those rockets. So I think that we created a legacy for Aerospace that we're very proud of.

Strom: *It's a legacy that continues to this very day.*

Wambolt: Absolutely. And the next thing that happens is we are going to launch EELVs [Evolved Expendable Launch Vehicles, and there seems to be mixed support for whether or not these principles of launch readiness verification should be applied to those vehicles since they're commercial. But I really think in the long term, in the next few years, the people that are flying on those EELVs with very, very high-value payloads are going to want the same kind of assurance from Aerospace that they had back in the days of Gemini, Atlas, Mercury, and our heritage launch vehicles that we fly today.