How to make a Multistage2 Spacecraft

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Introduction

This tutorial is mainly to help new add-on developers make a multistage2 spacecraft. You will have to pay very close to the information or this might not work for you. The most important thing though is patience. I had a lack of this when I made my first multistage vessel and it put tons of stress on me. So just take your time and everything will go smoothly planned.

So to get started, you need to make a mesh. First thing is to develop an idea of how the rocket should look like. It should be something simple if this is your first time. If you still do not have a clear idea, go to Orbit Hangar for some great tutorials on how to model a rocket.

After that you need to come up with names for you meshes and have unique names for them. Such as stage1, stage2, and etc. You also need to have a payload atop of the third stage. So make that mesh as well.

If you are using anim8or or Blender for making the mesh, there are scripts that you can export the mesh you made to an Orbiter native mesh. Name those files precisely and place it for now in your Orbiter mesh folder. Make sure you rotate it 90 degrees on the X axis after you have it as a mesh.

INI file

Now create a configuration file for the rocket and all of its stages. This is going to be the ini file. It includes all the stages and the payload unique characteristics. This is where you edit the information on how the spacecraft performs and its characteristics. I will post an example of an ini file so that you can see on how it is structured and how to make one properly. Here is mine.

```
[MISC]
FOCUS=1
COG=8.75

[TEXTURE_LIST]
TEX_1=Exhaust2

[PARTICLESTREAM_1]
NAME=stages
SRCSIZE=8.0
SRCRATE=6000
V0=150
SRCSPREAD=0
LIFETIME=2.5
GROWTHRATE=0
ATMSLOWDOWN=0
LTYPE=EMISSIVE
LEVELMAP=LVL_PSQRT
LMIN=0
LMAX=1
ATMSMAP=ATM_PLOG
AMIN=1e-4
AMAX=1
TEX=Contrail2
```

I am going to start with the texture list. You will place all the textures under here so that later when you add an ENG_PSTREAM it shows up. You will name it TEX_1 under the TEX_LIST and so on. You can have up to 16 textures.

Particle stream: The fire or smoke that is ejected from the engines exhaust. There is more than one way to define the particle stream such as ATT_PSTREAM, RETRO_PSTREAM, and MAIN_PSTREAM.

SRCSIZE: This is the smoke's particle size. Example; SRCSIZE=12.5. This means that the particle size is 12.5 meters.

SRCRATE: This is the average number of particles that get created per second. Example; SRCRATE=5. This means that about five particles will be produced each second.

V0: This is how fast the particles get generated from the exhaust point. Example; V0=150. This is 150 meters per second.

SRCSPREAD: This is the distribution of the particles referring to the emission velocity. Example; SRCSPREAD=1.0

LIFETIME: This is the average lifetime of each particle generated. Example; LIFETIME=5.0. This means that each particle should last up to five seconds.

GROWTHRATE: This is the growth rate of the particles emitted from the exhaust. Example; GROWTHRATE=3. This means that the particles grow at about three meters per second.

ATMSLOWDOWN: This is the deceleration rate beta in atmosphere. You can use this equation. V = v0*e^ (-beta*d*t). Example; ATMSLOWDOWN=2.0.

LTYPE: This is how the exhaust texture is defined from EMISSIVE or DIFFUSE. You would want emissive if you want more of a fire type texture. Diffuse is good for smoke. You can only pick one though. Example; LTYPE=EMISSIVE

LMIN: This is the minimum level for alpha mapping. Example; LMIN=1.

LMAX: This is the maximum level for alpha mapping. Example; LMAX=2.

ATMSMAP: This is the maximum level for alpha mapping. Example; ATMSMAP=ATM_PLOG.

AMIN: This is the minimum atmospheric mapping for alpha mapping. Example; AMIN=1e-4.

AMAX: This is the maximum atmospheric mapping for alpha mapping. Example; AMAX=3.

INI file (continued)

```
[STAGE_1]
Height=39.4
Diameter=9.6
EmptyMass=13000
FuelMass=210000
Thrust=4323600
BurnTime=130
off=(0,0,0)
MeshName="multistage\JDs1"
eng_1=(0,0,-28.5)
eng_diameter=3.5
ENG_TEX=Exhaust2
ENG_PSTREAM1=stages
ATT_PSTREAM1=Contrail1

[STAGE_2]
MeshName="multistage\JDs2"
IGNITE_DELAY=2.5
Height=36.02
Diameter=9.8
EmptyMass=3600
FuelMass=54500
Thrust=1130000
BurnTime=335
off=(0,0,36)
eng_1=(0,0,-25)
eng_diameter=2
ENG_PSTREAM1=exhaust

[STAGE_3]
MeshName="multistage\JDs3"
IGNITE_DELAY=2
Height=28.03
Diameter=25
EmptyMass=1000
FuelMass=24500
Thrust=1345000
BurnTime=70
off=(0,0,46.2)
eng_1=(0,0,-5)
eng_diameter=2
```

Now we got that out of the way, I will tell you all about the ini. file's characteristics. You want to start out with this. [STAGE_1] This defines what the first stage will be like. Now here is what else you need to put under it.

Height: This is the height of your spacecraft in meters. Example; Height=39.4. The rocket is therefore 39.4 meters in height.

Diameter: This is the diameter in meters. Example; Diameter=9.6.

EmptyMass: This is how much mass the spacecraft will have when it is empty. It is measured in Kg. Example; EmptyMass=13000.

FuelMass: This is how much fuel is present when the PRPLEVEL is full. It is measured in Kg. Example; FuelMass=21000. This states that the fuel mass is 21000 kg.

Thrust: This is how strong the thrust will be in Newtons. Example; Thrust=4323600.

Burntime: This is how long each stage will burn for in seconds. Example; BurnTime=130.

Off: This is where the mesh will be placed at. For the first stage it should be looking like this. Example; off=(0,0,0). That means that it is zero on all three axes. The other stages will have a different offset so that it appears on top of the first stage and etc.

MeshName: The mesh name will be the first stage of the rocket you have made. Let's say your first stage mesh is called Minotaur. It would look like this. Example; MeshName=”multistage\Minotaur”. Make sure it has the multistage part because that tells Orbiter to look in the multistage vessel folder and find Minotaur or whatever rocket you have.

Eng_1: This is where your primary engine will be placed. Don't get this confused with the actual mesh of the rocket. This is where the exhaust and force of the thrust will come out. Sometimes you have to guesstimate, but it will get easier as you go along. Example; eng_1=(0,0,-28.5).

INI file (Continued)

```
[STAGE_1]
Height=39.4
Diameter=9.6
EmptyMass=13000
FuelMass=210000
Thrust=4323600
BurnTime=130
off=(0,0,0)
MeshName="multistage\JDs1"
eng_1=(0,0,-28.5)
eng_diameter=3.5
ENG_TEX=Exhaust2
ENG_PSTREAM1=stages
ATT_PSTREAM1=Contrail1

[STAGE_2]
MeshName="multistage\JDs2"
IGNITE_DELAY=2.5
Height=36.02
Diameter=9.8
EmptyMass=3600
FuelMass=54500
Thrust=1130000
BurnTime=335
off=(0,0,36)
eng_1=(0,0,-25)
eng_diameter=2
ENG_PSTREAM1=exhaust

[STAGE_3]
MeshName="multistage\JDs3"
IGNITE_DELAY=2
Height=28.03
Diameter=25
EmptyMass=1000
FuelMass=24500
Thrust=1345000
BurnTime=70
off=(0,0,46.2)
eng_1=(0,0,-5)
eng_diameter=2

[PAYLOAD]
OFF=(0,0,52.5)
Mass=750
MeshName="JD_capsule"
Name="JD_capsule"
Module="spacecraft\spacecraft3"
Diameter=4.8
SPEED=(0,0,1)
```

Eng_diameter: This is how wide the engine's exhaust will be. Not the smoke, but the fire that comes out of the engine.

Engine_TEX: This is the texture that will come out of the engine. Example: ENG_TEX=Exhaust2. That means that the texture in the texture directory that is named Exhaust2 will be used for this rocket. Make sure that you include in the TEX_LIST no the top.

ENG_PSTREAM1: This is the particles that will be emitted for the engine. In this case it is stages so it would look like this. Example; ENG_PSTREAM1=stages. You will be continuing the number sequence such as ENG_PSTREAM2 and so on.

ATT_PSTREAM1: This is the particles that come out of the attitude thrusters. Example; ATT_PSTREAM1=rcs.

On the second and third stage you come across two different things. Ignite delay and BurnTime. I already showed you burn time on the fourth page.

IGNITE_DELAY: This is the time in seconds that the engine will delay on separation from another stage. Example; IGNITE_DELAY=2.5. This means that the engine will delay for two and a half seconds before igniting again.

INI file (Continued)

Multistage2 is not over yet so just hang in there. We still have to discuss the fairings and interstages. Primarily boosters as well.

We will start with the booster section since it is one of the very first sections in the ini.

Here is an example of a booster stage used for multistage rockets.

```
[BOOSTER_1]
N=1
MeshName="Multistage\merc_atl_boost"
Height=2
Diameter=3.00
EmptyMass=8754
FuelMass=5126
Thrust=14739
angle=0
eng_1=(-1.408,0,-2.00)
eng_2=(0,0,-1.915)
eng_3=(1.39,0,-1.987)
eng_diameter=0.55
off=(0,0,-19)
BurnTime=128
ENG_TEX=Exhaust2
ENG_PSTREAM1=exhaust
ENG_PSTREAM2=contrail
```

As you can see, everything in the booster section has been defines previously in this tutorial. (Note: You must put the BOOSTER_1 right before the first stage of your rocket in the ini).

Our next phase in multistage is the interstages. This is a fairly simple one as well. Here is how it should look like.

```
[SEPARATION_12]
MeshName="multistage\gem_interstage"
SEPARATION_DELAY=0
Diameter=0
Height=0
EmptyMass=0
off=(0,0,12.5)
```

Place it right between the stage you want it to jettison with. There is a few more things left in this part of the tutorial so just hang in there. Sound and fairings. We'll start on fairings first.

INI file (Continued)

Here is an example of a fairing configuration. When you have made yours, place in the ini file right before the PAYLOAD_1 and etc.

```
[FAIRING]
N=2
MeshName="multistage\able_cap"
size=2.85
Diameter=4.55
Height=8
angle=0.
off=(0,0,-1.5)
```

Now we start on the SOUND section of the ini file. It can range from a lot of ways depending on what way you want it to fit your needs. Here is an example.

```
[SOUND]
MAIN_THRUST=Sound\Vessel\AtlasICBM.wav
```

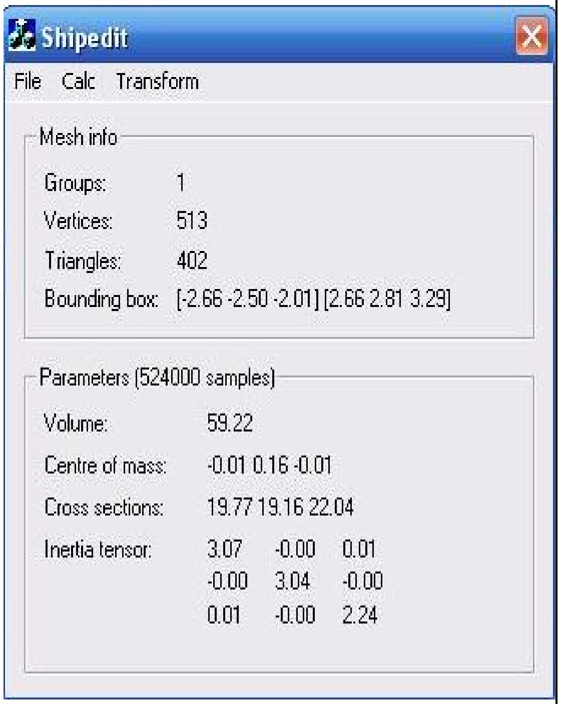
You can also add many more types of sounds for different parts of the ship. For example,

```
HOVER_THRUST
RCS_THRUST_ATTACK
RCS_THRUST_SUSTAIN
AIR_CONDITIONING
COCKPIT_AMBIENCE_1
COCKPIT_AMBIENCE_2
COCKPIT_AMBIENCE_3
COCKPIT_AMBIENCE_4
COCKPIT_AMBIENCE_5
COCKPIT_AMBIENCE_6
COCKPIT_AMBIENCE_7
COCKPIT_AMBIENCE_8
COCKPIT_AMBIENCE_9
```

That is basically all there is to multistage for now. Next in this tutorial we will discuss how to set up the scenario file, Spacecraft3 file, and etc.

Spacecraft3

It all seems difficult now, but trust me, it isn't. Our next phase in development is to create a payload. Your payload, unlike the rest of the ship, will be a spacecraft3 vessel and it is a wee bit harder to make the configuration file. Make sure you have your payload mesh completed though.
Here is how a spacecraft3 configuration/ini file should look like. Every spacecraft is unique so your completed outcome should look a bit different from mine. For example, my mass is going to be different from yours. Therefore the CROSS_SECTION and PMI should be different. The PMI is the principle moment of inertia. You can calculate this and the CROSS_SECTION by using Ship edit in the Orbiter SDK download folder. Here is a picture of it.



Mesh info

Groups: 1
Vertices: 513
Triangles: 402
Bounding box: [-2.66 -2.50 -2.01] [2.66 2.81 3.29]

Parameters (524000 samples)

Volume: 59.22
Centre of mass: -0.01 0.16 -0.01
Cross sections: 19.77 19.16 22.04

```
Inertia tensor:   3.07   -0.00   0.01
                 -0.00    3.04  -0.00
                  0.01   -0.00   2.24
```

```
[CONFIG]
MESHNAME="JD_capsule"
FOCUS=1
SIZE=9.7
EMPTY_MASS=5000
FUEL_MASS=500
ATTITUDE_THRUST=1800
ISP=3054TRIM=0.05
CW_Z_POS=0.2
CW_Z_NEG=0.5
CW_X=1.5
CW_Y=1.5
CROSS_SECTION=(33.54,33.54,22.18)
COG=2.70
PITCH_MOMENT_SCALE=0.00001
BANK_MOMENT_SCALE=0.00002
ROT_DRAG=(0.43,0.43,0.29)
```

Here is what each of the words mean.

MESHNAME: This is going to be the payload's name.

FOCUS: This is the focus. Just set it to one.

SIZE=This is the size of the payload in meters. Example; SIZE=3. The payload is three meters in diameter.

EMPTY_MASS: This is how heavy the payload is when it is completely empty.
FUEL_MASS: This is how much fuel the rocket holds. Example; FUEL_MASS=3200.

ATTITUDE_THRUST: This is how much thrust power the attitude thrusters will have. Example; ATTITUDE_THRUST=1800.

ISP: This is the measure of thrust per kg per second fuel in kg/sec. Example; ISP=1000. That is one thousand kg per second.

TRIM: This is how much trim your payload will have. Example; TRIM=0.5

CW_Z_POS: This is the drag coefficient when the payload is moving in a forward motion in the atmosphere.
Example; CW_Z_POS=0.05

CW_Z_NEG: This is the drag coefficient when the payload is moving backwards.
Example; CW_Z_NEG=0.5

CW_X: This is the drag coefficient when the payload is moving along the X axis.
Example; CW_X=1.5

CW_Y: This is the drag coefficient when the payload is moving along the Y axis.
Example; CW_Y=1.5

COG: This is basically the altitude of the payload relative to the stages.
Example; COG=2.70

PITCH_MOMENT_SCALE: This is the resistance when your spacecraft has pitch changes.
Example; PITCH_MOMENT_SCALE=0.00001

BANK_MOMENT_SCALE: This is basically the resistance when your spacecraft banks.
Example; BANK_MOMENT_SCALE=0.00002

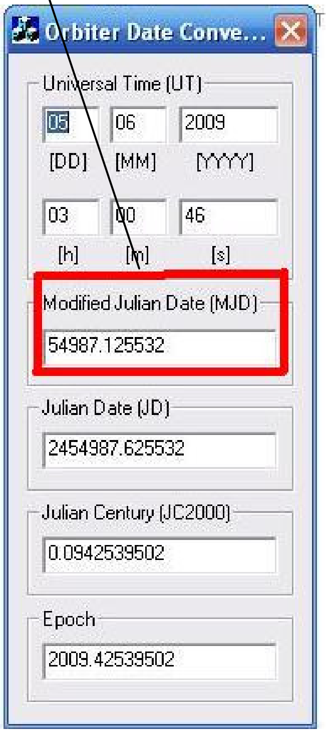
ROT_DRAG: This is the resistance to rotation on all axes.
Example; ROT_DRAG=(0.43,0.43,0.29)

Scenarios

The scenarios are structured just a little differently. Here is an example.

```
BEGIN_DESC
JD rocket on launch
END_DESC

BEGIN_ENVIRONMENT
  System Sol
  Date MJD 54977.179653
END_ENVIRONMENT

BEGIN_FOCUS
  Ship JD
END_FOCUS

BEGIN_CAMERA
  TARGET JD
  MODE Extern
  POS 2.89 -0.51 -70.39
  TRACKMODE GlobalFrame
  FOV 50.00
  BEGIN_PRESET
  Ground:JD:40.00:Earth -80.6207899 28.6273195
  Ground:JD:10.00:Earth -80.65298 28.58028 20.00

END_CAMERA

BEGIN_HUD
  TYPE Surface
END_HUD

BEGIN_MFD Left
  TYPE Orbit
  PROJ Ship
  FRAME Ecliptic
  ALT
  REF Earth
END_MFD

BEGIN_MFD Right
  TYPE Map
  REF Earth
  TRACK ON
END_MFD

BEGIN_SHIPS
JD:Multistage\Multistage2
  STATUS Landed Earth
  BASE Cape Canaveral:11
  HEADING 90.00
  FUEL 1.000
  CONFIG_FILE Config\multistage\JD.ini
  CONFIGURATION 0
  CURRENT_BOOSTER 1
  CURRENT_STAGE 1
  CURRENT_PAYLOAD 1
  FAIRING 0
END
END_SHIPS
END
```

If you look at another scenario file you will notice that they have different information. Like on this one, since it is a multistage, you have to be precise. Under BEGIN_SHIPS you put the name if the completed rockets ini file. You can reference what to do by looking off of my scenario file. If you want to have a specific date for the scenario go to your Orbiter utils directory and open up Date MFC Application. Type in the time and date and multiple numbers will pop up in four different sections. Choose this one.



Universal Time (UT)

05 06 2009
[DD] [MM] [YYYY]

03 00 46
[h] [m] [s]

Modified Julian Date (MJD)
54987.125532

Julian Date (JD)
2454987.625532

Julian Century (JC2000)
0.0942539502

Epoch
2009.42539502

Orbiter uses Modified Julian Date (MJD) for the time format when you are making scenarios. Luckily they made this or else we would have much problems.

Status: This is either Orbiting earth or Landed Earth. Pick which one you want.

Base: This is where it referenced the rocket to.

Heading: This is the heading of the rocket preceding launch.

Fuel: This is how full your tank is in the rocket.

Config_file: This is going to be the ini. file you have been working on that includes all three stages and a payload. I'll get to making the payload shortly.

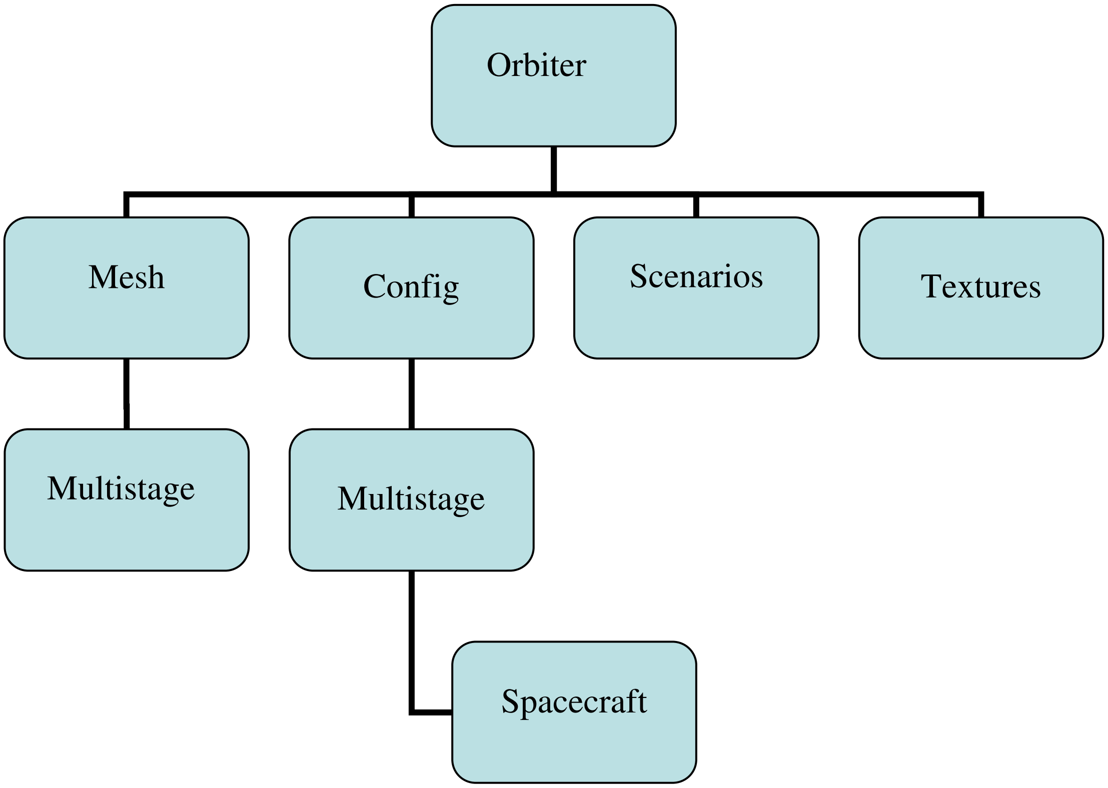
Configuration: This is going to be set to 0 for launch.

Current booster: This is the booster you are controlling right now. Some rockets don't have any so you can put a zero unless you do.

Current stage: This is what stage you are. You want to put a one on this one.

Current payload: This is how much payload you have. Most of the time it is just one.

Fairing: This is if you have a fairing or not. If you do specify the number and if

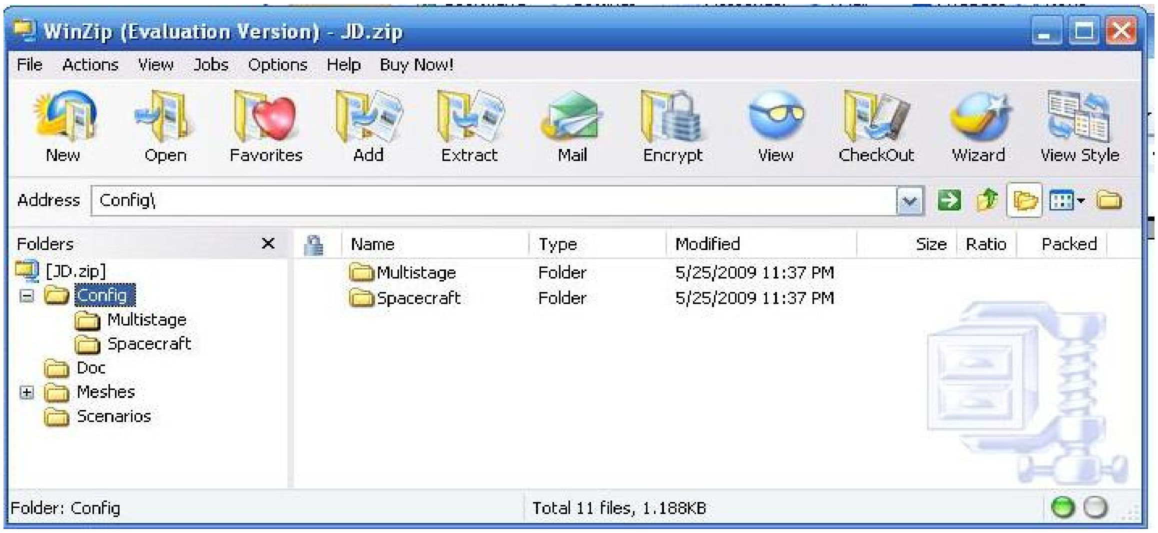


Now I will show you how to structure your zip file. By now you should have an ini file for the multistage and the spacecrafts payload which is in spacecraft3 format. I also taught you how to make a scenario file for the rocket. These are the guts of the addon other than the mesh. I haven't explained texturing in this tutorial, but there are tutorials for that. I will tell you the basic though. It needs to be a power of 2 file. For example, 128x128, 256x256, and 512x512, and etc. After you got that you will use DXTex to change it to a DXT-1 or DXT-5 file. Then you name it according to the bmp. file you exported the mesh with. It is actually pretty easy. Making the texture from scratch takes creativity and time. Just practice on it and you will get it.

The table above shows you what directories you should have for your addon. I also have pictures on the next page showing you how it should look like in a zip archive. It does not include the texture folder, but all you do is make one and name it Textures. Place the textures in there and voila. I bet you thought that making a multistage rocket was hard. Now I hope I change my mind.

Structuring

Now make a main folder for your rocket. Open the folder. Make four folders for this zip file. Scenarios, Meshes, Doc, and Config. Open up the Config folder and make two more folder called multistage and spacecraft.



Address: Config\

Folders:
- [JD.zip]
  - Config
    - Multistage
    - Spacecraft
  - Doc
  - Meshes
  - Scenarios

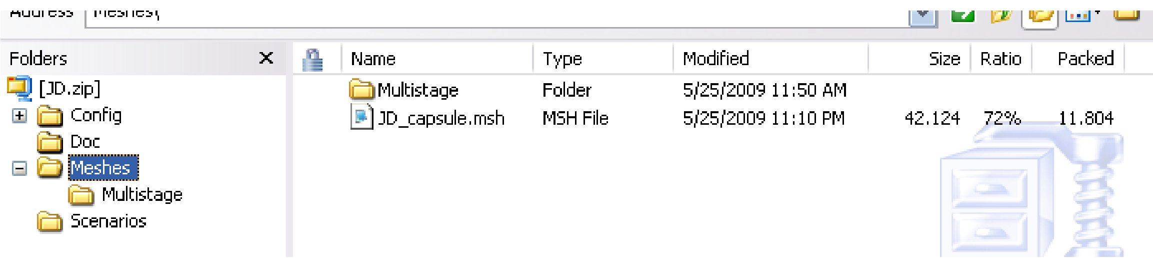
Name	Type	Modified	Size	Ratio	Packed
Multistage	Folder	5/25/2009 11:37 PM			
Spacecraft	Folder	5/25/2009 11:37 PM			

Folder: Config

Total 11 files, 1,188KB

Your multistage ini will fall under the multistage folder and your payload will fall under the spacecraft folder.
Same thing with the mesh.

Except you won't have a spacecraft folder for the mesh.
For the scenario and doc, you just place the file in there.
Hopefully this tutorial helped you guys out just enough to get the basics of making the Config and scenario files.



Address: Meshes\

Folders:
- [JD.zip]
  - Config
  - Doc
  - Meshes
    - Multistage
  - Scenarios

Name	Type	Modified	Size	Ratio	Packed
Multistage	Folder	5/25/2009 11:50 AM			
JD_capsule.msh	MSH File	5/25/2009 11:10 PM	42,124	72%	11,804

Testing the rocket

Now you are done with the rocket. Time to test it out in Orbiter and find the flaws or inconsistencies. These are the things that you want to look for when you are beta testing your new rocket in Orbiter. Pay close attention!

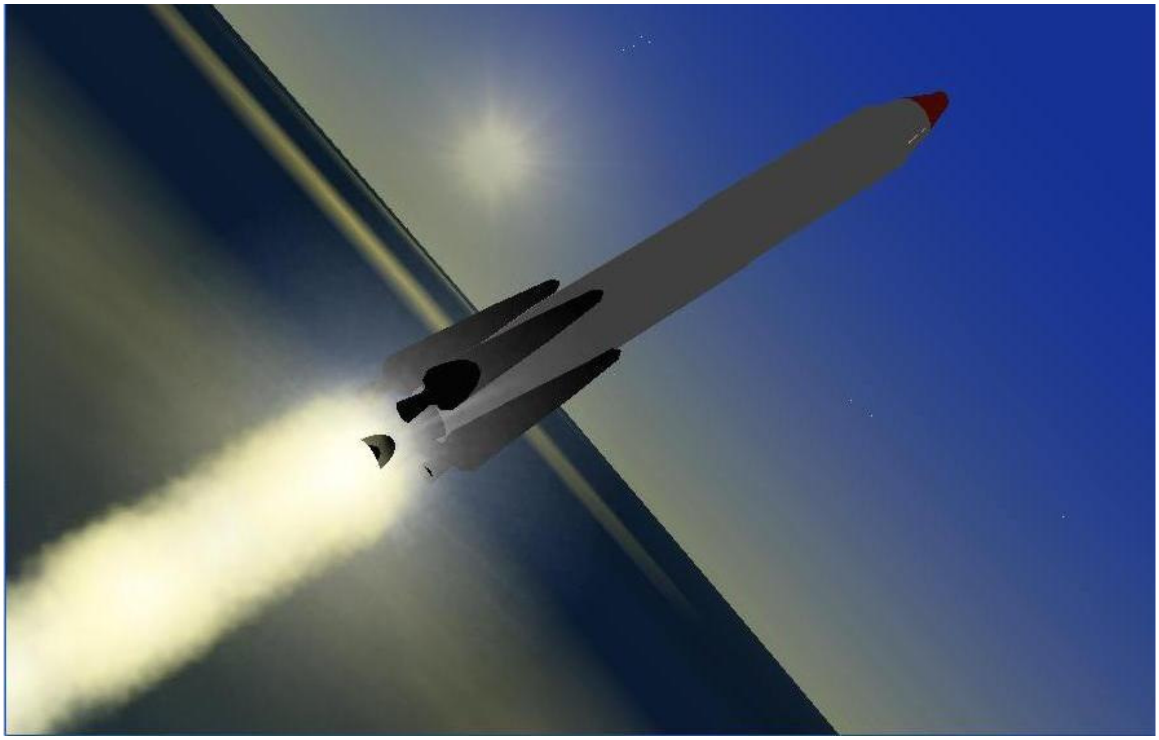
- Missing textures
- Misplaced mesh
- How the ini works with the rocket
- If your meshes need improving
- If you get any errors in the orbiter.log
- Inspect each mesh thoroughly
- Can it reach orbit
- Do you have enough fuel when in orbit
- Are the textures deformed or uneven
- Is it appealing to the eye

Publishing

Now it is time to publish your addon to orbit hangar or an addon expository of your choice. I recommend coming up with a name that is catchy and creative. Then make a picture or take a picture of your rocket.

I would also make sequels or different versions of the spacecraft. It is nice to see more than one thing in a completely diversified. That is basically it for the publishing part. Here is my picture. It is not the best, but it will do.

Notice how the sun is ahead on the horizon and how the atmosphere is visible in a fastidious way.



Regards

If you have any more trouble contact me at doughboy94@live.com or contact me on the forums as MJR.

(First rocket)

I give thanks to Ar81 for gaining information off of him, liber for help when I needed to structure the zip file. And tbaxland for correcting my scenario file.