Breakthrough Heralds Dawn of the Age of Single-Stage-to-Orbit Spaceplanes

by Michael James Carr

The mind is not just the mind of man; the mind that's a superior mind is the mind of the universe, the mind that organizes the universe—the principle of universal anti-entropy, of which the human mind is a reflection. And no animal that we know of has any such reflection—only the human being.[1]

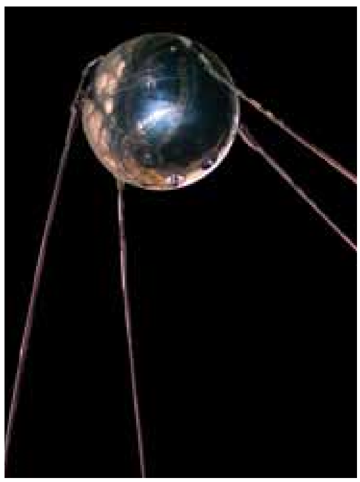
—Lyndon LaRouche

June 3—The process of man becoming aware of the mind which "organizes the universe," is the first step by which the mind which "organizes the universe" pursues the process of perfection—self-consciously. Put another way, God *intended* man to fill the universe and subdue it. So pursuing scientific research and development, spreading mankind's dominion across the universe is not just a hobby or nice idea, it is the purpose of intelligent life. (Yes, I am speaking to *you*.)

The good thing about this is that we will never run out of work to do!

Just now a series of processes is coming together (in many respects according to outlines long promoted by Lyndon and Helga LaRouche) to develop and apply the full mind-power of the soon-to-be eight billion souls on the planet, not only to develop Earth, but to begin to accelerate the spread of mankind and man's dominion across the universe. The British Empire or the "British Entropy" is being outflanked and superseded by a New Paradigm of anti-entropic initiatives increasingly resonating and self-reinforcing across the continents—even inside Old England itself. In this article we will discuss the technological breakthrough which promises the near-term breakout of civilization from the grip of Earth.

This fall, a revolutionary new air-breathing rocket technology will be tested under simulated full-flight conditions at a new testing facility in Colorado. This new technology promises to make possible the creation of the long dreamed of aerospace plane—a single-stage-to-orbit, winged vehicle able to routinely fly from a runway all the way to Earth orbit and back, without the assistance of booster rockets or staging—a true "aerospace plane."



U.S. National Air and Space Museum

A replica of Sputnik 1.

Some Background

The idea of an aerospace plane seems so simple. In 2016, the world's airlines transported 3.7 billion passengers, and the number of passenger trips continues to grow phenomenally. In 2017, not one fatality occurred in passenger airline service worldwide. You may be safer flying at just under the speed of sound at roughly 10 kilometers altitude (33,000 feet) than you are sitting in your living-room, reading this article.

Global air transportation has come a very long way. So why haven't you been able to just hop a flight straight into orbit? In his autobiography, *Forever Young*, Astronaut John Young put it this way:

> In imagining how humans would voyage to the Moon and the planets, nearly all the pioneers of rocketry—Tsiolkovsky, Oberth, Goddard, von Braun—had envisioned the value of a staging base in Earth orbit. . . . But Sputnik changed all that. That blasted little Russian satellite turned everything inside out. The country went crazy. It totally changed what we were going to do in the aerospace field. Without the Russian "first," which so traumatized American society, the first American astronauts would likely have flown back from space on the wings of a hypersonic glider; that was what the researchers in the National Advisory Committee for Aeronautics [NACA], NASA's predecessor, had been working on since the mid-1950s. Yes, instead of plunging into the ocean in a ballistic capsule, America's original astronauts would have traveled to space and back in a landable

space plane akin to a small space shuttle. And NASA probably would not have even come to life; we'd have been happy continuing with the ol' NACA.[2]

In 1944, the NACA and the U.S. Army Air Forces began to look into building an experimental rocket plane for aerodynamic testing of piloted supersonic flight. In 1945, the contract was let to Bell Aircraft to build the X-1 (X for experimental). In 1947, a Bell X-1A, piloted by Chuck Yeager, became the first piloted vehicle to exceed the speed of sound (Mach 1) in level flight. Over decades, a series of X planes followed, many of which pursued expanding the envelope of speed, altitude and control possible under piloted flight. Many of the X planes were rocket planes dropped from carrier aircraft.[3]

NASA

Bell X-1

Thus it was both the intention, as well as the natural expectation, that if you could get a carrier aircraft flying high enough and fast enough to launch it, building a rocket plane capable of taking people to orbit seemed to be the natural road to space. Indeed several X-15 flights achieved altitudes above the official edge of Space at 118 km (73 miles), although the X-15 had nowhere near the power necessary to orbit the Earth. So, a two-staged winged system to orbit seemed within grasp.

The logical development course of "bigger, faster, higher" winged aircraft, proceeding on to Earth orbit, with the concomitant development of a space station and interplanetary infrastructure, was circumvented because in the Soviet Union, the Soviet military required a massive rocket to deliver its very, very heavy nuclear weapon to North America. Rocket genius Sergei Korolyov was able to stretch the Soviet military requirement into a reluctant permission from Khrushchov to orbit Sputnik. Creating an artificial satellite had been a life-long goal of Korolyov, as of his predecessor, the Promethean Russian space pioneer, Konstantin Tsiolkovsky.

Once Korolyov had done it, Wernher von Braun was allowed to do it for the United States, and then Korolyov launched Yuri Gagarin—and the so-called space race began. There were miraculous achievements on both sides—but something was lost along the way. Blasting off atop a huge cylinder filled with propellant, to later return by crash-landing a crew capsule in the ocean under a canopy of parachutes, could never become "normal."

Of course, it must also be added that, without the impetus coming from the audacious actions of Russians like Korolyov and Gagarin, the British Empire/Wall Street interests might never have allowed successful completion of American efforts to create hypersonic aerospacecraft capable of taking people to orbit and back on wings. This has been a complicated process, generally involving overcoming imperial political sabotage from the defenders of entropy, more than overcoming problems of technological development (though the technical problems are huge).

To attain Earth orbit, a vehicle must reach a velocity of roughly 28,400 kph (17,640 mph) which is roughly Mach 26, at an altitude of at least 193 km (120 miles)—merely to remain aloft for at least a few orbits. That is roughly 35 times the speed of your commercial jetliner, at roughly 17 times the typical cruising altitude. The American Space Shuttles and the Russian *Buran* shuttle demonstrated the ability to orbit winged spacecraft to maneuver and land, using variable combinations of aerodynamic controls and small maneuvering rockets. The NASA/USAF X-37B aerospacecraft continues to use that winged landing technology.

The fundamental issue always has been, and still is propulsion. For as long as we are limited to using chemical reactions to generate thrust, we have been unable to fly a single integral or unitary vehicle into orbit without shedding portions (or stages) in order to shed weight to allow the vehicle to attain orbit. The power densities of rocket fuel/oxidizer combinations are so low compared to the requirements, that huge volumes of vehicle space are needed for the chemical reactants. Thus, the great weight involved in both the propellants themselves and in the expansive housing necessary to contain them and support the rest of the vehicle's mass, have left no alternative to staging—until now.

During the 1960s, looking past the Mercury, Gemini, and Apollo programs, engineering thoughts returned toward using the knowledge developed via the X plane research to build a winged spacecraft. In spite of the proponents of entropy—who precluded, in some critical cases, the use of the best engineering solutions (to save money, which in the end naturally cost more money plus lives)—the space shuttles did develop the science of aerodynamics for controlled (winged) flight all the way from Mach 26 on down to touchdown. But ascent was accomplished via a three-stage vertical launch system.

In 1986, President Reagan called for the development of a National Aerospace Plane able to achieve orbit, and then fly back to a runway, without external boosters, tanks, or stages. This would require a revolution in propulsion. How could you integrate the various types of propulsion necessary into a single vehicle? This was the problem facing the X-30 project.

A turbojet can take you no further than from a standstill to somewhere around Mach 3+ to Mach 3.5. NASA's X-43a test vehicle demonstrated a capability for sustained scramjet (supersonic combustion ramjet) propulsion at Mach 9.6. However, no ramjet (in which incoming air is burned at subsonic speeds) or scramjet (in which combustion takes place at supersonic speeds) can begin operation from a standstill. Ramjets operate efficiently from around Mach 2 to around Mach 6. A

Precursors and Limitations

public domain

The Lockheed SR-71 Blackbird (above) holds the speed record for a manned turbojet aircraft—around Mach 3 (officially recorded at 3,529.6 kph or 2,193.2 mph). This record was set in 1976 and appears to represent a sort of speed limit for turbojet aircraft.

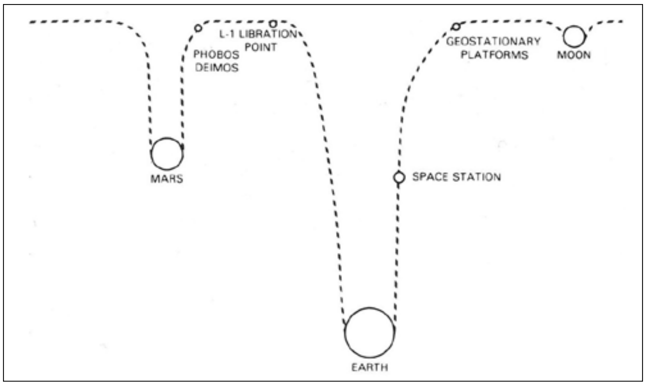
NASA artist's rendition

In 2004, the unmanned NASA X-43A scramjet (supersonic combustion ramjet) test vehicle posted an air-breathing speed record of 12,144 kph (7,546 mph), roughly Mach 9.6, after having been dropped from a B-52 carrier aircraft and boosted by a rocket engine to an initial high altitude and velocity.

The X-15 manned rocket plane, also dropped from a NASA B-52 carrier aircraft, achieved the status of being the first spaceplane, as some of the flights passed beyond the officially recognized "edge of space." The pilots of those flights received Astronaut wings, although the X-15 had nowhere near the power necessary to achieve orbit. Yet in the western world it had been thought that this approach would eventually lead to human space travel. The Soviet requirement to launch very heavy nuclear weapons gave Sergei Korolyov the opening to build a rocket capable of putting a satellite into orbit—thus Sputnik. The western world had to change tactics to catch up. In America, Wernher von Braun was finally allowed to launch a satellite atop his U.S. Army Redstone rocket. The seemingly more natural development of "bigger, faster, higher" winged flight, was soon supplanted, as human beings were placed atop military launch vehicles. Here Neil Armstrong poses in front of an X-15 after completing a flight.

NASA

Continued on next page



Pioneering the Space Frontier, Bantam Books, 1986.

One way to think about this problem graphically is with the concept of "gravity wells." It illustrates the old adage that "Once in orbit, you are halfway to anywhere." From geosynchronous orbit, or from the Moon, very little effort is required to go vast distances into space. However, just attaining low Earth orbit (shown here by the Space Station circle) is a huge undertaking.

scramjet already needs to be traveling at about Mach 4 to be able to operate. So, to build your hypothetical spaceplane, you would need a rocket, a turbojet, or perhaps a very, very long and fancy catapult to get the vehicle up to a speed at which a ramjet or scramjet could begin to operate.

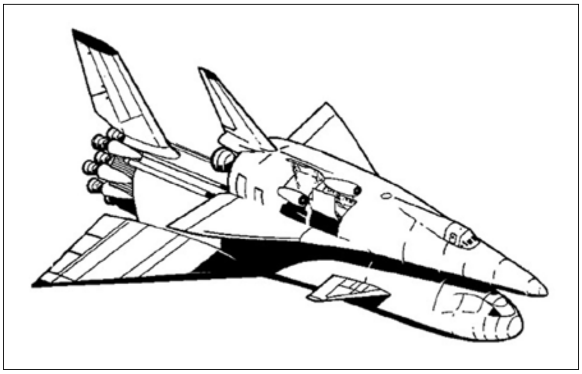
Thereafter, of course, you would also need a rocket engine to operate from the "edge of space," where oxygen levels are inadequate for a scramjet, on into orbit. This becomes very complex and heavy. Work is ongoing in the United States and China to figure out ways to create "combined cycle engines" which incorporate turbojet/ramjet/scramjet technologies into a single engine. Although it poses very difficult challenges, this is another area in which LaRouche's Third and Fourth Laws must be used to finance these cutting edge efforts.

The X-30 project, while making advances in many areas, could not achieve its objective without major increases in funding and actual flight testing. It would not be a cheap, simple process. The resources were not made available and the program had fizzled out by 1994.

In 1986, the same year that the X-30 project was proposed, and in the wake of the *Challenger* disaster, the National Commission on Space released its report,

Precursors and Limitations

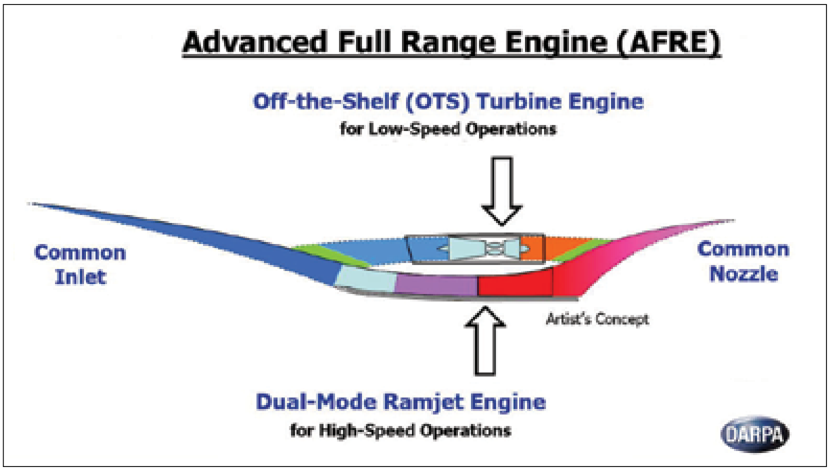
Continued from previous page



NASA

The early designs for NASA's shuttle program were based upon the idea of a completely reusable two-stage fly-back system. Here is a 1972 rendering of the North American Aviation-General Dynamics proposal (above). As soon as its boosting mission was completed, the liquid-fueled booster would fly back to the runway near the launchpad; the orbiter would also land on that runway. But budget cuts left only a modified orbiter relatively intact. Short-sighted budget cutting and other political constraints (along with compromises required to satisfy both military and civilian users), undermined its potential safety and reusability—not to mention increasing the actual economic (as opposed to merely monetary) total cost per flight.

The U.S. Defense Advanced Research Projects Agency (DARPA) recently let a contract to Aerojet-Rocketdyne to develop a Turbine Based Combined Cycle Engine. This engine must transition from turbojet, to ramjet, to scramjet propulsion as its speed increases. China, where scramjet research is being pushed forward intensely, intends to flight test such an engine by 2025.



DARPA

Pioneering the Space Frontier.[4] This study laid out an overview of a space infrastructure stretching out to a manned base on Mars, much along the lines advocated by space pioneer, and friend of Lyndon and Helga LaRouche, Krafft Ehricke. Among the important points developed in this report are these:

• It is "imperative that the United States maintain a continuous capability to put both humans and cargo into orbit; never again should the country experience the hiatus we endured from 1975 to 1981, when we were unable to launch astronauts into space."

• We "must separate the functions of one-way cargo transport from the round-trip transport of humans and high value cargo to and from orbit."

• "The Commission sees two essentially different but complementary means to cost reduction. One is *the introduction of new concepts and technologies that lead to fundamentally more efficient systems*.... The other is a process of systematic design improvement and evolutionary development directed at reliability and low operating cost...." And "The sooner the private sector can assume responsibility for design, specification, development, fabrication, flight test, production, and operation of space vehicles and launch and landing facilities, the sooner the United States can begin to pattern Earth-to-orbit transportation after commercial airline operations."

The report laid out the necessity of an intense project to develop an aerospace plane—integrating the multiple propulsion technologies into a single vehicle. These technologies would allow for putting people into orbit, but also for commercial passenger travel anywhere in the world within a two-hour flight.

But all of the long-term work towards an aerospace plane technology was dropped under the assault of the forces of entropy. Instead of intentional progress, "the magic of the market" was to decide what would be done.

Once the International Space Station (ISS) was completed in 2011, the shuttle program was shut down. Since 2011, American astronauts have had to ride Russian Soyuz spacecraft to and from the ISS.

The parallel revolutionary/evolutionary approaches (the key to any technological advance) were replaced with simply evolutionary development of existing technologies.

So the revolutionary work of NASA was put on the back burner; evolution was promoted. NASA was put into the role of consumer of services (whether from Roscosmos or commercial launch companies), instead of producer of new technologies to advance space travel and to power economic growth.

To "save money," NASA was forced to make proposals based upon "off the shelf" technologies (in the case of the Space Launch System, even actually using the same Space Shuttle main engines designed in the 1970s and first flown in 1981!). Of course this is economically backward. It is the research and development of new technologies which transforms the means of production and provides major advances to society—as with the Apollo program.

It seemed as though, under the Bush/Obama administration, scientific, technological and economic progress had ground to a halt.

A Solution Coming from Britain?!!!

For all the problems Americans have faced in attempting to push technology forward, these problems pale to insignificance in comparison with those faced by Britons attempting to develop technology in Britain—in the heart of the anti-progress British Empire (sometimes called the British Entropy).

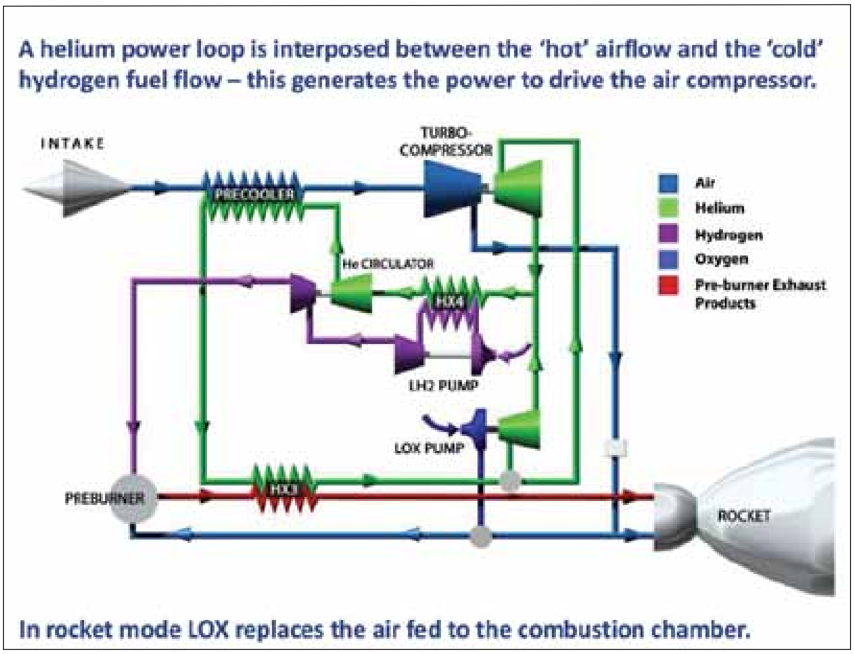
British engineer Alan Bond, who began building rockets as a boy, worked during the late 1960s in rocket engine development for Rolls Royce, which culminated in the Black Arrow project. Black Arrow was the first and only satellite launch vehicle developed in Britain—already canceled three months before its first and only satellite launch in 1971.

On his own, Alan Bond had been looking for every possible way to build better rocket engines. He was the lead author of a 1970s study by the British Interplanetary Society, for a fusion-powered rocket capable of reaching nearby stars within a 50-year time frame. But the dream of nearly every aerospace engineer is to build a Single Stage To Orbit (SSTO) vehicle—especially a winged one allowing normal, relatively gentle aircraft-style operations to orbit and back. This is not possible with the technologies in use today. Many believed that such capabilities were impossible short of using very energy-dense nuclear fission or fusion power sources for propulsion.[5]

While working later at British Aerospace (BAE) and looking at nuclear thermal rocket engine (NTR) designs, Bond had the idea of looking into the possibility of replacing the NTR hot exhaust gas with hot ambient air scooped up along a rocket's ascent. In an NTR, heat from a nuclear reaction is used to warm a gas to extreme temperatures. The heated gas is then ducted to a nozzle to create thrust. In all such designs, the gas is initially stored as a cold liquid to keep it in a dense form and to use it for cooling of the combustion chamber/nozzle as necessary.

What if you used air, instead of a liquefied gas? In a chemical rocket, could you make ambient air cool enough and dense enough to replace liquid oxygen? Assuming you could quickly do this, how would you prevent ice from gumming up the works within a few seconds?

In 1984 Bond had a meeting with John Scott-Scott and Bob Parkinson. Bob Parkinson at BAE had been working on a concept for a reusable space plane, and John Scott-Scott had been working on propulsion systems at Rolls Royce.



Richard Parker of Reaction Engines, Ltd.

A schematic view of the flowing circuits within the engine.

The three put together an outline of a reusable single stage robotic Horizontal Take-Off and Landing (HOTOL) space plane, to be a successor or competitor to the NASA Space Shuttle system (although on a smaller scale). Parkinson was able to spark an interest at BAE and in the British Government. However, as development progressed, significant problems were discovered—both in the air-breathing engines and in the vehicle's overall airframe design. Instead of allowing the problems to be worked out, the British Government canceled all funding.

When Bond attempted to get the European Space Agency (ESA) to take up the project, the British Government classified Bond's patented HOTOL engine design as Top Secret under the State Secrets Act. Bond could not (and still cannot) even talk about his design with fellow Britons—not to mention foreigners.

After the HOTOL project cancellation, Bond went to work at the Joint European Torus (JET) fusion research project at the Science Centre in Culham, England. Bond began to use JET's computer systems to model every conceivable configuration of an air-breathing rocket engine. The biggest hurdle was to be able to cool the incoming air down from around 1,000° to –150° Celsius in a few milliseconds (in Fahrenheit, from 1,832° to –238°). How can you do that without icing up your whole system within a few seconds?

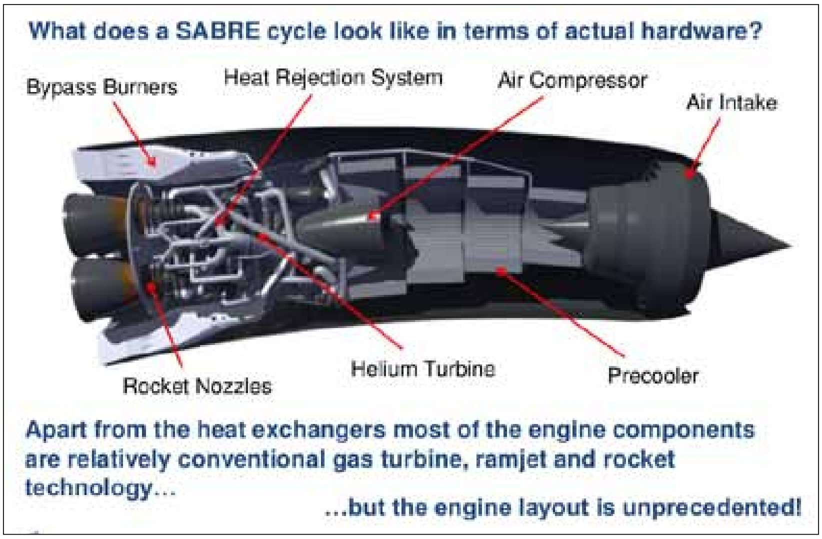
In 1989, Bond, Scott-Scott and Richard Varvill started Reaction Engines, Ltd. at Culham, adjacent to the JET project, to continue work in this direction. It took 15 years to make a breakthrough.

In the end, Bond and his team found a way to solve the icing problem.[6] The team discovered a way to use a methanol anti-freeze in small quantities flowing *against the incoming stream of air into the pre-cooler or heat exchanger, and to collect the anti-freeze and reuse it.* The engine also uses a separate helium cycle to propel the air compressor. Every effort is made to use every last bit of available energy in the engine to provide thrust. In its entirety, the engine design is known as the Synergistic Air-Breathing Rocket Engine (SABRE).

Aviation Week and Space Technology[7] reports that the USAF Research Laboratory independently validated this technology in 2015, and that this fall, under a Defense Advanced Research Projects Agency (DARPA) contract, Reaction Engines Ltd. will put the pre-cooler (or heat exchanger) through full flight simulation conditions at a test facility being readied in Colorado. *Aviation Week* has further reported that Boeing, Rolls Royce, and BAE have invested large sums in Reaction Engines.

Reaction Engines, Ltd. is now working to build the SABRE engine. They are not building any spacecraft or aircraft, but they have conceived of a spaceplane design which would accomplish what has hitherto been impossible: to achieve runway takeoff to orbit, and back to runway operation, without having to shed stages, tanks or booster rockets. Their concept, called Skylon, solves the problems found in the HOTOL design, and promises routine robotic airline-style, high utilization rate operations to service space stations and to orbit satellites.

Reaction Engines, Ltd, while it is steadily growing,



Richard Parker of Reaction Engines, Ltd.

An overview of the SABRE engine design.

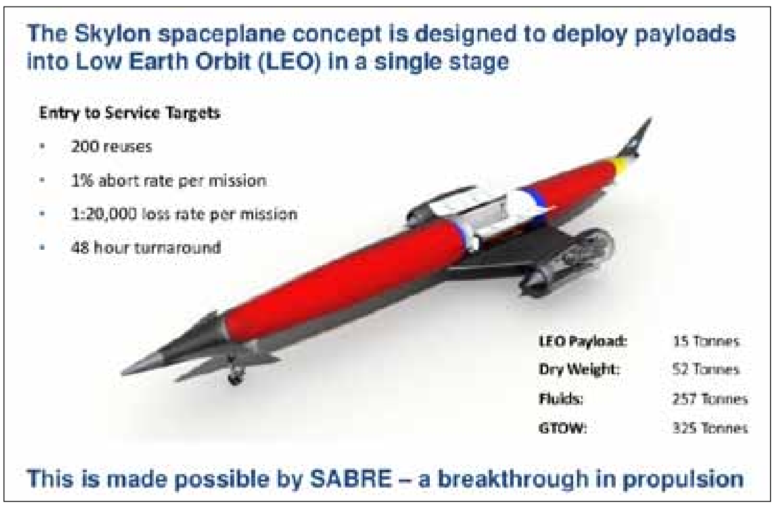
is a small company. It will have to partner with much bigger aerospace airframe and propulsion companies around the world to bring the promise of its technology into broad use. It is one more demonstration that, in the New Paradigm being brought to life around the world, conquering space will involve all of Mankind.

The typical flight profile would use ambient air to burn onboard hydrogen up to about Mach 5.5 and up to about 26 kilometers (85,000 feet) of altitude, whereupon—in the absence of significant ambient oxygen—the engine inlets would close and onboard liquid oxygen would be fed into the engines until orbital velocity is achieved. It is the air-breathing process from 0 to Mach 5.5 which is about to be tested in Colorado.

Most important, such technology would make space travel a normal aspect of human activity. Blasting off atop a huge cylinder filled with propellant, and crash landing in the ocean under a canopy of parachutes will never become "normal." Instead of requiring crew and passengers to endure high G forces involved in ballistic ricket launches and returns, we want passengers to gently accelerate and decelerate to and from orbit with all of the inherent safety and other advantages of wings. Skylon or some other spaceplane promises to achieve this long-sought "Holy Grail" of human space travel.


Richard Parker, Reaction Engines, Ltd.

Skylon in orbit.



Richard Parker, Reaction Engines, Ltd.

Cutaway view of Skylon. Notice the long, red hydrogen fuel tanks and the very small blue oxygen tanks next to the payload bay.

As mentioned earlier, since the Challenger disaster in 1986, it has been recognized that it were probably better to separate heavy-lift launches from human spaceflight. Every human being is irreplaceable and should have the safest, gentlest pathway to and from orbit. Risks, high-G forces, huge volumes of propellant, and the historical 2% failure rate, should be, as much as possible, limited to separate heavy-lift freight systems.

Vehicles such as the Skylon should not be considered alone. They are just a part of a full space transportation system as outlined in the writings of space pioneer Krafft Ehricke and in subsequent studies.

Such a system also needs heavy lift systems; transfer stations orbiting Earth and relatively close-in destinations such as the Moon and Mars; space tugs shuttling between the transfer stations; and descent/ascent vehicles for travel back and forth between the transfer stations and their respective terrestrial, lunar, and martian surfaces. Much of the propulsion outward from Earth-orbiting transfer stations will depend upon fission- or fusion-powered thermal or electric engines (engines that use magnetic fields to accelerate particles through an exhaust nozzle at a high fraction of the speed of light).

The most difficult problems, however, are associated with first attaining Earth orbit.


Reaction Engines, Ltd.

Of course SABRE engines can also be applied to many kinds of commercial and other hypersonic applications that require reaching any place on Earth in just a few hours. Here, a hypersonic airliner concept along with a Skylon orbital vehicle.

Conclusion

It is fortunate that Alan Bond and his collaborators have been able to survive and overcome all of the suppression and difficulties encountered over recent decades to accomplish an important task facing humanity. It is fortunate that industry heavyweights like Boeing, Rolls Royce and BAE are investing in this technology. However, to effectively impact society, large-scale Federal credit, along with U.S. Federal Government sponsorship, must again be applied to this area, according to LaRouche's Four Laws.

We require a commitment to a crash program development of a Skylon demonstrator—followed by deployment of the SABRE engine technologies into derivative and related uses. This is possible within 5 to 7 years. At the same time, similar efforts must be devoted to other systems of space transportation. The scale of investment required in these areas is beyond anything private companies can accomplish. As with the International Space Station, a division of labor can be worked out among partner nations to ensure successful building of the entire space transportation system out to the Moon and Mars. But this time, we should be sure to include our friends in China, who are striving in this area. There will be plenty of good work for all, if we push through LaRouche's Four Laws. Investment must replace speculation! In this way we will truly reflect the "mind that organizes the universe."

Footnotes

1. "Mind Is the Principle of the Universe," *Executive Intelligence Review*, Vol. 37, No. 41, October 22, 2010, p. 15.

2. *Forever Young*, by John W. Young with James R. Hansen, Gainesville: University Press of Florida, 2012. See Chapter 21, "The Next Logical Step."

3. For a very good overview of the history of hypersonic flight, see "NASA's Hyper-X: Hypersonic Flight Ready for Takeoff," by Marsha Freeman, *21st Century Science & Technology*, Fall 2001, pp. 40-47, http://21sci-tech.com/Subscriptions/Archive/2001_F.pdf

4. *Pioneering the Space Frontier: The Report of the National Commission on Space*, Bantam Books, 1986, https://www.nasa.gov/pdf/383341main_60%20-%2020090814.5.The%20Report%20of%20the%20National%20Commission%20on%20Space.pdf or: https://history.nasa.gov/painerep/begin.html

5. The recent announcement by President Putin of Russia, that Russia will have a nuclear-powered cruise missile capable of remaining in flight almost indefinitely, points to the sorts of power densities available to nuclear-based engine designs. It also reflects the fact that fission and fusion designs are generally considered the best propulsion designs for interplanetary or interstellar long distance flight out past Earth orbit. (See "The Promise of Fusion Rocketry," by Joel DeJean, *Executive Intelligence Review*, July 21, 2017, Vol. 44, No. 29, for a report on an ongoing fusion rocket development program in Princeton.) There are important potentials in fission/fusion propulsion which need to be developed with direct Federal Government support on a large scale, in concert with broad crash-program support for development and deployment of fusion-based electrical power (as outlined in the fourth of LaRouche's famous Four Laws). However, it is likely that all of the technologies to which we refer in this report will be used in one or another situation well into the future. Each technology has unique advantages in particular situations.

6. "Reaction Engines Reveals Inner Secret of Sabre Propulsion Technology," by Guy Norris, *Aviation Week & Space Technology*, July 13, 2015.

7. "Turbojet Runs Precursor to Hypersonic Engine Heat Exchanger Tests," by Guy Norris, *Aviation Week & Space Technology,* May 15, 2018.