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SATURN HISTORY DOCUMENT
University of Alabama Research Institute
History of Science & Technology Group

Date ---------- Doc. No. ----------

4/28/61

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SATURN LAUNCH VEHICLE

(To be presented by C. L. Bradshaw, Deputy Director, Computation Division at Supervisor's Club, Knoxville Utilities Board, Knoxville Tennessee, April 28, 1961 at 7:00 p.m.)

Gentlemen, it is a real pleasure to visit with you tonight and participate in one of the activities of your Supervisor's Club. I am looking forward to getting to know as many of you as possible and I sincerely hope it will be possible to visit with you again.

As you know, there is a great deal of activity in Huntsville which is directed toward the exploration of space. I would like to discuss for awhile this evening some of the reasons why space exploration is desirable, giving some possible benefits through a movie entitled "Eyes in Outer Space." A little later I would like to give some description of how we at the Marshall Space Flight Center think that a full-fledged space exploration program may take place within the next few years.

The answer to the question "why explore space" is quite simple, yet at the same time complex and intangible. To the scientist the answer is immediate -- to be able to delve into the unknown and to discover that which no man has seen before is reason enough to expend his energies, his resources and his lifetime. The sea of space is a great frontier that has challenged man since his creation. Probably no man has ever lived who has not looked at the sky and asked himself many questions as to what it is like out in space and is there life similar to his on some other planet. Down through history our civilization has always been stimulated by the mystery surrounding space and it can probably be stated that many areas of science would have died and been forgotten had it not been for the nudging of the astronomers and mathematicians as they strived to unravel the mysteries of the heavens. One thought I would like to leave this evening is that we have already reaped untold benefits from space through the simple expedient of its being there and through man's intense curiousity. Before viewing the first film, I would like to name a few specific applications of space exploration but at the same time I would like to strongly suggest that the real benefits of the space program which we have undertaken in our lifetime will be much more appreciated by our descendents than by us.

The first great practical application of space flight will be seen in the field of communications. Recently, AT&T announced that they have decided to spend several millions of their own money for the establishment of a fleet of communication satellites to be used in the transatlantic telephone service. Their proposal provides that a number of satellites, each weighing 300 to 500 pounds, be placed in orbit at an altitude of approximately 2500 miles. At this altitude a satellite will be in line of sight contact with any station for about 20 minutes and the altitude is sufficient to make such a satellite visible from the United States and Europe at the same time. Another field of practical application is the weather satellite. Most of you have seen pictures of the Tiros satellite equipped with a television camera which looks down onto the earth. This television camera puts pictures on video film to be transmitted back to the receiving station when signaled to do so. A satellite will go around the earth between 12 and 15 times a day looking down all the time, and it can transmit a complete cloud coverage picture of the entire earth. With such an arrangement, it may well be that weather forecasting will become a really true science and we will not depend on the rather dubious weather forecasting as we are forced to do today.

The following movie produced by Walt Disney extrapolates as to what could very well be possible with a series of weather satellites and I might add even though some of the things indicated in the film may sound a little like Buck Rogers, many of the things we are doing today had this same flavor just a few years ago.

Movie - "Eyes in Outer Space"

There is, of course, another very good reason for going into space. In fact it is most certainly the reason there is an urgency about getting further along with the space program. This is because we are now in a race with a dictator controlled country that has shown considerable imagination and effort in the space field.

There is no question but that we must and will win this race, but there again I predict that the results of the race will be completely obliterated by the change in our civilization that this program will bring about.

The question as to <u>how</u> we will go into space is perhaps a little easier to discuss than the why of space exploration. So far we have generally made our small forays into space using missile systems designed for military applications. When the time came to emphasize our space effort, soon after Sputnik I in October 1957, there was only one operational missile capable of orbiting a small payload. This was the Redstone missile developed at Huntsville. There were at that time under development other systems such as the Jupiter, Thor and the Atlas. In addition, there was the Vanguard vehicle which was designed exclusively as a vehicle to place a small payload into orbit. During the past three years these various military vehicles have been modified to perform some space missions. This is why the payloads we have delivered into space have been quite small, as compared with our Russian competitor. The capability of these military systems has been geared toward delivering a payload over IRBM (1500 miles) or ICBM (5000 miles) distances and not space activities. The controlling element here is that of thrust; that is, the amount of energy that can be released at the Earth's surface to propel a rocket system through the gravitational field and the atmosphere to the vacuum of space. To put it in everyday terms, it is a matter of horsepower. To give some idea of our present capability, the Jupiter missile develops some 150,000 lbs. of thrust and the Atlas missile, using two engines of like design, develops some 300,000 lbs. of thrust. More thrust can be obtained in one of three ways, (a) increasing the specific impulse of the fuels - i.e., getting fuels with better performance, (b) scaling up the size and capability of the engines, or (c) clustering together engines of proven capability. The first two approaches require considerable research and time, but will eventually give our country vehicles with larger weight-lifting capacity. There is one other approach that permits getting larger payloads into space and this is staging; that is, stacking one vehicle on top of another. To fill the need for a quick, reliable, high thrust booster the Saturn launch vehicle is presently being developed by the Marshall Space Flight Center. The Saturn[1] will cluster eight improved Jupiter type engines in its first stage. Together these eight engines will develop some 1,500,000 lbs. of thrust (or 32,000,000 horsepower). The eight engines are attached to an eight-legged thrust frame on the aft end of the vehicle and arranged in two square patterns. The four inboard engines are rigidly attached while the outboard engines are mounted on gimbals

1. The large-scale model is to be used here and following for clarity.

and can be swiveled through about ten degrees to provide control for the vehicle during first stage powered flight. Nine separate tanks feed the eight engines. Eight tanks of 70 inches diameter are clustered around a 105 inch tank. The center tank and four of the outer ones furnish liquid oxygen (LOX) and the remaining four furnish kerosene as fuel. The fuel and LOX tanks are interconnected in separate systems at the base to allow the maintenance of equal levels in all tanks during burning. In case one engine malfunctions and is cut off during flight, this permits the remaining seven engines to consume the fuel intended for thedead engine. In this manner, the burning time of the remaining engines is increased and there is essentially no loss in overall booster performance. This first stage is called S-I. Several versions of the Saturn, each a logical follow-on of the other are being contemplated. The first, consisting of three stages and designated Configuration I, is well into the hardware development and testing phase. It will be about 180 feet in height and its liftoff weight will be 500 tons. The second state of the C-I is called S-IV and will be powered by four 17,500 pound thrust engines developed by Pratt & Whitney. This engine uses liquid hydrogen and LOX and is known as the CENTAUR engine. The S-IV is 220 inches in diameter and 40 feet tall. It is now under contract for design and development by Douglas Aircraft in Santa Monica, California. The third stage of C-I will be a stage called S-V and will be a modified Centaur engine.

Another configuration which is proposed and is called C-2 will have S-IV and S-V for its third and fourth stages and will have a new second stage called S-II. S-II will be comparable in length and diameter with S-I and will be powered by four 200,000 lbs. of thrust engines. This second stage will then have 800,000 lbs. of thrust.

To give some idea as to the time span over which the development of the Saturn will take place, a launch schedule presently calls for one first stage (with dummy upper stages) firing this year and two in 1962. In 1963, three firings will take place with stages S-I and S-IV and a dummy third stage. Also in 1963, two firings are scheduled with the entire C-I configuration. Two or three additional firings in 1964 should make the C-I operational.

Now, just what will this Saturn do? The determination of missions for the Saturn is a process in which vehicle characteristics, mission and spacecraft (explain) are tied together. The Saturn C-I will be capable of placing some 19,000 lbs. in a 300 mile earth orbit, of sending 5,000 lbs. of payload into an excape velocity and placing some 2,500 lbs. on Venus or Mars. The Saturn C-2 would be capable of orbiting 45,000 lbs. or transporting a manned vehicle around the moon and back to earth. Some of the uses under study for C-I and C-2 include:

1. Flights for re-entry tests of unmanned Apollo spacecraft. Apollo is NASA's planned three-man space ship for earth orbital and circumlunar flight - gross payload weight is here around 3 tons.

2. Man and Venus probes.

3. Lunar landings of instruments such as moving vehicles.

4. Launching communications satellites, etc.

Another interesting point concerning the Saturn development is its mode of transportation to its launching site at Cape Canaveral, Florida. Because of its size it cannot be moved by rail, highway or air, so it must go by barge down the Tennessee, Ohio, and Mississippi Rivers to the Gulf of Mexico through inter-coastal waters around Florida to the east coast. A 180 ft. barge, the Palaemon, has been built by Todd Shipyards, Houston, Texas and is now ready for its mission.

I would like to conclude with a few remarks concerning the future, after which a short film on the Saturn is to be shown. As to further developments in the thrust field, I would mention the F-1 engine now being developed for NASA by North American Aviation. This single engine will be capable of developing 1.5 million lbs. of thrust. If these engines are clustered as in the case of Saturn, then one can get some 10 to 15 million lbs. of thrust. Another area being pursued is that of nuclear propulsion. Coupled together, these propulsion systems should be able to get man and his equipment into space, supply him and move him around. This, after all, must be the goal of space vehicles.

The movie "Saturn - Workhorse of Outer Space" is about 15 minutes long.