World of 2001: A Space Odyssey
Version 3.11
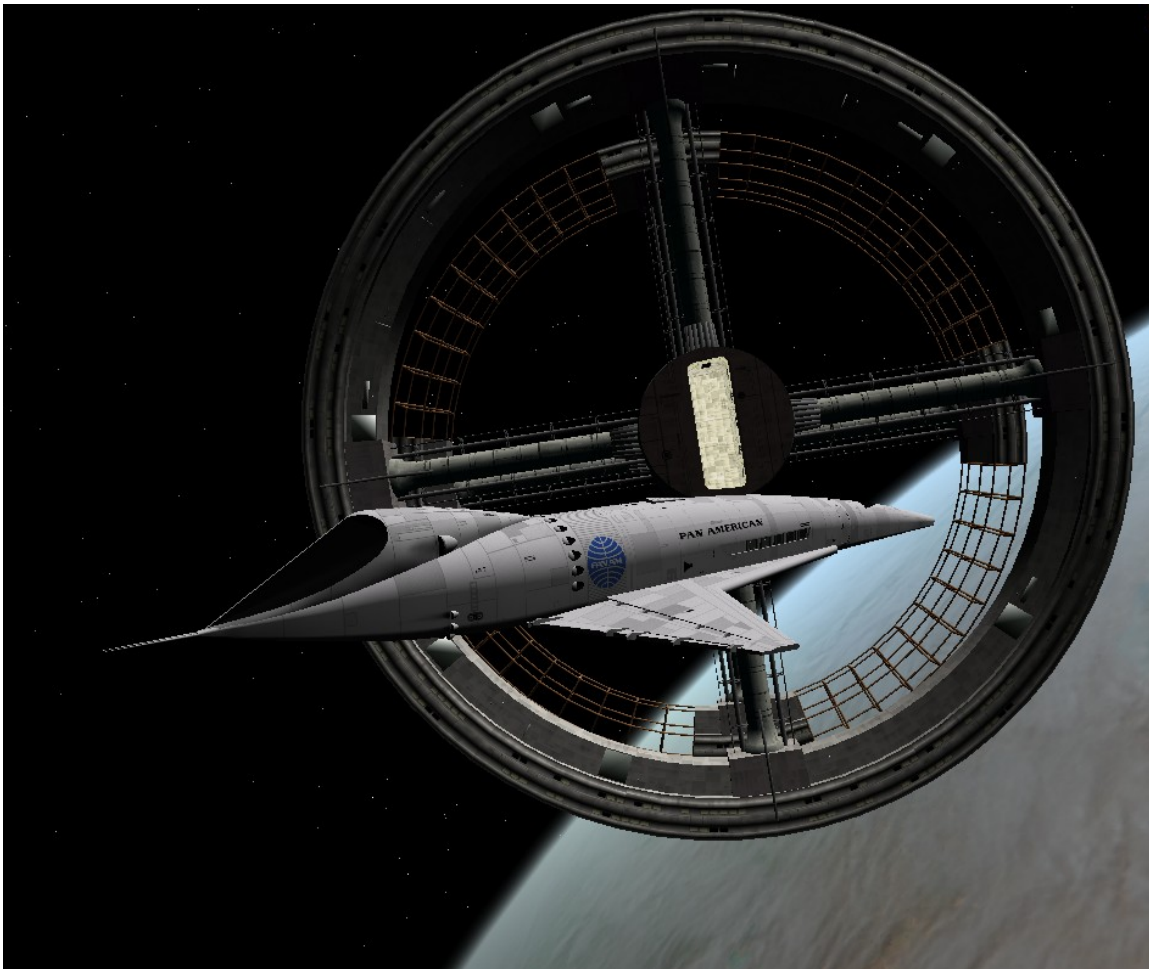
By Erik Anderson aka Sputnik   erik_h_anderson@hotmail.com
and Alain Hosking aka 80MilesHigh   eightymileshigh@hotmail.com
and Wolfgang Schwarz (Nautilus)   wolfgang.schwarz@eads.com

Project website may be found at: http://www.worldof2001.com

Unpacking:

Use Winzip to put each subfolder in its matching Orbiter folder. Then:
The Sol_2001 environment has been created to minimize the challenge of installation. BUT to get night textures (and their corresponding day textures), **you >MUST< edit your Base.CFG.**
To do this, **Open** the included text file "/Add-OnDocs/2001 Paste to Base.cfg"
Copy all of the texture names (all lines except the first two, comment, lines)
Paste them into your Base.cfg in the /Config directory.

You **MUST** do this, or many base textures will not appear!

To round out your 2001 experience, you'll need DBartles' Discovery and pod, and the Leonov. Get them at: http://homepages.nildram.co.uk/~dbartles/
To launch a space pod aboard an Orion II, you'll need dbartles' Discovery v5.0, as just mentioned. It is no longer required to add a docking port to dbartles' pod, as World of 2001 includes a changed copy in the Config/Vessels/2001 folder.

Optionally, you might want to change dbartles' scenarios to reference Sol_2001.CFG instead of Sol.CFG. Or you might not; it's not like you'll land Discovery at Clavius, after all.

You'll need Sputnik's Paracone add-on to use the silly little scenario that employs it.
You'll need Kev33's An-225 for the one scenario that uses it (Air-launching a Titov V)
A partial copy of Kulch's steam catapult add-on is included to run the scenarios which require it. If you have not installed the full steam catapult add-on, you don't have to, but consider this an endorsement of a fine add-on. You'll want to get Kulch's full add-on to enjoy the SRC base, settings for the Delta-Glider and other stock vehicles, and more. If the steam catapult add-on is updated, an updated version of this add-on will follow, but ensure the newest steam catapult is not overwritten by an older copy.

Changes since v3.1:
Satellites corrected – what WAS the 1/3-size Soviet sat has become French. The (flat, 1/2-size) former GBSat has become the Soviet satellite. The former French (long, thin, 1/2-size) sat has become British. And the Chinese Titov now launches a Taikosat, as it should have all along.

Changes since v3.0:
Soviet space-to-space craft added – Gagarin moon lander, Komarov inner-system transport, Patsayev tanker, Dobrovolsky engine testbed, Bondarenko self-deploying space station Merkur experimental-engine testbed, Skorpion patrol corvette.
Herculis cargo transport and Draco patrol corvette added.
Space Station Four and Three added. Station V Early and Complete added. Docking to the centerline port of Stations Four and Five will now cause traffic control to shift you to a side port, freeing up the centerline port for use. Press undock to go back to the centerline port for departure.
Upper stages (Centaur-O and Titov G) added.
Orion II/III and Titov autopilot reworked for better flight-path-angle management and a bit more turning ability. Also, throttling issue fixed; no non-intuitive dashing off at max power now.
Many satellites and payloads added. Landing module added that permits a re-entry and soft landing for ballistically launched Mars cargoes. So THAT's how the Mars bases were built!
Attach point handling added – craft can grapple satellites and cargo, making it possible to trans-ship from Earth launch to a deep-space craft to its final destination. Now the Taurus has something to do!
M-53 Soviet SST added.
New bases: Aberporth, Brest, Cuxhaven, Hainan. All the major space powers can launch their nuclear weapons into orbit now.
MANY scenarios added!

The changes since v2.3 have been extensive.
The Sol_2001 environment has been created, containing numerous 2001 bases and locations without fooling with your base sol.CFG environment.
Lost Worlds of 2001 has been scoured for other solar system installations. In addition to Clavius and Tchalinko, Port Lowell on Mars and Cytherean Station One in orbit about Venus, have been added.
The Moonbus (and Soviet Rocketbus) has been added.
The 2001 EVA astronaut has been added.
The Orion III has been completely re-meshed and re-coded. Now includes moving control surfaces, opening door, landing gear. Also includes Orion II cargo model, Orion I drop tank, and Orion IV booster stage.
The Soviet Titov V spaceplane has been added, with capabilities analogous to the Orion.
Kulch's steam catapult added at Canaveral and Baikonur to launch the spaceplanes as described in the book (horizontally).
Aries Ib completely re-meshed and re-coded. New variants on the Aries are included – cargo variant, Mars variants, the Taurus orbital tug, and the Aquarius interplanetary transport. Aries is now a tailsitter; it's the only answer that makes sense given where the pilot's windows are.
The satellites seen in the first space scenes of the film have been added, to give those cargo spaceplanes something to put in orbit.
The Boeing 2707 SST has been added, to fly Floyd on the first leg of his journey. Floyd's Journey scenarios extensively reworked.
Enjoy!

Introduction:

Read Bases of 2001.pdf for a description of the bases in this add-on.

Welcome to the World of 2001 add-on! When we say "2001" we don't mean the "2001 ships." The ships (Discovery, its Pod, and Leonov) are under active development by dbartles at http://homepages.nildram.co.uk/~dbartles/, and we couldn't be happier.

But the rest of the 2001 universe (Space Station, Orion, Aries), as v2.3, has been aging. Installation of the entire pack is not as simple as it could be, so playing around in the 2001 universe has required a bit of fiddling. Also, v2.3 was built for an older version of Orbiter. When the new Orbiter is released, v2.3 will probably cease to work altogether. It would be nice, we thought, if 2001: ASO were still under development.

And, meaning no disrespect to the authors of versions 2.3 and earlier, we could see areas for improvement. Clavius and the Moonbus were not done at all. The v2.3 Orion didn't use a booster stage, as described in the book; instead, it took off with hover thrusters like a DeltaGlider.

This add-on, then, is an attempt to build on those earlier versions and resume active development of 2001: ASO.

The idea is to create a one-stop shop for a World-of-2001 installation, save of course for Discovery, Leonov, and pod. The idea is to create a complete world, populated by the routine shuttlecraft and mundane everyday missions that appear to be happening in the background of the 2001 universe. The book describes a booster for the Orion; a booster we shall have! The Soviets must have a shuttle as well, called Titov V in the book; here it is. Clavius is a big base, obviously requiring more than just monthly Pan Am passenger service to build; so a cargo version of the Aries is included.

The book Lost Worlds of 2001 describes a Mars base. Logical; but something needs to haul passengers and cargo to Mars, so the Aquarius long-range variant of the Aries was created; made up out of whole cloth, really. And of course something else needs to act as a shuttle service to Mars orbit--more Aries variants. The Soviets must have an Aries equivalent, with variants...so, we designed them.

And so on.

Deciding what to use as a source is a bit of a challenge, as the books 2001/2010 (and 2061) don't even agree with each other, let alone the films. Throwing Lost Worlds in the mix might further complicate things. But the idea is to create a consistent, realistic world of technological optimism, yet believable and achievable from 1968-2001 if only we'd been considerably smarter and willing to spend a lot more.

To resolve contradictions, some sources and statements have to be ignored. For example, 2061 states the first landing on Mercury was in the 2030's; Lost Worlds has it prior to 2001. It makes little sense to launch a Jupiter mission if the inner system has not yet been explored, and we "know" the Jupiter mission was launched in 2002 or so, so this strongly implies a Mercury landing in the same time frame. And the hardware we've designed supports that. Also, might as well admit it, we just want to go places and do things in our 2001 universe. For us, then, the Mercury base was started in 2001.

Another source we have rejected is Fred Ordway, who states flatly that the Orion III was single-stage and nuclear-powered. (This is why the instructions for the plastic model by Aurora say the same thing). The book states flatly that the vehicle is two-stage. Routine nuclear shuttle operation in the atmosphere seems unlikely, and choosing a propulsion system that uses pure LH2 as a fuel does absolutely nothing for the chief visual problem of the Orion, which is that it doesn't appear to have enough in the way of fuel tanks to be single-stage to anywhere. Nothing against Fred Ordway, but Arthur Clarke should trump him when deciding what goes on in Clarke's universe.

No, the Orion and Titov use good old-fashioned LOX and LH2, though with advanced technologies (triple-point LOX, slush LH2, low-NPSH pumps for low tank pressures and weights, advanced combustion cycles, aerospikes (Orion) or extendable nozzles (Titov), etc)

If you prefer a nuclear-powered single-stage Orion, though, you can keep using the old one. The v3.1 Orion III doesn't actually overwrite the v2.3 one.

Redshift will probably only work with the v2.3 Orion, as the new one is much tighter with fuel.

Operating the ships of 2001

Orion II/III and Titov V
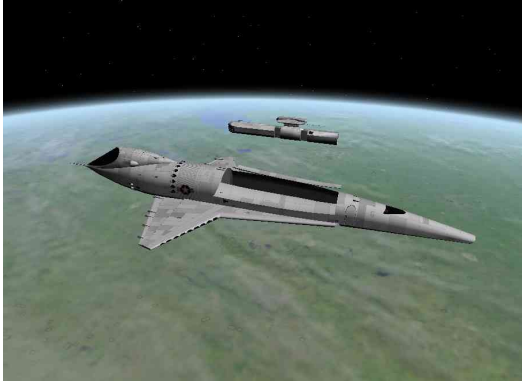
The two spaceplanes of the 2001 universe share similar code and operate similarly enough that we will try to discuss them together as one unit.

A key part of the technological optimism of 2001 is routine, cheap access to space. Clearly, their shuttle program turned out entirely differently from ours.

Here, the success of Apollo in the 1960's was followed by lunar bases and 50-man space stations, both American and Soviet, in the 1970's. These culminated in Mars missions in the early 1980's. All were launched by large expendable launch vehicles; Saturn V, Neptune, and N-1. Development of a reusable shuttle proceeded, but later, by which time we were all a bit smarter and better-looking. Full employment of the Apollo team was not a goal of the shuttle program; they were busy doing other things like going to Mars. This had beneficial effects on a lot of archite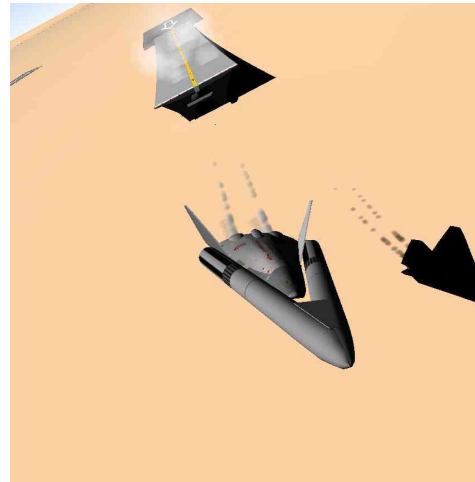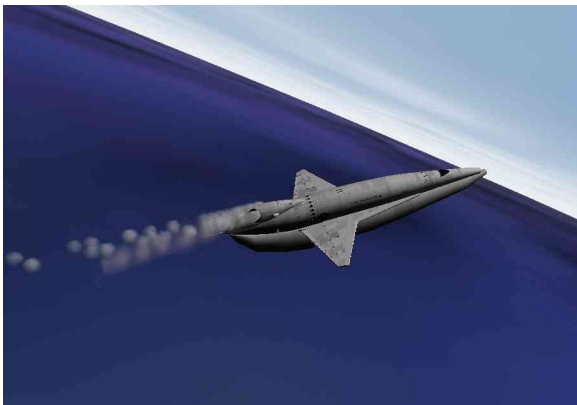cture choices, especially the decision to leave shuttle operation to third parties, rather than making it a space-agency monopoly.

Development of the spaceplane proceeded in two stages. The first stage was to develop the orbiter, which would get to orbit by staging a drop tank. The Lockheed Starclipper was taken as a design starting point, though the final configuration of the Orion II/III was different in many details. The Titov V was not; it unabashedly shows its origins as the borrowed Starclipper.

Both designs wound up being horizontal takeoff, assisted by a steam catapult. This was driven partly by customer demand – airlines wanted an airplane that could reject a takeoff or return to base at any point, not a flame-belching vertical-takeoff behemoth that needed to get

supersonic before it was possible to abort and return to land. This also allowed easier adaptation to the later two-stage concept, as no engines would have to be removed to make that work.

The drop tank itself was named Orion I; the cargo shuttle Orion II. The passenger-only version came later, named Orion III.

The Titov used different nomenclature; the drop tank was Blok A (Titov A), the booster Titov B, and the orbiter Titov V (third letter in the Cyrillic alphabet).

By the end of the 1980's, it became significantly cheaper to launch supplies in small pieces on the shuttles than to launch on Saturns, or even the economy-size Neptunes purchased in bulk. First propellant, and later, as orbital assembly became a going concern, structural elements, were brought up routinely in small daily (and later, hourly) flights rather than big monthly ones. Space stations and moon bases and the Mars base were not abandoned; they were expanded.
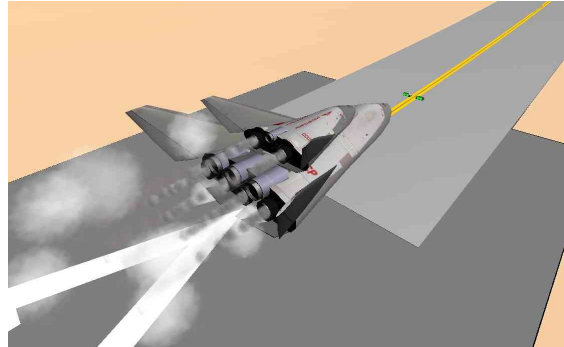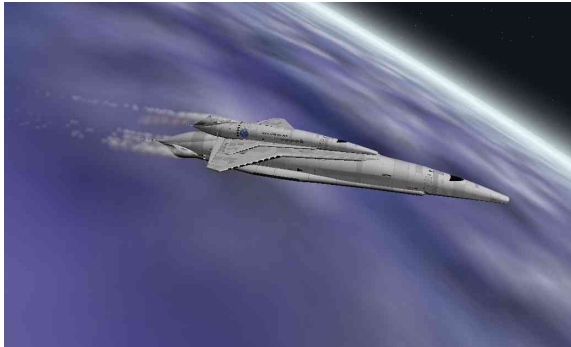

The market for shipments to orbit well-established, it was time to bring costs down another increment. The Orion IV and Titov B boosters were developed, and passenger service became cheap enough to be afforded by thousands, then millions. An orbiting hotel was built.

The USSR passed into the hands of pragmatic leaders, communist by name but with capitalist reforms. Ideological competition between the superpowers lessened, though did not end entirely. The two superpowers did cooperate to try to lessen other powers' access to space; this was almost completely unsuccessful. The Chinese built space stations and moon expeditions; the British built a moon base.

Thirty-eight declared nuclear powers flexed their muscles, and for reasons not fully explored or explained, at least six of them placed nuclear weapons in orbit. (By the time of 2010, this was apparently illegal by treaty, but violated anyway. What the advantage is of putting your nukes where it takes longer to use them and anyone can tamper with them, nobody can explain.   We're faithful to the canon anyway.)

Today, the drop tank versions continue in service for some missions.   While riding a reusable booster is clearly cheaper, boosters are scarce resources, closely scheduled. The drop tank allows missions, particularly military ones, to proceed without tight schedules in advance. It is the ONLY practical way to place a military spaceplane on alert, ready for launch but at an indeterminate time.
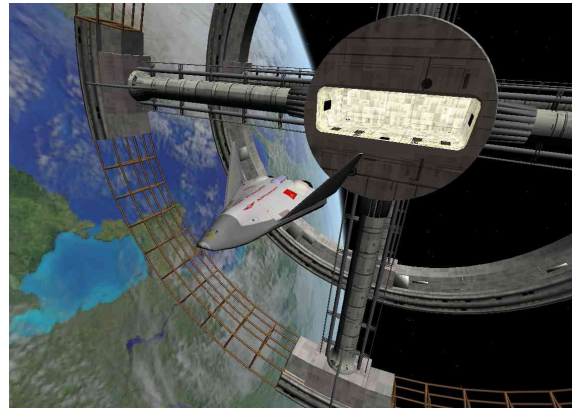
Orion II/III and Titov V operate the same way: the spaceplane is launched with a drop tank or booster stage, catapulted off and up from a steam catapult. A wing-borne flight phase gets the combination above the atmosphere with low drag losses. The engines throttle back to maintain a comfortable acceleration level (3.5 G's for Titov V, 3 G's for Orion). Propellants are fed to the upper stage so its engines can help push. The booster / drop tank carries most of the propellant and does most of the work, staging at around Mach 20.

You can switch viewpoint and fly the booster home at this point, making a high-mach 180-

degree turn. At the end of this, you'll be much slower; stretch the glide and turn on the airbreathing engines once they are usable.

Internal tanks fly the spaceplane the rest of the way to orbit, serve for on-orbit maneuvering, and perform the de-orbit maneuver.

The "stage" of the vehicle can be incremented on-orbit, disabling the big engines which are very overpowered for orbital maneuvering. All engines (except the jets) share the same LOX/LH2 propellant tanks; there is no separate RCS or de-orbit tank. Save some!

Re-entry is very conventional for the Orion II/III. The Titov V uses the Soviet folding-wing concept to reduce re-entry heat loads. After re-entry at high angles of attack, the wings will fold down automatically once below Mach 5, dramatically improving the glide.

Both spaceplanes use air-breathing propulsion to stretch the glide or perform a go-around. The Titov V places a subsonic commercial jetliner engine in the tail, protected by a cover which opens below Mach 1. This will change you over to the jet engine's fuel tank.

The Orion uses a "ram-wing" concept with small turbopumps for subsonic operation. This allows operation at up to Mach 3.0 and saves mass, though at a cost in fuel consumption.

There are some differences between the spaceplanes; as already noted, the Orion can cruise supersonically. The Orion has a dedicated passenger version; the Titov has a single model that drops in a passenger module for passenger service. A dedicated version with windows would make little sense in a lifting-body, where windows would give views of the hydrogen tanks.

Due to the configuration, the Titov V can launch with a booster AND a drop tank at the same time. Nicknamed the "kludge" by American analysts, the configuration is rarely used, mainly for military quick-reaction flights to high orbits.

Both spaceplanes dock with station V using a "virtual" docking port that allows the craft to move into position nose-first but has no physical reality. At Station V, docking arms and cradles (not animated!) would hold the spaceplane in position (or move it to a location off the centerline) and a boarding access arm would snake up to the hatch on the side of the craft.

The side hatch is also a legal docking port. The other craft would have to have a flexible collar to mate to the spaceplane's less-than-perfectly-flat exterior face. But this does not seem to be a major problem with 2001 technology.

Both spaceplanes are commercial successes, including export sales. China makes Titovs under license; other countries have airlines and sometimes militaries that operate Orions (Western Europe, Australia) or Titovs (Eastern Europe, India).

Orion/Titov 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.
    Jettisoning the payload only works when the bay doors are open.
    Stages:
    -3   Booster stage only
    -2   Booster stage with orbiter (next stage will skip to Stage 1)
    -1   Booster, drop tank, AND orbiter (Titov only)
    0   Drop tank and orbiter
    1   Orbiter with main engines
    2   Orbiter, main engines disabled (OMS engines enabled)
    3   Orbiter on airbreathing engines
K – Open/close the payload bay doors
P – Open/close the side personnel hatch
E – EVA from the spacecraft (only if the personnel hatch is open)
G – Lower/raise the landing gear
B – Toggles the wheel brakes
CTL-J – Join a nearby payload to a suitable attach point.
        (Only if point is within 20 meters distance and 20 degrees of alignment)

CTL-SPACEBAR – Show compatible attach points

Launch with the autopilot to see how it's done, or do it yourself. You'll need to bank to turn onto your selected launch azimuth; steam catapults aren't mounted on turntables. Launch with full nose-up trim (the code will start the scenario for you with full-up trim). Rotate to 30-40 degrees nose-high. (40 degrees for Titov. The Orion has less power, and so needs to use 30, at the cost of more drag losses).

Pitch over, level with the horizon, slowly. The drop-tank version will need to pitch more slowly still as it loses mass slower due to the lower number of engines. You want to time things so that your vertical velocity reaches zero as you hit orbital velocity, of course.

Reskinning the shuttles

It is possible to re-skin the Orion II/III and Titov V. You may have noticed that the Orion III comes with a Pan-Am logo but the Orion II defaults to USAF livery. It's possible to override this selection, or to add new skins for the ships. Over a dozen skins are included in the distribution.

To re-skin the Titov V, you'll need to make a copy of the mesh in the \Meshes\2001 folder. Edit the copy with notepad or similar; go to the 4th line from the bottom, where it says:

2001/tvBody.dds

And change that to the file path of your new skin in .dds format. You should put the new skin in the Textures\2001 folder as well.

Make your skin with any paint program, and convert it to .dds with dxtex or the .dds plug-in and Adobe Photoshop.

Re-skinning the Orion is similar, but more complicated because the Orion mesh comes in 3 parts: Orionbase.msh, plus sub-parts for Orion II or Orion III, depending. The default subparts are Orion2USAF.msh and Orion3PanAm.msh.

You can probably get away with re-skinning just the Orion2 and Orion3 subparts, since they contain the files Logo.dds (with the PanAm logo) and HullS.dds (with the side of the hull where it says "Pan American"). For more extensive re-skinning, like changing the hull color, you'll need to edit more .dds files than that, and so you'll need to copy and alter Orionbase.msh as well.

You need to keep your company name on HullS.dds narrow and in the same place as the "Pan American", because the left side of the spacecraft will use the same texture as the right side, but reverses a narrow strip so that the text reads the correct way. If your logo is too tall, it will fall out of this reversed area and will look terrible. Sorry about that; it's an artifact of the original mesh.

Tell the scenario to use a re-skinned shuttle by giving it the command:

For Titov V:
TVMESH 2001/TitovV   (or rather, point it to your renamed mesh)

For Orion:
OR2MESH 2001/Orion2USAF   (or your renamed mesh. Only for Orion II's)
OR3MESH 2001/Orion3PanAm (or your renamed mesh. Only for Orion III's)
BASEMESH 2001/OrionBase   (or your renamed mesh. Optional; only for extensive re-skins)

You cannot re-skin Orion IV or Titov B boosters, as that would require more extensive work to ensure the correct skin gets passed on booster jettison. Ugly. Happily, the boosters have no markings anyway. This is because a Pan Am Orion doesn't get boosted on a Pan Am booster; the boosters are owned by another company, or the Spaceport Florida Authority, and get used to launch whatever orbiter is next in line. Pan Am owns no Orion IV's, and would lose money on one if its job was to wait around until the next Pan Am flight, skipping other customers.

Aries and Variants

As critical as the spaceplanes are to shaping the world of 2001, the existence and effectiveness of space-to-space transport is at least as important.

Soviet equivalents to the Aries exist and operate similarly; differences will be noted in the next section.

The Aries Ia was ball-shaped moon lander and space-to-space transport throughout the 1980's. It was LOX/LH2 powered, and is not modeled in this release.

The 1990's versions were built to use small, mass-produced nuclear rocket engines. Using Particle Bed Reactor technology and using all the tricks learned from the early missions to Mars, the Aries engines achieve superb efficiency at the cost of lower thrust than their chemical-engine counterparts. Attitude jets employ high-powered microwave thrusters to achieve excellent efficiencies with pure LH2 fuel.

The Aries lander is only the best-known of a series of related space-to-space vessels sharing common components. The better-known models are:

Aries – Lunar and Mars lander

Aries I: Lunar landers

Aries Ib – Nuclear-powered lunar lander. The development of nuclear engines was first adapted to high-speed passenger transport to the moon.

Aries Ic – Cargo-only version of the Aries Ib.

Aries II: Mars landers

Aries IIb – Like the Ib, but adds an Aeroshell for Mars landings. Also replaces some LH2 with LOX tankage for LANTR (LOX-Augmented Nuclear Thermal Rocket) application. To boost takeoff thrust and allow liftoffs from Mars, LOX is added in the nozzle of the nuclear engine as a sort of afterburner.

Aries IIc – Cargo version of the Aries IIb
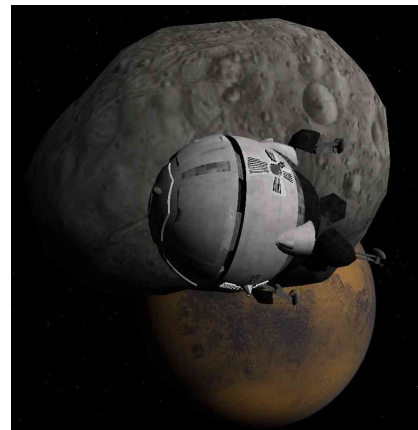
Taurus – Orbital tug, rescue vehicle, and space-to-space transport. No landing legs, but adds a forward docking port.

Taurus Ib – The only existing model; used for placing satellites in high orbits and resupplying high-orbiting stations. Also serves as an on-call rescue craft in Earth orbit.

Aquarius – Long-range space transport based on Aries components. You could fly to Mars in an Aries – that's how they get there – but by 2001 this is regarded as slow and uncomfortable. And an Aries could carry little in the way of passengers or cargo on the trip; the lander itself is the primary payload. For true interplanetary travel, the Aquarius adds additional tankage and a pair of extensible hab modules for artificial gravity. The hab modules do not rotate; the entire ship has to. Because of the small size, lunar gravity is all that can be reasonably maintained.
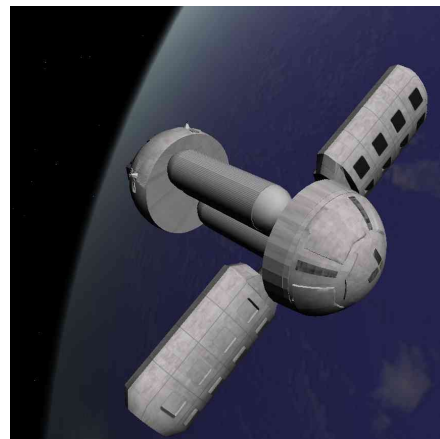
The Aquarius habs are also in use as components for space stations smaller than the massive Space Station V.

(The A-model was LOX/LH2-fueled; B-model used a single, lower-efficiency NERVA nuclear rocket. Neither are modeled in this release).

Aquarius Ic – All-purpose transport within the inner system, used primarily to transport people and cargo to and from Mars orbit to supply Port Lowell, and also to Cytherean Station One orbiting Venus.

Aquarius IIc – The experimental "Mars-adapted" version adds landing legs to enable landings at Phobos Base. An Aquarius could never land on a planet like Mars.

Aquarius Id – Available only in the 2005+ timeframe, this version adapts a single Gas Core Reactor from the Polaris X-1E and Discovery to make a much faster transport.

Herculis – Long-range cargo transport based on the Aquarius, but without the habs. Cargo boxes and fuel tanks are carried along the spine, mid-length, where an Aquarius would keep the habs. Three internal spots for boxes are also available; these are normally used for hibernation modules. The Herculis cannot travel to Mars when all attach points are filled, or at least when they're filled by cargo boxes (the heaviest). The only version in existence is called a Herculis Ic to align it with the Aquarius models.
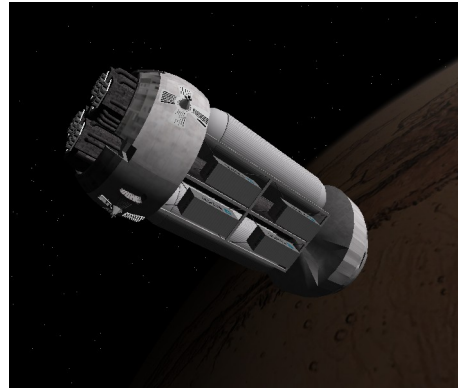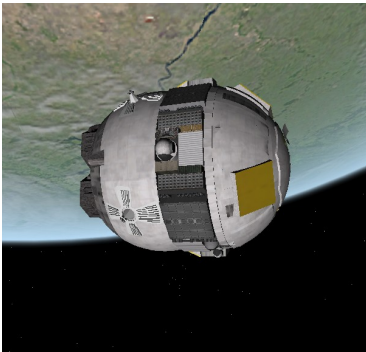
Draco – Short-range patrol corvette which is used for rescue, inspection, interception, "showing the flag", and the like. The Draco-class is based on an Aries, but adds a gunnery deck with weapons, sensors, decoys, stores, and more.

Polaris 1-XE – This eXperimental-Engine vehicle was a quick Aries adaptation thrown together to test the high-power "Cavradyne" Gas Core Reactor engine that made the Discovery mission to Jupiter practical. There is only one example of this ship. Dave Bowman, either solo or with a very small crew (sources are unclear), piloted the Polaris 1-XE's single flight to Mars and back.

Lost Worlds describes this as an ion-powered spacecraft, but Discovery was ion-powered during that draft, too. We've decided that when Discovery got Gas Core Reactors, so did Polaris. It would only make sense to transfer Bowman to Discovery if it had the same propulsion system as the testbed he was already familiar with.
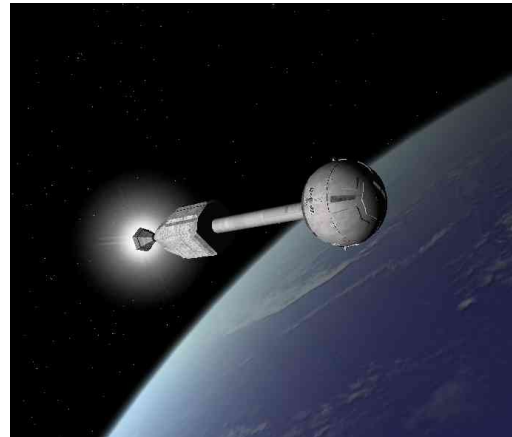
Aries Keys:
.
J - Jettison the next attached payload
K – Open/close the payload bay doors (N/A Aries Ib, IIb, Polaris)
O – Open/close the engine dOors (Aries II)
P – Open/close the Personnel habs (Aquarius)
G – Lower/raise the landing gear
E – EVA from the spacecraft
CTL-J – Join a nearby payload to a suitable attach point.

(Only if point is within 1 meter distance and 20 degrees of alignment)
CTL-SPACEBAR – Show compatible attach points

Navigate using the MFD of your choice. Aries has enough delta-V to make an accelerated transit to the moon; Aquarius can do the same to Mars. The Gas Core Reactor models (Polaris and Aquarius-Id) can stand yet more trip-shortening, and should be able to make a round trip on a single fueling to boot.

Main engines are disabled when engine doors are closed or personnel habs are open.

If the Aries variant you're flying has no gear, the touchdown points are on the ventral side, about 25 meters down. This is purely to facilitate landing the Polaris 1-XE on the wire grid at Phobos Base. You can land other (Aquarius) variants this way. Landing at a location other than Phobos Base's wire grid will cause odd results.

The LANTR thrust augmentation (Aries II (Mars) variants) is automatic when there's LOX in the LOX tank. No user action is required. You'll get a lot of thrust, and then thrust will drop considerably when the LOX tank is exhausted. Use caution; an Aries II with empty LOX but nearly-full LH2 tank has a very low thrust-to-weight ratio for Mars or Mercury. A landing may not be possible until you burn down more fuel.

The Aries II is also used on Mercury, as the thrust increase from LOX injection is required due to Mercury's surface gravity. The aeroshield is retained, too; while it obviously is no good for aerobraking, it makes an adequate sun shield.

Gagarin and Variants

The Soviet Gagarin lander is conceptually very similar to the Aries. There are a number of differences, however, which need to be kept in mind.

The Gagarin has a "fighter-like" cockpit, but it's on the ventral ("bottom") side of the craft, rather than on the dorsal side as it might be in an aircraft. The reason for this is that the seats are designed to pivot 120 degrees to allow a view during lunar landing. During normal operation, the seats face forward (opposite the thrust line). By pivoting the seats and controls 120 degrees, the pilots can look out the ventral side at the horizon when the ship is sitting on its tail. This unusual layout takes some getting used to, but is quite useful for manual lunar landings. The **V** key toggles the view angle switching.

The main engines are pure solid-core, folded-flow (wire-core) nuclear thermal rocket engines, without the tradeoffs that gave the Aries additional Isp at the expense of thrust/weight. Thus, the Gagarin's engines are less efficient, but have greater thrust.

Because the engines have greater thrust, LOX injection is not used for the Mars variant (Gagarin-M). Additional engines are added to the Mars variant, but the additional boost provided by LOX injection was not required.

The Aries comes in cargo and passenger variants; the Gagarin does not, as it mixes the two. With a smaller cargo capacity than the Aries Ic, and a smaller passenger capacity than the Aries Ib, it is nonetheless more flexible in operation. Cargo is carried on the flat forward face of the Gagarin. Some variants, like the Komarov and Bondarenko, put the hab modules on this flat forward face, so they have a forward platform that serves the same purpose.


The Gagarin's gear has a narrow stance, requiring skilled piloting for landing. The advantage is that the gear is very light due to its short length and simplicity. The Gagarin landing gear is fixed, further saving weight. The Gagarin-M (Mars variant) requires retractable landing gear due to the heat shield, at an additional weight penalty. Because the Gagarin pays very little weight penalty for having gear, there was no reason to develop a no-gear variant for orbital tug operations, like the Taurus.

While the Aries has variants, and the Gagarin has variants, not all the variants do the same things as their American counterparts. The Gagarin variants are:

Gagarin – Lunar and Mars lander   (U.S. Equivalent: Aries)
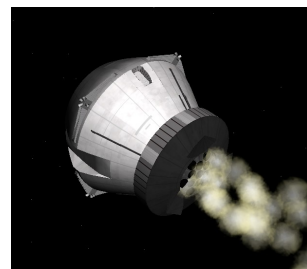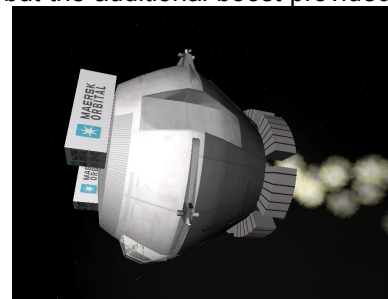
    Gagarin: Lunar lander
   Gagarin-M: Mars/Mercury lander
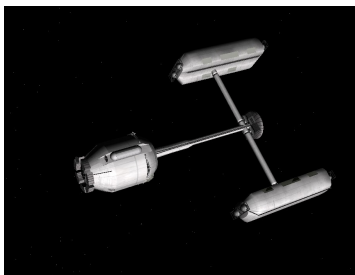
Komarov – Inner-system transport (U.S. Equivalent: Aquarius)

    Komarov: General-purpose transport used to supply Cytherean Station One and the Mars colony. Habs swing out on the end of tunnels so that the entire hab gets the benefit of centrifugal gravity. The pivot point is as far forward as possible to

provide distance from the reactor. Komarovs are comfortable rides, except that "down" is towards the aft wall when under thrust. The crew's twice-daily transfer from the hab to the crew section and back has earned it the nickname of the "hamster hab".

Komarov-Bis: "Bis" just means "Improved" but in this case the improvement is substantial. The Komarov-Bis is "improved" with a Sakharov-drive engine. This drive (a scaled-down version of the one on the Leonov) is a micro-fusion pulse drive. It's even more efficient and powerful than the American Cavradyne (Gas Core Reactor) engines. Komarov-Bis is the equivalent of the Aquarius-Id transport.
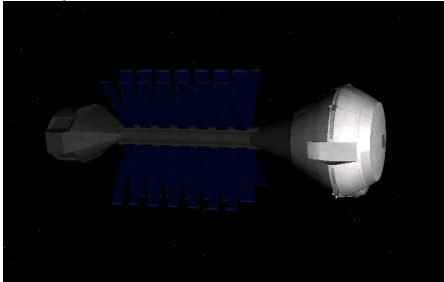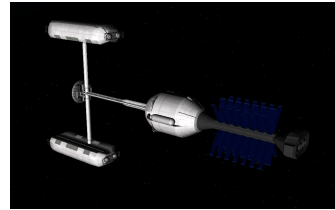

**Merkur** – Experimental engine testbed (U.S. Equivalent: Polaris 1-XE)

The Merkur was a testbed for the first Sakharov drive unit, flying to Venus and back in record time. As with its equivalent the Polaris, the ship and fuel tanks are too small for practical use as an inner-system transport. Only one example of this ship exists.

Patsayev – Tanker   (U.S. Equivalent: Taurus, Herculis, None)

Patsayev: Previously, before the Tchalinko base was able to process lunar ice into fuel, there was no refueling capability on the moon. The Patsayev tankers were used to shuttle fuel to the lunar surface and return empty. With fuel now available at Tchalinko, the Patsayevs are undergoing conversion into Komarovs, or are performing the Taurus mission of boosting payloads to high or escape orbit. Since the Patsayev has the fuel capacity of a Komarov transport but not the mass of the habs, it is capable of far more delta-V change than the Taurus to which it is sometimes compared.
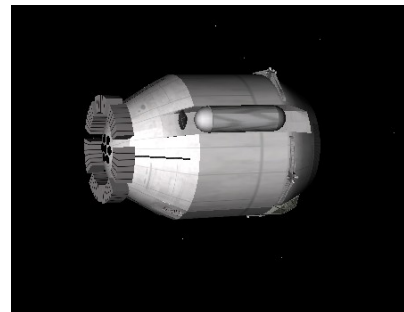
Patsayev-M: A Mars cargo vessel, simply adds the Mars aerobrake and a "luggage rack" to carry up to a dozen cargo containers externally. The Patsayev-M is the functional equivalent of the U.S. Herculis. It is quite different in operation, however, as it aerobrakes into Mars orbit. Normal procedure then is to land on Phobos or be unloaded in orbit. The Patsayev-M could probably land on Mars in theory, but never does in practice.
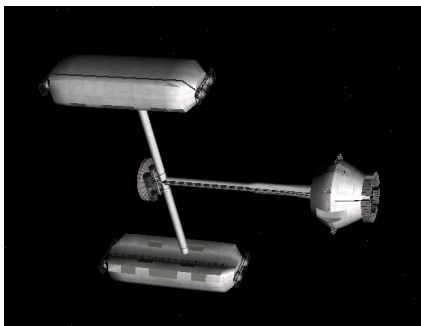
Bonadrenko – Self-deploying space station
(U.S. Equivalent: None)

If the Patsayev tanker is a Komarov's tankage without the habs, the Bondarenko is its opposite – it's got the habs, but not the tankage. The Bondarenko self-deploying space station can move, but only on the lowest-energy trajectories (read: slowly). Bondarenko was in lunar orbit during the Tchalinko buildup; it's currently in GEO to aid operations there. Bondarenko was designed for deployment to Mars, but this has not been done as the Phobos base makes the Bondarenko's facilities redundant. Only one example of this ship exists.

Skorpion – Patrol Corvette
(U.S. Equivalent: Draco).
Short-range patrol corvette which is used for rescue, inspection, interception, "showing the flag", and the like. The Skorpion-class is based on a Gagarin, but adds a gunnery deck with weapons, sensors, decoys, stores, and more.

Gagarin Keys:

.
J - Jettison the next attached payload
O – Open/close the engine d<u>O</u>ors (Gagarin-M, Patsayev-M)
P – Open/close the <u>P</u>ersonnel habs (Komarov, Bondarenko)
G – Lower/raise the landing gear (Gagarin-M, Patsayev-M)
E – EVA from the spacecraft
V – Toggle viewpoint forward/ventral
CTL-J – Join a nearby payload to a suitable attach point.
 (Only if point is within 20 meters distance and 20 degrees of alignment)
CTL-SPACEBAR – Show compatible attach points

If the Gagarin variant you're flying has no gear, the touchdown points are on the LEFT side, about 25 meters down. This is purely to facilitate landing the ship on the wire grid at Phobos Base, in a manner similar to the Polaris 1-XE. The ship must land on its side, however, to keep the Sakharov Drive radiators from getting caught in the wires. Landing at a location other than Phobos Base's wire grid will cause odd results.
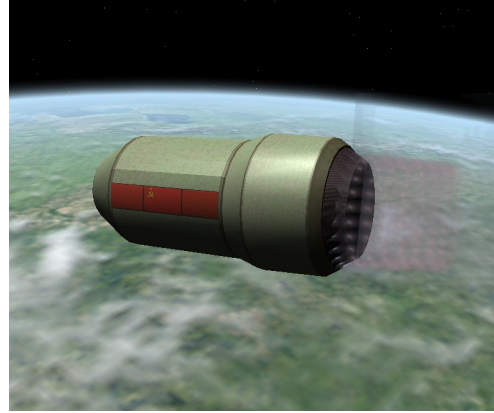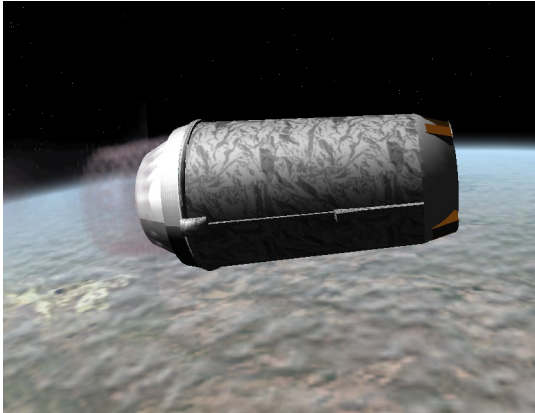
A LOX/LH2 high-performance chemical upper stage is included for the U.S. and USSR. Depending on the mission, the upper stage might be expended, or it might be returned to a low orbit for refueling and re-use; sort of a very simple space tug. The upper stage can attach payloads via CVEL, or by an attach point on the nose. A docking port in the tail permits docking the stage for purposes of refueling it with FuelMFD.

Both upper stages use an aerospike configuration for high performance, short stage length (allowing it to fit in the payload bay with a payload), and also permitting easy access to the fueling ports via FuelMFD.

For very high-performance missions, try "flinging" the payload with an upper stage attached; use the upper stage once separated.

At the time of 2001, use of the upper stages is declining. The Taurus and Gagarin and Patsayev nuclear spacecraft are taking over the space-tug mission, and by "flinging" payloads, are lessening the need for the Earth-escape mission too.

The Centaur-O (for Orion) evolved from the highly successful Centaur series of upper stages for expendable launch vehicles.

The Titov G was developed specifically for the Titov V spaceplane as its tug/upper stage. The G designation is simply the next letter in the alphabet (Blok A for the drop tank, B for the booster, V for the orbiter, and G for the upper stage).

Centaur-O/Titov G Keys:

J - Jettison the attached vessel or payload.
CTL-J – Join a nearby payload to the attach point.
   (Only if point is within 10 meters distance and 20 degrees of alignment)
CTL-SPACEBAR – Show compatible attach points

Moonbus and Rocketbus

The moonbus is designed for personnel transport on the moon. It has also been adapted, with some difficulty, for use on Mars. It has a pressurized personnel compartment, treads for surface movement, and rocket engines to hop over obstacles or make faster transits. The Moonbus is sometimes used for ballistic point-to-point hops on the moon; it can even make it to lunar orbit, in a pinch.

The Soviet equivalent is the Rocketbus. It is similar, but not identical. It lacks the tread system; it can only move by thrusting. By way of compensation, it has more delta-V capability, and has forward thrusters in addition to the hover thrusters.
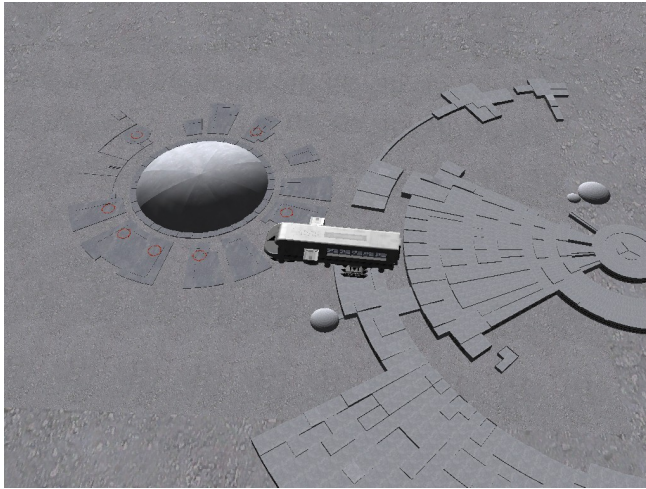
The moonbus has only hover thrusters (and attitude jets). This makes for a comfortable ride; everyone can stay seated during the flight. There are three basic ways to move the Moonbus:

Surface Movement – BOORING! We fly Orbiter to fly, not to drive trucks. But this is by far the most fuel-efficient, and most common, way that moonbuses get around in the "real world" of 2001.

Skimming – As seen in the film. Throttle up the hover engines. Once off the ground, pitch down to start moving horizontally. Control pitch and power to stay low. Once moving at a good clip (several hundred m/s), rotate level and throttle back to 1.7 m/sec^2 acceleration, just holding against the lunar gravity. Reverse the process at the destination. Lunar gravity is low, and there's no air drag, so this works without too much of a penalty over the pure-ballistic hop. And it's a much more comfortable ride.

Ballistic Hop – Whee! Throttle up to take off, and point towards your destination. Pitch 45 degrees nose-down, and keep the hover thrusters at maximum. Check the MapMFD; when your instantaneous point of impact reaches your destination, kill the hover thrusters. Note your altitude at cutoff; when you pass that going back down, it's time to reverse the process. More fun than a barrel of monkeys. Also slightly more fuel-efficient than skimming, so you can justify it to those chair-warmers back at HQ. Try not to smack the lunar surface at very, very high speed.

On Mars, the Moonbus thrusters are barely adequate against the local gravity, leading to high gravity losses. In addition, air drag means that skimming doesn't really work. Finally, a good high-speed ballistic hop would heat up the Moonbus' fragile airframe beyond tolerances due to air friction. For these reasons, a Moonbus operated at Port Lowell on Mars is used almost exclusively in surface mode, with the jets used only to hop crevasses and cliffs and the like. Of course, you do have enough fuel to hop BIG crevasses, perhaps even Marineris....
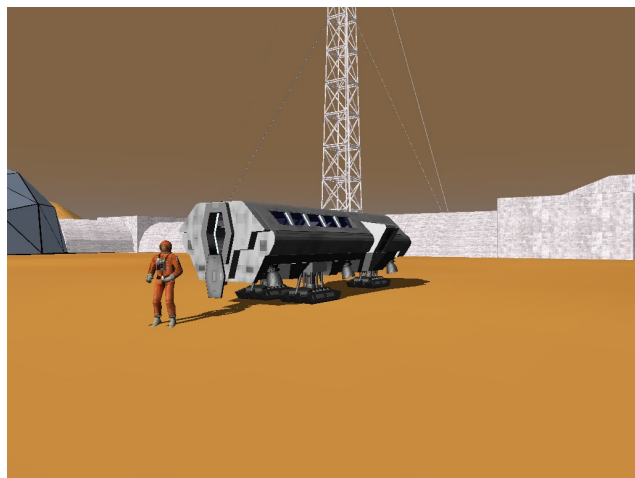
Moonbus Keys:

J - Jettison a CVEL payload (if you have one)
P – Open/close the <u>P</u>ersonnel hatch
E – EVA from the spacecraft (only when the personnel hatch is open)

Surface Movement (N/A for the Soviet Rocketbus):
8 – Forward by surface movement (use the number 8, not the keypad you use for thrusters)
2 – Back by surface movement
1 – Turn left
3 – Turn right

EVA Suit

If there's one thing the world needs, it's an affordable, comfortable, flexible pressure suit. The world of 2001 apparently has such a suit, with gloves suitable for constructing massive space stations and simplicity suitable for use by space-traveling bureaucrats.

This version includes code suitable for walking around on planetary surfaces. Go everywhere! Do anything!

Thanks to Roger (Frying Tiger) Long for the Space:1999 EVA mesh which we've adapted for use in the world of 2001.

EVA Keys:
.

E – Return to the spacecraft (only if it's the one you came from, and it's close by)
8 – Forward by surface movement (use the number 8, not the keypad you use for thrusters)
2 – Back by surface movement
1 – Turn left
3 – Turn right
4 – Slide left
6 – Slide right
S – Strap/Unstrap from a Paracone or other vehicle.
G – Grab/Let go of a nearby object's attach point. Requires that the next keypress be:
    1 – Grab/Let Go from Left hand.
    2 – Grab/Let Go from Right hand.
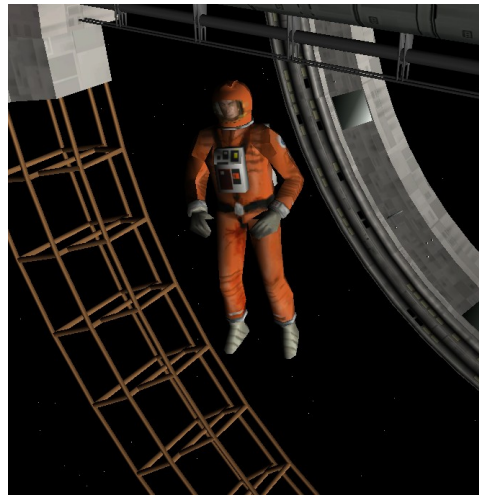
Space Station IV and V

Station V is the grand, stately Earth-orbiting transfer point and spaceborne Hilton hotel. The international station is still under construction, but is already the largest and most important space station. Three versions are included: "StationV" is the version pictured at left, still under construction. "StationVEarly" is a circa 1999 station, with the second ring not even under construction yet. "StationVComp" is completed, with a second ring.

Station IV was its predecessor. It's smaller and more cramped, but still useful as a transfer point for moon-bound travelers.

Docking is accomplished by getting on centerline and flying nose-first into the docking bay. Match rotations once close.

Orions and Titovs and the Aries-Ib come with a "virtual" docking port that doesn't really mate to anything physical, but rather provides good guidance for DockMFD to guide you into the bay. There, docking cradles and arms (shown, but not animated for this release) will snug your spacecraft into place. Your spacecraft might be moved to one side or the other to free up the centerline bay for docking/undocking. In any case, a boarding access arm will move into position over the side hatch. Seems cumbersome, but it works.

Station V is not a focus-enabled object.

For the v3.1 release, the side docking ports are usable. You must dock at the centerline port as always; once there, your vessel will be shifted to the first available side port, to free up the centerline port for someone else to dock. If there is no available side port, you'll stay on the centerline, blocking everyone else. So hurry up and unload!

To undock from a side port, just undock the forward port. You'll be shifted to the centerline port, where you can repeat the request and leave. If the centerline port is taken, you're stuck.

Small craft (pods and Moonbuses) are shifted instead to one of the four small docking ports at the periphery of the bay, staying out of the way of the bigger traffic.
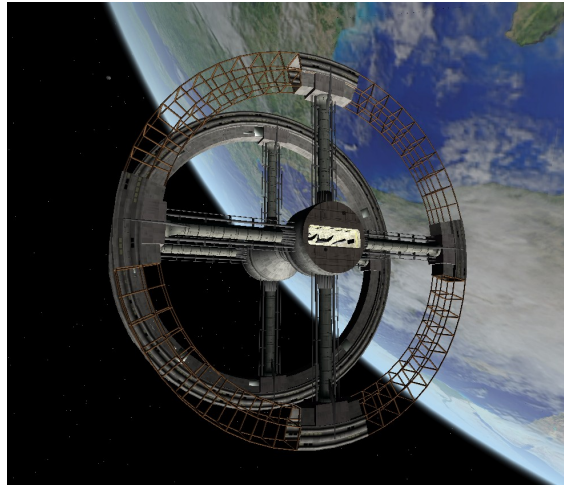
Space Station Three

This small station is in polar orbit. This is done mostly to facilitate use by the high-latitude bases on European territory. An older base, Station Three is based on Aries components. An integral fuel capacity allows the support of the occasional moon run to Serenitatis, twice a month when the alignment is right.

Boarding arms to facilitate entering and exiting a docking Orion shuttle are not yet animated. There are two docking ports; one on each end.
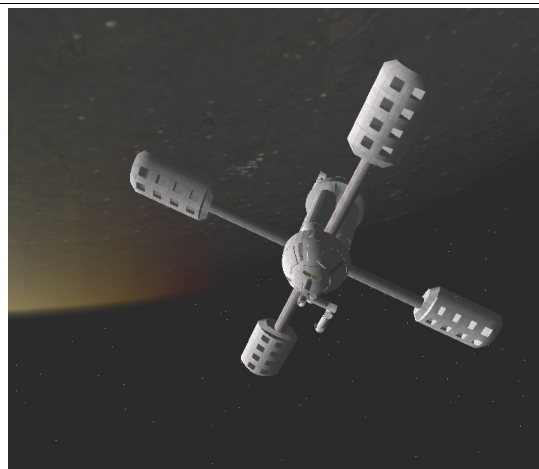
Cytherean Station One

The small international research station over Venus is designed to investigate the mysterious planet. Its crew is frequently dropping probes into the atmosphere. There's a more-or-less-annual flight of an Aquarius/Komarov-class transport to resupply and swap crews.

This station is a configuration typical of some smaller stations – a station constructed of an Aquarius hab module. You can use this station as a stand-in for small space stations in Earth or lunar orbit.
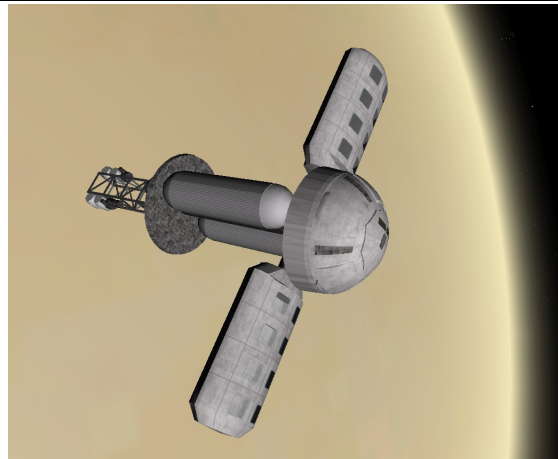
Military Satellites

These satellites are designed as payloads for your cargo-carrying satellites. Sat1A and Sat1B are described as American; Sat2 is apparently German. Sat3 we have made Soviet; Sat4 (called "Weathereye") is currently homeless; it might be French, British, or another type of American satellite. The Taikosat is a Chinese military satellite; it was not shown in the movie, but is reasonably supposed.

All of these satellites fit one to the payload bay, except for Sat3, which is 1/3 size and fits three to a Titov V payload bay.

We have added the GBSat and FrSat; British and French military satellites, respectively. They are half-size and fit two to an Orion II payload bay.

All of these satellites are currently very generic in capability; they don't really DO anything except get deployed, and they can maneuver a bit. In the book and movie, of course, they carried nuclear weapons. These are not simulated here.

Other Satellites

Several other satellites, mentioned in the book and modeled after photos found in the Kubrick collection, have been included. These include:

Intelsat VII – A manned geosynchronous communications platform.
Artificial Comet 5 – A fast-moving probe to explore the Oort cloud and heliopause.
Deep Space Monitor 79 – A com relay and probe.
High Inclination Probe 21 – Appears to correspond with the Ulysses probe; a look over the solar poles well above or below the ecliptic.
Mars Orbiter M-15 – Mars will need comm relays, weather sats, and a GPS-type system. The Mars Orbiter series presumably accomplishes all three.
Lunar Reconnaissance Orbiter – Examines the moon in many spectra. Discovered TMA-1.
Soviet Lunar Orbiter – The Soviet equivalent. A Lunar Orbiter.

Cargo Boxes and Landing Modules

Cargo, in the world of 2001, is moved around the system frequently enough that commercial standards apply. The standard cargo carrier in the inner system is an ordinary short (20-foot) shipping container. The container is usually not standard, but modified for space use by being made of aluminum, fitted with tiedowns for its intended use, and plumbed for RCS jets if it's to be paired with a landing module. Nevertheless, the cargo container can and does make its way by

road, rail, and ship to the spaceport, where it is launched, trans-shipped outside of Station Four or Five, and then sent on its way to the moon, Mars, or elsewhere.

BoxMaersk – An ordinary shipping container, in the livery of the Maersk line.

TankAL – A fuel tank, fitted to the size of the Orion II payload bay. This tank is a non-standard size and cannot be mated with a landing module, so does not really belong grouped with these standard payloads. We're just listing it for completeness.

TankAL2 – A smaller fuel tank fitted within a gridwork box that mimics the dimensions and handling features of the 20-foot shipping container. Used to ship fuel, or any other bulk liquid or pressurized gas.

HiberBox – A pressurized container similar to the above, but with access doors. Used to ship humans in suspended animation as a payload. To be shipped attached to a cargo vessel; these modules are NEVER flown attached to a landing module!

LandMod – Landing Module. Not a standardized container as such; this is an 8-foot extension to a standardized container. This gridwork extension holds communications and navigation gear, fuel, RCS jets, landing jets, an inflatable re-entry shield, and a landing parachute. The LandMod turns any of the standard 20-foot cargo boxes into a self-sufficient spacecraft capable of making small course corrections to enter the Martian atmosphere, then land there safely.

Landing Module operation:

For course corrections, use the rotational and linear jets normally.

For atmospheric entry, the aeroshield will deploy automatically as you hit entry interface. Use the + Normal autopilot command to set a good ballistic-neutral course; then yaw toward the planet to pull down into it; yaw the nose toward the sky to pull up.

The drogue 'chute, and then the mains, will deploy automatically, at Mach 11 and Mach 5, respectively. The 'chutes are green to aid visibility in the Martian terrain.

When the drogues deploy, the landing module detaches and is suspended between the chute and the payload. This allows the main thrusters to fire "down", slowing the payload for a gentle landing. You'll want to start this process at about 3 km altitude, still going Mach 1.5 or so. Fire the thrusters, modulating for a nice soft touchdown. Hopefully you have at least 35% or so before you start, or you'll run out early.

Keys:

S – Strap/Unstrap the payload from the landing module.

Boeing 2707 SST

The Boeing SST was cancelled in our timeline; here, it was completed. The Boeing model 2707 has given good service for nearly 25 years. Capable of transoceanic cruise at Mach 2.7, its stainless-steel and titanium skin is the limit on speed. U.S. (and Western European) airlines tend to use the Concorde for shorter-haul routes, and the 2707 for longer ones where its faster speed and higher capacity are used to advantage.

Optimum cruise altitude is between 18-20 km; above that, the engines will lose power and the speed will decrease.

Keys:

G – Toggle the gear.

Wing sweep, nose droop, and control sensitivity automatically adjust with speed.

The Boeing 2707 is a CVEL-capable vehicle; carry whatever you want on or under it.
You may re-skin the Boeing 2707, in the same way as described for the Orion and Titov, above. The base mesh is b2707.msh, you can copy that, edit it to point to an edited b2707.dds, and tell the scenario to use your edited .msh with the command:

MESH 2001/b2707   (or point to your edited mesh)

Myashishchev M-53 SST

The M-53 SST was another cancelled project in our timeline. Though smaller than the Boeing 2707 (indeed, not much larger than the Concorde and Tu-144), the M-53 is capable of true Mach 3 cruise.
Optimum cruise altitude is between 18-20 km; above that, the engines will lose power and the speed will decrease.

Keys:

G – Toggle the gear.

Moving control surfaces are not currently implemented.

The M-53 is a CVEL-capable vehicle; carry whatever you want on or under it.
You may re-skin the M-53, in the same way as described for the Orion and Titov, above. The base mesh is m-53.msh, you can copy that, edit it to point to an edited m53_skin.dds and m53_panel.dds, and tell the scenario to use your edited .msh with the command:

MESH 2001/M-53   (or point to your edited mesh)
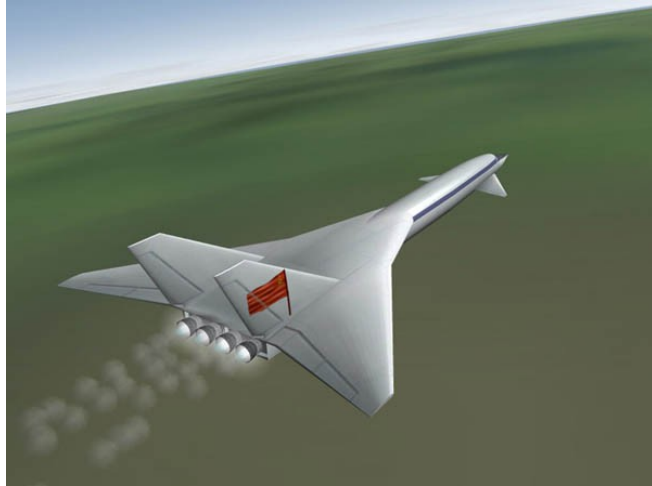
Known Issues

Aries has been converted to a tailsitter. Hey; don't look at us; we didn't put the pilot's windows on the front of the model. Unhappily, this means LandMFD doesn't work with the Aries until LandMFD is itself upgraded to support tailsitters. Sorry. On the bright side, the Moonbus works with it just fine.
Gas from RCS jets are modeled as particles. Looks good at 1x compression; okay at 10x; totally bogs down at 100x. Avoid external views at 100x time compression while jets are firing.
The Orion and Titov autopilots will bank to turn onto a selected launch azimuth, then hold that heading to orbit. Thrust is not vectored to turn onto the launch azimuth; thus, if you run out of sensible atmosphere before you get to your selected heading, you'll never get there. About 60 degrees of turn is the maximum the autopilot can reasonably handle. More than that could be done by flying the craft manually, but this will lead to greatly increased drag losses and there's really never an operational need to turn that much in the "real" world of 2001. Spaceport catapults are built to cover the likely launch azimuths.

Bibliography:

Books by Arthur C. Clarke:
   2001: A Space Odyssey (with Stanley Kubrick)
   2010: Odyssey Two
   2061: Odyssey Three
   Lost Worlds of 2001

Movies:
   2001: A Space Odyssey
   2010: Odyssey Two

Books:
   2001: Filming the Future by Piers Bizony. A drawing on p. 88, upper right-hand corner, is a sketch of an Aries concept which was rejected. We've used it as the basis for the Gagarin instead.

Web:
3D Models at http://www.2001-3d-archive.info/
Fascinating 2001 info at http://www.2001exhibit.org/2001_page2.html
   Note particulary http://www.2001exhibit.org/science/2001_engineering.html
Also see exhibit at: http://www.palantir.net/2001
Air Force One livery inspired by a nice collection of CGI screenshots at:
   http://www.io.com/~o_m/omworld/images/sb/99-01/page_1.htm

Music:
Free downloads:
The Blue Danube Waltz played by the Vienna Symphonic Orchestra is available here
http://www.wien.gv.at/english/views/download/index.htm

And 'Also Sprach Zarathustra' played by the USAF Heritage of America Band is available here
http://www2.acc.af.mil/music/frontier/

You really NEED to purchase the soundtrack and convert it to MP3's for proper enjoyment of this add-on. The soundtrack is copyrighted of course; we can't include it.
Also look for the "lost" score of 2001. Alex North originally wrote a soundtrack for the movie; the classical music was just a placeholder for screen test versions. Studio execs liked the classical enough that it stayed in; Alex North brought his whole family to the movie's premiere, and only by watching the movie did he learn his score hadn't been used. Ouch.

Version history:

v3.11
  Re-compiled for Orbiter 2010
  Satellites corrected – what WAS the 1/3-size Soviet sat has become French. The (flat, 1/2-size) former GBSat has become the Soviet satellite. The former French (long, thin, 1/2-size) sat has become British. And the Chinese Titov now launches a Taikosat, as it should have all along.
  Orion / Titov aerodynamics fixed for launch aborts
  TWA skin for Boeing 2707 added

v3.1
  Added bases, Aberporth, Brest, Cuxhaven, Hainan, Korolevgrad, Tranquility Museum
  Added Gagarin and variants
  Added upper stages
  Added attachment handling
  Added cargo box, fuel tank, hibernation module, landing module
  Added LRO, Soviet LRO, Intelsat, M-15, AC-5, HIP-21, GBSat, FrSat
  Added Stations Three and Four, and two variants of Station Five.
  Added M-53 SST
  Added traffic-switching system so StationV, IV can use all their docking ports
  Bugfix: Astronaut would teleport to Mars from Phobos via walking code
  Bugfix: multi-vessel child animations were interfering
  Bugfix: was possible to Loadstate doors open for Aries with no doors
  Bugfix: Throttle bug fixed: no more charging off at max power in an Orion/Titov.
  Bugfix: Autopilot finessed, and turning angle added.

v3.0
  Complete makeover by Sputnik, 80mileshigh, and Nautilus
  Added Sol_2001 environment.
  Added Clavius base, Emergency Depot 3, Port Lowell, Serenitatis Base
  Added Tchalinko, Lunar Observatory, Washington Space Centre
  Added Phobos Base, Prime Base, Tycho
  Added animated dome to Clavius landing pad
  Redid Orion III code and mesh with more realistic properties, also Orion I, II, and IV
  Aries with changed properties, redone code and mesh, now with variants
  Added military satellites, plus Taikosat (80mileshigh)
  Added Moonbus, 2001 astronaut, Boeing 2707 SST, Titov V
  Added RocketBus (thanks to Kev33's Moonhopper)
  Included HAL9000 MFD
  Added auxiliary docking ports to Station V
  Added modified Canaveral (Nautilus and 80mileshigh)

v2.3
  For Orbiter version 021202
  Removed the pod (added to dbartles' Discovery)

v2.2
  For Orbiter version 020114
  Orion substantially changed; aero properties added.
  Aries attitude thruster exhausts visible and placed at the correct location.
  Aries more sluggish during Orbital flight which corresponds better to the handling of a big ship.
  Pod attitude thruster exhausts are now placed at the correct location.
  Pod is still a very "handy" craft but more sluggish which eliminates the very fast angular rates.

V1.1
First release of which we're aware