Alpha Vector: Spacecraft Design
version 1.1

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1. Choose Hull Size

The hull is the basic framework of the ship within which all other components must fit. Hull size is measured in tons equivalent to ten cubic meters of volume.

2. Choose Hull Configuration

Hull configuration determines the overall shape of the hull and the percentage of the ship's tonnage that must be dedicated to hull space. There are three possible configurations to choose from: Basic, Streamlined, and Airframe. The major differences between hull types are their ability to maneuver in an atmosphere.

Basic hulls are designed for use only in vacuum They require space equal to ten percent of the ship's tonnage at a cost of $20K per ton. Basic hulls are the most efficient in terms of utilizing the hull's available space, but entering an atmosphere will destroy them.

Streamlined hulls are designed for limited use in an atmosphere, generating lift directly from engine thrust instead of wings. They require fifteen percent of a vessel's tonnage at a cost of $40K per ton.

Aerodynamic hulls are capable of operating in an atmosphere like a conventional aircraft. They're the most tonnage hungry hull types, requiring twenty percent of the vehicles tonnage for the wings and control surfaces for atmospheric flight at a cost of $60K per ton.

3. Install Engine

The basic engine is a high-efficiency muon catalyzed fusion reactor that uses liquid hydrogen as reaction mass, heating it to a plasma state in a magnetic confinement vessel and then releasing it to provide thrust. While the lack of an engine obviously limits the maneuverability of a spacecraft, they aren't required.

Multiply the ship's tonnage by it's desired acceleration in G's to determine the engine thrust required. For example, a 100 ton ship capable of 1G acceleration would need an engine with a thrust of 100. Installing an engine with a thrust of 200 would make the same ship capable of 2G's.

Determine the size of the required engine in tons by taking the square root of the engine's thrust x 2. Divide the engine's size by ten to yield it's fuel consumption in tons per hour. Multiply the thrust rating by $5K to determine purchase price. The chart below has the tonnage for a number of common engines.

Thrust Rating	Size (in tons)	Thrust Rating	Size (in tons)
100	14	2000	63
200	20	3000	77
300	24	4000	89
400	28	5000	100
500	32	6000	110
600	35	7000	118
700	37	8000	126

800	40	9000	134
900	42	10000	141
1000	45		

4. Assign Fuel Tankage

The tonnage assigned to fuel tankage determines how much fuel is available for the engines to burn. Calculate the ship's endurance in hours by multiplying the engine's fuel consumption in tons per hour by the tonnage devoted to fuel tankage. There is no additional cost for fuel tankage.

5. Assign Living Space

Living space includes the rooms inhabited by passengers and crew, life support facilities, consumables storage, and recreational areas. Three types are available: Standard, Temporary, and Spin.

Standard living space is designed for use primarily in zero-G and uses the floor, walls, and ceilings of rooms for accommodations. While efficient in using the available space they can be confusing and potentially dangerous to people used to a fixed up-down orientation. An even greater drawback is the need for regular, intense workouts to avoid the potentially lethal bone and muscle degeneration brought on by extended zero-G living. Standard living space requires a minimum of 1 ton of space per person at a cost of $50K per ton.

Temporary living space is physically the same as Standard, but with short term life support facilities. It provides 100 hours of life support, ideal for small ships and interface craft that spend limited amounts of time traveling through space before reaching their destination. Temporary living space requires a minimum of .5 tons of space per person at a cost of $20K per half ton.

Spin living space avoids the problems of zero-G degeneration by rotating perpendicular to the ship's axis of thrust to simulate gravity. Most ships use a pair of small living areas on opposite ends of a transit shaft leading to the vessel's main body, but large installations often have a complete habitation ring or torus rotating around the central axis. Spin living space requires 3 tons of space per person at a cost of $100K per ton.

Living space is initially purchased as Basic accommodations, consisting of utilitarian furniture and fixtures, simple acceleration couches, some storage lockers, a supply of cheap dehydrated food powder, and basic life-support systems. To upgrade to Normal quality living space, on a par with a budget hotel room, multiply the Basic tonnage by 2. To upgrade to Comfortable accommodations, equivalent to a business suite in a chain hotel, multiply tonnage by 4 and cost by 2. To upgrade to Luxurious, equivalent to a suite in an upscale hotel, multiply tonnage by 6 and cost by 2.5.

6. Install Sensors

Sensors include all the detection equipment used for navigation and combat, including optical, thermal, laser, and radar subsystems. Each point of Sensor rating up to level 10 requires .25 tons of ship volume and costs $50K. Each point of Sensor rating from level 11 to 20 requires .5 tons of ship volume and costs $100K. Each additional point of Sensor rating over level 20 requires 1 ton of ship volume and costs $150K.

7. Install Communications

Communications includes all the ship's radio, laser, and microwave transmission and receiving gear. The ship's Communications rating provides a relative measure of the quality of it's equipment and capabilities as well as limiting it's combat networking capacity. The volume and cost requirements for Communications are identical to those of Sensors.

8. Install Computer

The Computer system includes the ship's central processors, workstations, onboard network, master memory banks, and backup systems. Volume and cost is calculated as for Sensors and Communications.

9. Assign Cargo Holds

Cargo can be carried in purpose-built holds equipped with tie downs, cargo handling equipment, and standard 3x3 meter cargo doors in the hull. Pressurized holds, capable of holding an atmosphere and allowing the crew to work in a shirt sleeve environment, cost $50K per ton. Unpressurized holds, exposed to vacuum when the ship is in space and requiring the use of space suits, cost $5K per ton.

10. Assign Vehicle Bays

Storage space is required for any vehicles, including landers, dropships, or rovers, the ship carries. Each bay requires 150 percent of the carried vehicle's size in tons and includes an appropriately sized bay door in the hull. Pressurized bays cost $50K per ton while unpressurized bays are $5K per ton.

11. Install Specialized Fittings

Cargo grapples are mechanical linkages that hold a standard 25 ton cargo module. Each grapple masses 3 tons and costs $75K.

Refueling probes allow a ship to transfer fuel from it's tanks to another vessel at a rate of 1 ton per minute. Probes mass 2 tons and cost $100K.

12. Install Weapons

Ships can choose from a variety of weapon systems for protection or attacks. Each weapon installation includes basic targeting sensors, recoil compensators, and supplementary power generation equipment to prevent draining the main power supply during firing.

Swarmguns are rapid-firing cannons that accelerate metallic rounds to high velocity using magnetic fields. Each burst of fire creates a cloud of projectiles moving at over 10 km/second and capable of turning any ship it hits into a drifting hulk. Unfortunately, the distances involved in space combat means it can take minutes or hours to reach a distant target, limiting swarmguns to applications like point defense and close combat where long range accuracy isn't necessary.

Lasers attack with a beam of concentrated light that melts or vaporizes a small area of the target. They're extremely accurate, the beams traveling from emitter to target at the speed of light, but lose power at long ranges because of beam dispersal. Specialized anti-laser aerosols that scatter the beam before it can damage a ship have also been developed.

Particle Beams fire a stream of hydrogen nuclei accelerated to near lightspeed. They suffer from the same dispersal problems as lasers, but can produce devastating explosive, electrical, and radiation damage in a target. Particle beams are adversely effected by magnetic fields.

Missiles are guided rockets mounting explosive warheads that create lethal sprays of shrapnel when they detonate near a ship. After launch they glide to the target under passive guidance, switching to active homing for a final sprint that brings them within range. The only weakness of these brutally effective ship-killers is their vulnerability to point defense weapons.

The Weapons Table lists the required tonnage and price for each weapon. Choose the desired Damage rating for laser, swarmgun, and particle beam mounts, represented by "X" on the table, and then multiply the base size and cost by "X".

Weapons Table

Weapon	Damage Rating	Tonnage	Cost	Special Effects
Laser	X	X tons	$50K X	+2 To Hit
Swarmgun	X	.5X tons	$30K X	-2 To Hit
Particle Beam	X	2X tons	$100K X	+2 To Damage
Light Missile	5	2	$50K	
Medium Missile	10	5	$100K	

Heavy Missile	20	10	$150K

13. Install Defenses

Defensive systems are designed to prevent attacks from hitting a ship or limit the damage of those that do. Vessels designed for combat carry a number of different systems to provide protection from an assortment of threats.

Anti-Laser Aerosol is composed of millions of metallic glass microbeads packed in one-shot canisters. When fired, they create a particulate cloud that prevents damage from laser fire by breaking up the beam before it can strike the ship. A cheap and effective countermeasure to laser weapons.

Chaff/Flare Dispensers fire munitions designed to distract enemy missiles away from their target. Flares are fast-burn thermal emitters that generate the same heat profiles as engine nozzles or cooling radiators. Chaff is made from thousands of strips of metallic foil sized to reflect particular radar frequencies and produce hordes of false targets on enemy sensors. Dispensers fire a cluster of both types of rounds when activated.

Decoys are inflatable balloons equipped with engines, thermal generators, and transmitter suites designed to mimic the profile of a ship. They draw fire away from their parent vessel by confusing enemy sensors as to which ship is the real one.

Defenses Table

Defense	Tonnage	Cost	Uses
Anti-Laser Aerosol	2	$20K	1
Chaff/Flare Dispenser	1	$15K	5
Decoy	Variable*	$50K	1

*Decoys take require 5 tons or 1% of the ship's tonnage, whichever is greater.

14. Finalize Design

Total up the tonnage of all components to make sure it doesn't exceed the ship's tonnage, add up the cost of all the components, and give the ship a name.