Spiral Version 1.01

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Thanks to:
Hendo, for the CVEL Soyuz and Proton (not included)
Hendo and Daver, for the CVE-Lite code on which this is based.
Scott Oehlerking and the Gemini team for the Gemini seat mesh.
The Gemini team, again, for the ejection seat which I've borrowed without change.
Rodion, for the Gemini EVA astronaut mesh.
Christophe Chabot, for the RealExhaust texture.
Kev33, for the Baikonur runway, and the Tu-95 (not included)

And, above all, many thanks go to Martin Schweiger, for actually developing the simulator I used to daydream about in astrodynamics classes!

http://www.orbitersim.com

Unpacking:

Use Winzip to put each subfolder in its matching Orbiter folder.

For this add-on, Velcro Rockets and the CVEL-Proton-K are recommended (not included) if you want to run the scenarios involving those launch vehicles.

Kev33's Tu-95 (not included) is required to run the test drop scenarios.

Rodion's Gemini astronaut mesh is included, but is renamed to reference a Soviet flag texture. It will not overwrite any of your files.

The RealExhaust.dds texture is also included.

You will very badly need to have a runway at Baikonur to properly use this add-on; the stock Orbiter install doesn't come with one. Use the aftermarket Baikonur of your choice, or rename the included “Baikonur-Spiral.CFG” to overwrite your Baikonur.CFG.

Or you can change the following lines (between BEGIN_OBJECTLIST and END_OBJETCLIST) to your Baikonur.CFG: (Courtesy Kev33's K-Baikonur)

```
BEGIN_OBJECTLIST
LPAD2
      POS 0 0 0
      SCALE 0 0 0
      TEX Lpad02
      NAV 127.10
END
RUNWAY
    END1 -820 0 1600
    END2 -820 0 -3400
    WIDTH 100
    ILS1 132.6
    ILS2 132.6
    RWTEX Runway2
    NRWSEG 9
    RWSEG1 1 0.018 0.25 0.5 1 0.875
    RWSEG2 1 0.088 0 0.25 0.5 0
    RWSEG3 1 0.018 0.25 0.5 0.75 0.625
    RWSEG4 1 0.088 0 0.25 0.5 0
    RWSEG5 5 0.576 0 0.25 1 0.5
    RWSEG6 1 0.088 0 0.25 0.5 0
    RWSEG7 1 0.02 0.25 0.5 0.625 0.75
    RWSEG8 1 0.088 0 0.25 0 0.5
    RWSEG9 1 0.02 0.25 0.5 0.875 1
END
RUNWAYLIGHTS
    END1 -820 0 1600
    END2 -820 0 -3400
    WIDTH 100
    PAPI 20.0 3.0 -500
    VASI 1.5 152 671
END
END_OBJECTLIST
```

Introduction:

Welcome to the Spiral add-on! Sometimes called the Soviet answer to Dyna-Soar, the Soviet program actually appears to precede the X-20, though the X-20 later provided additional impetus and urgency. After the cancellation of Dyna-Soar, the Spiral project continued at a reduced pace, before collapsing later due to its own problems.

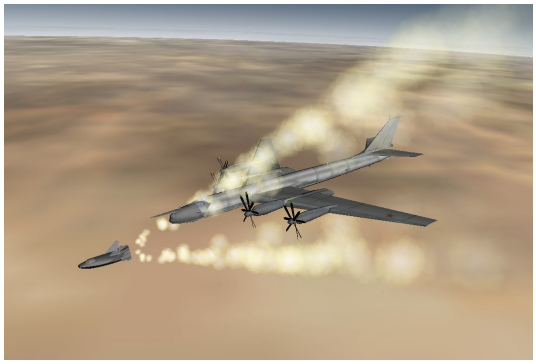
The Spiral was to be a military-application reusable spaceplane. Missions included visual reconnaissance, electronic reconnaissance, satellite interception, inspection, and negation, and ground attack.

Spiral went though many iterations, so this represents the best-guess among sometimes-contradictory published figures.

The Spiral spaceplane was to be launched atop its own Hypersonic Launch Aircraft (HLA), the

combination being termed “50-50”. The HLA would take the combination to Mach 4 to 6; then the Spiral, with a pair of upper stages attached, would separate for the climb to orbit. The intermediate stages were LOX/LH2 (or, in later models, LOX/Fluorine. The LH2 versions are modeled).

As an intermediate step, a stripped-down Spiral was to be launched atop a Soyuz launcher for testing and limited operations.



Preceding all this, of course a test Spiral was to be air-dropped, much as with the X-20: first subsonically, then supersonically using the solid-motor escape stage. Unlike with the X-20, the Spiral's subsonic drop tests were actually accomplished.

In the end, Spiral suffered from limited utility, limited funding, and limitless needs. For what was really just a small orbital payload, Spiral required a lot of development: in addition to the space plane itself, there was a hypersonic launch aircraft which would be the fastest (and most expensive) bomber ever built. Additionally, the LOX/LH2 boost stages were a significant project in their own right, roughly comparable to a new launch vehicle development.

Many Spiral systems and innovations found their way into other programs, and formed the basis of the “BOR” series of shuttle re-entry test articles. But Spiral never flew in space.

The crew of Spiral was exactly one pilot-astronaut. There was no practical way to expand this.

The Spiral used a “hot structure” design. One innovation was to keep the bottom heat shield completely unbroken; hence the landing gear would project from the top and aft of the spacecraft. These gear are metal skids, only. Wheels were fitted for some of the subsonic test flights, but are not modeled here.

A more important innovation is the folding-wing concept. By folding the wings up for hypersonic re-entry, and down for good low-speed gliding, the Spiral avoided extensive thermal protection for the wings, and achieved a good stable re-entry.

Spiral Operation:

How you fly the Spiral depends a lot on how you're going to launch it.

To airdrop it, run the appropriate scenario and drop the Spiral at about Mach 0.85 and 12 km. After motor burnout (if any), glide to the runway and land.

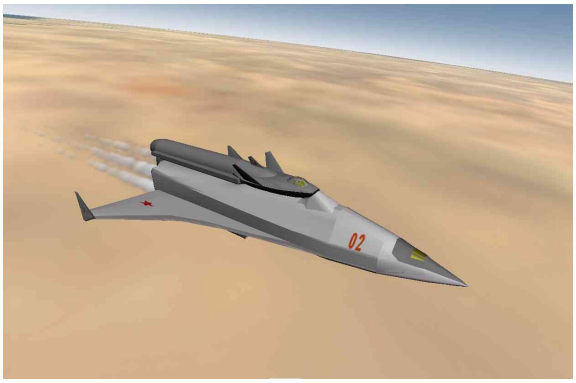
To launch it on a CVEL Proton, fly the vehicle to orbit normally. The Proton launcher does not come with an autopilot.

To launch it on a Soyuz launcher, hand-fly the vehicle or use the Velcro Rockets autopilot.

The Soyuz will deposit you on a suborbital trajectory with a solid-fuel escape stage. Were you to jettison prematurely, all 12 solid motors would fire to get you clear of the Soyuz launcher. At high suborbital speed, though, the solid motors are fired in 3 groups of 4, allowing you to make a somewhat-quantized apogee kick maneuver. If you've flown the Soyuz well, you'll need to fire only 2 of the 3 groups. Advance the throttle to fire a solid-motor group. Retard the throttle again; once the solid-motor set is burned out, you can advance the throttle for another firing.

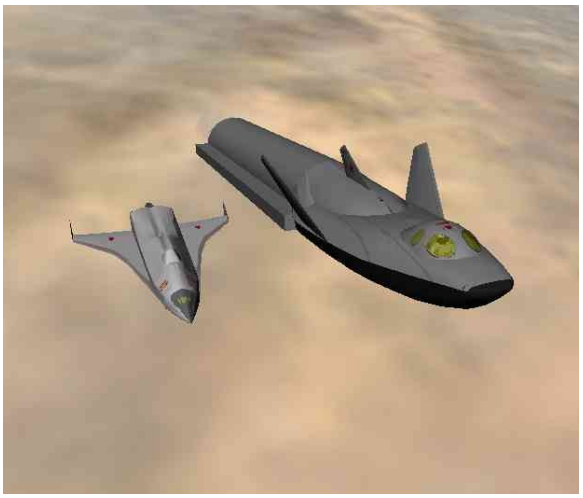
To fly the “50-50” combination to orbit, you'll begin on the runway in the HLA. Throttle up and take off at about 170 m/s. Retract the gear (**G** key) and climb out at about 7 degrees. Adjust pitch using the pitch trim.

Bank to turn, of course. Establish your launch azimuth and hold the wings level.



The HLA is powered by a set of turbo-ramjet-rocket engines. The way it works is that the HLA engines will deliver the power you request through the throttle. If it can't make the requested power with the turboramjet, it will make up the difference with rocket power. You do not have much fuel in the HLA, so avoid use of the rocket! The key here is: stay below 29 km. Above 29 km, fuel consumption rises rapidly as the rocket engines take over.

You won't be able to stay much below 29 km, either. As the craft approaches Mach 6, heating and drag become enormous at lower altitudes. Accelerate to Mach 6 at 28 km, then pull up about 10 degrees.

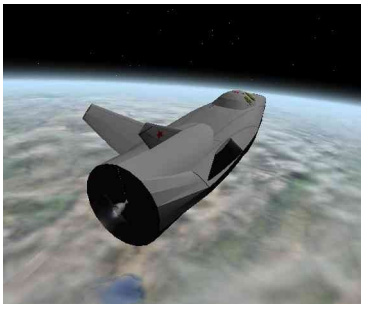


Release the stick to let the AoA decrease, then hit **J** to jettison the Spiral upper stages. Important: let the AoA come back down before release, otherwise the HLA will pull up into and recontact the Spiral as it's jettisoned, destroying both. Okay, in Orbiter there is no collision detection and it makes no difference, but it still looks bad.

You may, if you wish, transfer viewpoint back into the HLA to fly it back to the runway on its turbo-ramjet engines. It works.

You may employ the HLA as a hypersonic carrier aircraft of any CVEL payload by creating it in the scenario file with CONFIGURATION -3.

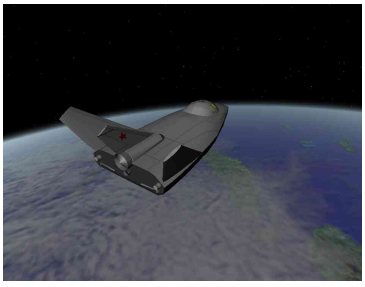
It was impractical to fly the HLA with an autopilot. Instead, hitting the **O** key (for autopilot) will jettison the upper-stage stack, AND turn on its autopilot. The upper stages will fly a pitch-profile to orbit, with the azimuth established at separation from the HLA.



HLA Keys:

J – Jettisons the upper-stage or CVEL payload.
O – Jettisons the upper stage with its autopilot engaged.
G – Lower/raise the landing gear

Once jettisoned from the HLA, you're flying a conventional two-stage rocket. Point about 45 degrees up to get the climb going. Gradually reduce the pitch angle until you're flying the second stage level with the horizon.



Once the second stage is exhausted, you're in orbit or just shy of it, depending on payload and inclination. Make up the difference, if required, with the on-board propulsion system. This LOX/Kerosene engine will also make your on-orbit maneuvers and de-orbit burn. Save some!

Spiral Keys:

J – Jettisons the next stage, or the payload if there are no stages remaining.

K – Open/close the payload bay doors. (Not available in all missions)

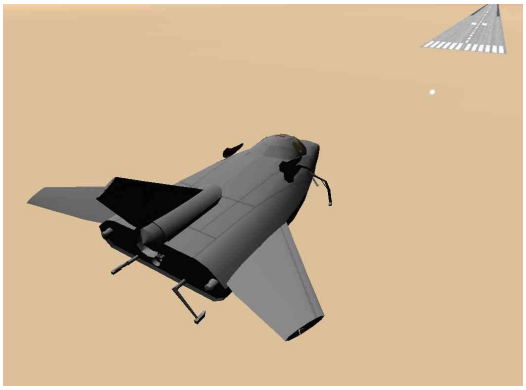
P – Open/close the pilot's top hatch
E – EVA from the spacecraft (only if the top hatch is open)
CTL-E – Eject! Jettisons the escape sphere, a complete survivable re-entry capsule
G – Lower/raise the landing gear
B – Toggles the speed brakes (both rudders cant outwards, slowing the glide slightly)

To an even greater extent than with the X-20, the Spiral is built with a notional "payload area" but rarely made use of powered payload doors. Different missions were not a matter of plugging something modular into the bay, but rather were a complete conversion of a given airframe. For example, the daylight photography mission put a camera in the payload area, but didn't use dorsal bay doors. Instead, a hole was cut in the side of the spacecraft for the camera. For this reason, the scenario will specify whether the bay can open with a "BAY_OPENS 1" (or 0) line. If the bay cannot open, you can still send payload fold/unfold commands with the **K** key. In this way, you can close the door over the camera's aperture. This will be useful if you want to re-enter!

As with the X-20 add-on, a jettisoned payload is quickly checked for attach points of the BOLT type and, of any are found, the payload is secured into place with the attach point. There are no provisions for later separating this bolt-in attach point, but the attached payload can be activated/de-activated with the **K** key.

Use the on-board propulsion system to de-orbit. The Spiral is relatively high-drag, so about 155 degrees from your destination should work.

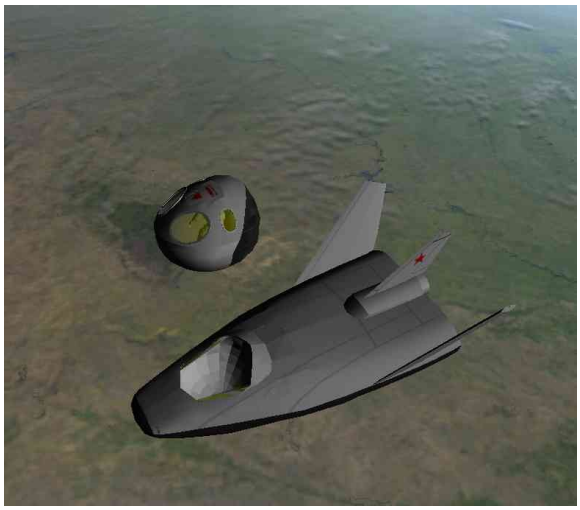
The Spiral's wing-folding system gave it an unusual re-entry profile. Since the wings are effectively shadowed in the shock wave at high speeds, they don't contribute to the stability of the aircraft. Instead, the Spiral acts a bit like a flat-bottomed capsule. Angle of attack on re-entry will be 50 to 60 degrees! This gives a large area for drag and heat dissipation, though. Also, the lee side of the aircraft is protected, so re-entry protection of the windows is not required. Hypersonic L/D is only 0.8 as a result, so large cross-range is not available.



As the Spiral slows to Mach 5, rarefied air will start to impinge on the wings, producing a pitch-down moment. At the same time, the wings will fold down automatically. After a significant pitch excursion, you'll wind up flying a more-or-less conventional aircraft at Mach 5. Keep the speed below Mach 5 and head to the airport. Now would be a good time to use up your remaining rocket fuel; you'll get excellent glide-stretching at Mach 5.

Once you've slowed below the speed of sound, the dorsal jet engine cover will open, and you'll have a jet engine available for more glide-stretching.

Set yourself up for a glidepath of about 12 degrees. Aim a kilometer or so short of the runway, and "pre-flare" a kilometer from that, aiming for the start of the runway. Drop the gear a kilometer out, and grease that pig on! You'll need about 90 m/s over the threshold to maintain a good pitch rate, but you can hold the nose off and touch down much slower – 70 m/s or so.



You may bail out of the Spiral in your own self-contained capsule. The emergency capsule has no attitude jets, but it does have a re-entry heat shield. Use it to bail out of a stricken spacecraft, but only do so when your orbit intersects the atmosphere. Otherwise, it will be a long wait.

The ejection capsule also lacks a parachute. Once your re-entry is complete and you've slowed to subsonic velocity, you'll need to eject again with your ejection seat to personally parachute to a safe landing. Just like Yuri Gagarin.

Capsule Keys:

P – Open/close the pilot's top hatch
E – EVA from the spacecraft (only if the top hatch is open)
CTL-E – Eject! Jettisons the pilot and ejection seat for parachute landing

Fun tricks to play with your Spiral:

Rendezvous with an American satellite. EVA and take a good look at it. Don't touch it – it might be booby-trapped! Weapons are not included in this release of Spiral, though “negation” was a projected mission.

No version of the Spiral could dock with anything. Pity.

Since hypersonic L/D is only 0.8, a “synergistic maneuver” is not a good use of fuel, though it was proposed to test it anyway.

The Proton launch mission I threw in just for fun; I built it for testing. There's no source anywhere that describes a Spiral on a Proton. Still, had the Spiral been built, it's a logical upgrade, and a semi-logical mission....

Known issues:

Sorry about the involved procedure for adding a runway to Baikonur. You NEED a runway at Baikonur, though. Now you can use it for other things, too.

The ejection sequence is borrowed directly from the Gemini add-on. I did rename it to avoid overwrites.

Bibliography:

Web:
The indispensable Astronautix: http://www.astronautix.com/craft/spiralos.htm
http://www.astronautix.com/lvs/spil5050.htm
An outstanding Russian page: http://www.buran.ru/htm/molniya3.htm

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Version history:

v1.01
Re-compiled for Orbiter 2010.
EPOS launcher is a Velcro Soyuz instead of CVEL-Soyuz 0.4

v1.0
First release.