

DARK HORSE RUNNING, Part IV

Bell and Martin-Bell's Cold War Orbital Glide Bombers

By Dave Stern

During the mid-1950s Dr. Dornberger and his select Bell BoMi engineering teams continued to refining the basic BoMi concept with Air Force support and funding leading into the Bell R459L Brass Bell reconnaissance glider studies. During his tenure, Gen. Thomas S. Power commanding the Air Research & Development Command (1954-1957) was aware of and supported continued funding of Bell's BoMi and its reconnaissance spinoff, Brass Bell.¹ On September 18, 1956, Larry Bell, suffering ill health, resigned as president, becoming Chairman of the Board, and chose Leston Faneuf as company president. Larry suffered a congestive heart failure on October 20, 1956, and died at age 62. Mr. Faneuf and his senior executives reorganized the company, and replaced the old names "Niagara Frontier," or "Buffalo-Niagara Falls" with two new division names. They were, Aircraft and Weapon Systems Division managed by Ray P. Whitman, further divided into four subdivisions: Avionics, Rockets, Guided Missiles and Research.²

THE SKELETONS ENDO AND EXO

Bell engineers initially investigated high-speed thermal research in 1948 while designing the Mach 3 Bell X-2 research aircraft.³ Chromium-nickel was applied as wing skins while fuselage sheets were formed of stainless steel and K-Monel, an age-hardened nickel-copper alloy, developed by International Nickel Company, Inc (INCO).⁴ In 1953, the BoMi structures engineers began from scratch to develop radical thermal protection methods for BoMi. However, in 1956, their research and efforts were now focused upon Brass Bell.

The engineers reduced the glider's empty weight by creating a basic aluminum airframe (endo-skeleton) that supported aerodynamic loads. An exo-skeleton thermal protection shield would envelope the glider thus effectively shielding it at sustained hypersonic speeds: it promised 98% heat dissipation of both fuselage and wings.⁵ Called the "double-wall cooling and insulation thermal protection system," its potential was acknowledged by the USAF Flight Dynamics Laboratory of

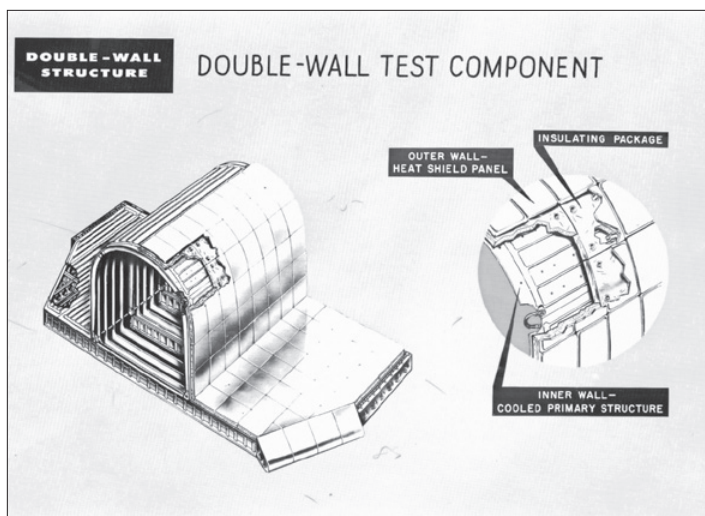


The final R459 Brass Bell reconnaissance glider configuration still undergoing refinements proposed to the USAF. Its clean top allowed a reasonable semi-recessed fit in an enlarged bomb bay of a Convair B-36 Mother-ship, also used to air-launched Bell Rascal missiles at Holloman AFB, New Mexico. (Photo & Model: Dave Stern).

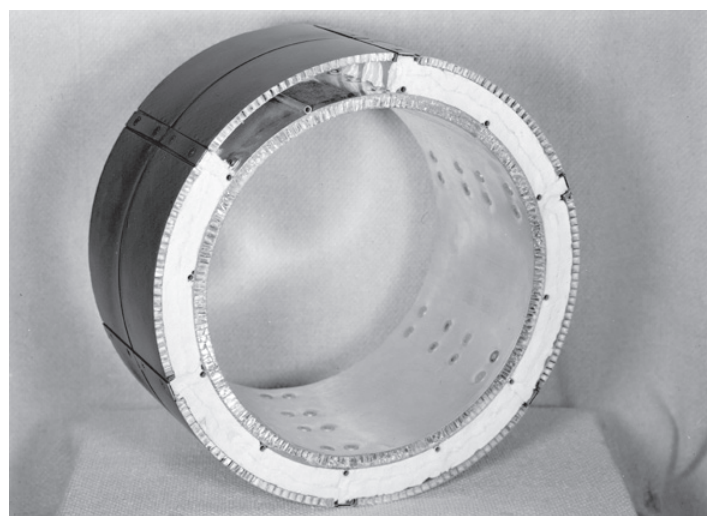
Also known as "HiFi Recce," Brass Bell was designed to reach 170,000 feet and glide at Mach 17 for 5,500 miles plus, providing hi-quality photographic, radar and ferret, intelligence with a minimum of political risk while over flying enemy territory beyond reach of advanced SAM missiles. (Photo & Model: Dave Stern)



Gen. Thomas S. Power commanding Air Research and Development Command (April, 1954-1957) supported the Bell MX-2276, R459 Brass Bell, SR-126 Robo and Dyna Soar for an operational military space force utilizing advanced boost-glider vehicles and lifting re-entry spacecraft. In 1957 Power received his fourth star as a full general replacing Gen. Curtiss E. LeMay as CINCSAC retiring in 1965. (USAF-SAC photo)



Fulfilling a 27 month USAF contract, Bell shops constructed a "D" shaped boost-glider segment with an operational double-wall cooling system. A stubby wing leading edge provided enough area to attach the latest leading-edge cooling materials for thermal tests. (Bell Aircraft drawing)



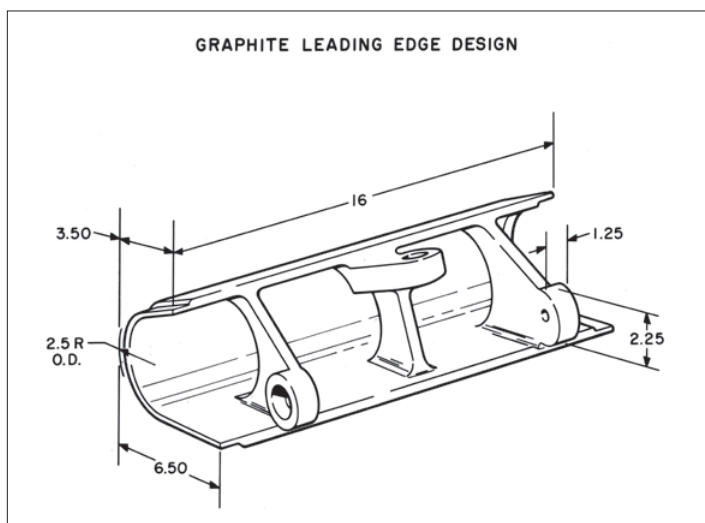
Bell shops also fabricated compound or circular curved double-wall specimens for thermal tests. This test segment displays thin honeycomb sheet material. The outer panel expansion joints can be seen here. (Bell Aircraft photo)

the Research and Technology Division, Systems Command at Wright Patterson Air Force Base (WPAFB). The USAF annually funded continued research with "Supplemental Agreements" for Bell to construct and test segments and replicate actual thermal temperatures endured in flight.⁶

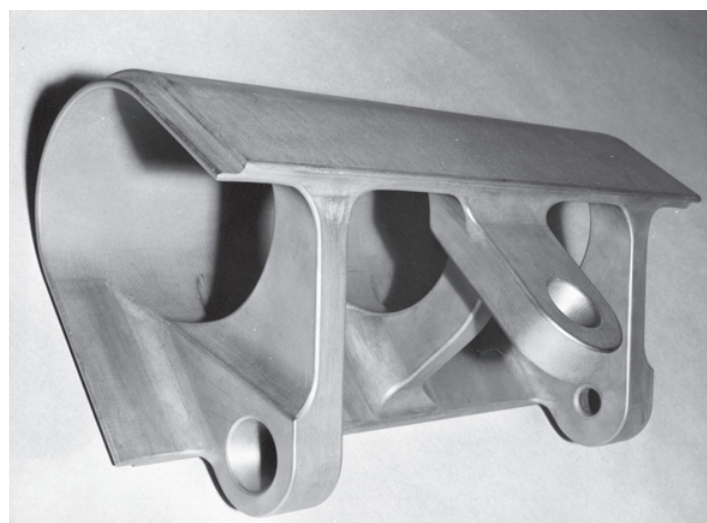
The structures team engineered methods (see sidebar) of constructing super alloy panels sustaining thermal ranges between 1,800 and 2,000 degrees F;⁷ newer metals were predicted to sustain temperatures between 2,200 and 3,000 degrees F.⁸ Immediately shrouding the endo-skeleton was a very thin foil insulation blanket (powders were also studied), while the outer exo-skeleton was fastened over this ultra-thin blanket.⁹ The inner or endo-airframe sustained temperatures approaching 200 degrees F, yet retained structural integrity.

Curved and compound shaped panels were also fabricated and thermal tested;¹⁰ this included various shaped wing leading edges with shallow radius.

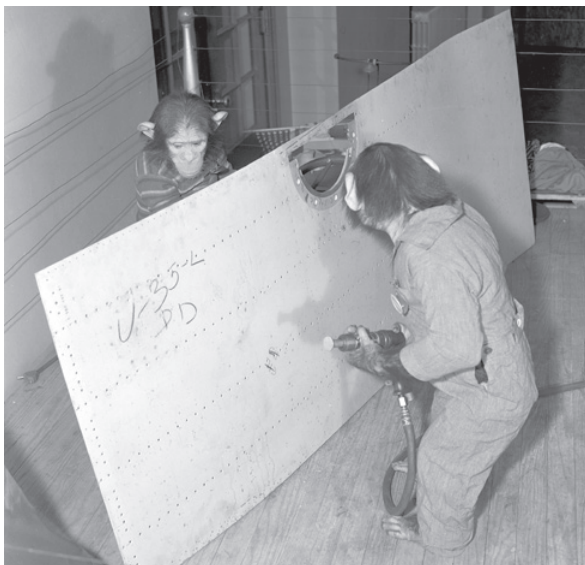
Two leading-edge thermal protection approaches were chosen—absorptive (internal liquid cooling system) and radiative (heat radiated into the atmosphere).¹¹ Exo-panels included an internal network of metal lines circulating a specific liquid coolant absorbing the panel's heat.¹² This work was supported by the USAF Materials Laboratory and Aircraft Laboratory at WPAFB Wright Air Development Center (WADC). The Air Force, realizing Bell's pioneering work was applicable to future orbital glide-reentry vehicles, continually funded their work through its AF33(616) contract series,¹³ renewed annually well into the 1970s.



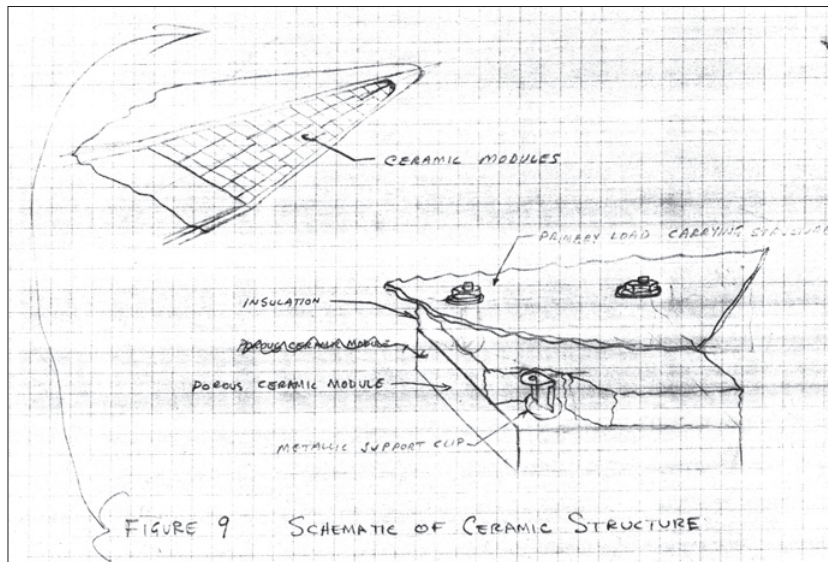
Each graphite leading edge segment with spaced directional mounting lugs reportedly sustained uneven thermal stresses along its surface; it included flight stresses, aerodynamic loading—even possible random vibrations. (Bell Aircraft photo)



A graphite leading edge specimen, one of many different blunt compound curved wing leading edge specimens constructed and heat tested. Various liquid cooling systems ceramics and cermets were also fabricated and tested. (Bell Aircraft photo)



A crack team of well-trained and skilled Bell sheet metal workers fabricate aluminum segments for a boost-glider's endo-skeleton. Bell's shop workers were described as expert craftsmen. (Bell Aircraft photo, honestly)



Bell structural engineer Wilfred Dukes sketched a boost-glider ceramic tile insulation system applicable to other winged orbital vehicles. It long pre-dates the Space Shuttle's similar tile system. Dukes is simply being given credit for his original thinking. (Drawing from the Wilfred Dukes collection)

Bell's shops constructed thermal resistant liquid cooled test panels, thin insulation foils and special exo-skeleton attachment fasteners, thus continually updating the overall system.¹⁴ Wing leading edge studies included ceramics and cermets plus the liquids Sodium, Lithium and a hydrogen system were constructed and tested: Beech Aircraft and Garrett's Air Research Division also researched liquid hydrogen as an internal coolant.¹⁵ Also explored were radiant wing leading edges consisting of shaped blocks of silicon carbide and connecting systems of "pyroceram" for high temperature strength and low thermal conductivity material (0.05 inch thick panels utilizing reinforced "waffle-wall webs").¹⁶

Long before the Space Shuttle tiles were created, Mr. Wilfred Dukes sketched out a similar tile system – an alternative exo-protection system to explore-a version seen in a colored HAYNES Alloys advertisement. The shops constructed test specimens utilizing columbium, ZL-M (Medium Grade), Antex-K, Durellium, Inconel X, Haynes alloy, coated Molybdenum and Molybdenum honeycomb panels, Rene-41 and other metals.

The wing leading edge sample diameters were critical in order to endure and survive thermal and shock testing,¹⁷ utilizing Graphites, Tungsten and the latest Cermets available from industry.¹⁸ While initial test articles sustained thermal gradients peaking at 2,000 degrees F their heat resistance was increased to 2,500 plus degrees F although vehicle re-configuration designs were required.¹⁹ The engineers hoped to expand their goal for leading edges to sustain 3,000 plus degrees F because newer exotic heat sustaining metals and Cermets were becoming available.²⁰

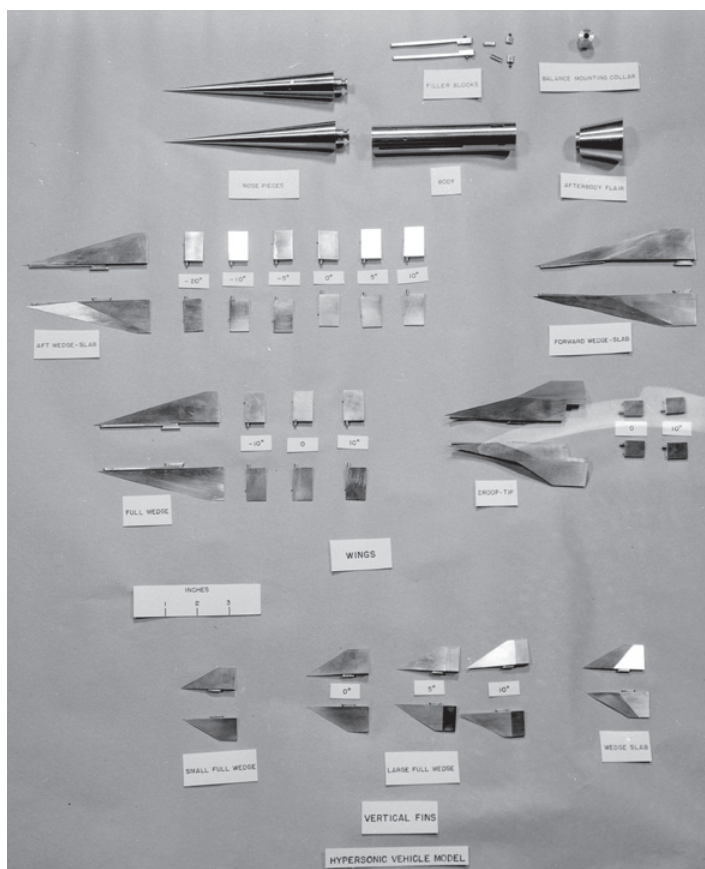
THE GLIDER

In 1956 Bell engineers selected one baseline Brass Bell aerodynamic configuration including a refined hot-structure.

The extremely clean two-seat (side by side) tailless glider was 772.0 inches long with a modified-wedge wing spanning 250 inches (325 square feet) at 75 degrees sweep and exhibited (head-on), a cathedral of 4 degrees. Its height on nose wheel tires and twin-skid landing gear reached 110 inches. Empty weight was approximately 13,182 pounds, with a useful load of 2,456 pounds at approximately 15,640 pounds gross weight.²¹ This configuration minus on-board rocket engines provided space in the extreme aft for the cooling system's liquid metal pump, motor, liquid metal separator and storage tank with an overboard vapor discharge nozzle. The bay immediately ahead housed the camera suite with six unidentified oblique mounted cameras per the Air Force's choice.²²

Brass Bell's cameras and other reconnaissance systems were contract studies funded by the Intelligence and Reconnaissance Systems Division, ARDC between March, 1956 and August, 1957.²³ Two 72 hp hydrogen-peroxide driven auxiliary power units drove a 15 KVA alternator provided all the systems electricity including a photo or Elint reconnaissance suite.²⁴ Brass Bell would fulfill three missions, "Pioneer Search" pre-hostilities reconnaissance (locate-record critical military offensive-defensive complexes), Surveillance and Technical Intelligence (periodic target surveillance of target activities) and Technical Intelligence recording enemy technology applied to offensive-defensive activity.²⁵

Airborne Instruments Laboratory studied the Ferret missions and equipment and recommended the necessary wide-ranging superheterodyne frequency scanning equipment.²⁶ Proposed infrared missions remained unperfected pending further development until "hot" infrared window technology was tested aboard the X-15 from 1963 to 1966 at speed up to Mach 5.²⁷ Brass Bell's photo reconnaissance suite and missions were studied by Chicago Aerial Industries.²⁸



Government wind tunnel tests cost by the hour so it was economical to construct break-down models, where nose, wing, body, tail-fins, etc. could be swapped out between tests. This is an unidentified Bell boost-glider "wind-tunnel kit" with numerous alternate attachments. (Bell Aircraft photo)

Crew escape consisted of two ejection seats and each man wore full pressure suits during missions. Two extensively researched optical viewing systems included a vertical high-speed cruise flight viewing system operated by the navigator-observer. The pilot operated a forward and downward viewing system for let-down, approach and landing, with the vertical system providing a 160 degree view, subject to updated optical systems.²⁹ Had the USAF issued a classified contract for a Brass Bell prototype, its clean fuselage top allowed it to be semi-recessed for air-drop glide tests by a modified B-36 or from a B-52 with an under-wing pylon mount. However, fully reliable cooling and insulation systems were still under development testing.

NACA ASSISTANCE

Bell Aircraft owned no wind tunnels, but acquired outside assistance to accomplish panel flutter, panel loads and thermal stress characteristics, beyond their in-house static heat-furnace and vibration tests. Bell engineers H.K. Fletcher and J.L. Powell visited the High Speed Flight Station, Edwards AFB in February, 1956.³⁰ They briefed NACA engineers R.E. Ray and H.M. Drake on Bell's 3-phase project; an air-launched Brass Bell glider from a modified B-36, with or without a rocket booster, a two-stage vertical launched boosted glider gliding

at Mach 18 and RoBo, vertical launched by a booster rocket to Mach 22.

Also discussed were the NACA Test Station's reaction control systems for possible application on both gliders.³¹ In December, 1956, Bell engineers E.C. Haight and W.C. Buckley visited NACA Langley's Structures Research Division to establish test procedures for Brass Bell's double-wall panels.³² Tests were conducted in the 9 x 12" Transonic Blowdown tunnel, the 26" Transonic Blowdown tunnel and the 8' transonic tunnel. A rocket propelled model launched at the Wallops Island Pilotless Aircraft Research Division (PARC) facility was commissioned to test panel flutter at transonic speeds. The NACA Wallops Island ethylene jet – a high thermal test facility generating temperatures to 1,700 degrees F provided thermal data on Bell's fabricated test panels.³³ Bell formally initiated the NACA requests through Air Force channels for approval since they were the contracting authority.³⁴

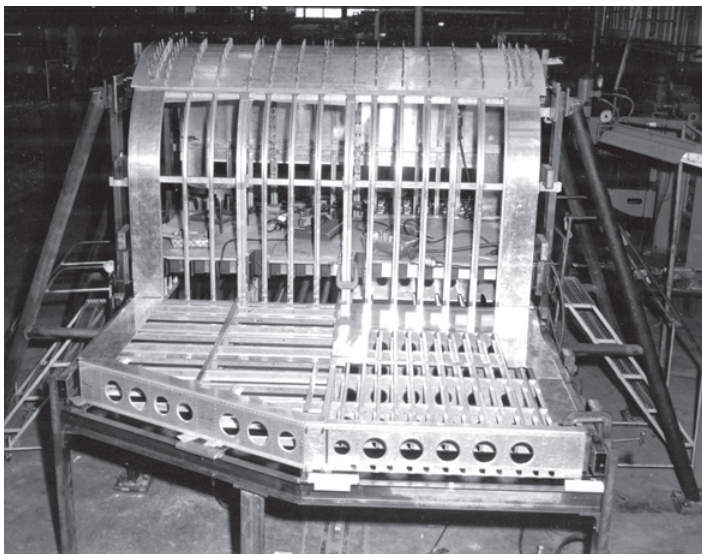
Bell also constructed 4x8 foot exo-skeleton panels tested on the floor of the NACA Langley tunnel at speeds from Mach 0.8 to Mach 1.3. They apparently withstood both thermal and flutter tests reasonably well.³⁵

THE PIVOTAL YEAR - 1957

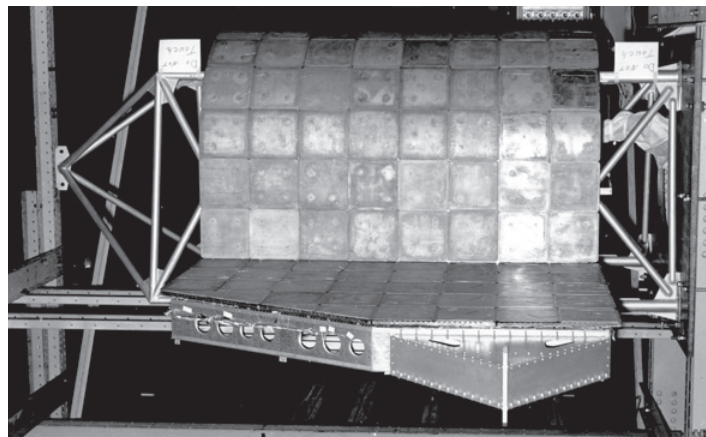
Capt. William C. Walter (a USAF trained aeronautical engineer) was Engineering Manager of the USAF Hypersonic Boost-Glider Study Project at Detachment 1, Headquarters, ARDC, in the Bomber New Developments Division at WPAFB. In mid-1957 he was tasked with combining R459L Brass Bell, R455L HYWARDS (NACA research glider), SR-126 RoBo plus SR-181 studies from the previous ARDC Development Plan 133L/A³⁶ into the all-inclusive three-phase Abbreviated System Development Plan – System 464L, Hypersonic Glide Rocket Weapon System.

He wrote R464L that satisfied Systems Requirement 131, of November 14, 1956, for a Hypersonic Research and Development Supporting Systems GOR 92 (General Operational Requirement) of May 12, 1955. It was titled; A Piloted Very High Altitude Reconnaissance Weapon System, including SR-126 RoBo dated June 12, 1956.³⁷ Walter was also credited with creating the excellent and accepted acronym for 464L – Dyna Soar ("Dynamic Soaring").³⁸ Walter designated Dyna Soar I as a CTV (Conceptual Test Vehicle) to prove the boost glider concept, Dyna Soar II, a glider testing the necessary military equipment and Dyna Soar III becoming the actual operational reconnaissance or glide-bomber.³⁹

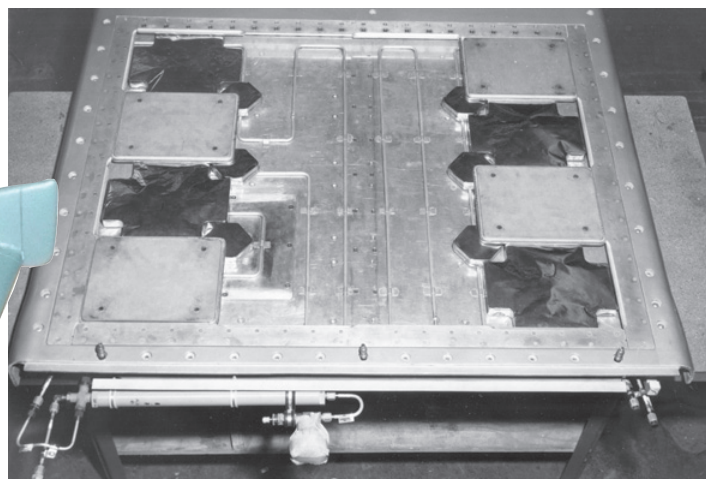
Brass Bell was not immediately absorbed into R464L, merely its reconnaissance mission because Brass Bell research continued until at least June 1958.⁴⁰ On October 4, 1957, the Sputnik-I was successfully inserted into a 559 mile orbit with Russians proudly basking in worldwide acclaim (the total amount of vodka consumed throughout the USSR in celebration was never released by the CIA).⁴¹ In late December 1957, an RFP (Request For "a General Management Proposal") letter reached nearly 10 contractors requesting proposals by March 24, 1958, sent to the WPAFB Dyna Soar project office. The Preliminary Development Plan 464L was revised in August 1957 and issued on November 25, 1957.⁴² Listed participants



Bell's shops fabricated this "D" shaped boost glider cross-section test specimen and wing segment. This is its end-skeleton –the inner aluminum airframe structure later covered by the double-wall cooling system. Bell performed in-house thermal tests then delivered it to the Air Force. Top skin is temporarily attached by sheet-metal clecos prior to being riveted in place. (Bell Aircraft photo)

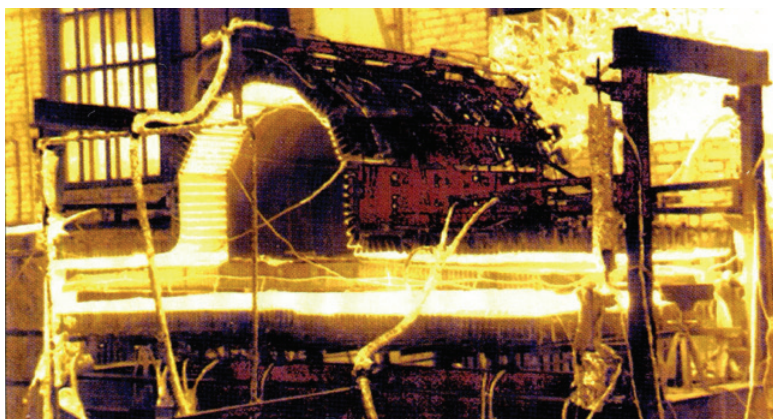
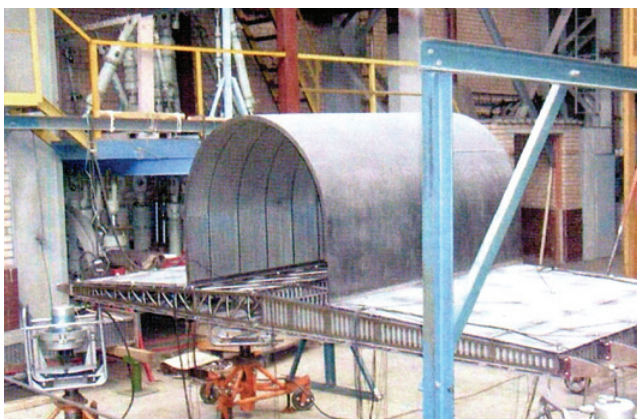


The completed jig-mounted Bell boost-glider specimen at the USAF Flight Development Laboratory-Structures Division Test Branch, WPAFB. Either high wattage radiant heat lamps or a newly developed heater sustaining temperatures to 3,000 degrees was applied. Close image examination reveals it was subjected to terrific radiant heat tests: the panels are severely discolored from heat. Image has been printed upside down to match specimen at left. (USAF photo)

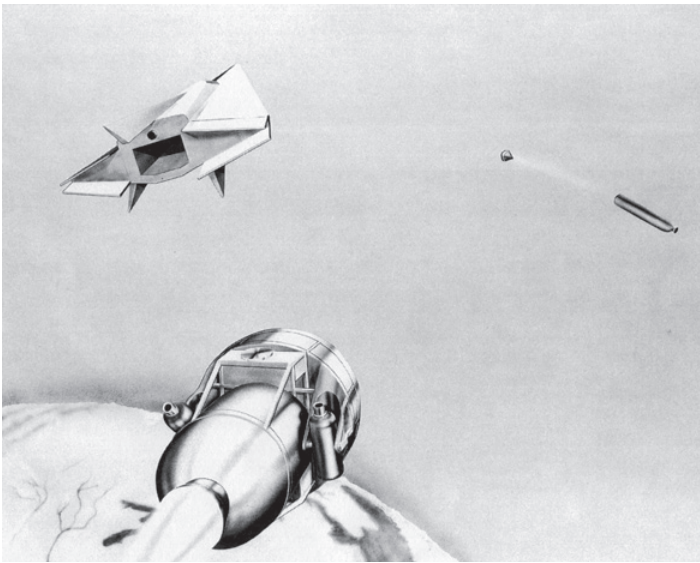


This Bell double-wall 32 x 40 inch flight test specimen is being fabricated for attachment to a B-58 upper-wing at Station 4379. The upper wing wheel well production fairing was modified and the double-wall panel fitted into it. It consisted of Haynes Alloy #25, and fibrous insulation enclosed in .002 Inconel foil packages. (Bell Aircraft photo)

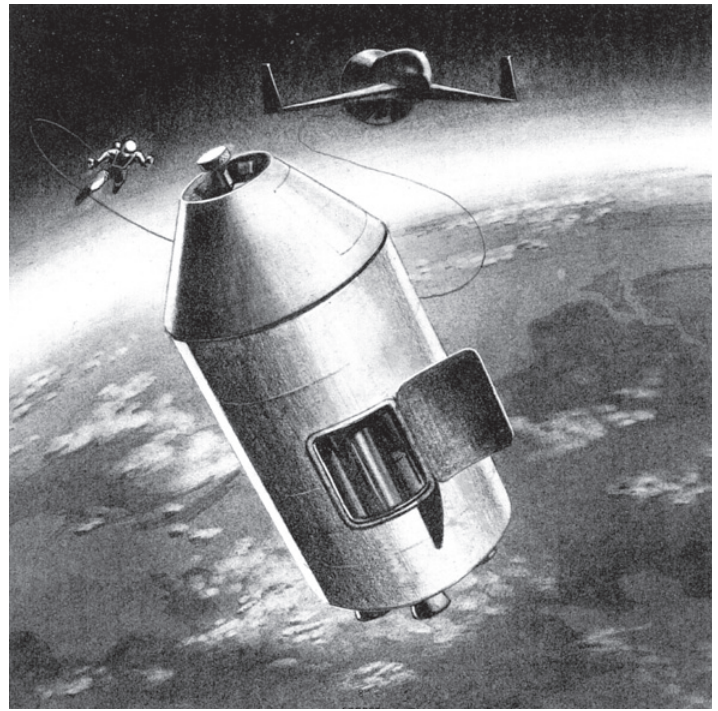
Republic Aircraft's 464L Dyna Soar I CTV model and one spine-mounted space to ground missile. The circle atop the nose opens and a sealed pod elevates the pilot into the slipstream to visually land the glider. (Model & Photo by Dave Stern)



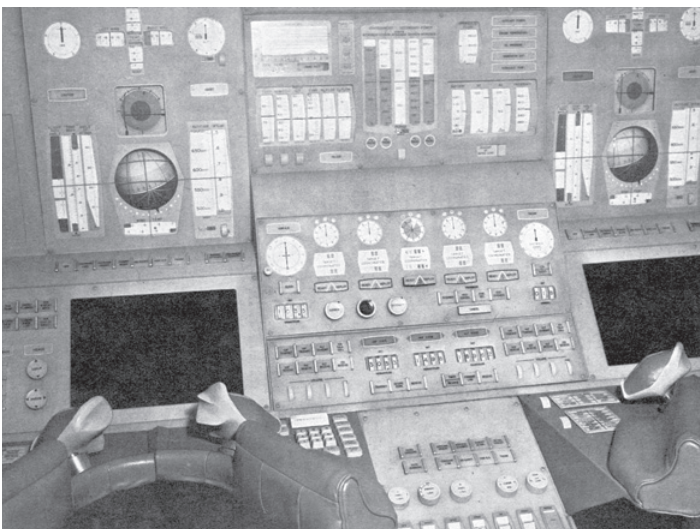
How coincidental. Mimicking Bell's work, the Soviets also tested a "D" shaped boost-glider cross section, also subjecting it to radiant heat lamps. Its structure is fabricated differently from Bell's but still, it's a copy of the Bell-USAf concept. Aviation Week did not publish any Bell specimen photos or drawings, unless they were published elsewhere. (Photo from Igor Afanasev)



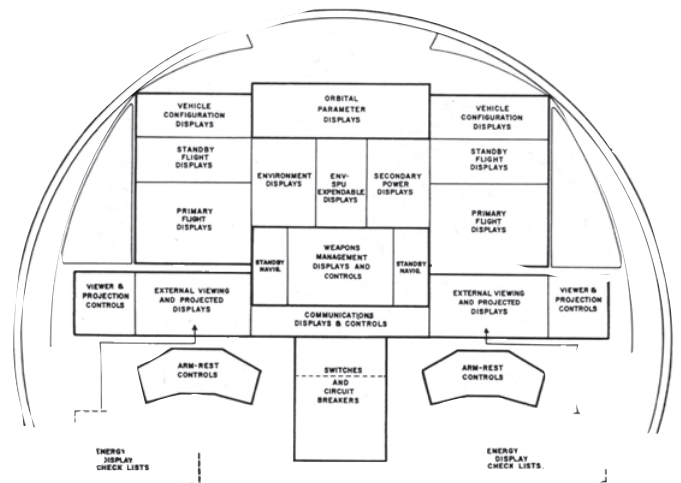
Boeing's Model 814-1010 initial Dyna Soar I depicted launching a missile at a detached ICBM warhead. Another model 1010 drawing of the external bay houses an "ASM," Air to Surface Missile. This depicts the initial 1010 DS-I CTV not as a research glider but a DS-III orbital bomber. Photo: USAF.



The Bell Martin-Bell unmanned Orbital Bombardment Station being serviced by a Space Force maintenance astronaut, while a "Dyna Soar Force" bomber with ASM weapons Trailer attached maintains station nearby. The nozzles beneath the station are the nose retro-rockets of each missile to reduce its re-entry speed. Bell engineers even created a one-man "Remora" maintenance pod to inspect and repair this and other orbiting military assets. (Martin drawing)



A USAF study contract to Lear generated this instrument panel for an orbital bomber with two crewmen. Lear's research placed the instruments to give pilot and co-pilot quick assessment of the bomber's systems and weapons. (Photo from the Dave Stern collection)

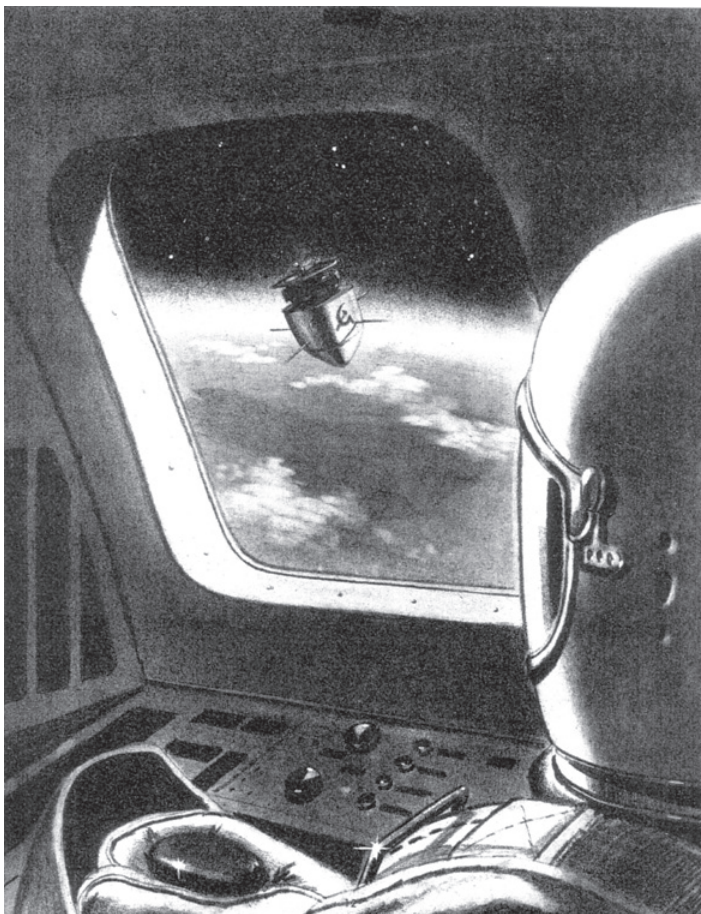


The Lear orbital bomber's various instruments are placed to allow quick, easy reading. The weapons panel is centered, with switches and circuit breakers beneath. This indicates the Air Force's serious intent to insert a permanent armed U.S. military force in low earth orbit. (Photo from the Dave Stern collection)

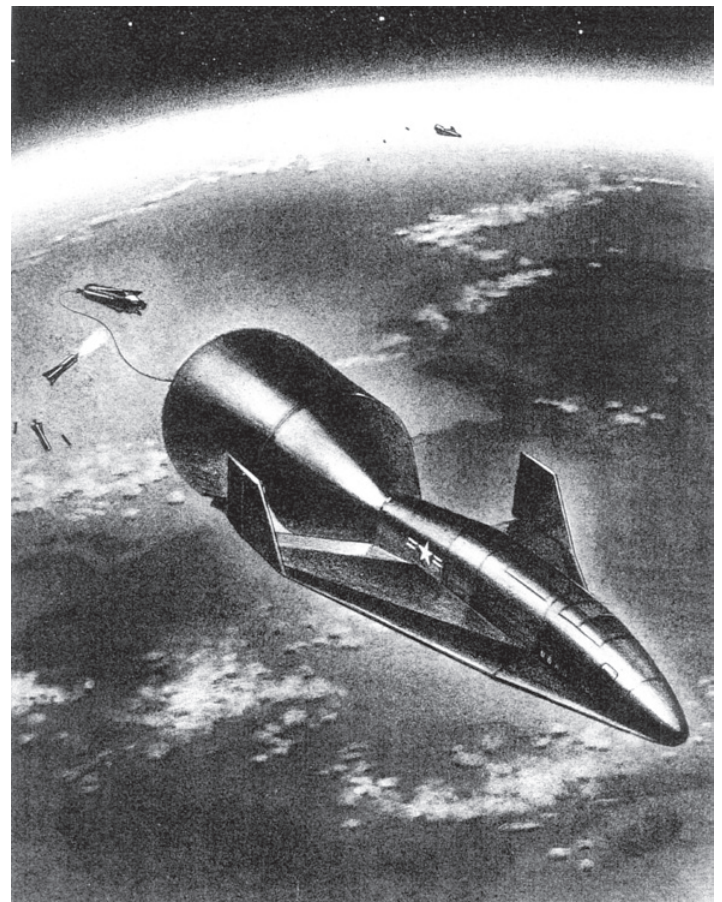


The Bell Martin-Bell "Dyna Soar Force" Orbital Bomber was an enlarged version of their April 1959 Dyna Soar glider configuration. The nose housed a large retro-rocket with a 3-man cockpit and just behind the cockpit, housed a large electronics suite with ASM warheads stored beneath it. Twin G.E. J-85-9 jet engines with retractable air intakes provided thrust for approach and landing. (Model & Photo by Dave Stern)

Another view of the "Dyna Soar Force" Orbital Bomber. The crew accessed the electronics suite-weapons storage through a tunnel crawl-way; beyond was another longer tunnel leading to the food-storage, exercise and sleeping area. The extreme rear of the "ASM Tractor-Trailer," housed the missiles, a pop-out doppler radar antenna and extendable silver-zinc solar cells for vehicle and equipment power while on station. (Photo & Model by Dave Stern)



An orbiting Dyna Soar astronaut inspecting a large Soviet satellite. The Soviets could easily have placed a proximity warning system with an explosive device on board, preventing U.S. Space Force personnel from inspecting, sabotaging, even retrieving their satellite, thus possible damaging or destroying the U.S. vehicle and crew. (Martin drawing)



Two Orbital Bombers sow their deadly load of ASM missiles in low orbit. One ASM is firing its nose mounted retro-rocket, while another is attached to the bomber's trailer by umbilical cord—a potentially dangerous situation, unless it has failed and is being retrieved. (Martin drawing)

were AMC (Air Materiel Command), NASA, ARPA (Advanced Research Projects Agency), the Navy and Army.⁴³

A news item reported that in December 1957 the USAF was studying five possible glider bomber proposals: Bell's BoMi, NAA's modified Orbital X-15A, Republic, Boeing and Martin also offered proposals believed to either fulfill SR-126 RoBo or the SR-79821 and SR-79822 orbital weapon systems.⁴⁴ The other news revealed the existence of a Soviet T-4A hypersonic glider project based upon the Sanger team's Amerika or Skip-Glide Bomber.⁴⁵

The USAF "jack-rabbit" response to Sputnik-I and Sputnik II with its shanghaied Moscow street mutt cum Cosmo-mutt Laika, surely caused the USAF Staff and Project officers to consume quantities of martinis, perhaps aiding in creating a plethora of USAF funded space project studies, known as SR or Study Requirements. Several aviation firms foresaw the birth of a highly lucrative space industry and internally re-organized to create new "space" departments in high anticipation.

Bell created the Space Projects group under its autonomously operating Niagara Frontier Division headed by Ray P. Whitman, with Dr. Dornberger, continuing as their Guided Missile Consultant.⁴⁶ In 1957 Glenn L. Martin changing its name to The Martin Company⁴⁷ created a Space Flight Division spinoff from its Research Institute for Advanced Study (RIAS)⁴⁸ headed by George S. Trimble.⁴⁹ Martin also funded a sinister sounding top-secret Littleton, Colo., research facility simply called "Force XXIV," that heavily researched spacecraft and spaceflight projects.⁵⁰ Boeing created an Aerospace Division and their Pilotless Aircraft Division (PARAD)⁵¹ appointing George Stoner as its weapons system manager.⁵² Dyna Soar's physical development history is far more extensive than published to date, thus it is excluded here. Some competitors acknowledged the three-phase Development Plan but Republic and Boeing's initial March 24, 1958 proposals presented weapons equipped Dyna Soar bombers: both obviously intent on impressing and influencing the Air Force Dyna Soar Project Office.⁵³

Both submissions were in effect, orbital bombers despite being presented as Dyna Soar I CTV research gliders. Interviews with its creator, William Walters, revealed that Bell Aircraft was "ordered" to combine with Martin Aircraft in order to enter the 464L competition. The two firms combined their respective Space Flight divisions to establish the BOMI Division of the Martin Company –an acknowledgement of Bell's pioneering boost-glider and structures research.⁵⁴

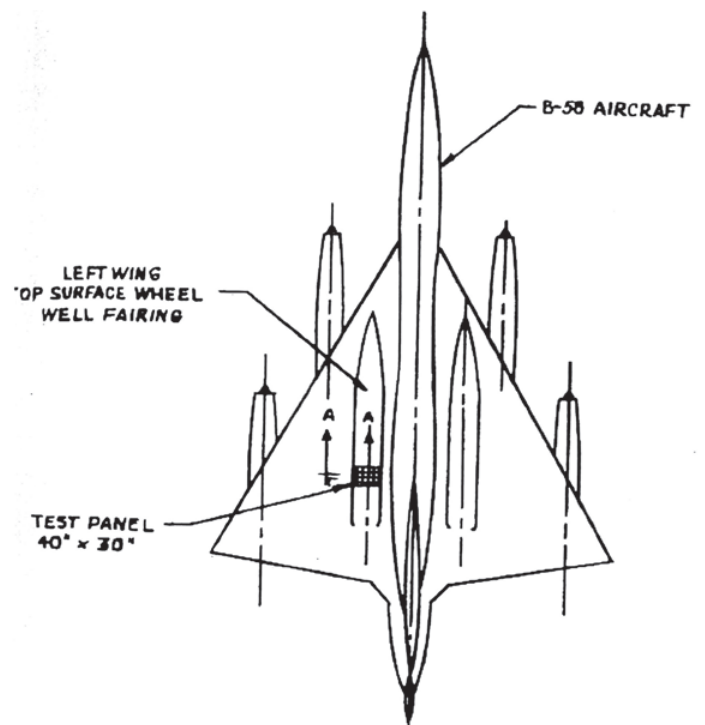
USAF STUDY REQUIREMENTS

The USAF Scientific Advisory Board (SAB) met at the Woods Hole Summer Study (1957 to 1958 before and after Sputnik I was orbited), with 60 to 70 participating scientists. After Sputnik II and Laika were successfully orbited, panel categories were reorganized to include military applications in space. This also provided the impetus to plan and propose establishing superiority in space with an actual armed "space force" commanded by SAC.⁵⁵ Lengthy discussions included military space projects with no concept being ignored or excluded: orbital bombardment platforms or stations, orbital stations and armed satellite interceptors were included in the discussions.

Meanwhile, the Dyna Soar competition between Bell, Martin-Bell and Boeing-Vought resulted in Boeing-Vought winning the coveted contract in April 1959. Martin was ordered to divorce itself from Bell and develop a series of Titan boosters for the Boeing glider. The USAF then implemented a determined lobby to control all military space-based weapons,⁵⁶ with support from its internal commands and divisions, but also extended their "space battleground" to 10 earth diameters into space (no "Space Marines" were mentioned).⁵⁷

USAF Staff and project officers intensely focused upon defining military space weapons, missions and vehicles necessary to conduct low earth orbit, cis-lunar missions extending to near Cis-Mars,⁵⁸ and other space operations.⁵⁹ SR contracts (Space Force and Operations) issued to industry were SR-79821, Strategic Low Orbit Bomber and a Strategic High Altitude Bomber above 20,000 miles⁶⁰ and "BOSS" (Bomb, Orbital Strategic System).

Other SR study contracts included SR-178 Global-Orbital Surveillance System (phasing into manned maneuverable "satellites"), SR-199 Positive Control Bombardment System, SR-187 Satellite Interceptor studies that generated SPAD and Black-Eye ray-weapon or radiation beam equipped satellite killers. Other studies included ASD-134038 Space Maintenance Proposals (astro-technicians or Space Mechanics) performing orbiting weapons maintenance and inspections,⁶¹ SR-79814 SLOMAR (Space Ferry), SR-182 Strategic Interplanetary System, and, gem of gems, the still classified and tightly controlled SR-181 Strategic Orbital System.



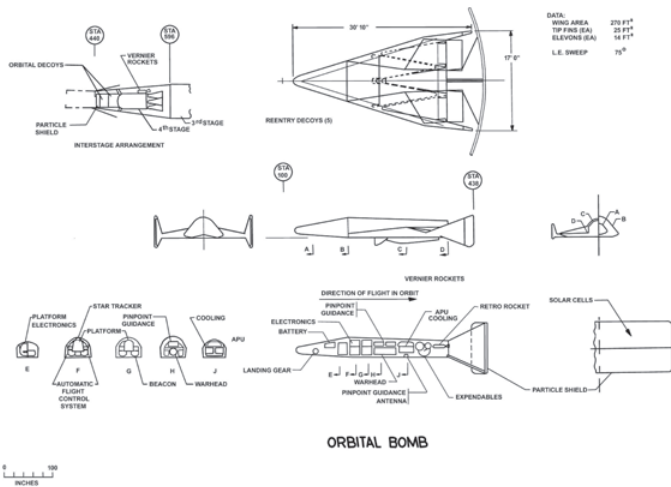
The B-58 Hustler drawing shows the location of the Bell double-wall test specimen tested up to Mach 2 during flight tests. The panel endured severe water soaking but reports state the tests were successful and proved the concept. (Bell Aircraft drawing)

SR-181 BELL AND MARTIN-BELL ORBITAL BOMBERS

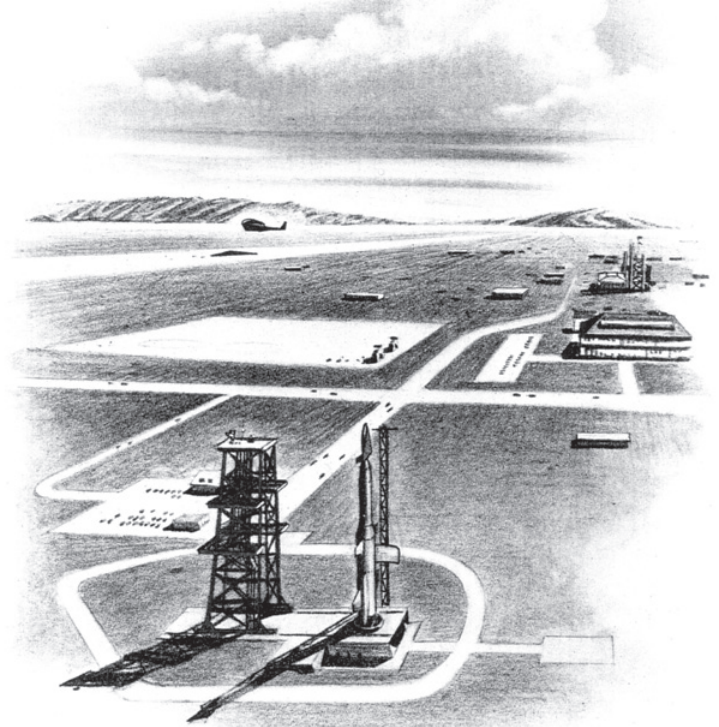
In response to USAF SR-79821, SR-79822, WS-464L Dyna Soar and classified SR-181 studies, Hans Multhopp (an Operation Paperclip German aeronautical engineer later a Technical Director of Martin's Space Flight Division), and George S. Trimble Jr. (V.P and General Manager, Martin Space Flight Division), assembled a radical Dyna Soar Weapons

system proposal.⁶² The unsolicited and informal proposal was submitted to the Guidance and Control Panel of the Scientific Advisory Board in April 1959 at the Wright Aeronautical Development Center WPAFB, Ohio.

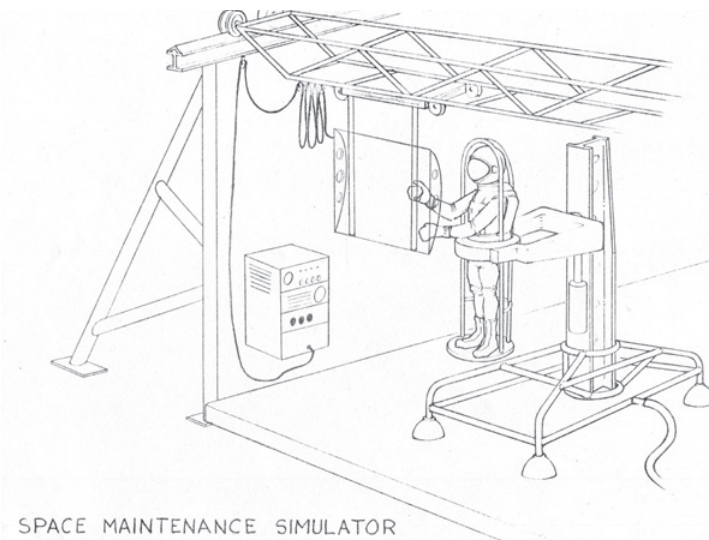
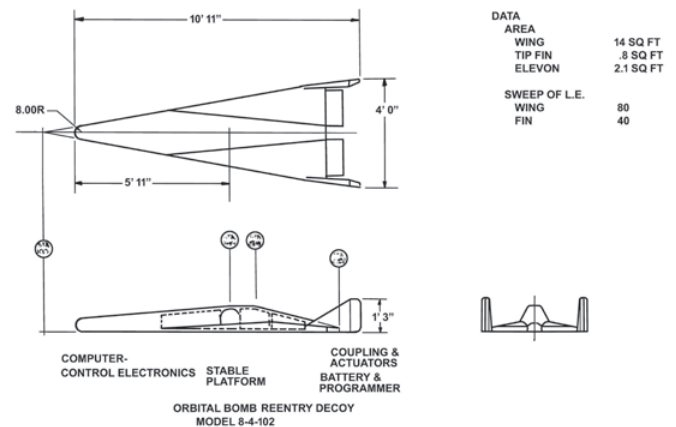
This "CEP Presentation" (Circular Error of Probability) with its orbital bomber proposals blended into the recently issued SR-181 studies underway by at least nine aircraft firms.⁶³



A Boeing unmanned Orbital Bomb with decoys based upon a boost-glider concept-flat bottom, severe wing sweep and cloned from Boeing's manned Dyna Soar glider series. (USAF drawing)



An Orbital Bomber returning to a proposed "soft centralized base" support for Martin's proposed continuous-alert mobile strike force dispersed and poised in orbit for quick retaliation – a "Dyna Soar orbital deterrence concept." Winged logistic ferries such as Martin's Slomar crew-change, supply and maintenance lifting re-entry gliders, would become SAC's spacecraft equivalent of the C-46 and C-47s of World War II fame. (Martin drawing)



Space Force maintenance were critical to maintain and service orbiting military weapons and assets. Aeronautical Systems Division issued a 1961 Request for Proposal (RFP) with two firms answering. Boeing's space maintenance simulator allowed limited actions and movement presents a technician working on a wing segment. It merely provided basic body actions and procedures whereas actual hands-on work experience would occur in orbit. Special tools would also be required to operate in zero-g conditions. (Boeing Aircraft drawing)

A Boeing "short-snorter" Orbital Bomb Re-Entry Decoy to confuse enemy radar by either heading for a target or simply gliding into enemy airspace. (USAF drawing)

The Bell, Martin-Bell designs were drawn from Bell Aircraft's BoMi, Brass Bell and SR-126 RoBo research and BoMi Division's Dyna Soar studies at Martin's Spaceflight Division. The initial bomber was the Bell, Martin-Bell piloted 9,000 pound Dyna Soar glider (Bell Martin-Bell's final competing Dyna Soar I configuration, carrying one nuclear armed OSM (Orbit-to-Surface Missile), aka; Air-to-Surface Missile) re-entry missile; ejected from the rear of the glide bomber.⁶⁴

Proposal two was a greatly enlarged 35,000 pound three-man Orbital Bomber called an "Air Alert System" placed in a circular orbit between 600,000 feet and 450 miles.⁶⁵ The attached "tractor-trailer," Martin's term for the Transtage housed crew quarters and five OSMs remaining on station for 30 days. Electrical power was provided by huge retractable solar panels: the trailer was jettisoned immediately prior to re-entry and left in orbit.⁶⁶

Configuration three was a 30,400 pound three man Manned Global Bomber or "Mixed Ground and Space Alert System," accomplishing a "once-around" (one complete orbit), at 400,000 to 500,000 feet or simply remaining on station for 24 hours.

Its "tractor-trailer" with living quarters also provided space for five OSMs. Configuration four was Bell's Model 7093 unmanned "Space Alert System" Orbital Bomber or Orbital Bombardment Station with five OSMs, but controlled from earth.⁶⁷ Yet another variant was a two-man Short Term Reconnaissance glider with a Transtage housing a maneuvering rocket engine, (a J-85-9 was the favored engine for many boost-gliders), a landing engine, the nose section and cockpit became a jettisoned crew escape capsule.⁶⁸

All required periodic inspection for foreign sabotage, meteorite damage and component failures and maintenance, hence the reason for astro-mechanics (maintenance experts), who would also operate Bell's proposed one-man Model 7052/7163 Remora, a space maintenance capsule.⁶⁹ An example is the historic in-place modification to the Hubble Telescope from a winged boost glider, the STS or Space Shuttle. The proposals were presented as attractive possibilities for a USAF "Dyna Soar Force," all versions launched from a fully equipped centralized "soft" (above ground) base.⁷⁰

BOEING SPACE WEAPONS

Boeing Company responded to the Air Materiel Command's request for proposals on SR-181 on April 28, 1960, with advanced military concepts operational between 1970 and 1980. Boeing, combined their offensive "Boss-Wedge," or Boss (Bomb Orbiting Strategic System) with their R464L Dyna Soar contract to present a plethora of weapon variations comprising "the Earth Orbital Military Space Force" (EOMSF).⁷¹

Boeing management stressed the establishment of a fully equipped military space force to attain space superiority, but constrained by current world situations and U.S. policies existing at the time. Their engineering team studies included Dyna Soar, Orbital Surveillance, Orbital Interception of Ballistic Missiles, a piloted Recoverable Booster, robotic winged re-entry bombs, winged decoys, and an orbital Dyna Soar command and control

vehicle. This included radical and exotic weapons referred to then as "death ray type weapons" to accomplish⁷² "Force missions." The EOMSF would be composed of Offensive systems, Defensive systems, Reconnaissance systems and the vital Support system.⁷³

THE BELL CONTRIBUTION

Dr. Dornberger correctly chose the unique and unorthodox Bell Aircraft Co. to present his proposals for a combination hypersonic winged reconnaissance-bomber aircraft with rocket engines. It was a genealogical progression from research by Dr. von Hoefft, the Sangers and the Peenemunde team's A-9 winged-piloted rocket gliders. Bell engineers initiated work in 1951 on this most difficult project at a time when hypersonic speeds were only achieved by unmanned missiles, and little data for a manned hypersonic vehicle did not exist. From 1951 through the 1960s Bell aircraft pioneered early boost-glider weapon systems vehicle concepts, their attendant aerodynamics and many years of research and testing of hot structure cooling systems and their construction. Bell Aircraft created a patented working "cooling and insulation system, engineered specialized in-house constructed machinery to fabricate and test difficult curved hot structure components for the NACA and Air Force. Structural engineer Wilfred Dukes sometimes accompanied by Frank Anthony, literally traveled the length and breadth of the U.S. (German and Switzerland too), presenting Bell's research work in hot structures, including the extremely critical leading edge cooling systems for winged gliders flying at sustained hypersonic speeds.

Naturally, Bell proprietary information and ARDC classified data were sanitized from Dukes's papers by order of ARDC. However Wilfred Dukes became Bell's unofficial engineering-envoy in this expanding field, throughout the 1950s and early 1960s. Thus, Bell Aircraft's hot structures work became well known and recognized throughout the aviation industry; they were literally the acknowledged experts in this field into at least the early 1970s. The author read numerous letters of genuine praise and congratulations from universities, institutes, metals firms and associated groups, other firm's structural engineers, the Pentagon, ARDC, several institutes, the American Rocket Society even aviation firms, who praised Mr. Dukes for excellent informative and well presented papers concerning Bell's structures research.

The USAF continued funding Bell hot structures research and proposals for various space craft into the 1970s. They provided valuable contributions that established the initial database for advances in hot structures. Credit is also extended to universities, the NACA cum NASA and other contributing researching entities that eventually led to the Space Shuttle and the classified USAF Boeing X-37B, an advanced winged boost-glider similar to its Boeing ancestor the original Model 844 series Dyna Soar gliders. ➔

BELL'S MACHINES, TOOLS AND PANELS

Period industrial machinery catalogs offered no specialized equipment to construct, assemble and thermal-test thin insulation blankets, panels and exo-skeleton test samples.¹ Bell engineers constructed and patented their own specialized in-house hot structures tools, fabricating equipment, test-rigs and fabricating techniques. Commercial equipment was modified to add flexibility in fabricating and assembling panels, small brackets, rivets and fasteners. They developed improved production, tooling and lofting methods for titanium, molybdenum and forming techniques for ceramics, cermets, and fasteners.

The structures shops operated a five-station multiple brazing unit – a “traveling furnace,” with specialized brazing tools and thin foil welding equipment.² Also developed was a resistance heated furnace, honeycomb tooling, clamping frames and patented resistance seam-weld machines with modified electronic controls for very thin foils. Specialized machines included a rotary seam-welder, pendulum welder, an improvised device uniformly filling insulation packages with powders, a plasma spray unit and a Bell modified rivet making machine, producing molybdenum rivets from wire slugs.¹ Outside purchases included a Callery Chemical Co. liquid metal evaporative cooling system loop to perform liquid sodium cooling tests, a Harper box furnace and Arcweld creep testing machine. The structures team engineered new methods of fabricating various metals and ceramic samples into complex curved panels, shapes and various bend radiuses for test panels.

A USAF-Convair agreement allowed Bell engineers to install and test a 40 x 32 inch full scale double-wall specimen

on the aft wheel well fairing on the upper wing surface of a B-58 Hustler. Eleven total flight hours with 1.5 hours of Mach 2.0 flight at 45,000 feet at a maximum dynamic pressure of 700 psf, and remained attached for another six months: the panel specimen test was judged operationally successful despite being totally water soaked during the tests.

Air Materiel Command Materials Processing Branch at WPAFB issued a 27 month contract in December 1959 for Bell Aircraft to construct a “D-shaped” representative center-section of a boost glider fuselage and wing specimen. The endo-skeleton was aluminum and covered by radiative cooling exo-skeleton panels of 12 x 12 x 0.25 inches. They were believed to be Haynes Alloy Number 25 (L-605) and brazed honeycomb configurations in both flat and single curvature panels. Upon completing the boost-glider center section, Bell engineers conducted in-house thermal tests and delivered the specimen to WPAFB Structures Division’s Structures Test Unit for thermal re-entry simulation tests spanning 150 Degrees F to 3,000 degrees F.

Bell engineers completed a double-wall cooling system study to be grafted to the forward fuselage and detachable ventral fin of the X-15, but this appears not to have occurred. In late 1960 Bell structures engineers offered a Technical and Management Proposal; they engineered an adapted version of their double-wall cooling and insulation system to Boeing’s wining Model 814-1050 Dyna Soar. Wilfred Dukes in a letter to the author stated that his engineers visited Boeing’s Dyna Soar engineering team in Seattle, Washington. The team did not feel welcome and received the “cold-shoulder” treatment!

Endnotes

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