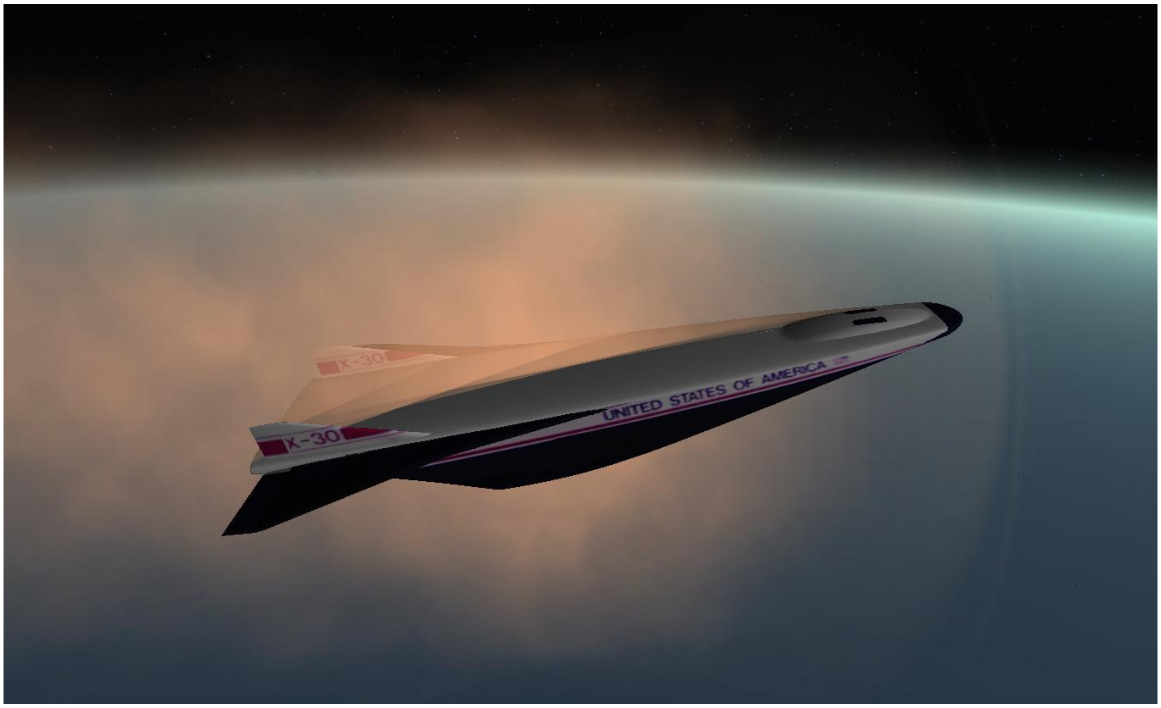
ORBITER
Space Flight Simulator
www.orbitersim.com (c) 2000-2005 Martin Schweiger

X-30 NASP Version 1.0



By Erik Anderson aka Sputnik erik_h_anderson@hotmail.com
and Rob Neumann aka matr5153 rob@f1composites.com

Thanks to:
Hendo and Daver and erv, for the CVE-Lite code on which this is based.

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.

Introduction:

Welcome to the X-30 add-on!

The X-30 National Aerospace Plane (or NASP) was a single-stage-to-orbit runway-launched vehicle which used airbreathing engines most, or all, of the way to orbit. Unlike the HOTOL, its contemporary to which it is sometimes compared, the X-30 NASP attempted to use hydrogenburning scramjets to run in an airbreathing mode almost all the way to orbit. The scramjets would not function at low speeds, so turbines of some sort would get the vehicle off the ground and into the supersonic regime. The scramjets would cease to produce positive thrust at some high Mach number, so rocket engines would complete the ascent.

The X-30 began in DARPA's "Copper Canyon" project, a study which determined that such a vehicle, breathing air from runway to orbit, might be possible. The intent was to create a spacecraft with the operations concept of an aircraft; single-stage, gas & go, runway operations, etc.

The structural challenge of NASP was twofold: first, the NASP used LH2 almost exclusively as fuel. Even combined LOX/LH2 rocket engine tankage is comparative high-density; the "fluffy" propellant necessitated huge tanks, and a huge aeroshell around it. The X-30 was to use "slush" LH2; that is, hydrogen which is chilled until it is partially frozen, for about a 15% density increase. Even so, the X-30 needed to be built of fantastically strong but lightweight materials, requiring advances in composite materials and design + manufacturing practice. Additionally, the air-breathing profile meant that the X-30 had to contend with extremely high surface temperatures during ascent. Not only did the materials have to be strong and lightweight, but they had to continue to be so at temperatures approaching 3000 degrees F in some areas. By 1986, significant progress had been made, culminating in structural test articles under the SCIENCE REALM and HAVE REGION programs.

Design and operation of a scramjet was at least as difficult a problem, comparable to lighting a match in a hurricane. Efforts focused largely on computational modeling of the flowfield; because scaling factors were uncertain, subscale models and flight articles were de-emphasized. The X-30 designation was assigned for a NASP demonstrator, but it was essentially to be built to the same size and scale as a large, payload-carrying NASP.

In his 1986 State of the Union address, President Reagan called for "…a new Orient Express that could, by the end of the next decade, take off from Dulles Airport, accelerate up to 25 times the speed of sound, attaining low earth orbit or flying to Tokyo within two hours." This was interpreted as calling for a large program to develop NASP and X-30. Though this happened, it was not to last.

Individual contractor designs and configurations were eventually combined by the program office into a "merged" configuration, the one modeled here. The "merged" configuration combined most of the features of the other configurations.

In the end, it was not to be. Uncertainties in the aerodynamics meant that no one could be certain to how high a Mach number a scramjet could continue to provide positive thrust. That number was continually revised downwards, until the X-30 was boosting on pure rocket power from Mach 14 to Mach 25. This doomed the concept, as, with all the installed weight necessary for scramjets and LH2 tankage, the X-30 made a poor rocket.

NASP and X-30 were never officially cancelled, but simply petered out into the normal low level of hypersonic scramjet studies toward the end of 1993.

The X-30 modeled here is the "merged" configuration, with performance as estimated before 1990. This version flies almost all the way to orbit while breathing air.

In this add-on, two versions of the X-30 are included. X-30 tail #1 is a pure X-ship, with a very small payload and a small payload / instrumentation bay behind the flight crew. It suffices to put a small satellite in orbit. X-30 tail #2 is a revised "X-30B" model (a designation invented for purposes of this add-on) which improves the dry weight, improves the scramjet performance, and moves the payload bay to a larger one in the top center of the craft. This approximates the promises of future NASP-derived vehicles.

X-30 Operation:

Two X-30 missions are provided: a due-east launch of a satellite, and a more complex rendezvous with the ISS. A logistics module with docking adapter is in the cargo bay.

Happily, the autopilot included with the X-30 add-on works from runway to orbit, so you may want to hit “O” and watch it do its thing a few times before trying it yourself.

Alternatively, throttle up. The X-30’s wings are small, so you won’t rotate until about 200 m/s. Continue in a steep climb, about 35 degrees. Gradually let this fall to 15 degrees as you accelerate through Mach 5; continue accelerating with a small positive climb.

The X-30 propulsion system is modeled as a rocket component supplemented by an airbreathing component; if you go too high, or eventually as your Mach number exceeds the max achievable, your fuel consumption will increase as the rockets take over full duty. (Of course, if you stay too low, drag losses will consume all your progress and you won’t get to orbit either).

Whether flying the autopilot or hand-flying, expect to be deposited in an orbit with the perigee, at burnout, still within the atmosphere at 70-75 km altitude. You'll need an apogee burn to stay up for multiple orbits.

The main fuel tank also runs the RCS and will be required for on-orbit maneuvers and the de-orbit burn. Save some!

X-30 Keys:

O – Autopilot toggle on/off
J – Jettisons the payload
K – Open/close the payload bay door
G – Lower/raise the landing gear
B – Toggles the wheel brakes
U – Enter a new launch azimuth

Use the on-board propulsion system to de-orbit. The X-30 aerodynamics differ from those of the shuttle in that the big fuel tank means significantly higher drag at the same altitude. Start your descent about 150 degrees out from your intended landing point.

Re-enter and land as though you were flying the Space Shuttle. Set yourself up for a glidepath of about 20 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 more slowly – 90 m/s or so.

If you abort an X-30 take-off and return to the runway, you'll find it necessary to burn off much of the fuel before attempting a landing. Not only would a higher landing weight collapse the gear (though this is not modeled for Orbiter), but the higher weight will mean higher approach speeds, without sufficient pitch authority to flare for touchdown. The resulting crash is sure to be spectacular.

Bibliography:

Web:
The indispensable Astronautix: http://www.astronautix.com/lvs/x30.htm
The Launch Complex: http://www.thelaunchcomplex.com/X30.html

Other media:
There’s a subscale (but still substantial) model of the X-30, now in storage at Space Camp at Marshall Space Center. Some photos:
http://www.ae.msstate.edu/rfrl/pics/aircraft/x30/x30c.gif
http://www.ae.msstate.edu/rfrl/pics/aircraft/x30/x30b.gif
http://www.ae.msstate.edu/rfrl/pics/aircraft/x30/x30a.gif

Version history:

V1.0
Minor tweaks.
First release.

v0.9
First beta release.