S-6826
From: News Bureau
The Boeing Company
Seattle 24, Washington

Note: This program was canceled in 1963.

THIS IS DYNA-SOAR

Men have flown to the edge of space in the X-15 rocket plane and have been launched like missiles into space in capsules.

In the case of the capsule, men travel through space with the speed of a ballistic missile, but must rely on parachutes to let them down gently, and on air-sea recovery units to get them home again.

Pilots of the X-15 rocket plane and other advanced research craft fly back to conventional landings on earth, but, to date, the speed and altitude they attain are not as impressive as the capsules.

An attempt to combine the best features of these two approaches -- high speed flight into space and return with airplane-like control -- is the goal of the Air Force's Dyna-Soar program.

First objective of the program is to send an earth-launched manned vehicle into space and, through a controlled re-entry into the atmosphere, bring it back to a conventional landing on earth.

The craft being developed for the job is a delta-winged glider. It is being manufactured by the Aero-Space Division of the Boeing Company in Seattle, Washington. It will look and behave more like an airplane than any space craft now built.

Rocketed into space by a powerful booster, the glider will be able to orbit the earth at speeds of more than 17,000 miles an hour. When the pilot is ready to return to earth, he will be able to fly his craft back into the atmosphere and land it at an airfield of his choice.

Lt. Gen. Roscoe C. Wilson, former Air Force deputy chief of staff for development, called Dyna-Soar the most important research and development project the Air Force has.

HOW WILL IT FLY?

The term Dyna-Soar is derived from "dynamic" and "soaring." It means that the vehicle will use both centrifugal force and aerodynamic lift.

Centrifugal force will sustain the glider when it attains orbital speed (about 18,000 miles an hour). At this speed, it will be flying just fast enough to offset the pull of the earth's gravity. The glider will remain in orbit like a satellite until the pilot decides to return. By firing small gas jets mounted on the glider, the pilot will be able to control the glider's attitude in space. Retro-rockets may be used to direct the craft out of its orbit and back into the atmosphere.

The glider will enter the earth's atmosphere in a single long glide, contrary to the "skip-glide" technique first proposed by Dr. Eugen Saenger, originator of the Dyna-Soar concept (see History of Dyna-Soar, page 10).

The craft's wings will give it aerodynamic "lift" and maneuverability as it descends through the atmosphere. This combination of high speed, extreme altitude and maneuverability will permit the pilot to shorten or lengthen his range by thousands of miles and to maneuver far to the left or right of his flight path to reach his landing site. Landing the Dyna-Soar glider should be no more complicated than landing the X-15 or a modern jet fighter.

DYNA-SOAR HAS UNUSUAL LANDING GEAR

The landing gear on Dyna-Soar, however, will be different than airplanes now use. The Goodyear Tire and Rubber Company is developing main landing gear skids for the glider which will look like wire brushes mounted on skis. Work on the unusual landing gear is being performed at Goodyear's Akron, Ohio, plant under a $45,000 subcontract to Boeing.

Dyna-Soar will not be equipped with brakes; the wire brushes and the friction they will create upon landing will bring the craft to a stop.

Bendix Corporation's Bendix Products Division of South Bend, Indiana, is developing a retractable nose gear for Dyna-Soar which will resemble a shallow kitchen dishpan. Work is being performed under a $75,000 subcontract to Boeing.

Searing temperatures which will be encountered by Dyna-Soar when it re-enters the earth's atmosphere rule out the use of rubber tires and lubricated bearings.

DYNA-SOAR WILL ENCOUNTER SEVERE HEAT

Parts of the Dyna-Soar surface will be heated in varying degrees from 2,000 to 4,000 degrees Fahrenheit when it glides through the atmosphere on its way back from space. Its pilot, however, will remain comfortable in a cockpit kept at room temperature.

The air in front of the glider -- the so-called stagnation point -- will heat up to 20,000 degrees or more. This super-hot air, or "plasma," is expected to behave differently than air in its normal form.

A plasma -- sometimes referred to as the fourth state of matter -- is a good conductor of electricity and its flow is affected by a magnetic field. Air in its normal state has neither of these properties. Preliminary studies indicate that it will be very difficult to communicate through this plasma. It acts as a shield to radio waves.

Boeing scientists and others are experimenting with various techniques in an effort to solve this problem before the first manned Dyna-Soar is launched into space. A report by Dr. James E. Drummond of the Boeing Scientific Research Laboratories early in 1961 indicated that low frequency waves of electrically charged particles called "ions" can be used to bore holes in the plasma through which radio waves can travel. Other studies offer hope that certain very high radio frequencies may hold the secret to effective communication.

The plasma "sheath," flowing back over the craft as it re-enters the atmosphere, will afford a spectacular sight. It will look much like a shooting star blazing across the sky.

The Dyna-Soar glider will be constructed of high-nickel-alloy steel, molybdenum or columbium and ceramic materials highly resistant to heat. Unlike nose cones of ICBMs, which are coated with an ablative material which can boil off, the Dyna-Soar glider will radiate heat from its surfaces back into the atmosphere.

The ICBM nose cone plunges back into the atmosphere in a matter of seconds and must endure much higher temperatures, although for a relatively short time. The Dyna-Soar glider will come back in a more leisurely manner and will take a longer time (upwards of 30 minutes) to dissipate the heat.

Even this type of re-entry will scorch the surface of the glider until it looks like an old-fashioned wood stove, but it will be a simple task to prepare the glider for relaunching.

Much has been written of the high "G" loads which the passengers of Mercury-type capsules encounter when they fall back into the atmosphere in a deep, ballistic re-entry (up to 10 or 11 times the normal pull of gravity). Because of his shallow glide re-entry, however, the Dyna-Soar pilot will have to contend with no higher gravity loads than the pilot of a commercial jet airliner.

DYNA-SOAR WIND TUNNEL PROGRAM BIGGEST EVER

The most exhaustive wind tunnel program in the history of flight has been conducted on the Dyna-Soar space glider. By the time it is completed, it will triple the total time spent in similar data-gathering tests on the X-15.

Even the eight-jet Boeing B-52 global bomber, under whose wing the Dyna-Soar glider will nestle in early flight tests, required only half as much wind tunnel time.

Goal of the big effort is to gather information helpful in building a vehicle which will have to fly in every speed range from landing speed to orbital velocity.

The fact that the Dyna-Soar glider will be rocketed into space by a multi-stage booster and will cover a wide range of speeds makes the extensive wind tunnel program necessary.

Every conceivable combination of the glider and its booster must be tested at various speeds -- the glider atop the complete booster, the glider and the booster after the first stage of the booster has fallen away, the glider in flight without the booster, and so on.

Wind tunnels used on Dyna-Soar include subsonic and transonic tunnels (from low speeds up to mach 1.4), supersonic tunnels (from mach 1.5 to mach 5.5), low hypersonic tunnels (from mach 6 to mach 10), and high hypersonic tunnels (from mach 12 to mach 25).

Even gentle breezes -- simulating off-shore winds at Cape Canaveral -- are directed at models of the Dyna-Soar glider-booster combination to determine how it will react while standing on a launch pad.

Of particular importance to the Dyna-Soar program are the so-called "hot shot" and shock tube tunnels which simulate speeds up to mach 20 and beyond. Although ICBM nose cones and other ballistic shapes have generated considerable information in this speed range, Dyna-Soar is the first attempt to build a winged vehicle which will survive intact the blistering hypersonic speeds.

Started in earnest in early 1958, wind tunnel tests on Dyna-Soar models have been gathering data to answer questions of performance, stability and control, aerodynamic and structural heating loads and the like.

Virtually every major wind tunnel facility in the United States has contributed to the development of Dyna-Soar. Included in the wind tunnel program are facilities at Boeing, AVCO, Cornell Aeronautical Laboratory, General Electric, Martin-Marietta, the University of Washington, Ohio State University, and the University of Southern California.

Also included are the Air Force's Arnold Engineering Development Center and the National Aeronautics and Space Administration's Ames Research Center, Langley Research Center and Jet Propulsion Laboratory. Altogether, about 30 wind tunnels and shock tubes have been involved.

EARLY BENEFIT SEEN BY AIR FORCE, N.A.S.A.

Both the Air Force and the National Aeronautics and Space Administration (which is participating in the technical development of the program) expect to accumulate valuable data from early tests of Dyna-Soar. The program will help determine what military uses of space are feasible and will aid NASA in space research.

As a test bed, the vehicle will furnish the opportunity to test military subsystems under actual space conditions and to determine the capability of man to operate them.

Early Dyna-Soar flights will be made at more than twenty times the speed of sound and will last for more than an hour. They will provide a means of conducting research and development tests in a true flight environment. Compared with the brief glimpse now available with the free-flight testing of scale models or parts mounted on rockets or nose cones, this is a long, leisurely look at the mysteries of space flight.

It is not possible at the present time to simulate simultaneously all of the environmental conditions of hypersonic and space flight merely by using ground facilities. Communication experiments with Dyna-Soar in actual hypersonic flight -- just one of many tests planned -- will contribute to the understanding of the problem of sending and receiving radio signals through the "plasma sheath."

PRINCIPAL ROLES IN DEVELOPMENT

Boeing, as system contractor for Dyna-Soar, is responsible for the manufacture of the glider. Under direction of the Air Force's Aeronautical Systems Division, Boeing also is responsible for tying in the vehicle subsystems, integrating vehicle and booster, and assembly and test.

Air Force management and engineering personnel of the Air Force Systems Command specifically assigned to the project at Wright-Patterson Air Force Base, Ohio, are managing the design work on Dyna-Soar.

The Space Systems Division is concerned with booster development.

The National Aeronautics and Space Administration is participating in the technical development of the program.

Both Air Force and NASA test pilots have been working with Boeing engineers since December, 1960, as consultants on certain design features of Dyna-Soar.

Associate contractors at work on the Dyna-Soar program include Martin-Marietta, suppliers of the Titan boosters which will rocket Dyna-Soar gliders into orbit; Radio Corporation of America, the communications system; and Minneapolis-Honeywell, guidance and secondary attitude reference.

BOEING'S MAJOR SUBCONTRACTORS

Boeing will spend more than $50 million on major subcontract items for the current Dyna-Soar program. Seven major subcontractors are involved. Their names and jobs are:

LING-TEMCO-VOUGHT, Dallas, Texas -- nose cap for glider. Made of ultra-high temperature ceramic materials, the nose cap will protect the forward section of the glider from searing re-entry temperatures.

ELECTRO-MECHANICAL RESEARCH, INC., Sarasota, Florida -- test instrumentation subsystem. Airborne equipment will be provided for collecting and transmitting Dyna-Soar test data to the ground. Also developed will be ground equipment for receiving, displaying, recording and processing the data.

GARRETT CORPORATION's AiResearch Manufacturing Division, Los Angeles, California -- Dyna-Soar's hydrogen cooling system, a vital part of the vehicle's environmental control system. Hydrogen expelled from a hydrogen storage tank will enter a heat exchanger where it will absorb the heat extracted from the crew and equipment compartments.

MINNEAPOLIS-HONEYWELL's Aeronautical Division, Minneapolis, Minnesota -- flight control electronics subsystem. This portion of the flight control system includes the electronic equipment necessary to achieve control of the glider through the use of automatic or manual commands.

SUNDSTRAND CORPORATION, Denver, Colorado -- accessory power unit. Designed to power the vehicle's generator in flight, the gaseous hydrogen-oxygen unit will consist of a reaction chamber, prime mover, gear box, hydraulic pump, propellant shut-off valve, and metering valves and controls.

THIOKOL CHEMICAL CORPORATION, Elkton, Maryland -- solid fuel acceleration rocket to be used either as escape rocket in case of emergency during launch or as a small booster rocket for additional acceleration after the last stage of Dyna-Soar's booster is expended.

WESTINGHOUSE ELECTRIC CORPORATION, Lima, Ohio -- generator and control unit. Mounted on the accessory power unit, this will be the source of the glider's electrical power.

HISTORY OF DYNA-SOAR

In 1933, James R. Wedell flashed to a new world's speed record for land planes by averaging 305.33 miles an hour in the Phillips Trophy Race, and Lt. Cdr. Frank M. Hawks set a west-east non-stop record by flying from Los Angeles to Brooklyn's Floyd Bennett Field in 13 hours 26 minutes. News accounts of these deeds were carried in virtually every daily newspaper in the country.

That same year, at the University of Vienna, an obscure engineer and physicist wrote a book entitled, "The Technique of Rocket Flight," in which he introduced the idea of a rocket airplane which would fly 50 times faster than Wedell's airplane and travel more than 10,000 miles beyond Hawks' non-stop mark. The book, by Dr. Eugen Saenger, caused scarcely a ripple of interest beyond a limited technical readership.

Three years later, the records of Wedell and Hawks had been erased and new aviation milestones added. By then, however, Saenger's work began to cause a stir. He was invited to Germany to continue his work under the auspices of the Hermann Goering Institute, the research organization of the Luftwaffe.

Saenger was assigned to a 10-year program for the purpose of developing his ideas on the long-range rocket aircraft. A specially built research center at Trauen was the site of his studies.

In formulating the design of his pioneer boost-glider, Saenger was joined by Dr. Irene Bredt, a brilliant mathematician who later became his wife. With a small team of technicians, various features of the design were painstakingly evolved.

The aircraft itself appeared in the designs as a low-wing vehicle with vertical stabilizers at the tips of the horizontal tail surfaces. The wing-section was that of a thin wedge with sharp leading and trailing edges. The water-cooled rocket engine of 100 tons static thrust was located in the tail.

Saenger's suggested launching procedure was unusual. He proposed to have the 100-ton craft take off from a railed track, almost two miles long, under powerful boost from a rocket-propelled sled. This tethered booster would bring the vehicle to a ground speed of more than one and a half times the speed of sound before release.

Leaving the track, the craft would climb under its own momentum at an angle of 30 degrees, reaching a height of some 5,500 feet before its rocket engine fired. Under propulsion, the aircraft would climb less steeply and, following the climax of thrust, would coast to a height of nearly 100 miles before falling back on a ballistic trajectory.

Instead of re-entering the atmosphere in a dive, however, it would return to earth along an undulated "skipping" trajectory, bouncing on top of the denser atmosphere like a flat stone skipped across the still waters of a pond. By this technique, Saenger proposed to achieve ranges of up to 14,600 miles.

(The "skip-glide" effect set Saenger's scheme apart from anything ever conceived and earned him recognition as the author of the Dyna-Soar concept, even though the "skip" feature was dropped by Dyna-Soar designers in this country.)

Target No. 1 in an early Saenger design exercise was New York City. The idea appealed to the German high command, but there were some major faults which detracted from the basic plan. The craft's tiny payload could not be overlooked, even if the problems of materials and propulsion could be solved. Over a range of 14,600 miles, its payload was only 672 pounds. In terms of chemical high explosives of the day, it was disproportionate to the overall weight.

TOO LITTLE, TOO LATE

Although Saenger and Bredt regarded their work as a purely preliminary study, it was continued right up to the summer of 1942 when, according to Saenger, "the long-term program came into conflict with the prosecution of the war." Hindered by the call-up of personnel, including those of participating industry, plus the acute shortage of such materials as nickel, copper and chrome, the project was faced with handicaps which could not be overcome. Germany, playing a losing hand in the war, chose to gamble its remaining resources on the V-1 and V-2 rockets. The skip-glide bomber project was shelved.

POSTWAR DEVELOPMENT

After World War II, several ideas for developing pilotless glide weapons were studied. In nearly every instance, the vehicle was designed to dive onto its target with the warhead. A great disadvantage was its approach speed to the target. It still was slow enough that its speed made it a sitting duck for high performance interceptors.

The work was by-passed when high-thrust rocket engines and light-weight rocket structures showed the way to ballistic missiles of outstanding range and performance, and which could embody a small-sized nuclear warhead.

The idea of the boost-glider was allowed to lapse until it became possible to think in terms of putting a man into space and bringing him back again. Even then, the first manned orbital craft officially conceived in the United States was not a winged vehicle but a ballistic capsule -- closely akin to the present Mercury capsule.

Reasons why the ballistic approach was adopted in preference to lifting re-entry were basically these: (1) the available booster did not permit the orbital payload to exceed one ton; (2) the ballistic capsule was considered a relatively short-term development in view of progress with stabilized missile nose-cones and ablative heat shields; (3) the boost glider required a more complex structure for which there was relatively little practical experience even in the laboratory.

Calculations disclosed that the skipping procedure advocated by early Saenger studies resulted in considerably higher temperatures than a straight, gradually descending glide path. Severe heating would result from the "pull ups" to generate the increased aerodynamic lift required to skip.

One study, called BOMI, called for boosting a glider to near orbital velocity and gliding to the target area thousands of miles away, arriving there at 15,000 feet or more per second and approximately 40 miles altitude. After dropping the bomb, the airplane would make a 180-degree turn and be boosted back up to the initial altitude and velocity conditions to make the return flight. This required carrying another rocket engine system for the return boost.

It soon was discovered that the aircraft would burn up in attempting to make the 180-degree turn because of the extreme increase in temperature resulting from this maneuver in the atmosphere. The additional rocket weight penalty also required a tremendous initial rocket booster. A far more efficient and practical method, it was decided, was to continue the flight path around the earth after dropping the bomb.

Studies in the United States have progressed through many phases involving different purposes and uses based on this same concept. In 1954, the government began to consider the concept more seriously. A series of studies by the Air Force, the civilian space agency (National Advisory Committee for Aeronautics) and industry followed. Included were Hywards, a winged hypersonic research and development system; 118P and Brass Bell, for various reconnaissance applications, and ROBO, a rocket bomber system requirements for which all companies were invited to study.

POST-SPUTNIK ERA

In November, 1957, one month after the Russians had launched an artificial satellite into orbit, the Air Force issued the first preliminary directives on Dyna-Soar. By March, 1958, a number of proposals had been submitted by industry members. In June of that year, the Air Force selected two major teams to prepare competitive studies of the Dyna-Soar. Boeing headed one team and the Martin Company and Bell Aircraft headed the other.

The unknowns which faced Boeing in 1958 were typical of those which confronted other members of the two teams. Dyna-Soar would fly at high mach numbers and there were few men in the country who had much knowledge of hypersonics. Boeing was known for its experience in supersonics, engine inlets, and other related fields, but this was something else again.

Because Dyna-Soar would have to endure the torture of blast-off and re-entry into the atmosphere, an entire new approach to materials and structures was demanded. The old ways weren't good enough.

One of the first steps toward solutions of these problems was to select preliminary design experts whose work in certain research areas fitted the needs of the Dyna-Soar program. Advance structures engineers who had conducted research into "hot frames" were added. Also brought into the program were engineers who had worked on the ROBO project (of which Dyna-Soar was a distant relative). While most of their experience had been with unmanned glide missiles, their ROBO background, it was felt, gave them an understanding of the flight regimes Dyna-Soar planners were talking about.

Aerodynamicists began wind-tunnel testing scores of models to gain data on hypersonic flight. Starting with simple, fundamental shapes, they tested them thoroughly. From these tests evolved the vehicle configuration Boeing proposed to the Air Force in 1959.

Typical of the contributions made by scientists and engineers at work on the program was that of Del Nagel, a young Boeing engineer who had been graduated not many years before from the University of Washington.

His discovery of the outflow phenomenon -- a method of predicting flow and heat transfer characteristics -- permitted aerodynamicists to understand what heating problems they would face, and gave them a feel for predicting and correlating test model results to full scale.

As new materials were developed, they were tested at the company-owned 5,750-KVA radiant heat facility. Built for conducting heating tests on supersonic or space vehicles, while at the same time subjecting them to high loads, the device enabled engineers to duplicate high temperatures and loads they knew Dyna-Soar would encounter during re-entry.

So intense was the heat during some of the tests that insulation on the wires carrying electric current into the facility burst into flames.

Material which wouldn't take the punishment was thrown out and others were tried. In the end, engineers beat the so-called "heat barrier" and even the pessimists on the program began to smile.

Not all of the problems could be solved with exotic materials. Structures engineers finessed their way out of at least one tight corner by using triangular girder arrangements which permitted trusses to deform but virtually eliminated thermal stress -- a technique used in building bridges, but seldom in aeronautics.

Banshee-like screams -- produced by Boeing's sonic testing facility -- also were used to test Dyna-Soar developments. Skin panels were exposed to the energy produced by noise, similar to the severe exhaust and aerodynamic noise the space vehicle likely will encounter during flight at hypersonic speeds.

In November, 1959, after intensive effort by both the Boeing team and the team headed by Martin and Bell, the Air Force made its decision. Boeing was designated system contractor and the Martin Company was named associate booster contractor.

Development work on the program, however, did not begin immediately. Because of the high costs involved plus serious doubts among many of the nation's top scientists and engineers that the program, as constituted, would be successful, the Air Force was ordered to perform a configuration verification study. This study, known as "phase Alpha," began in December, 1959, and lasted until April of 1960.

All of the technical data which had been generated to support the program was collected and catalogued. All possible re-entry vehicle designs were reconsidered. When the study was completed, there was general agreement that the program could, indeed, be accomplished successfully.

WHERE ARE WE TODAY?

The materials and structural designs chosen for a radiation-cooled solution to the high temperature problem have been developed and demonstrated in the laboratory.

A review of a full-scale mockup of the Dyna-Soar glider and its related systems was carried out by a government inspection team in September, 1961. No major changes in the glider design were ordered.

The glider -- the design of which is based on about three years of detailed studies -- will be manufactured in Seattle at Boeing's Missile Production Center.

Originally scheduled were sub-orbital flights down the Atlantic Missile Range with a modified Titan II ICBM booster. This was changed in December, 1961, with the announcement by the Air Force that a more powerful booster -- one which would combine liquid and solid rockets -- would be developed for Dyna-Soar. This new booster, based on Titan II technology and employing solid propellant rockets, will propel Dyna-Soar to orbital velocities. As a consequence, the sub-orbital flights have been dropped from the test program.

Here is the sequence of tests:

Air-drops of unpowered gliders from a B-52 mother ship at Edwards Air Force Base to check the craft's stability and control at slow speeds, and to give the pilots opportunities to perfect landing techniques. Later, gliders equipped with rocket engines will be flown faster than sound to see how they handle in the supersonic regime.

At the conclusion of the Edwards tests, unmanned and manned flights around the world will be launched from Cape Canaveral. These tests will check every phase of Dyna-Soar's operation, including stability and control, performance, and the effects of aerodynamic heating on the craft during re-entry.

The Air Force has not said publicly how much time will be saved in Dyna-Soar's development by the decision to give it an orbital booster. The initial announcement only said that the new booster will assure "early attainment" of manned orbital flight. It did not disclose when the first flight would take place. No official schedule for Dyna-Soar development ever has been announced.

Main purpose of the sub-orbital flights was to gain data on hypersonic flight, a regime never before sampled by manned winged vehicles. This is the speed range beyond mach 6. The new program will explore this area and accomplish orbital flight as well.

The orbital flight is expected to pose fewer problems for the pilot than the short one. For one thing, the extra hour involved in the around-the-world flight will give the pilot more time to adjust to his chores in space, set up his re-entry conditions, and make the necessary preparations before beginning his descent through the atmosphere.

DYNA-SOAR FUNDING

In his budget message to Congress in January, 1962, President Kennedy asked for $115,000,000 to be spent on the Dyna-Soar program during Fiscal Year 1963. This represented an increase of $15,000,000 over the amount earmarked by the Kennedy Administration for the program during FY 1962.

The spending level for Dyna-Soar during FY 1962 was $100,000,000, which was $30,000,000 more than that proposed by the Eisenhower Administration.

Even this, however, was less than Congress was willing to spend to accelerate the program.

On the recommendation of the appropriations committee of the U.S. House of Representatives in 1961, Congress appropriated an additional $85,800,000 (bringing the total to $185,000,000) and urged that the Dyna-Soar program be speeded up in FY 1962. Secretary of Defense McNamara decided against this and the additional funds were not spent.

Testifying before a House subcommittee of the appropriations committee in the spring of 1962, Secretary McNamara said:

"I have personally reviewed the project (Dyna-Soar) and concluded that, while we cannot say categorically it will yield an important military weapon, we do believe that its potential is sufficiently great to warrant the expenditures we have proposed ($100,000,000).

"...The military applications of manned orbital flight of the type toward which Dyna-Soar is directed are likely to be great. We can conceive of a number of such applications, although we have not developed them specifically, because we are trying to achieve the objective of the Dyna-Soar program (research)."

Following is a history of funding for Dyna-Soar since the program was given an official go-ahead early in 1960:

FY 1963 -- $115,000,000

FY 1962 -- $100,000,000 (an additional $85,800,000 was not spent)

FY 1961 -- $ 58,000,000

QUOTES

"The choice of flight paths available to the Dyna-Soar pilot will be almost infinite. By combining the high speed and extreme altitude of his craft with his ability to maneuver, he will be able to pick any air field between Point Barrow, Alaska, and San Diego, California, with equal ease."

-- George H. Stoner
Dyna-Soar program manager for Boeing
September 22, 1960

"The Air Force considers Dyna-Soar the most important research and development project it has ... The Dyna-Soar will open a new era ... It is the first step towards practical man-in-space flights."

-- Lt. Gen. Roscoe C. Wilson
Deputy Chief of Staff-Development, USAF
September 22, 1960

"The Dyna-Soar, in effect, is the first vehicle which will combine the advantages of manned aircraft and missiles into a single system ... It is interesting to note that although the Dyna-Soar will attain peak speeds of over 15,000 miles an hour during flight, its proposed landing speed is to be less than that of some of our present-day combat aircraft."

-- Gen. Thomas D. White, USAF Chief of Staff,
in AIR FORCE Magazine, September, 1960

"So far, Dyna-Soar has been programmed solely as an experimental craft for research purposes. However, as the first piloted military space system planned by the United States, Dyna-Soar has important operational potentialities which are now being explored by the Air Research and Development Command. A factor contributing to increased confidence in the Dyna-Soar concept has been the encouraging progress made in flight tests of the rocket-powered X-15. This experimental aerospace craft has been designed to study environmental conditions at the border of the atmosphere where Dyna-Soar will operate."

-- Lt. Gen. Bernard A. Schriever, Commander,
ARDC, in AIR FORCE Magazine, September, 1960

"Dyna-Soar ... offers an enormous potential for future maneuverable capability in space and the atmosphere ..."

-- Lt. Gen. Roscoe C. Wilson, Deputy Chief of Staff-Development, USAF, September 22, 1960

"We are quite impressed with the philosophy of this manned, maneuverable space vehicle which is recoverable under pilot control. My impressions are favorable."

-- Major Robert White, Air Force test pilot of X-15 rocket plane, January 18, 1962

"The committee foresees the need for an operational, manned military space vehicle over which the pilot has the greatest possible control and believes that the Dyna-Soar concept provides the quickest and best means of attaining this objective."

-- Appropriations Committee, U.S. House of Representatives, May, 1961

DYNA-SOAR MILESTONES

November, 1957	-- Development directive issued; development plan approved.
March, 1958	-- Proposal received from seven contractors.
June, 1958	-- Selection of Boeing and Martin to compete for selection of source for development of Dyna-Soar.
April, 1959	-- Evaluation of Boeing and Martin proposals begun.
November 9, 1959	-- Selection of Boeing and Martin as contractors. Boeing to be responsible for the manufacture of the vehicle portion of the system, and for integration of vehicle subsystems, integration of vehicle and booster, and assembly and test. Martin to manufacture booster portion of Dyna-Soar.
December 11, 1959	-- Boeing receives letter contract for Step 1 of Dyna-Soar.
December 11, 1959	-- Phase Alpha study ordered by Air Force, Phase Alpha is an intensive comparative study and redefinitization of all Dyna-Soar technology to date.

March 28, 1960	-- Boeing submits recommendation of system configuration to Air Force.
March 28-30, 1960	-- Aerospace Vehicles Panel of the Air Force Scientific Advisory Board meets to review findings of Phase Alpha study.
April 11-14, 1960	-- Dyna-Soar Symposium, Langley Field, Va., held to acquaint industry with problems and requirements.
April 25, 1960	-- Air Force okays Phase Alpha study report, gives go-ahead to permit actual design of Dyna-Soar glider immediately.
September 20, 1960	-- Boeing holds first of a series of bidders' conferences as step toward selecting major subcontractors for work on Dyna-Soar.
September 22, 1960	-- Air Force reveals first details of Dyna-Soar glider configuration at Air Force Association convention in San Francisco.
December 13, 1960	-- Minneapolis-Honeywell Regulator Co. of St. Petersburg, Fla., named associate contractor for Dyna-soar primary guidance subsystem.
December 16, 1960	-- Air Force announces selection of Radio Corporation of America as associate contractor for Dyna-Soar communications package.
January 6, 1961	-- Boeing announces award of its first major Dyna-Soar subcontracts to Chance Vought Corp. (for nose cap) and Minneapolis-Honeywell Regulator Co. of Minneapolis, Minn. (for flight control electronics).
January 13, 1961	-- Air Force announces decision to substitute Titan II for Titan I as booster for Dyna-Soar glider and subsystems.
September 22, 1961	-- Government review team completes inspection of full-scale mockup of Dyna-Soar glider and related systems.
December 28, 1961	-- Air Force announces decision to develop new booster for Dyna-Soar. Combining both liquid and solid fuel rockets, it will be capable of hurling glider into orbit.

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