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Dyna-Soar w/MOOSE   Version 1.34

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Unpacking:

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

For this add-on, the CVEL Titans add-on is strongly recommended, as that is the way to launch the Dyna-Soar into orbit. There are some scenarios for use without the Titan, however.

You'll need Project X-15 / Edwards High Range by Greg Burch and Scott Conklin to run the B-52 drop scenarios.

You'll need my Paracone add-on to use the silly little scenario that employs it.

You'll need estar's Mercury 5.0 for the one scenario that uses it.

You'll need Kev33's SLC-6 for the one scenario that uses it.

80Mileshigh's Dyna-Cam add-on is included in Dyna-Soar 1.3. You don't need it separately.

The MOOSE v1.0 add-on is included. You don't need it separately.

Rodion's Gemini astronaut mesh is included, and will overwrite the older gem-eva.msh included with your stock Gemini add-on, if you haven't already upgraded to Rodion's mesh.

The RealExhaust.dds texture is also included.

A config file for the Fortaleza base by Nautilus is included. No action is required; it'll drop into your Earth folder.

You'll need to add a runway to Vandenberg to use those scenarios properly. Either rename and move X20-Vandenberg.CFG to Earth/Vandenberg.CFG (replacing the .CFG that came with Orbiter), or paste the following lines into the Vandenberg.CFG of your choice between the BEGIN_OBJECTLIST and the END_OBJECTLIST:

```
RUNWAY
    END1 -820 0 10600
    END2 -5820 0 6400
    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 10600
    END2 -5820 0 6400
    WIDTH 100
    PAPI 20.0 3.0 -500
    VASI 1.5 152 671
END
```

Introduction:

Welcome to the Dyna-Soar add-on! The X-20 Dyna-Soar was to be a U.S. Air Force reusable spaceplane. Begun in the late 1950's as a re-formulation of the "BoMi" and other boost-glide studies, the X-20 was a reusable glider to be launched atop an existing expendable launcher. The X-20 was conceived as a research craft – the logical follow-on to the X-15, flying higher, faster, and farther. Unfortunately, the Dyna-Soar (for DYNAmic SOARing) became caught in the machinations of DoD politics. The project cost a lot of money, and had to compete against more pressing needs like bombers, fighters, and transports. This led to demands for a more immediate justification than pure research. In other words, a military pure-research spacecraft was out of the question. The X-20 would have to have a military mission.

Mixing research vehicles with operational mission requirements is never a good idea, and the X-20 is a case study in why this is so. Every mission justification (reconnaissance, bombing, satellite inspection, crew shuttle) could be done cheaper another way, though only the X-20 could have done them all. Still, each tacked-on "mission" made the X-20 more complex and expensive. In January 1964, the X-20 was canceled, having spent more than half of the estimated cost to first flight.

Many X-20 systems and innovations found their way into other programs, but "America's zeroth shuttle" never flew in space.

The crew of the X-20 was exactly one pilot-astronaut. More seats were planned for later versions, but the X-20 shown is purely a one-seater. (The passenger module adds four passenger astronauts).

The X-20 used a "hot structure" design. Instead of an aluminum structure with thermal protection tiles, the X-20 was made of high-temperature metals (a Columbium alloy) that took the re-entry heat directly. The X-15 was also a hot-structure spacecraft, but this design approach has been little-discussed since.

Because of the hot structure, it was impractical to fit the X-20 with wheels that could withstand the heat. Instead, it landed on giant metal wire brushes. For this reason, no brakes are modeled. Fortunately, the craft slows down quite well without them.

X-20 Operation:

Launch the X-20 using the CVEL Titan II or Titan III provided. The Titan II launch is a suborbital test mission; your landing target is an airstrip on the island of Fortaleza, off the coast of Brazil. For an orbital mission, launch on the Titan III into a polar orbit. If you do not have the CVEL Titans add-on (it's separate), you can still fly the X-20, but can only run the scenario that starts in orbit.

CVEL Titan Keys:

U - Set a launch azimuth for the autopilot (the scenario provides one already)
O - Start the autOpilot.
J - Jettison the next stage or payload.
CTL-E - Eject! Separates the X-20 from the launcher, jettisons the transtage, and fires the de-orbit motor as an escape motor. Once it's done, you can jettison the deorbit stage and land, or eject from the X-20

X-20 Dynasoar Keys: (for once you are in free flight)

J – Jettisons the Transtage, or the deorbit stage. If the deorbit stage is gone, OR the payload bay doors are open, this will jettison/activate the next CVEL payload (if any) instead.
K – Open/close the payload bay doors
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 top hatch, followed by you! You have a parachute to bring you gently to Earth.
G – Lower/raise the landing gear
B – Toggles the speed brakes (both rudders cant outwards, slowing the glide slightly)

Launch with the CVEL autopilot to see how it's done, or do it yourself. For a polar orbit mission, head south from Vandenberg at an azimuth of about 185 degrees; this will put you in a sun-synchronous orbit. That's why you're launching at dawn; you want sunlight (even at a low angle) for your entire flight, the better for ground reconnaissance.

The CVEL Titan III autopilot should pass its state to your Transtage, so if the autopilot was on for launch, the Transtage will rotate prograde and continue thrusting until the orbit is circular. If you were flying manually, you'll have to do this yourself. You should typically have about 30% left in the tanks after circularization, depending on launch inclination and payload mass.

Keep the Transtage attached. It's your maneuvering stage; you'll use it to maneuver, rendezvous, etc.

Open the bay doors and give your payload a view of the earth below. Take lots of pictures. Smile, everyone!

While the bay doors and payload operate a lot like the one on the Space Shuttle, this can be misleading. Most X-20 missions might have a non-jettisonable payload installed in that area, with fixed (non-movable) bay doors. A few non-jettisonable payloads needed to see out, which is what the movable bay doors are for. These payloads can then be activated with the "J" key, but an attach point on the payload will keep them snug in place in the X-20. Once a "bolted-in" payload is activated in this fashion, there's no way to eject it from the payload bay. However, if the payload has no attach point, then it will fly out of the payload bay like a deployed satellite. This was not a primary mission of the X-20, however – it would require a large Titan III to launch a very lightweight satellite!

When you're ready to return, jettison the Transtage and turn retrograde. Once the Transtage is gone, you're using the X-20 glider's internal tanks for RCS. Those thrusters are for rotation only; no translation. There are two exceptions; you can translate forwards (both the de-orbit stage and the glider have tiny thrusters in the tail for the purpose), and you can translate DOWN (the roll thrusters are on the center of gravity, so the designers included this capability). No other translation modes will work, however, so rendezvous is now pretty impractical.

Once pointed retrograde, engage your main thrusters. This will fire a Minuteman third-stage solid motor. Since it's sized for launch escape, you will really move! Hang on and enjoy the ride.

You will find that, depending on your altitude, the de-orbit motor is probably overkill. If only there were some way to turn it off!

There is a way. You've probably read somewhere that once a solid motor is started, there's no way to stop it. This is almost true...but not quite. The Minuteman third stage has a thrust-termination feature...blow a hole in the casing, and it's not a solid motor any more! We're going to blow the throats out of the nozzles with four shaped charges – the propellant will continue to smolder, but won't produce much in the way of thrust.

To trigger the thrust-termination feature, return the main throttle to zero, either with the joystick slider or the keypad * key. The **J** key will work, too. With any of these methods, you'll stop the de-orbit motor from continuing to drive you downwards. Trigger this only when you're really sure you won't need it any more!

Once the motor is done smoldering, hit **J** again to get rid of the de-orbit stage. Orient prograde, turn off your thrusters (CTL-/ on your keypad), and prepare to glide!

Once in the sensible atmosphere, turn towards your destination. As with any returning space shuttle, you slow by pulling on the stick and "G"-ing up the spacecraft. Slalom back and forth across your course to get more deceleration...point right at the destination and glide if you've decelerated enough.

The X-20 had a front re-entry shield that blocked the view out all the windows except the side ones from launch through re-entry. Keeping the windows from melting is important, but it still makes it hard to see! Fortunately, the view is not blocked in the Orbiter stock interface. (Future versions with a panel will be another matter). Anyway, the re-entry shield jettisons automatically below Mach 6 and 20 km or so.

Set yourself up for a glidepath of about 15 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 120 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.

Fun tricks to play with your X-20:

Rendezvous with a Soviet satellite. EVA and take a good look at it. Don't touch it – it might be booby-trapped! Weapons are not included in this version of the X-20. Weapons were discussed only for the more-advanced X-20X.

This version of the X-20 also could not dock as such. Included, however, is a semi-historical "passenger module" with a self-contained docking capability. This is similar to some proposals, but deletes the extendable arms. Other versions of the module put the docking tunnel further toward the back of the spacecraft, either pointing up or toward the tail, Hermes-style (you'd have to jettison the Transtage and the de-orbit motor would have to be relocated inside the glider for that to work). Where and how to dock a winged shuttle has always been a problematic issue; the X-20 never had a completely satisfactory answer.

The USAF was very interested in trying what it called a "synergistic maneuver". Today, we would call it an aeroassist maneuver. This was a plane change using aero forces, rather than (expensive) propellant. You will need propellant to make up losses, but you'll use less than you would have used for the plane change directly. To do it, you'll need the Transtage attached. Lower your perigee into the upper atmosphere (80 km or so). Once there, pull into your new plane (90 degrees bank) using aerodynamic lift. Make up the losses with the Transtage, and fire yet again to raise perigee out of the atmosphere. Done right, you can get about half again as much plane-change as you could on the propulsive power of the Transtage alone. Make the turn at the equator, and you'll change inclination. Make it at the poles, and you'll change the longitude of ascending nodes. This may be the more useful to an X-20 in reconnaissance mode, as you can revisit the same target twice in a row. Those sneaky Soviets, thinking you've made your one pass for the day, will throw the tarps off all their secret toys and start playing with them in the open...when you return again for a second pass! Ho, ho, ho, think of the fun you'll have!

Initial glide tests were to be performed from a B-52. Kev33's B-52 from his B-52/X-15 add-on has been appropriated; the B-52 (only) is a Spacecraft.DLL craft. There are two variants: one a simple glider, the second includes the transition section with solid motor to boost to supersonic speed and increased altitude.

The suborbital test hop is an interesting mission for the X-20. There's no Transtage, and no de-orbit motor, but the boilerplate transition section is ballasted (1000 extra kilos) so you don't go flying past your destination. Brazil in 20 minutes or less, or the next one's free....

The lunar flyby mission I threw in just for fun; I built it for testing. There's no source anywhere that describes an X-20 on a Titan IIIM-Centaur – the Titan IIIM came along after the X-20 was cancelled. Still, had the X-20 been built, it's a logical upgrade, and a semi-logical mission....

At one time or another, the X-20 was proposed for just about any U.S. launcher you could name, and quite a few nobody remembers, as well. Feel free to stick it atop any launcher that will accept it. A Saturn I or Ib would be nice....
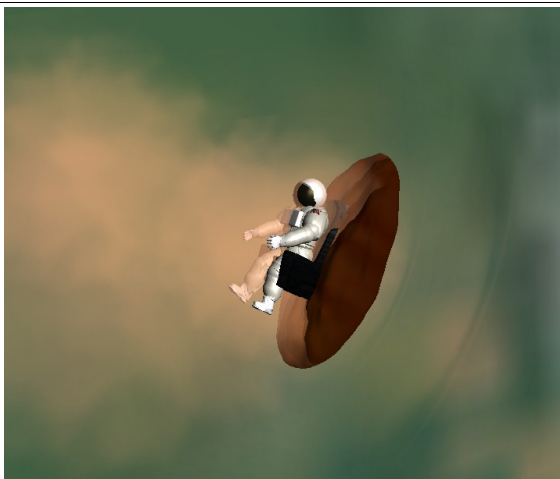
MOOSE Operation:

Surprisingly, the baseline ejection seat for the X-20 Dyna-Soar was to be a simple subsonic-only ejection seat, as used in fighters. Unlike the X-15, which had a fairly elaborate high-Mach seat, the X-20 was a glider with essentially no fuel onboard. Thus, the pilot could reasonably ride the glider down to subsonic speed before ejecting.

The MOOSE (Manned Orbital Operations Safety Equipment) personal re-entry system would not have been on the as-planned X-20, but it would have made a desirable upgrade. To simulate an X-20 without the MOOSE system, just don't bailout when supersonic!

The MOOSE escape system modeled here is built into the ejection seat. It deploys an

inflatable foamed re-entry shield for atmospheric re-entry. After re-entry, it also has all the equipment of an ejection seat – drogue, parachute, etc.

To operate the MOOSE, bail out of the X-20 using the CTL-E command. The ejection seat motor (a <u>hover</u> motor) will fire, rocketing you out of the spacecraft.

To de-orbit, first orient to +-normal with the "**;**" key. This will point the bottom of the seat (hover motor) in the retrograde direction.

Begin your de-orbit burn (about 135 degrees from destination) by activating the <u>hover</u> thrusters. A solid-fuel de-orbit motor will fire.

To terminate de-orbit burn, hit the "**J**" key. This will blow the nozzle off with a primacord line, destroying its effectiveness.

When the motor is depleted, the re-entry shield will inflate automatically. Point retrograde.

As re-entry ends, the drogue will deploy.

Once at a reasonable speed and altitude, the seat will jettison and the main chutes will inflate. Land normally.

Unstrap from the harness with the "**S**" key.

Keys:
J – Terminates the de-orbit motor burn.
S – Strap/Unstrap from the MOOSE.

Note that the MOOSE spawns as the MOOSE system, with the EVA astronaut attached. You can unstrap (detach) at any time, but this is not recommended during re-entry!

Invoking the MOOSE:
Your add-on can call up a MOOSE in any of several variations:

MOOSE – Creates a MOOSE seat with Gemini (David Clark) suit attached.
MOOSE2001 – As above, but the attached suit is the 2001 EVA suit (if you have that add-on)
MOOSEMMU – As above, but the suit is the default shuttle MMU carried as a CVEL payload.
MOOSEDG3 – As above, but the suit is from DanSteph's DG-III, as a CVEL payload.
NoSuitMOOSE – Just the re-entry pack, no suit attached explicitly. You can attach your own, or it can be free-floating and you strap into it during the scenario, provided only the suit in question has an attach point labeled SEAT.
EJECTSEAT – Creates an ejection seat without the re-entry pack. So now you have a generic ejection seat for aircraft, too.
EJECTSEAT2001 – Self-Explanatory
NoSuitEJETCSEAT – Self-Explanatory
PARACHUTIST – No seat either: this is a strapped-on parachute with a Gemini suit.
NoSuitPARACHUTIST – Just a simple strap-on parachute pack with no associated suit.

Known issues:

The lunar scenario is a bit odd because, while you might think you're swapping the Transtage for a Centaur, it's more complicated than that. For the lunar scenario, or any scenario where you're using a CVEL stage instead of the integral X-20 Transtage, you're flying the last stage of the Titan, and not the first stage of the X-20. Therefore, your aero properties will be those of the CVEL stage. The X-20 hasn't been invoked yet – so you have no wings! This will provide quite a surprise if you retain the Centaur for the first part of reentry, for example. Yes, this is personal experience talking.

Bibliography:

Dyna-Soar: Hypersonic Strategic Weapons System (Apogee Books Space Series) by Robert Godwin (Editor)

Aerospace Projects Review, by Scott Lowther (Editor)

Web:
The indispensable Astronautix: http://www.astronautix.com/craft/dynasoar.htm
http://www.astronautix.com/craft/moose.htm
An outstanding (Russian-language) page: http://www.buran.ru/htm/dynasoar.htm

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Notes for Developers:

This release contains a pair of integral X-20 payloads, and the code to use them is now in place. To build an X-20 payload, you'll need to do two things:
   1. Build a mesh of the payload, stowed. When stowed, it needs to fit within the payload bay. A .3DS mesh of the payload bay envelope is included; build your payload within that.
   2. Build a .CFG file that includes an attach point, so that when the payload is activated, it locks into place. The make sure the config file includes these lines:

```
; === Attachment specs ===
BEGIN_ATTACHMENT
P  0.0 0.0 0.0    0 0 -1  0 -1 0  BOLT
END_ATTACHMENT
```

   3. Optionally, if the payload unfolds on activation, you'll have to write a small .DLL that accomplishes this. Include a routine to stow again (on keypress K or a passed message – see the sample passenger module for example) so that the X-20 can return for a landing!

Version history:

v1.34
  Bugfix: missing the textures for the same mesh.

v1.33
  Bugfix: missing a mesh from the distribution.

v1.32
  Re-compile for Orbiter 2010.
  Change B-52 scenarios to use Project X-15 B-52.
  MOOSE updated for Orbiter 2010.
  Cockpit interior by Alain Hosking (80mileshigh). No true VC functionality yet.

v1.31
  Bugfix: MOOSE was sometimes crashing when expanding the foam on a jettisoned seat.
  MOOSE steadiness improved under parachute.

v1.3
  Added MOOSE
  Added MOOSE (Space Marines) scenario
  Added SigInt payload and scenario
  Added Clustered Titan launch scenario
  Added Centaur and Chariot as possible stages
  Reworked ascent autopilot to work with wide range of launches
  Altered animations to work under Orbiter 2006 Patch 1
  Re-ordered /Config directory to /Config/Vessels for compatibility with Orbiter 2006

v1.2
  Added runway to Vandenberg and converted scenarios to run from there
  Added Paracone (Space Marines) scenario
  Added Mike Mars (Mercury rendezvous) scenario
  Added SLC-6 test launch
  Added Dyna-cam and scenarios by 80mileshigh
  Added B-52 scenarios using Kev33's B-52
  Reduced sensitivity of pitch trim
  Fixed: crash when ejecting from glider stage only
  Fixed: astronaut not visible after returning from EVA

v1.1
  Added Fortaleza base (thanks Nautilus)
  Added new textures and specularity (thanks Duma)
  Added Mikey451's aero code
  Added alpha channel to make windows transparent
  Added passenger module
  Added telescope module
  Windshield cover jettisons at Mach 6, as it should (was Mach 3)

v1.0
  First release.

v0.9
  First beta release