Fires of Space
Designer's Notes

I have always been a sucker for space. I grew up in the age of Mercury, Gemini and Apollo, of Tom Swift and Boy's Life science fiction stories. My childhood bedroom stood in for a spaceship cabin; when I should have been paying attention in grade school, I was doodling spaceships and space battles.

I have played a number of space war games over the years, but never found one that tickled my fancy as much as the science fiction that had inspired them. That is not a criticism of the games; it is just that my vision of imaginary space warfare was different than the visions behind them.

I am also a naval warfare kind of guy. Much of my gaming and game design has been centered on naval warfare, and particularly on 20th century naval warfare. If we are going to go to all the trouble of fighting in space, I naturally feel that we should have big ships – battleships, cruisers, destroyers. Why fight in space just to blow up something small? Not that I wanted giga-ton monster armed planet sorts of ships. I generally found myself falling back on 20th century naval warfare for a sense of what was satisfying and unsatisfying in space warfare games.

Ultimately and inevitably, I decided to design my own space warfare game. This one, after all, should be simple. I could just make up the rules as I went along. What could possibly cause problems?

Space is Big.

Well, for starters, scale was tricky. In the far future, battle ranges should be measured in at least tens of thousands of kilometers. Anything less and you would wonder why weapons technology went to sleep for a few centuries. But once you have the engagement ranges roughed in, you have to consider time and maneuver scales.

I really like the idea of having tactical maneuver based on good old Newtonian mechanics, rather than some sort of hyperjump-stutterwarp non-inertial movement system. It just seemed that having momentum and inertia in the game would make it feel a bit more "realistic." The problem is that you have to apply a fair amount of thrust over a fair amount of time to get significant movement on a game map with hexes scaled in the vicinity of 10,000 kilometers. You can see this in the time scales of other space games using Newtonian mechanics. For example, GDW's "Mayday" had hexes of 300,000 kilometers and a turn of 100 minutes. I decided on 6 Gs as my maximum ship thrust – low enough so that the crew would not be mashed flat by the failure of whatever inertia-cancelling field kept them functional – but I also wanted a time scale short enough to make the players feel as if they actually were making tactical decisions. I settled on 6 minutes as the length of a tactical turn. Doing the math, 6 Gs for 6 minutes gets a displacement

distance of less than 4,000 km. That is not very far in the context of long reaching beam weapons and fast moving missiles.

My solution was to have players set the courses and speeds of ships before playing out the tactical game. They then watch the scenario play out, hoping that their maneuver plans lead to victory and not disaster. Missiles do maneuver during the tactical game, but then they don't have people inside. I thought that future technology would be at least good enough to build a 100 ton structure that could sustain 60 G accelerations for an hour or so. As to ships maneuvering during a tactical engagement, think of it this way. How much steady thrust could a ship apply in a set direction when it is maneuvering madly both to avoid incoming fire and to bring its own weapons to bear? It is the fighter pilot's adage writ large: never fly straight and level in a combat zone.

FTL Travel: We Need It.

I had to make a few other rules decisions as well. For example, every interstellar game needs a way to move ships between star systems without their crews growing old and dying during the trip.[1] So enter faster than light travel.

This has of course been done in a number of different ways in fiction and gaming. I opted for a system in which ships could jump fairly freely from point to point, with some important restrictions. For starters, jumping ships have to be a set minimum distance away from gravity wells. This gives a rationale for engagements, as ships move back and forth between their jump points and planetary orbits. Also, I require ships to spend some time stationary before being able to jump. Again, this encourages tactical engagements – a force could not just hit and run. Of course, the force capable of pulling the most Gs could outrun its opponent and eventually jump away. But that would require so much time that it would take the force out of the operational picture. Next, I decided that jumps could be easily detected at their starting point, but not at their ending point. This allows ambush tactics to come into play. And finally, I decree that interstellar jumps had to end in the general vicinity of a stellar sized mass. This keeps players from arbitrarily parking forces in interstellar space.

Jump scale was based on the latest information I could find on the incidence of earth-like worlds. The bottom line is that jump ranges of from 10 to 60 light years seemed to work best. Real earth-like worlds look to be fairly rare, but star systems in our part of the Milky Way average about 5-10 light years apart. So a ship with a 10 light year range could generally hop from system to system to get to an inhabited world.

Big Guns in Space.

[1] Okay, I know that some interstellar war novels stick to Einstein – such as *The Forever War* and the *Risen* series – but those wars take a really long time to resolve.

Working out the relevant weapons actually was not that hard. I wanted the look and feel of 20th century naval warfare, with a bias towards World War II. No aircraft, of course, but missiles and guns. The missiles are really a cross between aircraft and torpedoes. Missile defense weapons are analogous to the quick-firing small cannon that big warships carried throughout the 20th century, first as defense against small torpedo boats, then as defense against aircraft, and finally as defense against cruise missiles. Main beam weapons are, of course, the guns in the game.

I did let a bit of science intrude here, but only a bit. I wanted the beam weapons to attenuate in at least a semi-realistic way, so I did some looking into the inverse square law for radiation propagation. It turns out the inverse square rule in its basic form assumes a spherical radiator. If you assume a large enough aperture and small enough rate of beam divergence, the classic inverse square law doesn't kick in until the range gets quite long. That is how we get lasers and searchlight beams. So I assumed extremely small divergence to get the range attenuation effects in the game. How do they do it? I don't know.[2]

With weapons come defenses. I decided to forego magic mystery shields, in another burst of enthusiasm for a semi-realistic feel. I did put in point defense systems and provisions for anti-missile missiles. I also included armor – think some sort of super-dense ablative reflective super material. I threw in meson guns as weapons to defeat armor, and so also included a form of screen to defend against meson guns. That requires a bit of balance in designing ships defenses. I also made a ship's maneuverability an important factor in defense. A ship's electronic suite rating, which represents (among other things) threat detection and electronic counter-measures capabilities, confers both offensive and defensive benefits.

Of course, considerations of weapons and defensives launched me into a consideration of ship design. Many of the other games had a ship design component, so why not mine? In my case, I built a spreadsheet to produce ship classes. Basically, you start with a target tonnage, then fill it with weapons, jump drive, power plants, missile tubes and the like. I spent a fair amount of time fiddling with the results to get ship classes that look somewhat like WW II era ships.

Making Ships.

I always liked a good ship design system as part of a space war game. It takes me back to the days of grade school space rocket design. I found it easiest to put my design system in an Excel workbook, which I have included with the game. I wil not belabor the formulae in the

[2] If you are interested, here is the math: $I = Io(w/\theta)^2/(d + w/\theta)^2$
Where:
I = intensity at distance "d"
Io = intensity at the tip of the laser
w = width of the beam at the tip of the laser
θ = beam divergence (in radians)

spreadsheet, as they are there to see. But I did impose some additional limits on ship construction, which I include here.

- No warship may have more than 3 sizes of main beam weapons and 3 sizes of missiles. All warships must have at least 1 main beam weapon. No civilian ship may have more than 1 type of particle accelerator as a main beam weapon and no more than 1 type of missile.
- Maneuver and jump ratings are limited to a maximum of 6.
- Electronics suite rating limited to a maximum of 8.
- Missiles may range in size from 8 tonnes to 100 tonnes.
- Particle accelerator weapons can range in size from 300 to 21600 GJ.
- Meson gun weapons can range in size from 1200 to 12000 GJ.
- Armor cannot be more than 10% of total displacement. Meson screens are limited to a maximum rating of 7.
- Total ratings of point defense weapons are limited. Effective hits from point defense weapons must be less than or equal to (ship mass^1/3)/3 +1, with effective hits being calculated by (battery strength at range 0-4 * number of batteries/20).
- Ship fuel minimums (built into the spreadsheets) are 5% of (ship's mass * maneuver rating) + (5% of ship's mass * jump rating). Power plant fuel is intergral to the power plant and powers it for an unlimited time in game terms. Fuel for maneuver and jump are interchangeable. Jumps consume fuel at rate equal to (0.5% of the ship's mass * the jump distance in LY). Maneuver consumes fuel at a rate of (0.5% of the ships mass * the Gs of accel * 8 hours). Put another way, the minimum amount of fuel carried for maneuver equals (80 G/hours * the ship's maneuver rating), thus giving a minimum endurance at continuous full thrust of 40 operational turns.
- 1G, 180 hour life boats are included in accommodation mass – 10 tonnes per 50 evacuees (plus 1 pilot).

There are three spreadsheets in the workbook: one for military starships, one for civilian starships, and one for small craft without jump drives. The spreadsheets for the starships also include a module for missile design. Ships are designed using the upper part of the spreadsheet, with manual entries to the unshaded cells and the rest of the spreadsheet filling in automatically. Missiles follow a similar process.

The right hand column at the bottom of the ship design spreadsheets shows the chances out of 20 that a hit will affect a particular ship system. These values are used to create the damage tables for the optional damage systems. By convention, I always provide for a minimum 5% chance of a hit affecting each system present in a ship. If this takes the total above 20, I reduce the chances of hitting the systems with the greatest chance of being hit.

For warships larger than 3,000 tonnes or so, you will see that I generally left a margin of 50 or more tonnes to accommodate upgrades, ship's vehicles, additional troops, etc.

What's the Story?

I did not spend a lot of time working up an elaborate backstory for the game, as the backstory wasn't the point of this exercise. I did invent 8 space navies, most with obvious relations back to earthbound navies of today. I really wanted a rationale for cool-sounding ship names and different design philosophies, and enough of a background to be a framework for scenarios. Here are the navies and a brief rationale for each:

- Celestial Navy (Tianti Haijun) – the powerhouse in the game, but not so overwhelming that it could not be taken down by an alliance of other powers. This is China in space – strong, confident and looking to its Imperial antecedents. And possibly subject to some internal tensions.
- Extrasolar United States Navy – still fairly strong, but not the power of centuries past and perhaps a bit inclined to want to be off by itself.
- Force Espace Europa Fédérée – The European Union writ large, a big federated European state. But perhaps with a touch of an eastern European "underclass" that still harbors resentment over its perceived inferior status, and a sizeable Levantine client state that also has ambitions of its own.
- Royal and Commonwealth Worlds Navy – Because there will always be an England, no matter how small. But let's make the assumption that the Commonwealth nations were active in space exploration and colonization.
- Combinados Fuerzas Espaciales Navales de la Conferencia de los Americanos Interestelares – Why should the Norte Americanos have all the fun, particularly given the economic potential of Mexico and South America? This also creates a foil for the EUSN.
- Asian Alliance Space Navy (Ruang Tentera Laut) – Formed originally from a federation of South Asian states – think Indonesia, Malaysia, Vietnam, Thailand, etc. A neutralist wild card, not particularly enamored of the space-faring Chinese or Japanese.
- Stellar Japanese Navy (Tentai Nihon Kaigun) – Always trying to punch above its weight; always extremely aggressive and so a potential source of trouble. Think Japan of a century ago, not the Japan of today.
- Russian Space Navy (Rossiya v zvezdakh morskoye verdomstvo) – Yes, Russia survives, as it has for the past 1000 years. It is a bit more modest in size and resources than the other powers, but grandiose in thought and feeling – another potential trouble-maker.

These are all the navies in the game, but not necessarily all the powers. I can imagine a number of lesser powers, such as sub-Saharan Africa and India. But none have a large independent presence in space.

I'm also vague on stating the connection between the forces in the game and their historical antecedents. Figure that a few hundred years at least have to pass between now and this

imaginary future: time enough to get interstellar spaceflight, terraform a bunch of earth-like worlds, and then colonize them to the point that they are not just an extension of the then-current power structure on Earth. That all makes it hard to say whether (for instance) there will even be a China or a USA in this distant future. It is a bit like predicting the current world power structure using 1300 as your starting point. So do not take it too seriously.

And on the topic of vague, I'm also vague about how tied in these forces are to powers still on Earth. Earth gets to be a problem in space opera. Left to its own devices, it dominates all the other worlds. Hence the common science fiction attempts to get Earth out of the way: nuclear war, environmental catastrophe, biologic disaster, neutral zone, or just the sheer passage of time and expansion through the stars. All have been used to reduce Earth's significance. I have firmly taken the indefinite approach of not expressly wiping Earth out, but assuming that development on other planets has gone long enough and quickly enough so that Earth does not dominate known space. I have not read Earth out of the picture entirely, and have assumed that political groupings that began on Earth would still have some relevance and cohesiveness even long after people have colonized many worlds.

Let Me Play among the Stars.

This takes me back around to interstellar travel. To make sense of it, I had to assume that travel between the stars was relatively cheap and easy. As I wrote above, I gather that the best current thinking is that truly Earth-like worlds are going to be relatively rare. You need a stable B, F, G or K class star, without a stellar companion so close as to disrupt orbits, and then a right-sized rocky planet (or moon of a gas giant) at the right distance from the star. Less than 20 of the closest 100 star systems are the right sort of star systems, and that's before we get to which have the right sorts of planets at the right distances. Sure, you can imagine marginal worlds in other contexts, but none that I would want to live on. Bottom line: good earth-like worlds, even factoring in advanced terraforming technology, are likely to be pretty far apart – on the order of 30-50 light years.[3]

So for interstellar travel to work, jump systems should be able to take ships over these distances with a minimum of muss and fuss. Of course, star systems are a lot closer together than 30-50 light years – more like 5-10 light years apart, in our part of the galaxy. So shorter jumps are fine, as long as an infrastructure exists to service and refuel the ships as they make their way from populated world to populated world. These assumptions underpin the scenarios in the game. These lie behind a 10 light year jump distance being the basic rating for jump-1.

[3] I have to note here that scientific advances in the detection of planets outside our solar system have made science fiction a lot harder. Before, if a science fiction author wanted an earth-like world around Tau Ceti, presto! She just created it. And got a neat-sounding star name as a bonus. Now we know too much about the planets around the star. Solution: create a set of earth-like worlds without making any attempt to relate them to specific stars in Sol's neighborhood.

I then made jumps short enough in time to support the idea of interstellar commerce. Traveling 30 light years would take about 10 days of jump time, plus time for refueling , jump preparation, etc. Jumps in-system movement would be cheap and quick, encouraging exploitation of resources throughout the local planetary system. Figuring that in-system trade accounts for 80% of all shipping, that would leave 1 in 5 merchant ships for interstellar travel. Roughly extrapolating from current Earth ocean shipping, I decided that would equate to between 1,800 and 2,000 trade ships plying the space between the stars.[4] Assume that the in-system trade moves a lot of bulk materials, and that the interstellar trade is in smaller high value items and even more ephemeral stuff such as trade information and details of new technologies. It all adds up to a vital economic force that none of the powers in the game would want to see disrupted for long.

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That is a more about background than I really intended, but it is all in the service of the game. I tried to design a game for play value, with a space opera look and feel. I have not set out to write a work of science fiction, and a damn good thing too. I have succeeded if the game is fun to play, and players are encouraged to design some of their own ships and create some of their own scenarios.

[4] I figured this way. Assume a population of 700 million people spread around 36 star systems with inhabitable planets. Current Earth, with a population of 7 billion people, has more than 50,000 ships engaged in ocean trade, with a deadweight tonnage of something over 1 billion tonnes. I also assumed that there would be double the number of ships at half the tonnage per ship. (Less settled trade routes, more concentrated, higher value cargoes, etc.) So 10,000 ships to serve a 700 million population, with 8,000 dedicated to in-system trading, leaving 2,000 in the star lanes. Those 2,000 would have an average tonnage of a bit more than 10,000 tonnes per ship, with a wide variety between ships.