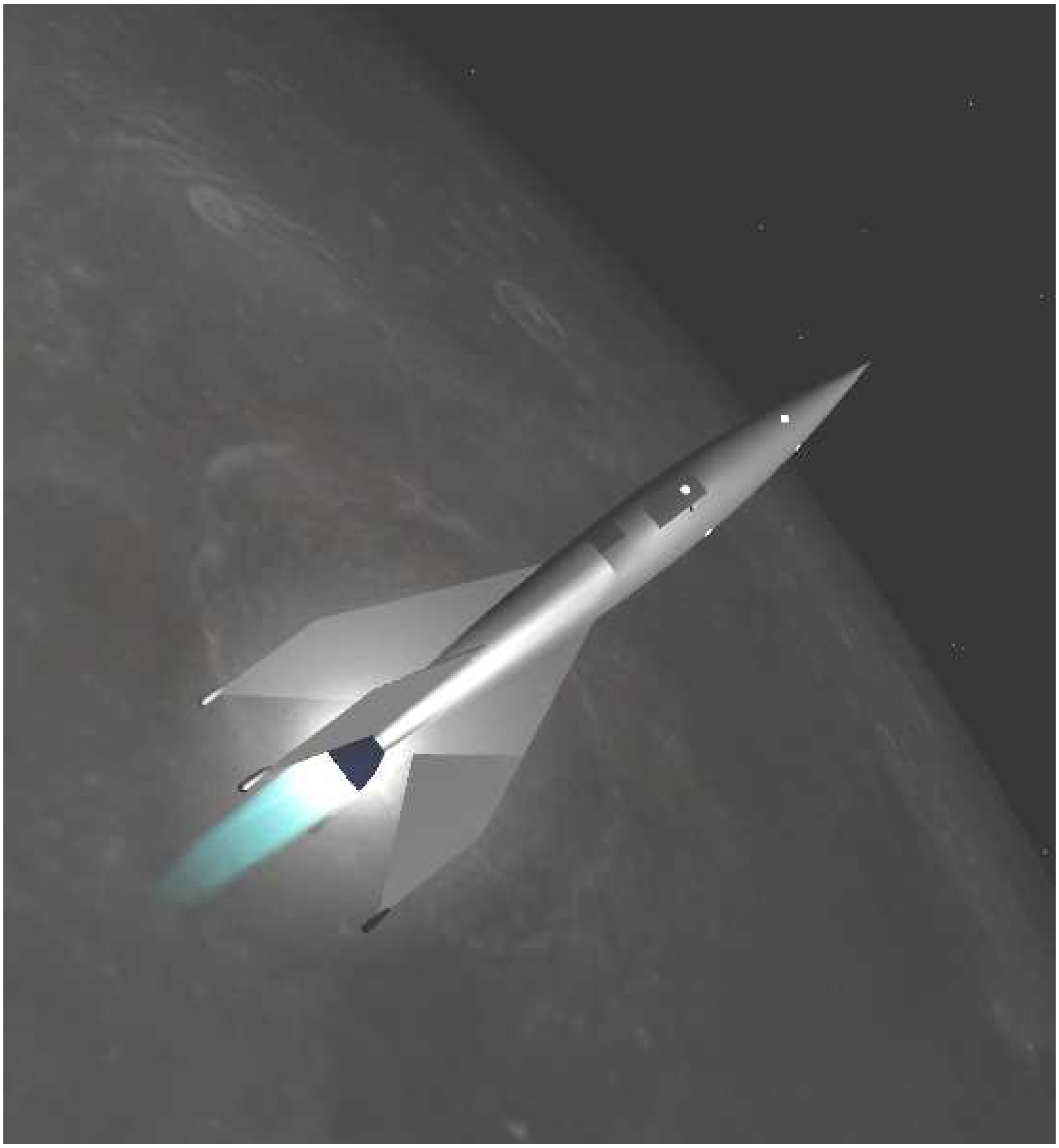
Robert A. Heinlein's *Rolling Stone* v1.0



Model and Documentation by
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Installation

This add-on needs vinka's spacecraft.dll to function, which can be located here: http://users.swing.be/vinka/spacecraft030115_021217.zip. Just unzip the package into your Orbiter directory, preserving the folder structure. Then start up Orbiter and look for the folder "Rolling Stone" and enjoy!

Background

Robert A. Heinlein's "The Rolling Stones" was published in 1952. It is a charming story of a family of disparate geniuses that have adventures as they take their nuclear-powered spaceship from the Moon to Mars to the asteroid belt. The novel has a number of unique aspects to recommend it, including interesting female characters (including Hazel – the grandmother all Orbinauts will wish they had), technical virtuosity with dialog, and most important to Orbiter fans, accurate descriptions of orbital mechanics. The second ship I wanted to model in Orbiter was the *Rolling Stone*, so that I could experience these descriptions.

Launch Parameters for Scenario

Using the detailed description of the day the family launches from the Moon, I came up with a date and lunar location. Interestingly, this differs from Heinlein fan estimates. Based on hints from Heinlein's stories, these fans come up with a launch sometime shortly after 2148-08-04. I originally used these estimates, but the celestial bodies were not in the positions described in the text. I figured that while Heinlein could have easily made timeline errors across multiple stories written through the decades, he would have been very careful in doing the calculations needed for the orbital boost and description of the sky at the time of launch.

The novel very specifically describes Earth as being in half-phase and near Orion. I used Celestia to find when the Earth is close to Orion as described in the novel on launch day. This happens in late September. There is a launch window on September 23, 2150. I think that the *Rolling Stone* actually launches on September 27, 2150.

Luna City is located on the eastern edge of Mare Crisium (from "The Moon is a Harsh Mistress"). I was unable to match this location with having the Big Dipper's handle on the horizon and a setting sun as described in the novel. I again used Celestia to find a location where this was true, and settled on a crater near Mare Nectaris called Crater Beaumont.

A launch time is not specified, so since many other people came out to bid the family *bon voyage*, and Loonies use GMT, I have their launch window at noon.

The launch profile in the scenario, and as described in the book, has them do a gravity-assist around Earth to save fuel. Here is the reasoning behind that, from http://www.geocities.com/Area51/Corridor/8611/orbopssf.htm

ΔV needed for Moon to Earth for slingshot: 815m/s
ΔV needed during slingshot: 600m/s
Total ΔV of maneuver: 1415m/s
ΔV from Moon to Mars without slingshot: 2547m/s
Savings with slingshot: 1132m/s

Ship Parameters

The *Rolling Stone* I modeled is based on the description in the book and on the spaceship *Luna* from Heinlein's Academy-Award winning movie "Destination Moon."

To achieve realistic ship parameters, I had to balance known parameters of nuclear-powered rockets (realistic ISP and thrust), with the volume devoted to living spaces, cargo, engine room, and fuel. And all this had to be able to go from Moon to Mars without additional tanks. For those who are interested, I have included the Excel spreadsheet I used to mess around with these variables until I could end up with something that worked.

Also, this ship needs to be capable of 5g with a full load of fuel. As the fuel runs out, though, it can go much higher! Keep in mind that you are piloting a family around, and one raised in the Moon at that, so watch those gees! (In case you don't know, the gauge on the upper left indicates the acceleration in m/s. Five gees is a little less than 50 m/s.

One note – in using the real PMI for a 50's era tail-sitter in conjunction with vinka's spacecraft.dll, you need to use caution. There is a large moment of inertia to work against to move the spacecraft in "useful" directions (yaw and elevation) but a LOT less to roll. As far as I can tell, spacecraft.dll does not allow you to assign differential thrust to the different RC motors, so you either have a ship that steers like the *Titanic*, or you have one that spins like a gyro if you tap the roll controllers. If you find the need to roll, I recommend using the CTRL key to knock those jets down a notch. Of course I could have changed the PMI to that of a sphere, but that seemed cheating and perhaps one day I will learn how to make a spaceship without spacecraft.dll. Love to have a 50's era panel too!

Let me know what you think about the *Rolling Stone* at grngrnflcn@aol.com or on the Orbiter Add-ons board.

Credits

This would not have been possible without:

Dr. Martin Schweiger – creator of the simulation
"Vinka" for spacecraft.dll
"Mindblast" for max2msh
"The Rolling Stones": Robert A. Heinlein

Elements of the spacecraft design: “Destination Moon” ship (specifically fins and landing pods)
Nuclear Propulsion Numbers: http://www.projectrho.com/rocket/rocket3c2.html
Spacecraft.dll: vinka
Nuclear propulsion based on bimodal NERVA:
Thrust 1620300 N
ISP 9860s
Credits for aid in reconstructing the Rolling Stone's transfer orbits:
http://www.geocities.com/Area51/Corridor/8611/orbopssf.htm
And dates:
http://www.geocities.com/Area51/Corridor/8611/rah3_rs.htm
Departure: sometime around 2148-08-04

And now, what every space-faring family needs…

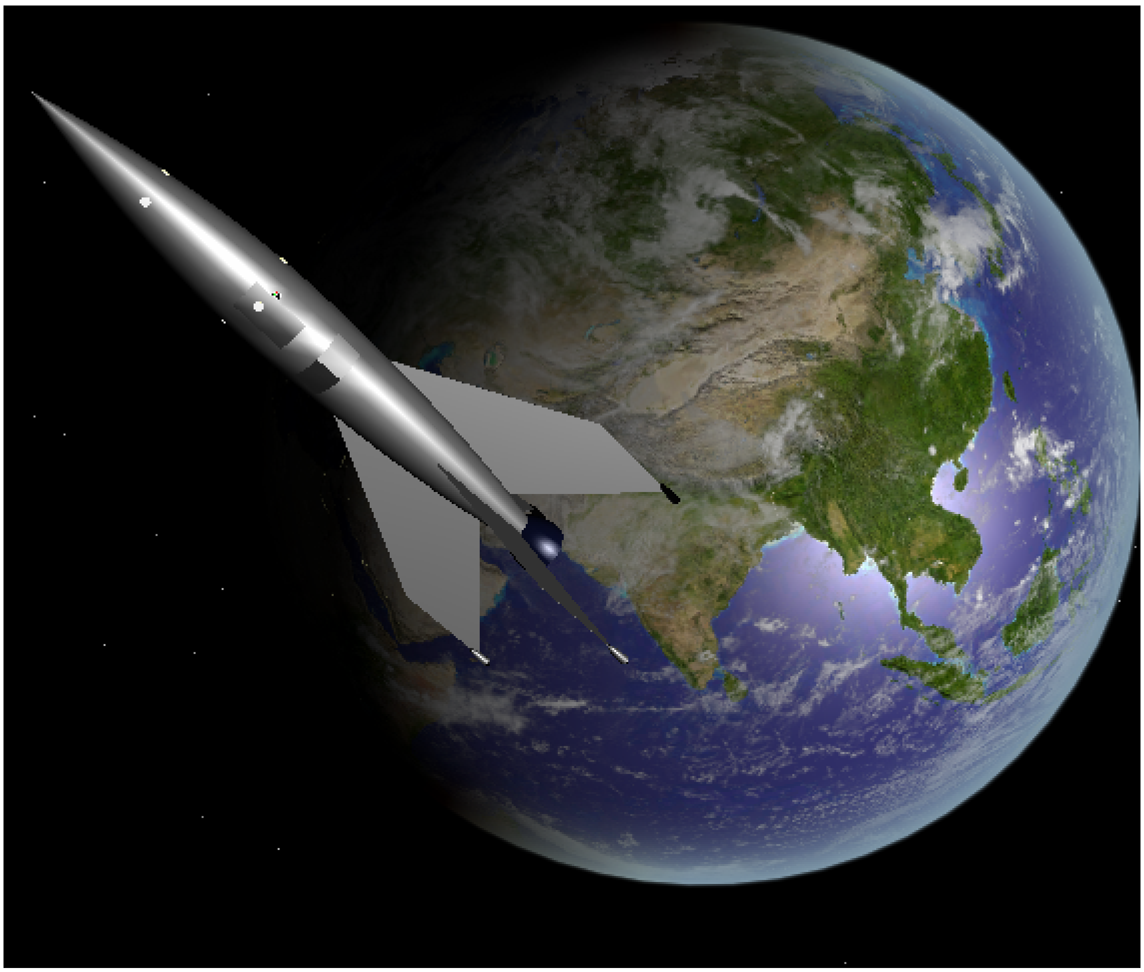
Carlotti Motors

Presents

The Newest in our Angel Series

THE *CHERUB* CARGO/PASSENGER LINER!

The Complete Owner's Guide (excerpted)



"Another Happy Customer!"

Welcome!

Congratulations on purchasing Carlotti Motors' *Cherub*, our newest and smallest Angel-series interplanetary liner! We are confident that you will have many fine years of productive use from your investment! Whether you are looking for an intimate luxury liner or a small tramp freighter, you will find that the *Cherub* meets your needs! Here are the few things you need to know to keep that "like-new" feeling of excitement going for years to come!

Propulsion

The propulsion motor is one of our reliable and cost-effective bimodal nuclear thermal rocket solid core fission engines. Simple in design, this motor is easy and safe to maintain. The nuclear reaction core consists of U^{238} beads (attained from duly registered agents of the Atomic Energy Commission) coated with a highly stable refractory to prevent isotope release and exhaust stream contamination. A beryllium control drum is used to control the reaction speed in addition to the reaction mass so that the core temperature is maintained at an easily controlled 3200K.

The reaction mass can be stabilized liquid monatomic hydrogen (single-H), liquid hydrogen, (both preferred) or at more remote refueling locations, methane, carbon dioxide, water, carbon monoxide, and nitrogen. (Note that using methane as a fuel will result in heavy carbon deposits, so frequent maintenance cleaning schedules must be followed (see Table 43.5)). In an emergency, anything that can be fed into the reactor will serve as reaction mass, but Carlotti Motors will not guarantee the safety of other reaction mass sources, and full motor rebuild after such an emergency is required to regain flight certification.

The reaction mass is fed into the nuclear core once the core temperature is attained. The heat expels the reaction mass out of the nozzle with high-thrust and high ISP fuel efficiency. The exhaust nozzle is of course made of the highest-quality *core material* obtained from asteroid belt mining operations to prevent excessive nozzle erosion and thermal damage.

The motor is capable of a fuel flow sufficient to produce approximately $50m/s^2$ acceleration when the *Cherub* is fully fueled with hydrogen. Note that commercial version of the craft are not acceleration-governed and as such can develop high gee accelerations at low fuel load. Please be advised that non-augmented passengers from Earth will only be able to endure 9g for a few seconds. Passengers from low-gravity environments are cautioned to seek medical advice before exceeding twice their acclimation acceleration.

Atmospheric Reentry

The *Cherub* is designed primarily for non-atmospheric operations. A one-use ablative shield conversion kit can be purchased from Carlotti Motors should the need to perform an atmospheric reentry arise. Of course, only reentry-certified pilots should attempt this maneuver.

Landing

In many instances, you will wish to land your new *Cherub* at local spaceports, either for cargo operations, passenger disembarkation, or just to impress the locals. Being a four-point "tail-sitter" you will be limited to improved landing surfaces.

In most cases, local tugs or automated landing control will be able to interface directly with the advanced RU-265 flight control computer, making landings a breeze – even on worlds without breezes! However, we at Carlotti Motors do recognize that our customers have diverse needs, and we have striven to meet those needs by providing a reaction control system (RCS) that will enable fine control of the *Cherub* on approach.

When landing in atmosphere, the excellent glide characteristics of the larger fins provide sufficient lift to enable some atmospheric control. Pitch, yaw, and roll are controlled with RCS. This feature provides authoritative control without the need or additional expense of a rarely-used control surface subsystem. Of course, if you find that your needs require active control surfaces, a simple conversion kit can be purchased from Carlotti Motors.

Emergency Landing

When landing on unimproved surfaces, as in an emergency, the main drive will excavate a crater sufficiently smooth and even for safe landing on most bodies equal to or larger than the Moon. On smaller bodies, the lower mass flow rate needed to achieve landing may not be sufficient for excavation. In this case, the landing pods are designed to adjust to local irregularities up to one meter at each pod. Given the safer four-point design, the *Cherub* should be able to make emergency touch-down in the very unlikely event this is needed. On-board gyroscopic stabilization will provide added stability once ground contact is achieved.

Onboard Power

Carlotti's reliable engine bimodal design means that you no longer worry about having to warm up and cool down your reactor for each main engine burn. This avoids costly maintenance due to temperature cycle fatigue. Once the reactor is up to temperature, and after you have used it for the burn, the reactor is cooled to normal power generation temperature with a heat exchanger and radiator system using a helium/xenon refrigerant. Older systems use reaction mass for cooling, wasting both mass and heat, while onboard power has to be generated via a separate Auxiliary Power Unit (APU). In our bimodal design, a Brayton power generator is used to provide ship's power for the duration of the cruise. Since the reactor is pre-heated this also means a shorter cycle time is needed before full main engine power is achieved.

Our customers who spend a lot of time away from large ports-of-call may want to consider our Repro-2000 fuel reprocessing unit. In one self-contained unit, your fuel beads are stripped, reprocessed, and re-coated with refractory, ready for duty once again! The 90-95% fuel recovery rate will quickly pay for itself both in reduced port reprocessing fees as well as improved reaction mass efficiency. The fission by-products are safely stored for disposal by the Atomic Energy Commission next time you are in a major port.

Living Facilities

The *Cherub* provides ample cubic for crew and passengers. The 22.5m^2 main lounge/galley/quarters section is right off the passenger airlock, and features fully configurable habitation areas. (See the attached price list for room divider, bunk, galley, acceleration couches, and 'fresher attachments.) The cockpit is a roomy 12.5 m^2 with acceleration couches for captain and navigator. Both cockpit and lounge areas have leaded glass portholes so that you can enjoy the awesome majesty of our universe! The engineering room provides easy access to crew-maintainable engine components and controls, along with two acceleration couches for engineer and assistant, all within 16 m^2. This leaves 84m^3 of cargo space, accessed by internal hatches as well as external cargo doors.

Reaction Mass Stores

The Cherub has cryogenic aluminum tanks for its reaction mass distributed efficiently throughout the ship totaling 328.57 m^3, enough to go from Earth orbit to Mars Phobos station. For those of our customers needed extra fuel capacity, specially designed and tested external tanks are available. Customers are reminded that only genuine Carlotti Motors tanks meet all of our stringent testing criteria, and that using others may void your remaining warranty. Expert certification of tank integrity should be carried out by cryogenic engineers prior to every refueling.

Conclusion

Whether you are looking for a tramp trader for the routes, a small-party luxury yacht, or a combination in between, the *Cherub* has what you are looking for! So stop reading this and take her out for a ride! And don't forget to contact Carlotti Motors for all of your service and add-on needs!

A Carlotti "go lot-y"™