Chapter 1: Installation Tutorial

Aurora Requirements

1. If you are living in a country which uses the comma (,) for decimal separator, then while playing Aurora you have to switch the Regional Settings of your computer over to US or UK or another country that uses the period (.) as the decimal separator. In XP this is in the Control Panel.
2. The minimum resolution required is 1280x1024. A higher resolution or multiple monitors will allow you to see more windows at once. If your display doesn´t support this, there are ways around it, provided your video card supports a higher resolution than your monitor/display.
3. Scrolling desktop. A program that extends the desktop beyond your screen can be found at http://360desktop.com/
4. In XP, something similar is already built in but it does carry a warning from Microsoft so you will have to decide if this is worth trying. Go to the screen where you set your resolution. Select the Advanced button and then select the Monitor tab. There is a checkbox which reads "Hide modes that this monitor cannot display". If you uncheck this box, you can set resolution to anything your graphics card can handle. If this resolution is higher than what your monitor can display, whenever your mouse pointer reaches the edge of your screen, the whole screen will scroll in that direction.

New Game Creation

When you start Aurora, the first thing you should see is a small window with Game Details in the title bar. Across the bottom are four buttons: New, Save, Delete Game and Select. In a moment we are going to be pressing New but a quick word on Select first. Select will choose the currently selected game and take you to the main menu bar (which is really just a window title bar and a menu in the centre of the screen). If you accidentally press Select and get to this menu bar before setting up a game, you can go back to the Game Details window by pressing Ctrl-I or choosing Game Info from the Game menu.

To start a new game, press the New button on the Game Details window, This will open a much larger window with the title "Create New Game". This may seem a little overwhelming at first but most of the standard options are already selected. I'll run through most of them so you can set up the type of game you want.

Game Name is self-explanatory. Perhaps "My First Game", or maybe "My First Rampage Through the Galaxy", depending on your style. Leave the SpaceMaster Password blank as that is really for refereed multi-player games.

Starting Year: Any number you like. Aurora keeps track of time using years, months, days and seconds. You will start at 00:00 on January 1st of whatever year you select.

Maximum Number of Systems: This isn't really the max number of systems that you can have in your universe as it can be changed at any time during the game. In effect, it is the highest system number that will be generated by the program in a random (not 'Real Stars') universe. Small numbers of systems means more chance of races being close together. So if you want a knife fight in a phone booth you can choose a low number of systems and if you want a slow leisurely build up before the carnage begins you can choose a high number. 1000 is in the middle of the range and is a reasonable number for a starting game.

Local System Generation Chance and **Local System Generation Spread** determines how much 'clustering' there is in a random game. This is something you don't need to worry about yet so you can skip this paragraph if you like. Still here? Well here we go then. In a 1000 system game, the program will select a number from 1-1000 when generating a new system. If the Local System Generation Chance is 50% then there is a 50% chance that instead the program will pick a number close to that of the current system. Just how close depends on the Local System Generation Spread. If your current system is number 100 and the Local System Generation Spread is 15, then if a local system is selected it will be between 85 and 115. Why does this make a difference? Well, if you pick a system that already exists when entering a jump point, you will create a link to a new system. If every system was generated randomly from 1-1000, the galactic map will probably comprise a large number of independent chains of systems stretching out form your start point. If the number range selected is small then there is a lot more chance of encountering nearby systems so you generate a far more inter-connected universe with a lot of connections between chains and loops of systems.

Construction Cycle Time: You get to build a lot of things in different things in Aurora and the actual construction takes place in what is commonly referred to as the 5-day increment. It would affect performance if Aurora updated construction times in every 5 second increment or sub-pulse so instead the game waits until an number of increments have passed that add up to about five days and then runs all the construction code after the normal movement/detection/combat phases. Because Aurora increments rarely add up to exactly five days between construction cycles, the program uses the actual amount of time that has passed, whether it is 5 days, 12 days or 6 days, 14 hours, 12 minutes and 45 seconds. This means that the amount of 'construction' carried out in each construction cycle may vary a little between cycles. You can choose to change the trigger time for a construction cycle from the standard 400,000 seconds if you want it to happen more or less often but I would suggest leaving it alone until you have a lot more experience with the game. Just for interest, here is a list of some of the things that happen during a construction cycle (jump to the next paragraph when you get bored)

1.) Population Growth takes place
2.) Each population is checked to see if sufficient workers exist to man its factories, shipyards, etc, If there are too few then the planet's industry works at a lower capacity
3.) Orbital Motion takes place
4.) Lifepods are checked to see if they run out of air
5.) Comets move
6.) Transfers of Foreign Aid take place
7.) Wealth is calculated and added to the wealth balance for each Empire
8.) Each population calculates its trade goods production and supply and demand are set for civilian trade.
9.) Ships are checked for system failures. If failures occur, the affected ships will resolve the problem automatically if they have sufficient maintenance supplies.
10.) Maintenance is calculated for ground forces.
11.) If some form of disaster scenario is in play, such as the Sun gradually heating up, then planetary environments in the affected system are updated.
12.) Mining production for both player-owned and civilian-owned mines and asteroid mining ships. There are eleven different 'minerals' in Aurora and they are required as the raw materials for virtually everything you can build
13.) Fuel production for harvesters in orbit of gas giants
14.) Terraforming updated
15.) Fuel is refined at populations with fuel refineries and sufficient Sorium.
16.) Shipyard Activity takes place. This isn't shipbuilding but rather modification of shipyards. Increasing their size, adding new slipways or retooling to build a different ship

17.) Ship Construction
18.) Training of new Ground Forces
19.) Construction of new installations, such as factories, shipyards, research facilities and about two dozen other facilities
20.) Ordnance Production (building new missiles, sensor buoys, recon drones, mines, etc)
21.) Fighter Production (small spacecraft < 500 tons are built in factories rather than in shipyards)
22.) Research
23.) Survey of planets by geosurvey satellites. Geosurvey by ships takes place during normal movement
24.) Civilian Shipping Lines may build new ships if they have sufficient wealth. Rarely, new Shipping Lines may be formed
25.) Civilian Mining Colonies may be setup. You can tax these or buy their minerals.
26.) Crew Training takes place
27.) Mass Drivers (usually on mining colonies) create new mineral packets and fling them toward their targets (usually populated worlds in the same system). Important safety tip! If you tell one population to send minerals by mass driver to another, make sure the receiving population has a mass driver too to catch it. Otherwise, the planet gets bombarded with unfortunate results for both industry and civilians.
28.) Political Status of each planet in your Empire is checked. Those that have been conquered will move through several stages over time before they are eventually fully integrated into your Empire. This can take a number of years, depending on a number of factors including their species characteristics, the strength of the occupation forces and just how much damage you caused capturing the planet in the first place. It's hard to see your occupier in a good light when the planet is still in a nuclear winter and all the cows have two heads. 'Loyal' populations can suffer from unrest due to a number of factors, including radiation (due to alien bombardment), insufficient military protection, minority status (of their species within the Empire), etc. This can be quelled with sufficient ground forces. Garrison battalions are ideal as they are relatively cheap but effective in this role.
29.) Ruin Recovery: Xenology teams try to decipher ancient alien languages and symbology from ruins. Engineer Regiments try to recover alien installations from ruins where the Xeno teams have completed their work.
30.) Geology teams search planets for mineral deposits that may have been missed by an orbital survey
31.) Espionage Teams try to gain intelligence data from rival Empires.
32.) Radiation effects are reduced slightly
33.) Ground units recover readiness and morale. Readiness is recovered far more quickly if Replacement Battalions are available.
34.) Ground combat units loaded in combat drop modules potentially suffer loss of morale if they are held there too long.
35.) Ground Combat (Boarding combat takes place during regular movement/combat phase)
36.) Communication attempts with alien Empires. Diplomatic Rating are updated or those Empires with which comms have been established and the status of treaties is reviewed
37.) Commanders are checked for health problems and training accidents
38.) Commanders potentially gain experience
39.) If automated assignments are being used, the program review existing assignments and assigns new officers as appropriate.
40.) Warnings are generated for any ships that are low on fuel
41.) The Danger Status of systems is gradually reduced over time. This is used by civilian shipping lines to decide whether it is safe to operate in a given system.

42.) Industrial Reactivation is checked. Sectors of industry on a particular world (Ordnance Production, Shipyards, etc.) can be shut down in the case on a manpower shortage. Reactivation of a sector takes six months

OK, I did say I might digress . So back to the New Game window

The Non-player Race Generation Chance is the chance that an alien empire will be created if an eligible world is created during system generation. Eligible worlds are not that common but 30% is probably reasonable for your first game. A world may still be eligible even if it appears to be uninhabitable to your species.

The Non-player race Population Modifier is a difficulty modifier. The size of a new alien homeworld population is generated on a bell curve with the midpoint being equal to the average player race total population. If you change this value to less than 100 the midpoint of the bell curve will move below the average player race population. If you increase, the midpoint will be higher than the average player race population. This method of alien race generation also means that you can choose any starting population size and the game will scale appropriately

If you really like comets, you can set a minimum number per system. Comets are good in the sense that they usually have accessible mineral deposits, often in the ten of thousands of tons range, but bad in the sense they may disappear into the Oort cloud with your mining colony and come back in a few thousand years . Short period comets are much better for mining or you can make hay while the sun shines if a long period comet happens to be in the inner system for a while. We have completed the Basic Parameters section and I can see this tutorial is going to take a while to write if I don't starting getting a lot more concise

The next section is **Setting Empire Parameters**. Empire Title, Species Name and Homeworld Name are just text entry fields so you can be as imaginative as you like, or just leave the standard 'Terran Federation', 'Human' and 'Earth' entries.

Government Type includes some modifiers for Empire characteristics, such as Xenophobia, Militancy, Determination, etc. and affects the amount of industry and how it is divided at game start. For now, just leave it as a player race.

Main Empire Theme adds flavour to your race. Your starting ranks, random system names and auto-generated names for ship classes will be based on the theme. So for example if you chose United States for the theme, the ranks would be US Naval and Army ranks, the system names would be US cities and the class names would be Essex, Lexington, Spruance, Ticonderoga, etc.. All names can be overridden during the games if you prefer something else and you can change theme mid-game. There are currently over sixty different themes including such varieties as Canadian, Deutschland, Demonic Realm, Ancient Egypt, Knights Templar, Welsh, Barsoom, Swedish, ASEAN, etc. **Commander Theme** affects the naming of your Commanders. For the US theme I imported the latest US Census data into the Aurora database. When you generate a Commander it will pick a random first name from 2000 possibles and a random surname from over 50,000. That provides about one hundred million names for the US theme alone. Different name themes will vary in how the names are generated are displayed. For example, the Roman name theme uses praenomen (given name), nomen and cognomen. The German theme will put the occasional 'von' in for flavour, etc. There are currently thirty-four name themes, including Russian, Japanese, Ancient Greek, Polish, Jewish, Arabic, Hobbit, Zulu, Norse, Indian, etc. Any name theme you need should in there somewhere. If you want to see more themes, I am always open to players creating themes and sending them to me for the next version. Let me know if you want more details.

The final part of this section is an option between a **Trans-Newtonian Empire and a Conventional**

Empire. Stick with Trans-Newtonian for now, which is a standard Aurora Empire. A Conventional Empire starts with no space-age tech and you have to pretty much start from scratch, converting your conventional industry and researching all of the normal basic starting tech. This would be frustrating for a new player and this tutorial will assume a standard start.

Next is the **Species Tolerance** section. Each species in Aurora has environmental tolerances with their midpoint being their homeworld. The habitability of planets will vary considerably depending on the species tolerances so a world that is ideal for humans may be uninhabitable for some other species and vice versa. Even humans can be set with varying tolerances that can affect the difficulty of the game. For now, set the maximum deviation in oxygen pressure to 50%, the max deviation in gravity to 70%, the max deviation in temperature to 22 and the max atmospheric pressure to 4.

These settings will mean that an ideal habitable world will have a temperature between 0 and 44C, an oxygen pressure between 0.1 and 0.3 atm, a gravity between 0.3G and 0.7G and a maximum atmospheric pressure of 4.0 atm. In addition to the individual species tolerances, the ideal habitable world will also need to have no dangerous gases such as Chlorine and will need the oxygen to be no more than 30% of the total atmospheric pressure. A planet that doesn't meet those criteria may be uninhabitable (if it falls outside the gravity range) or may require infrastructure to support the population. Note that you can put ground bases, troops, sensors etc. on any world except a gas giant, regardless of the habitability. If you want an actual population though, which you will need to run shipyards, factories, etc,, then the planet has to be habitable or at least have enough infrastructure for the inhabitants.

Next is **Starting Population**. This lays out the parameters for your initial population on Earth. Somewhere between 500m and 1000m is a good amount for a new player. Lets leave it at 500m for now. The other boxes can be left alone as they are mainly for specialized scenarios. For example, you might set the Wealth Creation Rate and Industrial Percentage fields to be very low (perhaps 15-20%) to simulate a country like China that has a lot of population but a much lower per capita industrial output and per capita income than the USA. In games that feature multiple starting Empires on Earth this can be an important balancing factor for the SpaceMaster.

Moving swiftly on to the **Starting System** section. Set the number of Sol Jump Points to 6. and leave the other boxes unchecked, This will give us plenty of avenues for exploration

In the **Starting Tech** system, uncheck the Assign Starting tech points box so we can allocate our own tech at the start of the game. If the box is left checked, the game will randomly assign our starting tech points to background technologies. That can be fun if you want to create a more challenging start where you have to cope with whatever tech you are given. As we are learning at the moment, it's much more educational to choose them ourselves . Likewise, leave the Create Ship Systems box unchecked as we will be doing that ourselves as well.

Now we move to the second half of the Create New Game window. This is easier to explain as much of the information is already on the screen. Leave the Starting Race as it is so we can start on Earth. The other option is for SpaceMasters who are setting up their own universe and it is a LOT more complex.

Precursors, as the blurb states, are robot ships that guard some of the ruins in the game and small Precursor ship occasionally appear in non-ruin system. Leave this selected as Precursors provide valuable combat experience. Rather than a complete Empire similar to your own (which is what NPRs will be). Precursors are isolated groups of ships left over from an ancient Empire that dominated the galaxy until they were destroyed by a foe that is yet to be introduced to the game. All that remains are the few ships that guard the ruins of defeated foes waiting for new instructions that never arrive. Their mission is simply to eliminate all non-Precursor life. They have no real populations, although they may have small listening posts and weapon caches in the system. Although few in number and they don't

have any survey ships for exploration, they are likely to be higher tech than your own Empire at game start and any starting NPRs. You will need to overwhelm, outsmart or simply avoid them until you are ready.

Leave the number of computer-controlled Empires (NPRs) as 1 and leave the two checkboxes in the section checked. One NPR is plenty for a starting game as new ones will be generated as the game progresses and new systems are found. An NPR is an Empire much like your own. It will be exploring the galaxy, encountering and fighting Precursors, setting up new colonies and improving its industry. When you finally encounter an NPR it may turn out to be friendly, depending on how diplomacy progresses, or it may be an implacable foe. Or it may change from one to the other at some point.

Don't bother with the optional simplifications for now. If you want to run a different style game in the future, you can always experiment with them.

Leave **Realistic Commander Promotions** on as it is one thing less to worry about and it does provide a good flavour to the Commander system. Turn off the Political Bonuses option as it adds an unnecessary complication at this point.

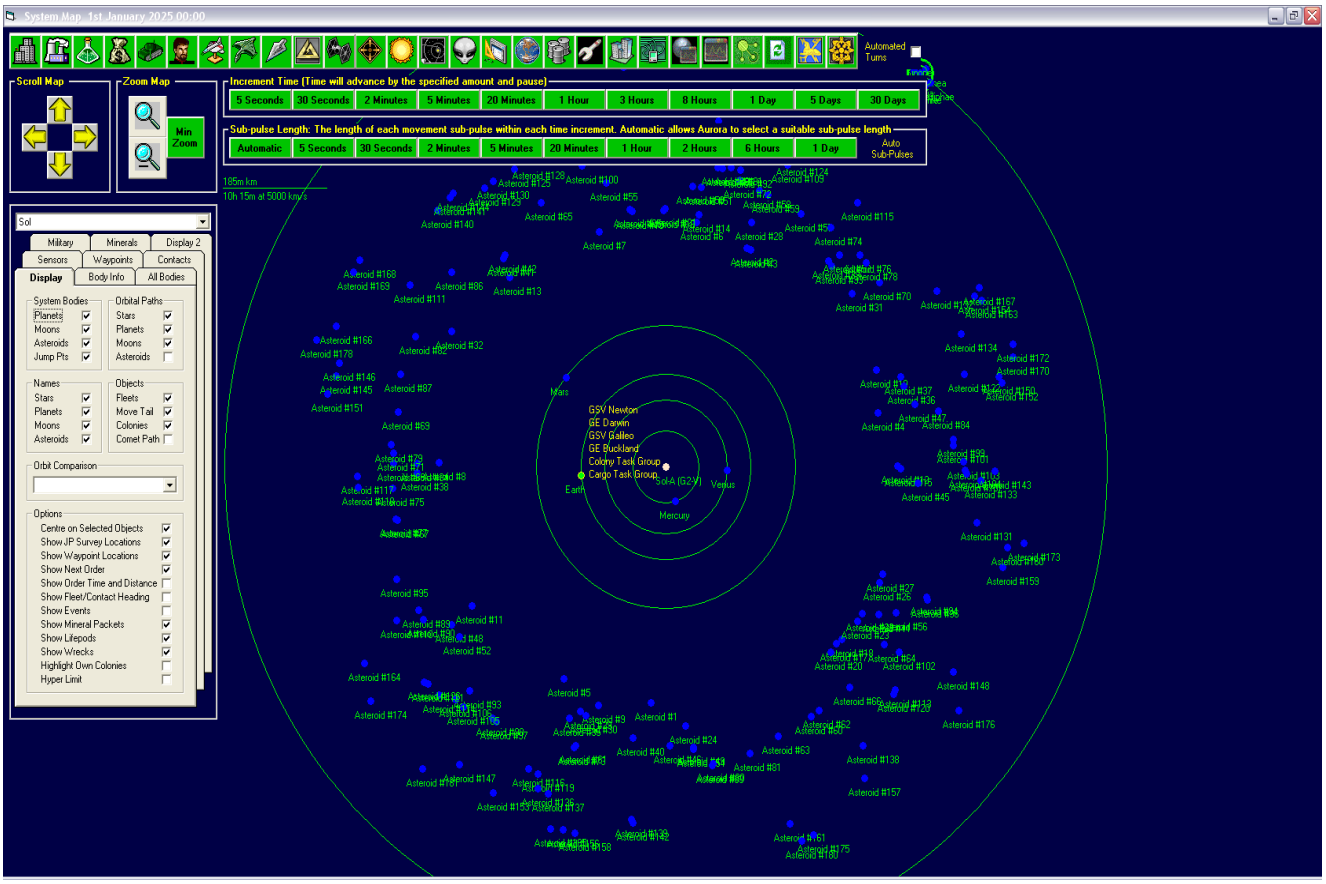
Leave **Inexperienced Fleets** on for now. You can turn it off later if you wish but the need to institute fleet training exercises adds a good degree of realism to the game. If you are a beginner then you should probably turn this off until you are ready to play a longer game. If you leave it on, you will need to train a fleet together for some time to get coordinated fire, and manuever. This is very important for missile combat.

Lets play with **Real Star systems** on as well. That takes care of system naming and it will add some familiarity to the universe. You can leave the Orbital Motion on as well. If you have a modern PC, you can turn on Orbital Motion for Asteroids as well.

Aha - the Moment of Truth! When you are ready click **Create Game**. This will take a minute or two and there will be a couple of popup messages. When all that is complete you will be back at the Game Details window with your new game selected. Press Enter to select the game and you will be at the main menu bar. Press F3 for the System Map.

Chapter 2: System Map

The Basics of the System Map



OK, lets take a look at the System Map window (F3 from main menu bar). When you open it for the first time we will be looking at the Sol system, possibly from a very zoomed-out view. The first time you look at a system the program will always try to include everything in the system within the frame of view, which means if Sol has some long period comets the system might be a green and blue blob in the middle. You can zoom in using either the + key on the your keyboard's keypad or the zoom icon near the top left. Each time you press Zoom the scale will double (you can check the current scale in the top left of the viewable area)

As you zoom in you will see two asteroid belts, the outer of which is the Kuiper Belt and the inner is the Mars-Jupiter Belt. You will also see about thirty small white circles with numbers scattered around the system. Those are jump point survey locations, which we will get back to later. Zoom in until you can see the inner system with Earth, Mars, etc. Click on Earth to centre the map and keep zooming. Eventually the Moon will appear in orbit. Small bodies are hidden at higher zoom levels so they don't obscure the map. Zoom out using - on the keypad and click on Jupiter to centre the map then zoom back in to see its system of moons. You can also use the numbers of the keypad to move around the system. When you leave a system the program will remember the zoom level and which part of the system you were looking at so you can easily jump back and forth between ongoing events in different systems.

The Sidebar

On the left hand edge of the System Map there is a grey Sidebar with nine different tabs and above it is the current system dropdown. This system dropdown is one of the ways you can select different system

maps, although at the moment there is only one - Sol. The Sidebar should have the **Display** tab selected, which gives you the option to toggle on/off some of the system map symbology. For example, if you click on the Comet Path checkbox, lines will be drawn from the Sun through each comet and out to the maximum distance to which the comet will travel. You may have to zoom out to see the ends of some of those lines.

In the centre of the Display tab is another dropdown entitled orbit comparison. This draws a circle around the system primary at the distances of various planets. Not much use in the Sol system but useful in other systems to give you an idea of scale. (just found an overflow bug here that will be fixed in v4.8). In the lower half of the display tab are several other display options with which you can experiment as you play the game. For example, unchecking the Show JP Survey Locations will hide all the small white circles I mentioned earlier.

If you move to the **Body Info** tab and click on any body in the system, you will get some basic information, although there are other places in the program where you can see more detail if required. The **All Bodies** tab has a tree view of all system bodies, including moons if you click on the small + icons. Selecting one will centre the system map on the selected body. **Sensors** allows you to configure how you view details of your sensor capabilities and **Contacts** allows you to modify how contacts are displayed. We'll get back to those later.

Waypoints allows you to set waypoints for movement or missile launches. To create one click on Add and then click somewhere on the map. Click on the waypoints listed in the sidebar and click delete to get rid of them. Clicking the Last button will place a waypoint on the last system body you selected and that waypoint will move with it. Try selecting Mars and then click Last. A way point should appear on Mars. Select it on the sidebar and click Delete to remove it. This is useful for setting up a destination for a missile or perhaps a probe

The **Military** tab lists all the fleets and ships in the system. At the moment it will just list some empty fleets. Empty fleets don't appear on the map but they will appear in this Sidebar view. **Minerals** shows all mineral deposits in the system. We haven't surveyed anything yet so the only minerals displayed will be those on Earth. The Mineral Text button will show the minerals in text rather than a tree view, which is useful for copying and pasting into after action reports. Mineral text view also displays the number of planets, moons and asteroids in the system. While this view is useful for a quick check, the Geological Survey Report window is far more useful for detailed investigation of mineral deposits. I'll talk about this window later in the tutorial but if you want a quick look, it is about six icons from the right along the top of the window. The icon is a grey planet with a chart in front of it. Finally, the **Display 2** window has a few more display options, including options to show weapon and fire control ranges. We'll use these later in the tutorial. If you discover any ancient ruins they will be listed in the Known Ruins section.

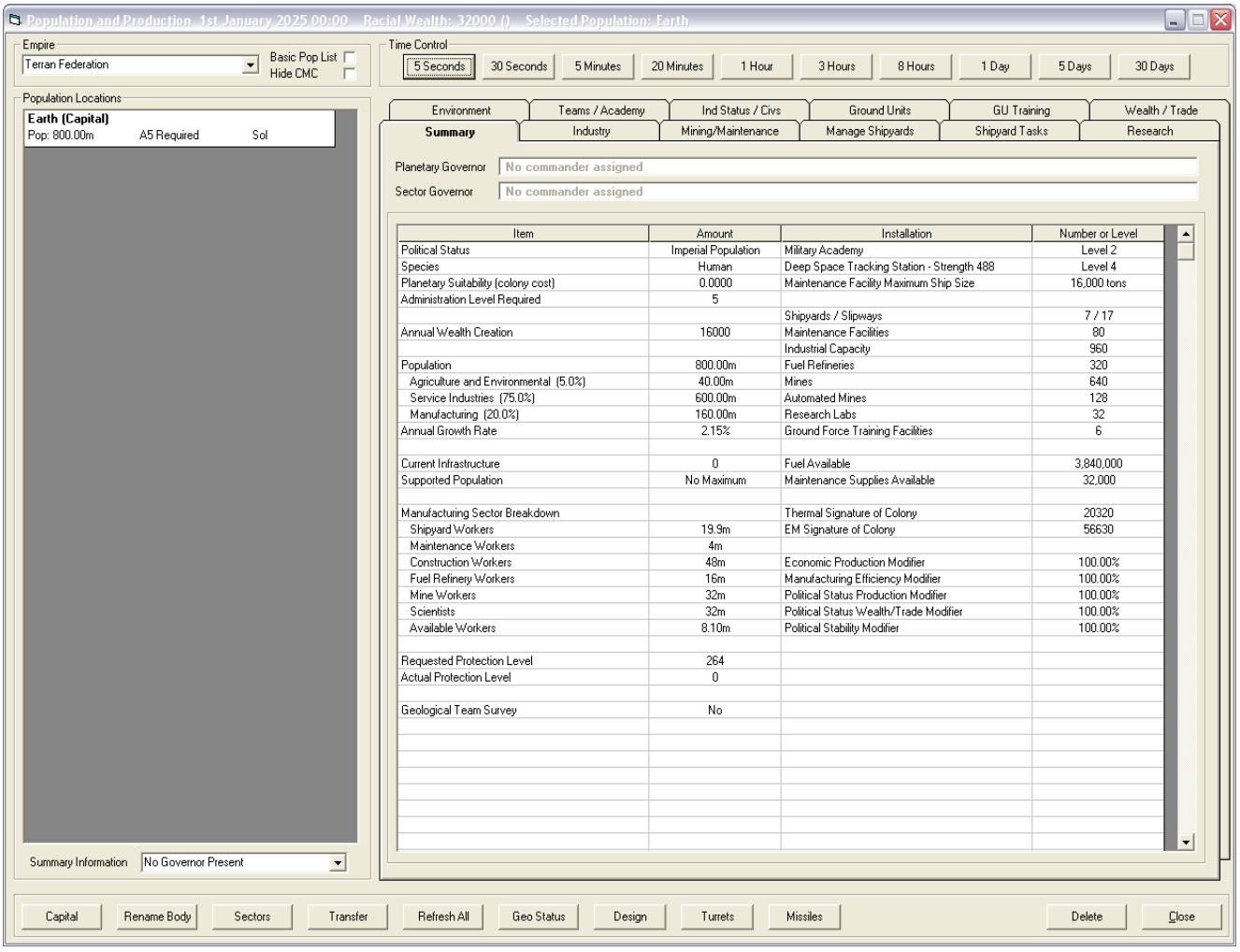
The icons along the top allow you to access all the other major windows in the program and the two rows of time buttons allow you to set increment and sub-pulse length. I'll explain those in more detail later. Next we will take a look at the Economics window. You can access this either by pressing F2 or by clicking the first icon on the left (which looks like a couple of office blocks). I'll cover that in part 3.

Chapter 3: Population

Population and Production window: Summary View

This is by far the most complex and detailed screen in Aurora and is key to the strategic portion of the game. The empire dropdown in the top left allows you to select each empire, although you will need to be in SM mode if you wish to view multiple empires. To the right of the empire dropdown is a checkbox that allows you to switch between two views of your colony list. The default view has more detail while the basic view requires less space. Across the top of the window is the Time Control section, which contains several buttons, each with an amount of time. Pressing a button will advance time in the game by the specified amount. There is a more detailed Time Control section on the System Map. The colony list on the left shows all populations in the Empire. The largest part of the Economics View is a series of tabs showing different aspects of your colonies. As each tab has a lot of information I will tackle them one at once. This post will concentrate on the Summary view, which is the tab displayed when you first open this window

Summary View



Item	Amount	Installation	Number or Level
Political Status	Imperial Population	Military Academy	Level 2
Species	Human	Deep Space Tracking Station - Strength 488	Level 4
Planetary Suitability (colony cost)	0.0000	Maintenance Facility Maximum Ship Size	16,000 tons
Administration Level Required	5		
		Shipyards / Slipways	7 / 17
Annual Wealth Creation	16000	Maintenance Facilities	80
		Industrial Capacity	960
Population	800.00m	Fuel Refineries	320
Agriculture and Environmental (5.0%)	40.00m	Mines	640
Service Industries (75.0%)	600.00m	Automated Mines	128
Manufacturing (20.0%)	160.00m	Research Labs	32
Annual Growth Rate	2.15%	Ground Force Training Facilities	6
Current Infrastructure	0	Fuel Available	3,840,000
Supported Population	No Maximum	Maintenance Supplies Available	32,000
Manufacturing Sector Breakdown		Thermal Signature of Colony	20320
Shipyard Workers	19.9m	EM Signature of Colony	56630
Maintenance Workers	4m		
Construction Workers	48m	Economic Production Modifier	100.00%
Fuel Refinery Workers	16m	Manufacturing Efficiency Modifier	100.00%
Mine Workers	32m	Political Status Production Modifier	100.00%
Scientists	32m	Political Status Wealth/Trade Modifier	100.00%
Available Workers	8.10m	Political Stability Modifier	100.00%
Requested Protection Level	264		
Actual Protection Level	0		
Geological Team Survey	No		

The Summary view shows the Planetary and Sector Governors as well as a summary of the currently selected colony. The Planetary Governor applies his bonuses to all aspects of the selected colony. The

Sector Governor applies one quarter of his bonus to all colonies within his sector. Both these positions can be assigned on the Officers Window (F4). The various lines on the summary view are as follows:

- Political Status: The status of the colony in relation to the Empire as a whole. An Imperial Population is a fully fledged member of the Empire and follows all normal rules. A status such as Client State or Occupied will have different effects. These will be covered in the section on Politics
- Species: The species of which the population is composed. Each empire may have populations from several different species, each with their own environmental tolerances and racial characteristics. Each population can only consist of one species so if there are two species from the same empire on the same planet, there will be two populations.
- Planetary Suitability: The colony cost of the planet. If a planet has zero colony cost, the population is not restricted in any way other than the maximum growth rate. Otherwise, the maximum population is equal to (Infrastructure * 10,000)/Colony Cost. For more details on colony cost, see the System View window (F9)
- Administration Level Required: The minimum Administration Rating of the planetary governor. In other words, no Administrator can be assigned to the role of planetary governor unless he has the specified rating or higher. If an Administrator is already assigned when the required rating changes he may remain within the role but any newly appointed governor must be at the new required rating level. Larger populations will require higher ratings.
- Annual Wealth Creation: The total amount of wealth that this population will generate in one year. This is gradually added to the Empire's current wealth every few days.
- Total Population: Total population of the colony in millions.
- Agriculture and Environmental (A&E). The percentage and actual amount of population working to feed the rest of the population and maintain any environmental infrastructure. The required percentage is based on the colony cost and is assigned automatically by Aurora. A colony cost zero world will only have 5% assigned to this sector.
- Service Industries (SI): This is the percentage and amount of population working in service industries, which includes everything that is not related to A&E or Manufacturing. The percentage required for SI is based on the total size of the population and is assigned automatically by Aurora. As a population grows, the relative size of the SI sector increases.
- Manufacturing: The available population after the size of the A&E and SI Sectors has been determined. All factories, mines, shipyards, etc must be manned by this sector of the population.
- Annual Growth Rate: The rate at which populations increase in size. The rate of increase is based on the size of the population and small populations have a higher rate of increase than large ones (what else is there to do on a new colony?). Population growth is fairly realistic and will be around 2% or less per year for a large population. The rate is also modified by any Population Growth bonus provided by the planetary and sector governors.
- Current Infrastructure: The amount of infrastructure on this colony. If the colony cost is zero, infrastructure is not required. Otherwise, the maximum population is equal to (Infrastructure * 10,000)/Colony Cost. For more details on colony cost, see the System View window
- Supported Population: The maximum population allowed by the current level of infrastructure. For colony cost zero, there is no maximum population.
- Manufacturing Sector Breakdown: This section lists all manufacturing workers that are employed in different parts of the Manufacturing Sector and shows how much population is available for additional industry
- Requested Protection Level: This value shows how much protection this population demands from the Empire's military forces. This is based on several factors including population size,

political status and species militancy.

- Actual Protection Level: This value shows how much protection this population is receiving from the Empire's military forces and is based on the total PPV value of Empire forces within the same star system. If insufficient protection is being provided, it will cause unrest within the colony population
- Radiation Level: The amount of background radiation present on the planet's surface. If this is zero, there will be no radiation line on the summary. Each point of radiation decreases industrial production by 0.01%. The most likely cause of radiation is recent bombardment of the planet.
- Atmospheric Dust Level: The amount of dust in the planetary atmosphere. The normal surface temperature of a planet is decreased by the Dust Level / 100
- Sector Command HQ: Construction of a sector command headquarters creates a sector with the colony as the sector capital. Higher levels of sector command headquarters increase the radius of the sector.
- Military Academy: The size of the colony's military academy. Each level of an academy produces five commanders and 1000 crewmen per year, with the crewmen having 100 grade points. Changes to a empire's Training Level (see the Empire window) will reduce the number of crewmen produced but increase their starting grade points.
- Deep Space Tracking Station (DSTS): DSTS provide EM and Thermal sensor capability for a colony. The first DSTS has a sensor strength equal to the racial Planetary Sensor Strength. Each additional DSTS adds 25% to the colony's sensor strength.
- Maintenance Facility: A maintenance facility is able to maintain ships of a certain size in orbit. Each level of maintenance facility increases that size by 200 tons, so a Level 20 Maintenance Facility could handle ships of up to 4000 tons. If a ship of the maximum size or less is in orbit, it does not suffer maintenance failures and therefore does not use up spares.
- Mass Driver Capacity: The tonnage of minerals that this population can launch per year. A single mass driver is sufficient to catch any amount of minerals.
- Shipyards/Slipways: Shipyards give the colony the ability to construct ships (see the Manage Shipyards tab). Their annual construction rate is based on the racial Shipbuilding Rate (see Research) and modified by Shipbuilding bonuses provided by the planetary and sector governors. Each shipyard requires population in the manufacturing sector to support it based on a formula of: Number of Slipways x Capacity x 0.0001
- Construction Factories: Construction Factories (CF) are used to build all other planetary installations, such as shipyards, mines, all factory types, fighter bases, etc. Their annual rate of construction is based on the racial Construction Rate (see Research) and modified by Factory Production bonuses provided by the planetary and sector governors. Each CF requires 50,000 supporting population.
- Ordnance Factories (v4.8): Ordnance Factories (OF) are used to build missiles. Their annual rate of construction is based on the racial Ordnance Production Rate (see Research) and modified by Factory Production bonuses provided by the planetary and sector governors. Each OF requires 50,000 supporting population.
- Fighter Factories (v4.8): Fighter Factories (FF) are used to construct all fighter types. Their annual construction rate is based on the racial Fighter Production Rate (see Research) and modified by Factory Production bonuses provided by the planetary and sector governors. As with other factories, they require 50,000 population to support them.
- Fuel Refineries: Fuel Refineries convert mined Sorium into fuel for spacecraft. Each ton of Sorium produces 2000 litres of fuel. Their annual rate of production in terms of tons of Sorium processed is based on the racial Fuel Production Rate (see Research) and modified by Factory Production bonuses provided by the planetary and sector governors. Each Refinery requires

supporting 50,000 population.

- Mines: Mines extract Trans-Newtonian minerals from the core of the planet or moon on which the colony is based. Each mine extracts every available mineral at a annual rate based on the racial Mining Production Rate and modified by the accessibility of each mineral and the Mining Bonuses provided by the planetary and sector governors. Each mine requires 50,000 supporting population.
- Automated Mines: Automated Mines function exactly like the mines except they do not require a supporting population. This makes them ideal for hostile worlds or small moons and asteroids that do not have enough gravity to support a population.
- Terraforming Facilities (TF): Terraforming Facilities are used to change the composition of gases in the atmosphere. Each TF can add or remove an amount of gas equal to the racial Terraforming Rate, modified by the Terraforming bonuses of the planetary and sector governors.
- Research Labs. The total number of Research Points (RP) produced by a colony is equal to the number of Research Labs multiplied by the racial Research Rate, modified by the Research bonuses provided by the planetary and sector governors. Each Research Lab require one million supporting population. See the Research tab for details on Research Projects
- Ground Force Training Facilities (GFTF). Each GFTF can train one ground unit. Every GFTF produces 100 training points per year
- Fuel Available: The total amount of fuel available at the colony. This stockpile is used to refuel orbiting spacecraft.
- Maintenance Supplies Available: The total amount of maintenance supplies at the colony. This stockpile is used to resupply ships running low on maintenance supplies
- Thermal Signature of Colony. This has the same function as the thermal signature of a spacecraft and determines the range at which the colony can be detected by thermal sensors. Industry such as shipyards, factories and mines has far more of an impact on the colony thermal signature than the size of the population
- EM Signature of Colony. This has the same function as the EM signature of a spacecraft and determines the range at which the colony can be detected by EM sensors. The population size has a major impact on the colony EM signature.
- Economic Production Modifier (EPM). If a race is using deficit spending (i.e. its wealth is lower than zero), then any installations that use resources operate at a lower output, based on the size of the deficit compared to an Empire's annual wealth production. The EPM shows the percentage of normal output.
- Manufacturing Efficiency. This figure represents the efficiency of the manufacturing sector. If sufficient workers are available to support all industrial installations, the efficiency will be 100%. If insufficient workers are available, this figure represents the percentage of required workers that are available. The production of all facilities such as shipyards, mines, factories, research labs, etc is reduced to this amount. The radiation level of the planet can also reduce this figure by 0.01% per point of radiation. If the radiation level is 10,000 the Manufacturing Efficiency will be 0%, regardless of worker availability, and nothing can be built on the planet.
- Political Status Production/Wealth/Trade Modifiers. Some political statuses have an effect on the colony's production. These modifiers show the effect as a percentage of normal output.
- Political Stability Modifier. If a colony is suffering from unrest, its production will suffer.

Chapter 4: Production & the Economy

Installations

The following is a list of the facilities that may be constructed in Aurora, along with their uses. Managing your economy is one of the most important and challenging tasks in any game of Aurora, and understanding what everything does and why is critical to keep a stable economy.

Maintenance Facility - Used to provide support to orbiting starships. Requires 50,000 population per installation. Supports 200 tons per facility.

Construction Factories - Used to build every installation in Aurora. A vital need for any colony. requires 50,000 population per installation. Base rate is 10/year/factory, upgradeable via research.

Ordnance Factories - Used to produce missiles. Requires 50,000 population per installation. Base rate is 10/year/factory, upgradeable via research.

Fighter Factories - Used to build fighters. Requires 50,000 population per installation. Base rate is 10/year/factory, upgradable via research.

Fuel Refinery - Used to refine Sorium into fuel. Requires 50,000 population per installation. Base rate is 20,000 litres/year/refinery, upgradable via research.

Automated Mines - Robotic mines. Requires no population to operate. Base rate is 10/year/mine, upgradable via research. Note: lower than 1.0 accessibility affects the base rate as a percentage, i.e. .6 accessibility mines at 6/year/mine.

Mines - Manned mines. Require 50,000 population to operate. Base rate is 10/year/mine, upgradable via research. Note: lower than 1.0 accessibility affects the base rate as a percentage, i.e. .6 accessibility mines at 6/year/mine.

Terraforming Installation - Used to modify the atmosphere to a more hospitable type. Requires 250,000 population to operate. Base rate is .001 atm/year/installation, upgradeable via research.

Research Labs - Required to perform research. Requires 1 million population to operate. Base rate is 200 RP/year/lab, upgradable via research.

Financial Centre - Increases the wealth created on the planet. Requires 50,000 population to operate. Wealth is calculated by wealth technology x population for annual "tax". Financial centres add 1 to this total/year.

Mass Drivers - Used to launch and catch packets of minerals. Can also be used as large scale kinetic weapons. Each driver can launch 5000 tons.

Sector Command HQ - Allows creation of a sector command. A sector governor oversees a number of systems. A fraction of his bonuses are applied to each colony under his jurisdiction. Each level allows control up to its level in jumps, i.e. 4 levels = 4 jumps from sector HQ.

Spaceport - Allows the creation of trade routes. Note a spaceport must be available at each end, and all legs must have jump gates.

Naval Academy - Generates officers and junior officers for your fleets. Generates 5 officers/year/level. These are "named" officers.

Deep Space Tracking Station - The ground system for sensing approaching fleets. Each station has a

base rating of 200. This is upgradeable via research.

Ground Force Training Facilities - Used to train new ground units. Base rate is 10/year. Each facility may train 1 unit at a time. The base rate is upgradable via research.

Shipyards/Slipways - Used to build ships. Each shipyard has a number of slips and can build 1 ship per slip. The shipyard is also only configured to build 1 class of ships (though in some cases very similar versions of ships may be built without retooling). Population requirements - 100,000 per shipyard plus 1,000,000 population per slipway. Base rate is 400 pts/year. This is upgradable via research.

Commercial Freight Facility- Used to provide maintenance for freighter class ships. Requires 2 million population. This is a Yes/No facility. If it exists, it provides benefits.

The following table lists the costs, and minerals required to build each installation. Keep this list handy for future reference when preparing your economy and build queue. Minerals are a finite resource in Aurora, and require Careful management.

Table 1: Facilities by Cost

Facility Name	Facility Cost	Mineral #1	Additional Minerals
Automated Mine	**240**	Duranium x 120	Corundium x 120
Commercial Shipyard Complex	**2400**	Duranium x 1200	Neutronium x 1200
Commercial Spaceport	**1200**	Duranium x 300	Bor x 150, Mer x 300, Uri x 300, Cor x 150
Construction Factory	**120**	Duranium x 60	Tritanium x 30, Vendarite x 30
Deep Space Tracking Station	**300**	Duranium x 150	Uridium x 150
Fighter Factory	**120**	Duranium x 30	Vendanite x 90
Financial Center	**240**	Corbomite x 120	Uridium x 120
Fuel Refinery	**120**	Duranium x 120	None
Ground Force Training Center	**2400**	Duranium x 1200	Neutronium x 1200
Infrastructure	**2**	Duranium x 2	None
Maintenance Facility	**150**	Duranium x 75	Neutronium x 75
Mass Driver	**300**	Duranium x 100	Neutronium x 100, Boronide x 100
Military Academy	**2400**	Duranium x 1200	Tri x 300, Uri x 300, Cor x 300
Mine	**120**	Duranium x 60	Corundium x 60
Naval Shipyard Complex	**2400**	Duranium x 1200	Neutronium x 1200
Ordinance Factory	**120**	Duranium x 30	Tritanium x 90
Research Lab	**2400**	Duranium x 1200	Mercasium x 1200
Terraforming Installation	**600**	Duranium x 300	Boronide x 300

In addition, the following facilities may be transported. Each transportable facility requires 25,000 units of cargo space (5 cargo holds on a freighter in other words) with the exception of Research Facilities. This can be critical for setting up your economy, as supplying automted mines to mineral rich asteroids, or mass drivers to burgeoning colonies can be critical. See the shipbuilding section of the for instructions on how to build freighters, and the Task Force section for giving them orders.

The facilities that make be transported are:

Research Labs (total of 500,000 cargo)
Maintenance Facilities
Construction Factory
Automated Mine
Mine
Mass Driver
Fuel Refinery
Ordnance Factory
Fighter Factory
Tracking Station (also called Deep Space Tracking Station)

Each item that is constructed requires a build cost equal to the mineral cost. For example, a Shipyard complex requires 1200 Duranium and 1200 Neutronium, for a total cost of 2400. One construction factory will require 240 years at the base rate to complete the yard. Of course, multiple factories will reduce this time. Two factories will only need 120 years for a shipyard.

A Few Tips

Each game of Aurora is very different and you will find you have different construction priorities depending on how events unfold. Unlike many 4x games, where the economy expands without too much trouble, the Aurora economy will crash if you are not careful. You have to balance industrial capacity, resources and wealth, primarily by looking at developing trends such as mineral usage, whether the wealth balance is growing or shrinking and if you have enough population to support your industry. Try to look ahead at what is going to happen in the future rather than wait for things to go wrong. This is not easy for a new player but you will learn through experience.

Check the Mining/Maintenance tab of the Economics window to see if your mineral stockpiles are increasing or decreasing over time. Compare the estimated usage column with the stockpile plus projected column. Check the wealth tab for various time lengths (1 month, 3 months, etc) to see how your income compares to your expenditure. Check the Manufacturing sector breakdown on the summary tab to see how your workers are being used and if there is a worker shortage. Finally, check the bottom right section of the summary tab for the various production, status and efficiency modifiers. If any are less than 100%, you may have a problem.

Another common issue is supply management. It's very easy to run out of trans-newtonian minerals if you do not watch your supplies. Surveying your system and finding deposits of minerals to supplement your resources is essential, as is setting up mining colonies and mass driver networks to get them to your home world. See the Shipbuilding and Task Force sections of the guide to get your bearings on these two critical tasks.

Remember that while Factories and Mines are important, overbuilding them can quickly generate shortages of critical minerals. Balance your needs with your available supplies.

Chapter 5: Basic Ship Creation

The Class Design Window

Looking at recent posts on the forums I can see there is a demand for advice on designing ship classes so I will veer off in that direction and come back to economics later. Open the Class Design Window (F5). You should see a window that is mostly a huge blank space. The first step is to create a new class. Press New in the bottom left hand corner. If you can't see any buttons at the bottom then check you are running in a resolution of at least 1280x1024. Some text will appear in the white expanse as the program adds a few basic systems to this class. This is just the summary view though so switch to the Design View tab. You will now see the list of available components. Bridge, Crew Quarters, Engineering Spaces, etc. There aren't many because in Aurora you not only have to design the ships, you have to design most of the components as well. Before we get into how to do that, lets take a quick look around the class window. Across the top, starting from the left, are the name of the Empire, the Class Name, the Type, the Hull, the Build Points (Cost to build) and a set of checkboxes.

The **Class Name** will have been generated automatically based on whatever theme you selected during game creation. if you want to change it you can either press the Rename button and type a name or press Auto Rename, which will pick another name from the current theme.

The **Type** is either a Ship or a Planetary Defence Centre (PDCs). There are some difference between the two, such as no engines or shields on a PDC, but for the moment we will only be designing ships so leave that dropdown alone.

Hull contains a huge list of hull descriptions. This is purely cosmetic and you can choose whatever you like. So you can have a 1000 ton dreadnought or a 50,000 ton frigate if you wish. The actual size of the ship will depend entirely on what systems you add. This is because as time advances, ship sizes will generally increase so I saw no point in assigned fixed hull names to particular ranges of hull sizes. For example, modern destroyers are larger than battleships from the mid-19th century. You can also reclassify a class at any time so you may create an early cruiser which you re-designate as a destroyer as your technology advances. If you want a new hull name, click New Hull and type in a new name. Your design will change to that hull type.

Build Points is the total cost of all the systems on the ship plus the cost of the armour and is the amount of wealth that will be required to pay for the ship. The raw materials that will be required can be found in a list in the bottom left and should add up to the build points. We'll leave the checkboxes for now and come back to them later.

In the **Components** section on the far right, which lists every component added to the design, some basic systems have already been allocated to the design, including some armour, crew quarters, fuel storage, engineering and a bridge.

Down the left hand edge in the **Primary Information** section are details on armour, shields, the total number of Hits to Kill (HTK) and the build time for the ship.

The **Exact Class Size** is the size of the ship in Hull Spaces. This will also be the size of the ship for the purposes of active sensor detection.

Armour Rating is the thickness of the armour and can be increased or decreased by clicking the small arrows to the right of this box.

Armour Area is the surface area of the ship based on the assumption it is spherical in shape

The **Armour Strength Required** is equal to (Surface Area / 4) rounded up. Armour sufficient to meet this requirement is automatically added to the design as it gets larger. If you increase the thickness of the armour then each extra 'layer' is added to the previous one. As the total size of the ship and therefore the total surface area increases with each layer of armour, each additional layer will be cover a greater area and therefore require greater strength than the previous one. Each type of armour in Aurora has a different strength rating per hull space (HS) so as tech increases you will need less hull space dedicated to armour to meet the Armour Strength Required. As less armour also means a smaller ship, extra layers of armour will also be smaller.

For example, at the moment you have the technology for Duranium Armour, which has a strength per HS of 5. The armour area is 14.1. Dividing by 4 gives us a Required Armour Strength of 3.525. As Duranium has a strength per HS of 5, we need 3.525/5 HS of armour, which is 0.705, rounded to 0.7. As you can see on the design, 0.7 HS of Duranium Armour has automatically been allocated. If you had High Density Duranium Armour, which has a strength of 6 per HS, you would only need 3.525/6 = 0.6 HS of armour. Obviously this make little difference at the moment but as ships get larger and armour gets stronger, it can make a significant difference. Try increasing the Armour Rating to 2. The ship is now slightly larger and there are two layers of armour so the surface area has increased to 16 and the armour strength to 8. Duranium Armour is armour strength 5 so we need 8/5 = 1.6 HS of armour. Put the Armour Rating back to 1 for now. You don't really need to remember any of the details. Just remember that increasing the armour thickness or increasing the size of the ship will increase the amount of armour required and researching new armour tech will reduce the amount of armour required for future designs.

Armour Columns is the 'width' of the armour. The armour system in Aurora combat is similar to that of an old FASA game called Interceptor. The armour is represented by a block of 'boxes' with the width based on the size of the ship and the depth based on the thickness of the armour. Each weapon type has a damage template which determines which armour 'boxes' are damaged. Missiles tend to crater the armour while lasers cause narrower but deeper damage. Some weapons, such as railguns, have a high rate of fire and cause more overall damage than lasers but because that damage is split among many small hits, they tend to sandpaper armour rather than penetrating as a laser does. Any damage hitting in a location where all the armour has been destroyed will penetrate and cause internal damage. It is possible even for a well armoured ship to get unlucky and receive several hits in the same location, which will result in armour penetration and internal damage. That internal damage could even set off a string of secondary explosions, so a Hood style catastrophe is possible. Equally, if a ship has hits distributed all over the armour and doesn't lose any key system or suffer secondary explosion, it can withstand quite a lot of punishment

We'll come back to Shield Strength and Recharge a little later

Internal HTK (Hits to Kill) is the total HTK rating for all of the ship's internal systems. More on this later

Build Time (yrs) is the estimated build time for the ship in years. This may be decreased if the Planetary Governor of the colony where the ship is built has a bonus to Shipbuilding.

I'll come back to **Power Systems** later.

In the **Life Support** section, the Required Crew is the total crew required for all the various systems. Only 23 at the moment because we haven't added anything to the design. Life Support is the total crew possible based on the number and type of crew quarters. A standard Crew Quarters system provides accommodation for 250 crew. If you have too little life support, a message will appear in the Design Errors box in the bottom right.

Load Time is the estimated time to load a freighter, colony ship or troop transport design.

Design

Right, lets get back to actually designing something. As we are going to need a lot more minerals than are present on the Earth, a good first design choice is a geological survey ship. Lets change the hull to Geological Survey Vessel. This is only cosmetic but it tells us the intended role of the ship with a glance at the summary display. We already know how to build Geological Survey Sensors so add one to the design by double-clicking on the appropriate line in the available components section.

The Geological Survey Sensors will appear in the component list on the right and also will change the Brief Summary Display under the Available Components section.

Summary Window

Before we go any further, lets take a look at this Summary section. It should appear the same as the example below, with the possible exception of the class name

```
Tribal class Geological Survey Vessel    550 tons     48 Crew     151 BP      TCS
11  TH 0  EM 0
1 km/s     Armour 1-5     Shields 0-0     Sensors 1/1/0/1     Damage Control
Rating 1     PPV 0
Maintenance Capacity 172 MSP    Max Repair 100 MSP

Fuel Capacity 50,000 Litres    Range N/A

Geological Survey Sensors (1)   1 Survey Points Per Hour

This design is classed as a commercial vessel for maintenance purposes
```

The first line is the **name** of the ship plus its **hull type**, the **size in tons**, the **total crew**, the **number of build points**, the **TCS or Target Cross Section**, which is the exact class size rounded up to the next whole number and is the value used to detect the ship with active sensors, the **Thermal Signature (TH)** and the **Electromagnetic Signature (EM)**. I'll get back to the last two later.

The first item on the second line shows the **speed in km/s** (only 1 at the moment as the ship doesn't have any engines yet). Next is the **armour**, shown by thickness and then width. So at the moment the ship is protected by a belt of armour that is represented by a line of 5 boxes. If you increase the armour rating to 2, the armour on the summary display will change to 2-6, which means the armour is now represented by a set of boxes that is two high and 6 wide. Change it back to Armour Rating 1 for now. These armour boxes can be viewed on the Ship Window, including any that are lost to damage. We'll get to that when we discuss combat.

Next is **Shields**, which are shown as Strength and Recharge Time in Seconds. **The four Sensor values** are Thermal / EM / Gravitational / Geological. Every ship has default thermal and EM ratings of 1, which can be increased by the addition of dedicated thermal and EM sensors. The Geological Sensor Rating of 1 is provided by the newly added Geological Survey Sensors. The Damage Control Rating of 1 is provided by the 1x Engineering Spaces. **Damage Control** determines the speed at which repairs can be made and can be increased by adding damage control systems or additional engineering systems. Finally the **PPV** rating is the Planetary Protection Value and is based on the ship's weapons. This is used to determine how much protection the ship provides to nearby colonies.

Line three shows the current **Maintenance Capacity**, which is based on the size of the ship and the number of Engineering Spaces. **Max Repair** is the cost of the ship's most expensive system, in this case the Geological Survey Sensors. It is a very good idea to have maintenance supplies (MSP) greater than the Max Repair. When a ship suffers a maintenance failure, it will use up MSP equal to the cost of the affected system in order to prevent the failure. If insufficient MSP are available the affected system will be damaged and cease operation. If this is something vital such as a jump engine, the ship could be stuck a long way from home. Once damaged, a system can be fixed by damage control but the cost in MSP is doubled. Damaged systems can also be repaired by a shipyard.

The 4th line shows the **fuel capacity** and the **range**. The range is not shown yet because of the lack of engines. The 5th line shows the **Geological Survey Sensors** and the fact they generate 1 survey point. This is generated every hour. The 6th line shows this is currently classed as a **commercial vessel**, which means it doesn't suffer maintenance failures. That will soon change.

Engines

If we want to go anywhere we are going to need some engines so its time to design our first component.

Designing

Open up the F2 Economics window and press the Design button (in the middle of the line of buttons along the bottom). This will open the Create Research Project window. This is only a small and relatively simple window but very important. In the top right is the Research Project Type dropdown menu. At the moment it should be showing Active Sensors / Missile Fire Control. Change it to Engines. This should change the upper half of the window to show seven dropdown menus. Choosing different options on these menus will result in different engine designs. We know very little tech at the moment so we don't have any decisions to make, In fact the only dropdown with more than one option is the bottom one, which allows military or commercial engines. Leave it as military.

The lower half shows the stats for the engine design that will be generated by the selected options. **Power Output** is the power generated by the engine. The total power output from a ship's engines will determine the speed of the ship based on the following formula:

```
Speed = (Total Engine Output / Class Size) * 1000
```

So a ship of size 250 with a total engine power of 800 would move at (800/250)*1000 = 3200 km/s

Explosion Chance is the percentage the engine will blow up if damaged, causing a secondary explosion. **Efficiency** is the fuel efficiency of the engine. As you research fuel efficiency tech, you can design engines that will use less fuel for the same power output. The **Thermal Signature** is how much heat is generated by the engine. A ship's thermal signature at full speed is the total thermal signature from its engines and this is the value used to detect the ship on thermal sensors. You can design engines with lower thermal signatures by researching Thermal Reduction technology, although they will cost more to build. The **Engine Size** is 5HS, which is fixed for military engines. You can put as many military engines on a design as you want though. The **Engine HTK** is the Hit to Kill value for the engine. HTK is the amount of damage that would automatically destroy the engine, 2 in this case. If hit by 1 point of damage there is a 50% chance the engine will be destroyed and a 50% chance it will remain intact. Internal armour can be added to engines to reduce the chance of damage. The **Cost** and **Crew** are the Build Point Cost and amount of crew members that will be added to the ship by the addition of one engine. **Materials Required** is the type of raw materials required for the engine. In this

case 3x Duranium and 9x Gallicite. The **Development Cost** is the research cost required for this design before it can be put into production, in this case 120 Research Points.

The name given to this engine is the Nuclear Thermal Engine E10. You could change this name if you wish before creating the design but leave it for now and press Create. Press Close to shut the Create Research Project window. If the F2 Economics window is still open, close that as well

We are now going to enter SpaceMaster mode so we can give ourselves the new engine without having to research it. Make sure the F2 Economics window is definitely closed, move to the main menu bar and press Ctrl-S. This opens a small box for the SpaceMaster password. We didn't set one so just press Enter and you will be in SM (SpaceMaster) Mode. This means that certain windows, such as Economics, will have a few extra buttons that are only available in SM Mode. Now open the Economics window and go to the Research tab.

In the centre of this tab is the Create New Research project section. Just below the section heading there us a dropdown that should have Construction / Production selected. Change this to Power and Propulsion. In the list of systems tech available for research should be our new engine. If you select it, it should turn red. If we were going to research this project, we would also select a suitable scientist and press Create. Instead, thanks to the usefulness of SM Mode, press Instant. A popup box will appear asking for confirmation so press Yes.

Adding

The new engine should immediately appear on the list of Available Components in the Class Design window. Double-click the engine to add one to the design. It should appear in the component list on the right and it should make some significant changes to the summary view, as shown below

```
Tribal class Geological Survey Vessel    800 tons     73 Crew     164.5 BP
TCS 16  TH 25  EM 0
1562 km/s     Armour 1-7     Shields 0-0     Sensors 1/1/0/1     Damage Control
Rating 1     PPV 0
Annual Failure Rate: 5%    IFR: 0.1%    Maintenance Capacity 129 MSP    Max Repair
100 MSP

Nuclear Thermal Engine E10 (1)    Power 25    Fuel Use 100%    Signature 25
Armour 0    Exp 5%
Fuel Capacity 50,000 Litres    Range 112.5 billion km   (833 days at full power)

Geological Survey Sensors (1)   1 Survey Points Per Hour

This design is classed as a military vessel for maintenance purposes
```

Firstly, note that it is now classed as a military vessel so it will suffer from maintenance failures. This is reflected in the 3rd line of the summary, which now shows the **Annual Failure Rate**, which is the annual chance of a system failure, and the **Incremental Failure Rate**, which is the chance of a system failure in any given 5-day increment (which is when maintenance checks take place). These values shown on a class summary assume a ship has one year on its maintenance clock. On individual Ship Summaries, the Annual Failure Rate and IFR will be based on the ship's actual maintenance clock. The Thermal Signature value in the top right has changed to 25 to reflect the thermal signature of the engine, the fuel capacity line shows the range of the ship in both kilometers and time and the speed of the ship is now 1562 km/s. Remember the formula from the engine section. (Total Engine Output / Class Size) * 1000. So in this case, (25/16) x 1000 = 1562 km/s.

Lets add a second engine and a second geological survey sensor. The speed increases a little and the

thermal signature doubles. The armour is now up to 1-10 as the ship is larger and the failure rate has increased to 14% per annum, because the proportion of engineering spaces in comparison to hull size is lower than before.

```
Tribal class Geological Survey Vessel    1350 tons     123 Crew     280 BP
TCS 27  TH 50  EM 0
1851 km/s     Armour 1-10     Shields 0-0     Sensors 1/1/0/2     Damage Control
Rating 1     PPV 0
Annual Failure Rate: 14%    IFR: 0.2%    Maintenance Capacity 130 MSP    Max
Repair 100 MSP

Nuclear Thermal Engine E10 (2)    Power 25    Fuel Use 100%    Signature 25
Armour 0    Exp 5%
Fuel Capacity 50,000 Litres    Range 66.6 billion km   (416 days at full power)

Geological Survey Sensors (2)   2 Survey Points Per Hour

This design is classed as a military vessel for maintenance purposes
```

Active Sensors

Now its time to add an active sensor.

Designing

Open the Create Research Project window again, using either the Design button on the Economics window or Ctrl-F6 from the main menu. The first item in the Research Project Type list is active sensors, which is useful as that is what we need. There are five dropdowns this time. Lets make the size of the Antenna 2 HS. This increases the Sensor Strength of the component to 20, which our current Active Grav Sensor Strength of 10 multiplied by the 2 HS. In the text area that shows the details of the new active sensor, several of the fields are the same as the engines so I won't bother describing them again. New information includes the chance of destruction by electronic damage (from microwave weapons), the Resolution and the Range. Resolution Zero is actually resolution 1 but it is described as zero because it treats anything less than 1 as equal to 1.

The Range of an active sensor is equal to:

```
Range = Resolution x Sensor Strength x 10,000
```

So by increasing the resolution you can dramatically increase the range. At the moment, the range is 1 (resolution) x 20 (strength) x 10,000 = 200,000 km. Try changing the resolution to 100 (or 5000 tons). Now the range is 20,000,000 km. So why, you are no doubt asking, wouldn't you have the highest resolution possible? Good question!

An active sensor is able to detect any ship of a size that is equal to or greater than its resolution at its maximum range. So this sensor could detect a ship of 5000 tons or greater (size 100) at 20m km. If the target is smaller than the resolution, the maximum detection range is equal to Max Range x (Target Size / Resolution) ^2. So using this sensor against a target that was size 80, the formula would be:

20m km x (80/100)^2 or 20m x 0.8 x 0.8, which equals 12.8 million kilometers

Against a target of size 20 (1000 tons), the max detection range would be 20m x 0.2 x 0.2 or 0.8 million kilometers

Against a missile (size 1 unless it's huge), 20m x 0.01 x 0.01 = 0.002m, or just 2000 km.

So you need to design active sensors based on the role intended for that sensor. An area search sensor might be designed with a large resolution to find large enemy ships while a sensor designed to detect fast attack craft, which are 1000 tons or less would need a resolution of approximately 20. Missile detection sensors are usually resolution zero. In this case, we want a general search sensor so lets stick with resolution 100. If we encounter an enemy that likes to design ships of 4000 tons or 6000 tons we can modify future sensor designs to take the best advantage of an appropriate resolution (80 or 120).

You can give the sensor a different name if you like, then press Create. Go to the Research tab of the Economics window and select Sensors and Fire Control. Find the new sensor and use Instant.

While we are here, lets give ourselves a couple of other useful technologies. Change to the Power and Propulsion tab and use Instant on the Jump Point Theory tech. This opens up a few new technologies. Go back to Sensors and Fire Control and use Instant on the newly appeared Gravitational Survey Sensors.

Adding

Move back to the Class window where our new active sensor should have appeared. Add one of this sensor to the design, which should now appear as below. The GPS value for the sensor is its emissions signature. This can be detected by EM sensors while the active sensor is in operation. So use active sensors carefully as they can give away your position to ships or populations with passive EM sensors. Equally you can use your own EM sensors (when we create them), to watch for the active sensors of alien vessels. Note the ship is slightly slower now because it is larger and only has the same engine power as before. The failure rate has also increased a little and the max range has fallen slightly because the engines will burn the same fuel as before but because of the lower max speed you won't travel as far before it runs out.

```
Tribal class Geological Survey Vessel    1450 tons     133 Crew     300.5 BP
TCS 29  TH 50  EM 0
1724 km/s     Armour 1-11     Shields 0-0     Sensors 1/1/0/2     Damage Control
Rating 1     PPV 0
Annual Failure Rate: 16%    IFR: 0.2%    Maintenance Capacity 130 MSP    Max
Repair 100 MSP

Nuclear Thermal Engine E10 (2)    Power 25    Fuel Use 100%    Signature 25
Armour 0    Exp 5%
Fuel Capacity 50,000 Litres    Range 62.1 billion km   (416 days at full power)

Active Search Sensor S20-R100 (1)     GPS 2000     Range 20.0m km    Resolution
100
Geological Survey Sensors (2)   2 Survey Points Per Hour

This design is classed as a military vessel for maintenance purposes
```

Creating a Grav Survey Ship

While we could continue to play about with the design, it is adequate to show you the basics of a simple survey class. Now we will quickly create a gravitational survey design using the above design as a foundation. Press the Copy Design button. You now have a second design that is exactly the same as the first one, except the name has a " - Copy" suffix. Use Rename or Auto Rename to give this class a new name and change the hull to Gravitational Survey Vessel. You should have Gravitational Survey Sensors in the list of available components so double-click on the Geological Survey Sensors in the

Components list to remove them one at a time and replace them with a pair of Gravitational Survey Sensors. You now have two survey designs, one for each survey role.

How do you actually build them? I'll cover that in the next section, as well as some other useful designs

Chapter 6: Shipyards

Shipyards and Shipbuilding

Before getting into more detailed classes and the specifics of getting a particular class designed and built. I thought it would be a good idea to cover shipyards and shipbuilding in general terms.

Shipyard Complexes

All ships greater than 500 tons have to be built in Shipyard Complexes. The cost of a Shipyard Complex is 2400 BP and it is built using industrial capacity (construction factories in v4.8). When completed, the Shipyard Complex has a single Slipway with a capacity of 1000 tons. Additional Slipways and extra capacity for existing Slipways are built by the Shipyard Complex itself (without affecting the building of ships). Each Shipyard Complex is dedicated to building a specific class of ship and may build one of that class in each Slipway. The Shipyard may be retooled (see below) to build a different class of ship and this does not affect any ships currently under construction but once retooling is underway, no new tasks can be started. This simulates a shipyard getting ready for future construction while completing work on existing shipyard tasks. In effect, a Shipyard Complex has two distinct levels. The Slipway level, where ships are built, refitted, repaired and scrapped at the Racial Shipbuilding Rate, and the Shipyard level, where extra slipways are constructed, extra capacity is added and retooling is carried out, also at the Racial Shipbuilding Rate. The manning requirement for a Shipyard Complex is equal to one million for each shipyard complex plus 100 per ton of total capacity. For example, a Shipyard with two 5000 ton slipways would be 1m + (10,000 x 100) = 2m.

The Manage Shipyard tab of the Economics window lists the Shipyard Complexes (hereafter referred to as Shipyards) in orbit of each colony. The columns provide the following information for each shipyard.

Name: A name for the Shipyard. You can change this by using the Rename SY button and typing in a new name or you can keep pressing the Auto Rename button until you see a name you like.

Ty (short for Type): Whether the Shipyard is Commercial (C) or Naval (N). A commercial shipyard can only build classes that are specified as Commercial Vessels in their class summary.

Total Slipways. Each shipyard has one or more slipways. Each slipway can be used to build one ship of the class(es) that the parent shipyard is tooled to build.

Capacity per Slipway. The maximum size ship that can be built in each slipway

Available Slipways. The total number of slipways minus the total number of ships that the shipyard is currently building. If this is zero, the Add Task button is greyed out when selecting this shipyard.

Assigned Class: The primary ship class that can be built in the slipways of this shipyard complex. It is possible that other ship classes can be built in the same shipyard without retooling. For a second class to qualify as eligible for construction, it must be possible to refit a ship of the primary class to that class for less than 20% of the primary ship class cost.

Current Complex Activity: The activity in which this complex is currently engaged. This includes no activity, adding a slipway, adding extra capacity to all slipways or retooling for a different class. Shipbuilding by the Shipyard is not included as a current activity as it can take place concurrently with the above activities, with the exception that no new ship of the existing primary class can be laid down once retooling begins.

Progress: Percentage of the current complex activity that has been completed

Completion Date: When the current complex activity is estimated to be complete.

Mod Rate: The rate at which this shipyard can be modified. This is dependent on the racial Shipbuilding Rate, the size of the Shipyard (you can work faster on a large shipyard than a small one), any racial Shipyard Operations Time/Cost Saving and the Shipbuilding Bonus of the Planetary Governor.

Modifying Shipyards

Below the grid control is a section entitled Shipyard Complex Activity. This is where the expansion or retooling of the shipyard is set in motion. The player selects a Shipyard and can then choose can choose from a number of different activities. All the following rules apply to Military Shipyards. Commercial Shipyards are similar and the differences are covered later in this section

Add Extra Slipway: This costs 120 BP for every 500 tons of capacity per slipway at this shipyard complex. For example, if a shipyard had a capacity of 5000 tons per slipway then adding an extra slipway would cost 1200 BP. Mineral use is split between Duranium and Neutronium.

Add 500 ton Capacity per Slipway: This task adds 500 tons to the capacity of every slipway in the complex and costs 120 BP per slipway. So setting this activity for a shipyard complex with four slipways would cost 480 BP. Mineral use is split between Duranium and Neutronium.

Add 1000 ton Capacity per Slipway: As above except it costs 240 BP per slipway and adds 1000 tons instead of 500 tons

Add 2000 ton Capacity per Slipway: As above except it costs 480 BP per slipway and adds 2000 tons of capacity

Add 5000 ton Capacity per Slipway: As above except it costs 1200 BP per slipway and adds 5000 tons instead of 500 tons

Add 10000 ton Capacity per Slipway: As above except it costs 2400 BP per slipway and adds 10000 tons of capacity

Retool for Selected Class: The class selected for retooling is chosen from the adjacent ship class dropdown. Only classes that are small enough to fit within the shipyard's capacity can be selected. This task costs 0.5x of the ship class build cost plus 0.25x ship class build cost per slipway. So if a shipyard with two slipways wanted to start building a class that cost 800 BP, the cost to retool would be 800 x (0.5+0.25+0.25) = 800 BP. If there were four slipways, the cost would be 800 x (0.5+(0.25x4)) = 1200 BP. Mineral use is based on the minerals used in the class.

Continual Capacity Expansion. This is similar to the Add x tons Capacity per Slipway tasks, except that each 5-day increment an amount of capacity is added to the shipyard equal to the amount that can be built in that 5-day increment. This adds continual small amounts of capacity rather than an occasional large amount.

Shipyard Activity can be paused, to conserve wealth and minerals, or abandoned. If an Add Extra Slipway or Retool activity is abandoned then all work is lost. If an Add Extra Capacity activity is ended then the percentage of work done on the task will be added to the shipyard, rounded down to the nearest hundred tons. For example, if a shipyard has done 75% of an Add Extra 500 Capacity activity when it is abandoned, then the shipyard gains 300 capacity (500 x 0.75 = 375).

Shipbuilding

While all the above is happening, the shipyard can still build ships. A third section called Create Task is at the bottom of this tab. This includes the following controls:

Task Type dropdown: Tasks available are Construction, Refit, Repair and Scrap

New Class dropdown: Shows the class(es) that can be built in the currently selected complex

Refit From dropdown. Appears when a refit task is selected. Each Shipyard can refit any other class to their dedicated class(es). This dropdown and accompanying Ship Name dropdowns allow the user to select a ship to be refitted to the new class. This dropdown is also used (with a different label) for Repair and Scrap. Any Slipway can repair or scrap any ship of any class as long as the ship's size is within its capacity.

Ship Name box: Name of a new ship you are planning to build

Build Cost: Cost of the construction, refit, repair or scrap task.

Task Group: The fleet in which new construction will be placed. If you select a Task Group and then press Default Fleet, this Task Group will always be selected for this Shipyard.

Completion Date: Estimated date on which the task will be finished.

Required Materials: Shows list of minerals that will be consumed by this task.

Commercial Shipyards

Commercial Shipyards differ from the above in the following respects.

1.) They can only build classes that are specified as Commercial Vessels in their class summary.
2.) Expansion of Commercial Shipyards costs only one tenth that of Military Shipyards. For example, adding 2000 tons of capacity to a Military Shipyard would cost 480 BP. For a Commercial Shipyard it would only cost 48 BP (and use 24 Duranium and 24 Neutronium). Retooling costs are the same as before.
3.) Commercial Shipyards require only one tenth of the manpower of Military Shipyards for their size. Note that as commercial ships will generally not be ten times larger than before, this actually makes building Commercial Shipyards easier in relative terms than Military Shipyards.
4.) The modification rate of commercial shipyards is based on one tenth their capacity, although as the cost of increase is also one tenth of normal, this will work out to a similar expansion rate in percentage terms as Military Shipyards. Without this restriction Commercial Shipyards would grow amazingly quickly due to the faster growth rates for larger shipyards.
5.) The Build Rate of Commercial Vessels is based on one quarter of their size (see Ship Construction Rates below)

Shipyards in Combat

Shipyards show up as a separate contact type for active sensors and can be targeted and fired upon. All the shipyards for one Empire in one location show up as a single contact. The size of the contact is based on the total capacity of all the shipyards with the assumption that a single slipway is twice the size of the largest ship it can build. So a single slipway of 4000 ton capacity would have the same sensor signature as an 8000 ton ship. Two shipyards at the same population, one of which had two slipways of 10,000 tons and the second with four slipways of 6000 tons (total capacity 44,000 tons)

would appear as a single contact of 88,000 tons.

With regard to damage, rather than get into slipways being reduced in size, with the complexity involved if it is trying to build a ship larger than the reduced size, I have stayed with a similar model to planetary bombardment where slipways are either destroyed or unharmed by a hit. Each time a shipyard is hit, there is a chance the hit will destroy a slipway. The percentage chance of destroying a slipway is equal to: (Damage / Capacity) * 10000

In other words, if a shipyard with slipways of 5000 ton capacity is hit by a missile with a ten point warhead then the chance of one slipway being destroyed is: (10 / 5000) x 10000 = 20%

If the last slipway of a shipyard is destroyed, then the shipyard itself is also destroyed.

Towing Shipyards

If you have a vessel equipped with a Ship to Ship Tractor, commonly referred to as a Tug, you can tow shipyards. On the Miscellaneous tab of the Ship window where you connect tractors, there will be a list of shipyards if you are in orbit of a planet (assuming you have a tractor beam of course). Once you connect to a shipyard it is removed from its current pop and is detected (and can be attacked) separately. It also shows up in the Fleet window on the list of ships. Connecting a tractor will stop any tasks or shipyard improvements. For the purposes of movement (and detection) a shipyard is twice the size of its capacity. So a shipyard with two 6000 ton capacity slipways will be 24,000 tons. If you break the tractor link while in orbit of a pop, the shipyard will then be added to the shipyard list for that population.

Ship Construction Rates

The length of time is takes to build a ship depends on several factors. The primary one is the cost in build points. If there are two ships of the same size and the first costs fifty percent more than the second, it will also take fifty percent longer to build. The rate of ship construction is also affected by the actual size of a ship. The basis of this is that while a supertanker costs perhaps 1000x more than a fishing boat, it doesn't take 1000x as long to build. The larger shipyard needed for the supertanker can work on many more things at once than the small shipyard needed for the fishing boat. However, the reason the change in construction rate is based on ship size and not shipyard size is that it would hardly be efficient to build fishing boats in the shipyard intended for the supertanker.

The base racial Shipbuilding Rate apples to ships of size 100 (5000 tons). If a ship is a different size, the rate of shipbuilding will be:

Normal shipbuilding rate x (1+(((Class Size / 100) - 1)/2))

This is less complex than it looks. What it means is that the class size is divided by 100 to get a multiple of the base class size of 100. So a class of size 150 (7500 tons) would have a multiple of 1.5. This multiple is then reduced (or increased if less than 1) to half the distance between the multiple and 1. So for the size 150 ship, the final multiple would be 1.25.

So if the shipbuilding rate for a size 100 ship was 1000 BP per annum, the annual shipbuilding rate for a size 150 ship (7500 tons) would be 1250, for a 10,000 ton ship it would be 1500 and for a 15,000 ton ship it will be double (2000 BP per annum). A 25,000 ton ship will be built at triple the normal rate and a huge 125,000 ton Star Destroyer will be built at 12.5x the normal rate. Bear in mind that these ships will still cost the same as before and require the same resources. The shipyard will just use up wealth and resources at a faster rate.

Smaller ships will take longer than the racial shipbuilding rate would suggest. Still assuming a Racial Shipbuilding Rate of 1000 BP, a 2000 ton ship is 0.4x the size of a 5000 ton ship. Half the difference takes it to 0.7, so its annual construction rate will be 700 BP. A 1000 ton ship will be built at 600 BP per annum.

The rate at which each ship is being constructed is shown on the list of shipyard tasks and the estimated completion dates reflect the build rates. This enables large ships and very large ships to be constructed in a reasonable time while still taking longer than small ships. Of course you still need to build the shipyards capable of constructing monster ships.

The same general principles apply to shipyard modifications so you can increase the size of large shipyards more quickly. So if you want to add extra capacity to a 10,000 ton shipyard, you can do it 50% faster than adding extra capacity to a 5000 ton shipyard. Adding extra capacity to a 15,000 ton shipyard can be done at twice the rate of a 5000 ton shipyard. This applies to adding capacity, adding slipways or retooling. This means that very large shipyards become possible as their rate of size increase will escalate. Modification costs remain the same, you can just make the modification more quickly.

Note that this is different from the Shipyard Operations tech, which reduces the overall cost of modifying Shipyards. A combination of the two, reducing cost and increasing modification rates, will allow very large shipyard complexes to be built in a reasonable amount of time.

Chapter 7: Commercial Shipping

Commercial Shipping

Right, lets get back to class design. Two important early classes are freighters and colony ships, so let's look at those next. The first thing we need to do is create a design for a commercial engine so open up the Create Research Project window and select Engines. Select the last option, Engine Platform, and switch it back and forth between the options for Military Engine and Commercial Engine while checking the difference this makes to the engine design. The Commercial Engine has a higher power output, 62 instead of 25, and is much more fuel efficient, using only 10% of the fuel of a military engine of the same power. It is also classed as a commercial system, which means it will not cause a ship design on which it is mounted to become a military vessel. However, it is five times more massive which means it has a lower power-to-weight ratio of 2.48-1 compared to 5-1 for the military engine. More advanced engine tech will provide improved power to weight ratio for both military and commercial. The commercial engine is slightly more expensive in overall terms but much cheaper on a per HS basis. Make sure you have the Commercial Engine platform selected, change the name if you wish and press Create. Make sure you are in SM mode, open up the Research tab of the Economics window, change to Power and Propulsion and use Instant on the new engine.

Change back to the Class Window (F5) and press New to begin a new class design. Change the name if you wish using Rename or Auto Rename and change the hull name to Freighter. Change to the Design View tab. As with the survey ship, a few basic systems will already be included in the design. This is a cargo ship so the first thing to add is cargo holds. We'll add five holds, for a reason I'll explain in a moment. Rather than double-clicking five times, select the option for 5 just under the Available Components list and double-click Cargo Hold once (it is in the Transport & Industry section). You should now have five cargo holds in the components list and the summary display should appear as below. If you were to double-click on the components list it would remove 5 as well.

```
Atlas class Freighter    26000 tons     48 Crew     173 BP      TCS 520  TH 0  EM
0
1 km/s     Armour 1-78     Shields 0-0     Sensors 1/1/0/0     Damage Control
Rating 1     PPV 0
Maintenance Capacity 4 MSP    Max Repair 5 MSP
Cargo 25000

Fuel Capacity 50,000 Litres    Range N/A

This design is classed as a commercial vessel for maintenance purposes
```

As you can see, this is a much larger vessel than the survey ships we previously designed. It has to be in order to transport factories, mines, minerals, etc.. The reason for choosing five holds is that each hold can carry 5000 cargo points and 25,000 cargo points is the exact amount needed to transport a single mine, automated mine or industrial capacity (factory in v4.8). You could have a freighter with three holds or seven holds and it would move 0.6 or 1.4 mines or factories but moving them in whole numbers is easier to handle. Some installations, such as Research Facilities, are so large that you little option but to move them in sections. Each cargo hold can carry just 0.01 Research Facilities so even our new freighter with five cargo holds can carry only 0.05 Research Facilities. It would take twenty freighters of this type to move a Research Facility, or twenty trips by one freighter. Here is a list of some of the transport requirements for various installations.

- Industrial Capacity (Construction, Ordnance and Fighter Factories in v4.8): 5 Cargo Holds
- Mine, Automated Mine, Fuel Refinery, Tracking Station, Mass Driver, Maintenance Facility: 5 Cargo Holds
- Terraforming Installation: 25 Cargo Holds
- Research Facility: 100 Cargo Holds
- PDC Component: 1 Cargo Hold
- Trade Goods: 0.5 Cargo Holds
- Infrastructure: 0.5 Cargo Holds
- Minerals: 2500 tons of minerals per cargo hold

On the left-hand side of the Class Design window. just above the list of Materials Required, is a section entitled Load Time. This should show a value of 10:10:00 and is the time in days, hours and minutes to load the current design at a planet with no spaceport. Ten days and ten hours is far too long so we need to reduce that substantially. You can do this with cargo handling systems. Make sure the number option is set back to 1 and add one cargo handling system to the design (it is just above Cargo Hold on the Available Components list). The design should now have a Cargo Handling Multiplier of 5, which means the load time is reduced by a factor of five and should now read 2:02:00. Add a second cargo handling system and the multiplier will change to 10 and the load time to 01:01:00. The summary display should now appear as below.

```
Atlas class Freighter    26200 tons     68 Crew     193.5 BP      TCS 524  TH 0
EM 0
1 km/s     Armour 1-78     Shields 0-0     Sensors 1/1/0/0     Damage Control
Rating 1     PPV 0
Maintenance Capacity 5 MSP    Max Repair 10 MSP
Cargo 25000    Cargo Handling Multiplier 10

Fuel Capacity 50,000 Litres    Range N/A

This design is classed as a commercial vessel for maintenance purposes
```

If a colony has a Commercial Spaceport then the load time for a freighter (or colony ship) will be divided by the level of that spaceport plus one. So a Level 2 spaceport would divide the load time by 3. A Level 4 Spaceport would divide the load time by 5. After you build your first Spaceport on a colony, using Industrial Capacity to do so, every additional spaceport you build increases the level by 1. If the freighter is part of a Task Force (more on those later) and the Task Force HQ is in the same system, the load time is reduced by the Task Force Logistic Rating. The Logistics Rating for the task force is a combination of the Logistic bonus of the Logistics Staff Officer plus one-third the Logistics bonus of the Task Force Commander. The Task Force window is Ctrl-F4 if you want to peek, although at this point no one will be assigned as commander or to any of the staff positions.

Time for some engines. Begin adding commercial engines one at a time until the speed moves above 500 km/s. You should have six engines at this point. Because of the lower power to weight ratio of commercial engines, commercial-engined ships tend to be slower than their military engined counterparts. This is offset by a much better fuel efficiency and no maintenance failures. In effect, commercial engines are trading a high maximum speed for fuel economy and low running costs. The summary display should now appear as below.

```
Atlas class Freighter    33850 tons     218 Crew     304 BP      TCS 677  TH 372
EM 0
549 km/s     Armour 1-93     Shields 0-0     Sensors 1/1/0/0     Damage Control
Rating 1     PPV 0
Maintenance Capacity 6 MSP    Max Repair 16 MSP
Cargo 25000    Cargo Handling Multiplier 10

Commercial Nuclear Thermal Engine (6)    Power 62    Fuel Use 10%    Signature 62
Armour 0    Exp 1%
Fuel Capacity 50,000 Litres    Range 26.6 billion km   (560 days at full power)

This design is classed as a commercial vessel for maintenance purposes
```

There is another school of thought on freighter design where you create a more expensive but faster ship. Below is the same freighter but with fifteen engines and an extra crew quarters. It is 59% more expensive and has a shorter range (although you can add more fuel storage to offset that) but it is 87% faster, which means cargo will get to its destination more quickly. Fewer of these ships could be built for the same money but they will transport more cargo over time due to their speed. Load time would be the same though so the most efficient design often will depend on how what proportion of the total travel time time the freighter will spend loading and unloading. Don't be concerned that the Max Repair cost is higher than the Maintenance Capacity as commercial vessels don't suffer maintenance failures. They can use the maintenance supplies for damage control but if this vessel is under attack then lack of maintenance supplies will be the least of its problems.

```
Atlas class Freighter    45350 tons     448 Crew     483.5 BP      TCS 907  TH 930
EM 0
1025 km/s     Armour 1-113     Shields 0-0     Sensors 1/1/0/0     Damage Control
Rating 1     PPV 0
Maintenance Capacity 7 MSP    Max Repair 16 MSP
Cargo 25000    Cargo Handling Multiplier 10

Commercial Nuclear Thermal Engine (15)    Power 62    Fuel Use 10%    Signature 62
Armour 0    Exp 1%
Fuel Capacity 50,000 Litres    Range 19.8 billion km   (224 days at full power)

This design is classed as a commercial vessel for maintenance purposes
```

Let's move on to a colony ship. Copy the Freighter Design, rename the new class and select Colony Ship for the hull name. Remove the five cargo holds but leave the two cargo handling systems. The design should appear as below

```
Mayflower class Colony Ship    8300 tons     193 Crew     197.5 BP      TCS 166
TH 372  EM 0
2240 km/s     Armour 1-36     Shields 0-0     Sensors 1/1/0/0     Damage Control
Rating 1     PPV 0
Maintenance Capacity 15 MSP    Max Repair 16 MSP
Cargo Handling Multiplier 10

Commercial Nuclear Thermal Engine (6)    Power 62    Fuel Use 10%    Signature 62
Armour 0    Exp 1%
Fuel Capacity 50,000 Litres    Range 108.4 billion km   (560 days at full power)

This design is classed as a commercial vessel for maintenance purposes
```

Start adding Cryogenic Transport Modules and watch as each one gradually reduces overall speed. Lets

stick with four as that will keep the speed above the 1000 km/s level. You can play around with colony ships by changing the number of engines and number of modules to find something you like or perhaps create different types, such as small, fast ships or large ponderous ones. Here is the design with four modules.

```
Mayflower class Colony Ship    18550 tons     233 Crew     623.5 BP      TCS 371
TH 372  EM 0
1002 km/s     Armour 1-62     Shields 0-0     Sensors 1/1/0/0     Damage Control
Rating 1     PPV 0
Maintenance Capacity 21 MSP    Max Repair 16 MSP
Colonists 40000    Cargo Handling Multiplier 10

Commercial Nuclear Thermal Engine (6)    Power 62    Fuel Use 10%    Signature 62
Armour 0    Exp 1%
Fuel Capacity 50,000 Litres    Range 48.5 billion km   (560 days at full power)

This design is classed as a commercial vessel for maintenance purposes
```

The civilian sector will use your current designs when building their own ships so over time you will probably see a few of these designs belonging to civilian shipping lines. With the civilian sector in mind, lets design a third ship type. Copy the Colony Ship, rename the new class and select Luxury Liner as the hull type. Remove the four cryogenic transport modules and replace them with four Luxury Passenger Accommodation. Note that the Required Crew is now a lot higher so you will have to add two more crew quarters as well to get rid of a design error that has appeared in the bottom right. The resulting design should look like this.

```
Mauretania class Luxury Liner    18650 tons     603 Crew     653.5 BP      TCS 373
TH 372  EM 0
997 km/s     Armour 1-62     Shields 0-0     Sensors 1/1/0/0     Damage Control
Rating 1     PPV 0
Maintenance Capacity 22 MSP    Max Repair 16 MSP
Passengers 1000    Cargo Handling Multiplier 10

Commercial Nuclear Thermal Engine (6)    Power 62    Fuel Use 10%    Signature 62
Armour 0    Exp 1%
Fuel Capacity 50,000 Litres    Range 48.2 billion km   (560 days at full power)

This design is classed as a commercial vessel for maintenance purposes
```

Although there is no reason to build this design yourself, except perhaps for role-playing reasons, the shipping lines will occasionally decide to build passenger liners to transport people between established colonies or take a small amount of colonists to a new world. These trips generate as much income for the shipping lines (and tax money for you) as a colony ship of similar size and they are usually earning money in both directions. The civilians will use this design as the basis for those liners. You can play about with different liner designs (and colony ships/freighters) if you want to see more variety among the civilian ships, although as tech improves over time and you build new designs the civilians will pick up on those too.

Chapter 8: Beam Warships

Designing a Beam-armed Warship

Before we begin, make sure you are in SM Mode. This is a long section so prepare yourself

"Beam weapon" in Aurora refers to every weapon that isn't a missile weapon or CIWS (Close In Weapon System). At the moment that includes Lasers, Railguns, Torpedoes, Gauss Cannon, High Power Microwaves and Meson Cannon. For the purposes of this tutorial I'll use Lasers as an example and then cover the other beam weapons in the next tutorial.

Lasers are the yardstick for other beam weapons in Aurora and are reasonably good at everything. Larger lasers can be used as offensive weapons and have a good damage output. Small lasers can be used as dedicated point defence weapons, or slightly larger ones can be used in a dual point defence / anti-ship role. They can also be fitted in turrets. Lasers and other beam weapons are very short-ranged compared to missile weapons but they can do a lot of damage in a short space of time and they don't need ammunition. Beam-armed ships can be deadly when waiting in ambush at a jump point. Every ship suffers sensor and fire-control blindness after a jump for perhaps 30-60 seconds and a beam ship can do a lot of damage in that time, if it is experienced enough to respond to orders quickly.

Before we look at laser design, lets give ourselves some laser tech using the Instant button on the Research tab of the F2 Economics window. We have been using this Instant button quite a lot but you should get some free tech points at the start of a campaign. If you look under the list of Scientists you will see a text box entitled Starting RP. This shows how many free research points you have left. As you Instant something, the total will decrease. Once you have used them all the box will disappear and you should manually research from that point, although you can still go into SM Mode and Instant something if you want to override normal game play for some reason.

Change to Energy Weapons and Instant 12cm Laser Focal Size. Researching that technology makes 15cm Laser Focal Size available so Instant that as well. Next use Instant on Visible Light Laser and also the next tech in the series, Near Ultraviolet Laser. Now change to Power and Propulsion and use Instant on three technologies in the same series, Capacitor Recharge Rate 2, 3 and 4.

Now open the Create Research Project window and change the Project Type to Lasers. There are four background technologies for Lasers. Laser Focal Size determines how large the laser is, how much damage it causes, how much power it requires and the base range. Laser Wavelength modifies the range, with longer wavelength lasers having greater range. Capacitor Recharge Rate determines how fast the laser's power can be recharged and therefore determines its rate of fire. Reduced Size Laser technology, which we won't be examining in this tutorial, creates more compact lasers that have slower rates of fire. When you first select lasers, the program will select the best available background technology in each category, which should create a laser design that looks like this:

```
15cm C4 Near Ultraviolet Laser
Damage Output 6     Rate of Fire: 10 seconds     Range Modifier: 3
Max Range 180,000 km     Laser Size: 4 HS    Laser HTK: 2
Power Requirement: 6    Power Recharge per 5 Secs: 4
Cost: 29    Crew: 40
Materials Required: 5.8x Duranium  5.8x Boronide  17.4x Corundium
Development Cost for Project: 290RP
```

Lets go through some of the terminology. Damage Output is the maximum damage caused by the laser, usually at point blank range. The Rate of Fire is how often the laser fires, assuming sufficient power is

provided to the weapon. Rate of Fire is always rounded up to the nearest 5 seconds as that it is smallest time increment in Aurora. Range Modifier is the wavelength of the weapon. Damage falls off with range and the Max Range is equal to the maximum damage multiplied by the Range Modifier multiplied by 10,000 km. In this case, 6 x 3 x 10,000 = 180,000 km. Laser Size is the physical size of the laser in hull spaces (1 hull space = 50 tons). Laser HTK is the hits-to-kill for this system. If it receives two points of damage it is automatically destroyed. If it receives one point of damage it has a fifty percent chance of bring destroyed. The Power Requirement is the amount of energy that must to be sent to the weapon by power reactors before it can fire. Power Recharge is the maximum amount of power that can be sent to the weapon in 5 seconds. The rest are similar to previous systems.

Note that the rate of fire is 10 seconds because only four power can be sent to the weapon every 5 seconds and it needs 6 power. If your capacitor recharge rate technology was 6 instead of 4, you could build a 15cm laser that fired every 5 seconds. We are wasting power a little here as we are using a capacitor that allows 8 power to the laser every 10 seconds and we only need 6. If you change the capacitor recharge rate dropdown to 3 instead of 4 then the laser will still fire every 10 seconds but it will be a little cheaper to manufacture.

Press Create for the laser then change the focal size to 10cm. Now you have a laser that should appear as below. This 10cm laser only does half the damage of the 15cm per shot but fires every 5 seconds so the overall damage output over time is the same as the 15cm. Its damage output per hull space over time is actually greater as it is only 75% of the HS.. Because it only has half the range, an equal speed or faster ship equipped with a 15cm weapon would stay out of range and the 15cm has more crunch effect as hits from that weapon will penetrate more armour. The 15cm is superior as an anti-ship weapon. However, fast firing beam weapons make good point defence weapons. In the case of point defence, overall rate of fire becomes more important than damage per hit. Therefore press Create for this weapon too so we have two different lasers. Go to the Research tab of the Economics window and Instant our new weapons.

```
10cm C3 Near Ultraviolet Laser
Damage Output 3     Rate of Fire: 5 seconds     Range Modifier: 3
Max Range 90,000 km     Laser Size: 3 HS    Laser HTK: 1
Power Requirement: 3    Power Recharge per 5 Secs: 3
Cost: 15    Crew: 30
Materials Required: 3x Duranium  3x Boronide  9x Corundium
Development Cost for Project: 150RP
```

Fire Control Systems

Next, we will create some beam fire control systems. Once again we need to Instant some technology before we begin the design process. Go to the Research tab and give yourself Beam Fire Control Range 16,000 km, Beam Fire Control Range 24,000 km, Fire Control Speed Rating 2000 km/s and Fire Control Speed Rating 3000 km/s. Now open the Create Research Project window and select Beam Fire Control. There are seven different parameters, although we don't need to bother with the last three for now. The first two will show the best available technology for beam fire control range and tracking speed and there is no need to change these. Most of the decision making for standard ship-based fire control systems is in the third and fourth dropdowns. At the moment the beam fire control should appear as below.

```
Fire Control S01 24-3000
50% Accuracy at Range: 24,000 km     Tracking Speed: 3000 km/s
Size: 1 HS    HTK: 1    Cost: 11    Crew: 5
Chance of destruction by electronic damage: 100%
Materials Required: 2.75x Duranium  8.25x Uridium
Development Cost for Project: 110RP
```

The 50% Accuracy at Range at 24,000 km simply means that any beam weapon linked to this fire control will have a base chance to hit of 50% at 24,000 km. At shorter ranges the base chance to hit will increase at a linear rate, reaching 100% at 0 km. At longer ranges the chance to hit will decrease at a linear rate, reaching zero at twice the 50% range, in this case 48,000 km. In effect, every beam fire control you design will have its own to hit chart which is shown when you add the fire control to a class design. Our 15cm Laser has a max range of 180,000 km but linked to this fire control as it currently stands, it would be ineffective beyond 48,000 km because it wouldn't be able to hit anything. The Tracking Speed of 3000 km/s means that the fire control will be able to track any target moving at 3000 km/s or less without any penalty to the base to hit chance. Against targets moving faster than 3000 km/s, the base chance to hit is modified by (Tracking Speed / Target Speed). For example, against a target moving at 4000 km/s, the base chance to hit would be modified by 3000/4000 or 0.75.

At the moment the fire control is only 1 hull space. By using the third dropdown, Fire Control Size vs Range, we can increase the range of the fire control by increasing its size. Change this dropdown to read "Fire Control 2x Size 2x Range". The fire control is now two hull spaces and the 50% accuracy at range has doubled to 48,000 km. Change it to "Fire Control 4x Size 4x Range", so it appears as below. With a 50% range of 96,000 km, the max range is 192,000 km so it will match up with our 15cm Laser. Change the name if you like and Create this fire control system.

```
Fire Control S04 96-3000
50% Accuracy at Range: 96,000 km     Tracking Speed: 3000 km/s
Size: 4 HS    HTK: 1    Cost: 43    Crew: 20
Chance of destruction by electronic damage: 100%
Materials Required: 10.75x Duranium  32.25x Uridium
Development Cost for Project: 430RP
```

The 10cm laser is intended for use against missiles so the 3000 km/s tracking speed of the above fire control will be of no use to us. Even against a missile travelling at just 15,000 km/s the base chance to hit will be divided by 5 (3000/15000 = 0.2). Therefore we need to increase the tracking speed considerably. You can do this in the similar way to increasing the range. Change the Fire Control Size vs Tracking Speed to "Fire Control 4x Size 4x Tracking Speed". Now we have a problem. Although the tracking speed is 12,000 km/s, which is much better, the fire control is now 16 HS, which is huge. This is because the multipliers for size and range are cumulative. However, as this fire control is intended to engage missiles at very close range, we no longer need the range multiplier so reduce that to the original "Normal Size Normal Range" setting. Our beam fire control should now look like this:

```
Fire Control S04 24-12000
50% Accuracy at Range: 24,000 km     Tracking Speed: 12000 km/s
Size: 4 HS    HTK: 1    Cost: 43    Crew: 20
Chance of destruction by electronic damage: 100%
Materials Required: 10.75x Duranium  32.25x Uridium
Development Cost for Project: 430RP
```

The tracking speed of 12,000 km still isn't enough to avoid any penalty to the base to hit chance if you

are shooting at a 15,000 km missile, but as you will likely engage missiles at a range of 10,000 km, just before they strike the ship, the base chance to hit will be fairly high anyway. To build a faster tracking fire control, you would need to research the next level of fire control tracking technology. Go to the Research tab of the Economics window and Instant our new fire control systems.

Time to get started on our warship design. Open the F5 Class Design window and press New. Add one each of the two lasers and two fire control systems. Your design should appear as below.

```
Ark Royal class Cruiser    1050 tons     133 Crew     177 BP      TCS 21  TH 0  EM
0
1 km/s     Armour 1-9     Shields 0-0     Sensors 1/1/0/0     Damage Control
Rating 1     PPV 7
Annual Failure Rate: 8%    IFR: 0.1%    Maintenance Capacity 105 MSP    Max Repair
43 MSP

Fuel Capacity 50,000 Litres    Range N/A

15cm C3 Near Ultraviolet Laser (1)    Range 180,000km     TS: 3000 km/s     Power
6-3     RM 3    ROF 10        6 6 6 4 3 3 2 2 2 1
10cm C3 Near Ultraviolet Laser (1)    Range 90,000km     TS: 3000 km/s     Power
3-3     RM 3    ROF 5        3 3 3 2 1 1 1 1 1 0
Fire Control S04 96-3000 (1)    Max Range: 192,000 km   TS: 3000 km/s     95 90 84
79 74 69 64 58 53 48
Fire Control S04 24-12000 (1)    Max Range: 48,000 km   TS: 12000 km/s     79 58
38 17 0 0 0 0 0 0

This design is classed as a military vessel for maintenance purposes
```

Before I go into detail on the information, change to the Full Summary tab. For the lasers the information presented includes the name, how many of that system are in the design, the range, the tracking speed, the power requirements in terms of power to fire and power required per 5 sec, the range modifier, the rate of fire and the damage output in 10,000 km steps. We'll get back to why weapons (as well as fire controls) have a tracking speed in a moment. The fire control information includes the name, how many of the system are in the design, the maximum range, the tracking speed and the chance to hit in 10,000 km steps. On the right hand side of the Full Summary tab there is a section called Range Bands. If you change the Range Band to 20,000 km then the ten damage steps following each of the lasers and the ten to-hit chances following the fire controls will change from 10,000 km steps to 20,000 km steps. Compare the following to the original above.

```
15cm C3 Near Ultraviolet Laser (1)    Range 180,000km     TS: 3000 km/s     Power
6-3     RM 3    ROF 10        6 4 3 2 1 1 1 1 1 0
10cm C3 Near Ultraviolet Laser (1)    Range 90,000km     TS: 3000 km/s     Power
3-3     RM 3    ROF 5        3 2 1 1 0 0 0 0 0 0
Fire Control S04 96-3000 (1)    Max Range: 192,000 km   TS: 3000 km/s     90 79 69
58 48 38 27 17 6 0
Fire Control S04 24-12000 (1)    Max Range: 48,000 km   TS: 12000 km/s     58 17 0
0 0 0 0 0 0 0
```

If you choose other range bands, the damage and to-hit chances will change accordingly. Underneath Range Bands is Target Speed. If you change Target Speed it will affect the to-hit chances of the fire control systems. For 1000 km/s, 2000 km/s and 3000 km/s there should be no change as the both fire controls can handle those target speeds. the 5000 and 10,000 km/s steps should change the to-hit chances for the S04 96-3000 fire control as that is only designed to handle targets up to 3000 km/s but the faster tracking fire control will be unaffected. At 20,000 km/s the other fire control is affected too

because its max tracking speed is only 12,000 km/s. The Range Bands and Target Speed settings allow you to check how your weapon and fire control designs would perform against targets at different ranges and different speeds.

Earlier I mentioned that weapons have a tracking speed as well. While the fire control tracking speed is mainly concerned with tracking the target and calculating where to fire the weapons, the weapon tracking speed is the capability of the weapon to fire instantly in that direction when ordered to do so by the fire control. The base weapon tracking speed is equal to either the speed of the ship or your Empire's best Fire Control Speed Rating tech, whichever is greater. Your best Fire Control Speed Rating is 3000 km/s at the moment and as that is higher than the current ship speed of 1 km/s (it has no engines), then 3000 km/s is the weapon tracking speed. Try adding eight of our nuclear thermal engines to the class (remember to use the military version). It should appear as below. Note that because the ship speed is now 3174 km/s, that is higher than the Empire's Fire Control Speed Rating of 3000 km/s so the weapon tracking speed is now 3174 km/s. In essence, a faster ship has a better chance of quickly pointing its weapons in the right direction.

```
Ark Royal class Cruiser    3150 tons     333 Crew     283 BP      TCS 63  TH 200
EM 0
3174 km/s     Armour 1-19     Shields 0-0     Sensors 1/1/0/0     Damage Control
Rating 1     PPV 7
Annual Failure Rate: 79%    IFR: 1.1%    Maintenance Capacity 56 MSP    Max Repair
43 MSP

Nuclear Thermal Engine E10 (8)    Power 25    Fuel Use 100%    Signature 25
Armour 0    Exp 5%
Fuel Capacity 50,000 Litres    Range 28.6 billion km   (104 days at full power)

15cm C3 Near Ultraviolet Laser (1)    Range 180,000km     TS: 3174 km/s     Power
6-3     RM 3    ROF 10        6 4 3 2 1 1 1 1 1 0
10cm C3 Near Ultraviolet Laser (1)    Range 90,000km     TS: 3174 km/s     Power
3-3     RM 3    ROF 5        3 2 1 1 0 0 0 0 0 0
Fire Control S04 96-3000 (1)    Max Range: 192,000 km   TS: 3000 km/s     90 79 69
58 48 38 27 17 6 0
Fire Control S04 24-12000 (1)    Max Range: 48,000 km   TS: 12000 km/s     58 17 0
0 0 0 0 0 0 0

This design is classed as a military vessel for maintenance purposes
```

When a fire control tries to direct a weapon, the lowest tracking speed of the fire control or the weapon is used to calculate the chance to hit the target. In other words, it is no use having a fast fire control tracking speed if the weapon can't point in the right direction quickly enough and it is no use having a fast weapon tracking speed if the fire control can't make use of it. You need to match weapons with appropriate fire control systems as part of your class design process.

Turrets

You might be asking, why have I just created a 12,000 km/s fire control system then if this bucket of bolts has no chance of going at anything like that speed? Good question! That is why we have turreted weapons. A weapon mounted in a turret has a tracking speed equal to the tracking speed of the turret rather than the speed of the ship. So we had better put our 10cm laser in a turret. Open the F2 window, go to the Research tab and select Energy Weapons. Instant the tech for Turret Tracking Speed 2000 km/s and Turret Tracking Speed 3000 km/s. Now click the Turrets button in the row of buttons along the bottom of the window.

The top right of the Turret Design Window shows the best technology available for both fire control speed rating and turret tracking speed. The Turret Calibre and Type section allows us to choose the type of beam weapon and whether this will be a single, dual, triple or quad turret. The Turret Components section allows us to choose the desired tracking speed of the turret and any armour for the turret. We won't bother with armour for this turret but we do want to change the tracking speed. Before we do so, note that the Rotation Gear % is 33%. This is how much space is required for the turret itself rather than the weapons it will mount. Better Turret Tracking Speed technology will reduce this percentage. A turret will require rotation gear of 10% if the Desired Tracking Speed is equal to the Turret Tracking Speed technology. Because the desired turret tracking speed is currently set to 10,000 km/s, which is 3.3x the turret tracking technology speed of 3000 km/s, the percentage is also multiplied by 3.3x and therefore becomes 33%. Change the desired tracking speed to 12,000 km/s so it will match the fire control system we designed earlier. Note the rotation gear percentage increases to 40% (because 12000/3000 x 10% = 40%). You don't need to remember the formulae. Just remember that higher desired tracking speed = more turret rotation gear and that improving the turret tracking tech will reduce the amount of rotation gear you need. Once the desired tracking speed is changed our turret should look like this:

```
Single 10cm C3 Near Ultraviolet Laser Turret
Damage Output 3x1      Rate of Fire: 5 seconds     Range Modifier: 3
Max Range 90,000 km    Turret Size: 5    Armour: 0    Turret HTK: 1
Power Requirement: 3    Power Recharge per 5 Secs: 3
Cost: 25    Crew: 30
Maximum Tracking Speed: 12000km/s
Materials Required: 13x Duranium  3x Corbomite  9x Corundium
Development Cost for Project: 250RP
```

Most of this information is similar to that for a normal laser, except for turret size and max tracking speed. Also the damage output has 3x1, with the 1 representing a single weapon in this turret. Note that the turret is 5 HS (hull spaces) compared to only 3 HS for the standard 10cm C3 Near Ultraviolet Laser. This 5 HS comprises the 3 HS for the laser and 1.2 HS for the turret rotation gear (3HS x 40%), rounded up to 5 HS. Try changing this to a twin turret. It should appear as below:

```
Twin 10cm C3 Near Ultraviolet Laser Turret
Damage Output 3x2      Rate of Fire: 5 seconds     Range Modifier: 3
Max Range 90,000 km    Turret Size: 9    Armour: 0    Turret HTK: 2
Power Requirement: 6    Power Recharge per 5 Secs: 6
Cost: 45    Crew: 60
Maximum Tracking Speed: 12000km/s
Materials Required: 21x Duranium  6x Corbomite  18x Corundium
Development Cost for Project: 450RP
```

The damage output is now 3x2 because there are two lasers in the turret each capable of 3 damage. The power requirement has also doubled to 6. However, because there are 2 lasers, each with its own C3 capacitor, the power recharge per 5 seconds is also 6. The size is 9 HS. This comprises 6 HS for the two lasers plus 2.4 HS for the turret gear (6 x 40%), rounded up to nine. Which means the twin turret is more efficient in terms of size because two single turrets would total 10 HS. Check the options for triple and quad turrets and you will find they are 13 HS and 17 HS respectively. They are slightly more efficient in terms of size but 17 HS is a large system so not quite as flexible when trying to fit everything into a ship design. Go back to the twin option.

We still have some wasted space in this twin turret design as the rotation gear plus weapons only adds up to 8.4 HS and is being rounded up to 9 HS, Is there anything we can do with the 0.6 HS? Actually,

there is. If you increase the tracking speed to 15,000 km/s, the gear required will be 3 HS instead of 2.4 HS. The turret will still only be 9 HS and it will cost the same but it will include some future-proofing for free. When our new warship design eventually gets out of date, you could perhaps refit it with an improved fire control system based on more advanced technology. The turret will already be capable of matching up with a fire control that has a tracking speed of up to 15,000 km/s. Use Create to accept our new twin turret and use Instant on the Research tab under energy weapons. Go back to the class design window, change to the Design View tab, remove the existing 10cm laser and replace it with our new twin turret. The ship should now look like this:

```
Ark Royal class Cruiser    3500 tons     363 Crew     314.5 BP      TCS 70  TH 200
EM 0
2857 km/s     Armour 1-20     Shields 0-0     Sensors 1/1/0/0     Damage Control
Rating 1     PPV 13
Annual Failure Rate: 98%    IFR: 1.4%    Maintenance Capacity 56 MSP    Max Repair
45 MSP

Nuclear Thermal Engine E10 (8)    Power 25    Fuel Use 100%    Signature 25
Armour 0    Exp 5%
Fuel Capacity 50,000 Litres    Range 25.7 billion km   (104 days at full power)

Twin 10cm C3 Near Ultraviolet Laser Turret (1x2)    Range 90,000km     TS: 15000
km/s     Power 6-6     RM 3    ROF 5        3 3 3 2 1 1 1 1 1 0
15cm C3 Near Ultraviolet Laser (1)    Range 180,000km     TS: 3000 km/s     Power
6-3     RM 3    ROF 10        6 6 6 4 3 3 2 2 2 1
Fire Control S04 96-3000 (1)    Max Range: 192,000 km   TS: 3000 km/s     95 90 84
79 74 69 64 58 53 48
Fire Control S04 24-12000 (1)    Max Range: 48,000 km   TS: 12000 km/s     79 58
38 17 0 0 0 0 0 0

This design is classed as a military vessel for maintenance purposes
```

As you can see the turret has a tracking speed of 15,000 km/s so it can easily handle the fire control with the 12,000 km/s tracking speed. Also note that because we just increased the size of the ship, the speed has dropped to 2857 km/s. The tracking speed for the 15cm Laser (which isn't turret-mounted) has therefore reverted to the Empire's best tracking speed technology of 3000 km/s. Lets add a second 10cm twin turret and a second 15cm laser. When we get to combat I will explain how to link weapon systems to fire controls. For now we are happy that this design has some long ranged 15cm lasers and a long-ranged fire control plus two anti-missile turrets with a suitable fast-tracking fire control.

If you look at the design errors box in the bottom right you will see a message for insufficient life support. Check the Life Support section near the centre of the left hand edge and you will see Required Crew is 463 and Life Support is 250. Add a crew quarters to correct the life support problem. We'll have to keep an eye on this as we still have a few systems to add and the required crew is very likely going to rise above 500.

Power

Our next task is to provide some power for those lasers. We have two 15cm lasers, each with a power of 6-3 and two twin 10cm turrets, each with a power of 6-6. The first number is the total power required to fire and the second is the power required per 5 seconds. That second figure is the one for which we need to provide power as power plants (also known as reactors) are rated in the amount of power they produce per 5 seconds. So the total power we need to provide is 18 (3 each for two 15cm lasers, 6 each for two turrets). Open up the Research tab of the Economics window and give yourself

the Pebble Bed Reactor Technology. We already have Pressurised Water Reactors but we should have plenty of Starting RP remaining so lets go for a better model. Once Pebble Bed Reactors are available, that opens up the next engine technology and the third reactor technology. Leave those for now but remember that each new engine tech will have a pre-requisite reactor tech.

Use the Design button to open up the Create Research project window and select Power Plants. The Power vs Efficiency dropdown is for a line of tech that can increase reactor output at the cost of an increased chance of secondary explosion if the reactor is hit. We haven't researched anything in that tech line, or any internal armour, so leave those alone for now. Choose a Size of 1. Any system below 1 HS has a HTK of 0 so if it takes damage the system is destroyed and the damage is also applied against another system. Our power plant design should appear as below. Note the Power Output of 3. Use Create and Instant then return to the class design window.

```
Pebble Bed Reactor
Power Output: 3     Internal Armour: 0     Explosion Chance: 5
Reactor Size: 1 HS    Reactor HTK: 1
Cost: 9    Crew: 5
Materials Required: 2.25x Duranium  0x Neutronium  6.75x Boronide
Development Cost for Project: 90RP
```

The Pebble Bed Reactor should be on the list of available components. As we need 18 power and the reactor produces 3, add six of them to the design. If you look at the Power Systems section at the centre left, you can see that Reactor Power is 18 and Power required is also 18. For some designs it might be worth including extra reactors for redundancy in case of damage. If you lose a reactor it will reduce the total power available and increase the time required to recharge weapons.

Sensors

Although the beam weapons are short-ranged compared to missiles, the ship will need to find and target its enemies so we need one or more active sensors. We already designed an active sensor with a twenty million kilometer range for our geological survey ship so lets add one of those. That sensor won't be suitable for detecting missiles though so we will need a second sensor with a resolution of zero. By the way, if you have no idea what I am talking about at this point then please review the active sensor portion of Part 4: Basic Ship Creation. If you are familiar with active sensors and resolutions then open up the Create Research Project window and select Active Sensors / Missile Fire Control. Change to an Antenna Size of 1 HS and leave the resolution as Zero. This sensor only has a 100,000 km range but as our 10cm lasers can't fire at targets more than 90,000 km away that is sufficient. Create and Instant this sensor then add it to the design. You will also need a third crew quarters due to increasing crew requirements. Our warship should now look like this:

```
Ark Royal class Cruiser    4700 tons     518 Crew     500 BP      TCS 94  TH 200
EM 0
2127 km/s     Armour 1-24     Shields 0-0     Sensors 1/1/0/0     Damage Control
Rating 1     PPV 26
Annual Failure Rate: 176%    IFR: 2.5%    Maintenance Capacity 66 MSP    Max
Repair 45 MSP

Nuclear Thermal Engine E10 (8)    Power 25    Fuel Use 100%    Signature 25
Armour 0    Exp 5%
Fuel Capacity 50,000 Litres    Range 19.1 billion km   (104 days at full power)

Twin 10cm C3 Near Ultraviolet Laser Turret (2x2)    Range 90,000km     TS: 15000
km/s     Power 6-6     RM 3    ROF 5        3 3 3 2 1 1 1 1 1 0
```

```
15cm C3 Near Ultraviolet Laser (2)    Range 180,000km     TS: 3000 km/s     Power
6-3     RM 3    ROF 10        6 6 6 4 3 3 2 2 2 1
Fire Control S04 96-3000 (1)    Max Range: 192,000 km   TS: 3000 km/s     95 90 84
79 74 69 64 58 53 48
Fire Control S04 24-12000 (1)    Max Range: 48,000 km   TS: 12000 km/s     79 58
38 17 0 0 0 0 0 0
Pebble Bed Reactor (6)     Total Power Output 18    Armour 0    Exp 5%

Active Search Sensor S10-R1 (1)     GPS 10     Range 100k km    Resolution 1
Active Search Sensor S20-R100 (1)     GPS 2000     Range 20.0m km    Resolution
100

This design is classed as a military vessel for maintenance purposes
```

Notice that the speed is dropping and the Annual Failure Rate is rising. We will need to address these at some point. For now let's complete our sensor suite by adding some passive sensors. Go back to the Create Research Project Window and select Thermal Sensors. This is nice and simple with only three dropdowns. The first one just shows our current thermal sensor tech, which is 5, and the last one is for hardening against electronic damage, which we won't bother with for now as we don't have that tech line. Change the Antenna Size to 2 HS. The Thermal Sensor Sensitivity for this sensor is now 10 as we have the base tech of 5 multiplied by 2 HS. The thermal sensitivity of this sensor will determine at what range it can detect a given thermal signature. Lets assume it was detecting our own ship. Check the right hand end of the top line of the class summary and you will see TH 200. This is the thermal signature of this class at top speed and is derived from the total power output of the engines (8 x 25). To find the range at which this sensor (sensitivity 10) can detect this ship (signature 200), multiply them together and multiply the result by 1000 to get the range in kilometers. 200 x 10 x 1000 is two million kilometers. A ship with a thermal signature of 1000 would be detected at 1000 x 10 x 1000 = ten million kilometers.

A population also has a thermal signature. Check the Summary tab of the Economics window and if this is the tutorial the thermal signature (toward the bottom right) of our population is 11897. So this would be detected at 11897 x 10 x 1000 = almost one hundred and twenty million kilometers. Create and Instant this sensor and add it to our design. You will see that the summary will give you the detection range for a signature of 1000 so you can extrapolate from that if necessary. Or you can open the System Map and switch to the Sensors sidebar view. Click the Show Passive Sensor Ranges checkbox. As you drag the slider, the range of any passive sensors against the signature strength set by that slider will show as a blue circle on the system map. The most obvious one will be the circle surrounding Earth, which has deep space sensors with very high thermal sensitivity. The Show Passive Sensor Range can be used for both Thermal and EM (which we cover in a moment) sensors as their detection formulae against a given signature size are the same.

Now go back to the Create Research Project window and select EM Detection Sensors. EM, which is short for electromagnetic, sensors will detect shield emissions but are primarily used to detect the emissions of active sensors, which I will cover in a moment. Create/Instant a 2 HS EM Sensor and add it to your class design. The design should now appear as follows:

```
Ark Royal class Cruiser    4950 tons     538 Crew     521 BP      TCS 99  TH 200
EM 0
2020 km/s     Armour 1-25     Shields 0-0     Sensors 10/10/0/0     Damage Control
Rating 1     PPV 26
Annual Failure Rate: 196%    IFR: 2.7%    Maintenance Capacity 66 MSP    Max
Repair 45 MSP

Nuclear Thermal Engine E10 (8)    Power 25    Fuel Use 100%    Signature 25
Armour 0    Exp 5%
Fuel Capacity 50,000 Litres    Range 18.2 billion km   (104 days at full power)

Twin 10cm C3 Near Ultraviolet Laser Turret (2x2)    Range 90,000km     TS: 15000
km/s     Power 6-6     RM 3    ROF 5        3 3 3 2 1 1 1 1 1 0
15cm C3 Near Ultraviolet Laser (2)    Range 180,000km     TS: 3000 km/s     Power
6-3     RM 3    ROF 10        6 6 6 4 3 3 2 2 2 1
Fire Control S04 96-3000 (1)    Max Range: 192,000 km   TS: 3000 km/s     95 90 84
79 74 69 64 58 53 48
Fire Control S04 24-12000 (1)    Max Range: 48,000 km   TS: 12000 km/s     79 58
38 17 0 0 0 0 0 0
Pebble Bed Reactor (6)     Total Power Output 18    Armour 0    Exp 5%

Active Search Sensor S10-R1 (1)     GPS 10     Range 100k km    Resolution 1
Active Search Sensor S20-R100 (1)     GPS 2000     Range 20.0m km    Resolution
100
Thermal Sensor TH2-10 (1)     Sensitivity 10     Detect Sig Strength 1000:  10m km
EM Detection Sensor EM2-10 (1)     Sensitivity 10     Detect Sig Strength 1000:
10m km

This design is classed as a military vessel for maintenance purposes
```

The EM Detection Sensor has a sensitivity of 10, the same as the thermal sensor. For the purposes of detecting active sensor emissions, the strength of an active sensor's signature is its GPS (grav pulse strength) value. On our own ship design the two active sensors have GPS values of 10 and 2000. The GPS value is calculated from strength x resolution (but you don't need to remember that). EM detection works with exactly the same formula as Thermal detection. So our own EM Sensor, with sensitivity 10, could detect our large search sensor, with its GPS of 2000, at 2000 x 10 x 1000 = 20 million kilometers. If that EM Sensor had a sensitivity of 12, the detection range would be 24 million and a ship with this EM Sensor would therefore detect the emissions from the above active sensor (if it was switched on) before the ship with the active sensor could detect the ship mounting the EM sensor. Bear in mind that engaging active sensors might give away your position to EM Sensors. Imagine how far away planetary EM sensors could detect you. Lets check and find out. Go back to the sensor tab on the system map sidebar, make sure Show Passive Sensor Ranges is checked and also choose the x10 option. Now drag the slider until it has a value of approximately 2000. Look for the blue circle surrounding Earth (you might have to zoom out). If the ship above engaged its active sensor anywhere in that circle, those sensor emissions would be detected by the planetary sensors on Earth. The sensitivity per HS of thermal and EM sensors ship-based sensors can be increased through research. You can also increase planetary sensor strength by researching (oddly enough) Planetary Sensor Strength.

Engineering & Fuel

Right, lets get back to our class design. We have weapons, power, fire controls and sensors so its time to do a little housekeeping. The failure rate is very high so lets add a couple of Engineering Spaces. These decrease the failure rate and increase the maintenance capacity. The range is limited so add a second Fuel Storage system. Warships are not much use if they are easily destroyed so we need to

increase our armour. Firstly, review the armour section in Part 4: Basic Class Design if you are uncertain about the armour system in Aurora. Then increase the armour to 3. Note that this increases ship size from 5100 tons to 5650 tons. If you had better armour tech you could add the same protection using less hull space. Now the speed has fallen all the way down to 1769 km/s so add a couple more engines to take us above 2000 km/s. The ship should now look like this:

```
Ark Royal class Cruiser    6200 tons     611 Crew     639 BP      TCS 124  TH 250
EM 0
2016 km/s     Armour 3-30     Shields 0-0     Sensors 10/10/0/0     Damage Control
Rating 3     PPV 26
Annual Failure Rate: 102%    IFR: 1.4%    Maintenance Capacity 193 MSP    Max
Repair 45 MSP

Nuclear Thermal Engine E10 (10)    Power 25    Fuel Use 100%    Signature 25
Armour 0    Exp 5%
Fuel Capacity 100,000 Litres    Range 29.0 billion km   (166 days at full power)

Twin 10cm C3 Near Ultraviolet Laser Turret (2x2)    Range 90,000km     TS: 15000
km/s     Power 6-6     RM 3    ROF 5        3 3 3 2 1 1 1 1 1 0
15cm C3 Near Ultraviolet Laser (2)    Range 180,000km     TS: 3000 km/s     Power
6-3     RM 3    ROF 10        6 6 6 4 3 3 2 2 2 1
Fire Control S04 96-3000 (1)    Max Range: 192,000 km   TS: 3000 km/s     95 90 84
79 74 69 64 58 53 48
Fire Control S04 24-12000 (1)    Max Range: 48,000 km   TS: 12000 km/s     79 58
38 17 0 0 0 0 0 0
Pebble Bed Reactor (6)     Total Power Output 18    Armour 0    Exp 5%

Active Search Sensor S10-R1 (1)     GPS 10     Range 100k km    Resolution 1
Active Search Sensor S20-R100 (1)     GPS 2000     Range 20.0m km    Resolution
100
Thermal Sensor TH2-10 (1)     Sensitivity 10     Detect Sig Strength 1000:  10m km
EM Detection Sensor EM2-10 (1)     Sensitivity 10     Detect Sig Strength 1000:
10m km

This design is classed as a military vessel for maintenance purposes
```

Since we added engineering and fuel, the failure rate has gone up again and the fuel range came down due to the increased size from extra armour and engines. At some point though we just have to accept the figures or we will be adding systems forever. So we have finally completed the design for our first warship. This design was intended as a tutorial so don't accept it as a great design. Different players would modify it in different ways to suit their own style and the tech levels of different components vary considerably. It has much better fire control and weapon tech than armour, engine and sensor tech for example. It is intended for education and, as you play, you will find your own experiences in the game will guide future ship design. Different people will have different experiences and consequently will often develop different views on design, just like real life.

This is probably a good point to look at the Component Summary tab on the Class Design window. This lists all of the components in your design, along with the amount of each component and their size, cost, crew and HTK. You can sort on any of these using the buttons on the right and use this information to analyze your design. For example, in this case 40.3% of the hull space and 18.8% of the cost is dedicated to engines while the Engineering Spaces are just 2.4% of the space and 1.6% of the cost. This section is just for reference but it can be enlightening when looking at just where your money is going. Open the Fast OB Creation window from the SpaceMaster menu, select Battle Task Group and your new design. Enter 3 in the number field and press Add. Congratulations, you are no longer totally defenseless.

Chapter 9: Beam Overview

Summary of Beam Weapons and CIWS

This is a short tutorial section that provides a brief overview of the other beam weapons. Any general comparisons of weapons at a given technology level, such as "railguns out-damage lasers" may not reflect the exact designs shown below as the comparison will vary with the exact background technologies used. In effect, the balance between different weapons will vary as they all advance. In any event, Aurora is very situational and often you need the right weapon for the situation. There isn't a 'best' weapon for all circumstances.

Lasers

We covered this weapon in the last tutorial but as a reminder, lasers are a long range beam weapon and their damage drops off with range. As was shown in the tutorial they can be mounted in turrets for point defence use. Here are example of long range and point defence lasers

```
20cm C5 Ultraviolet Laser
Damage Output 10     Rate of Fire: 10 seconds     Range Modifier: 4
Max Range 400,000 km     Laser Size: 6 HS    Laser HTK: 3
Power Requirement: 10    Power Recharge per 5 Secs: 5
Cost: 63    Crew: 60
Materials Required: 12.6x Duranium  12.6x Boronide  37.8x Corundium
Development Cost for Project: 630RP

10cm C3 Ultraviolet Laser
Damage Output 3     Rate of Fire: 5 seconds     Range Modifier: 4
Max Range 120,000 km     Laser Size: 3 HS    Laser HTK: 1
Power Requirement: 3    Power Recharge per 5 Secs: 3
Cost: 20    Crew: 30
Materials Required: 4x Duranium  4x Boronide  12x Corundium
Development Cost for Project: 200RP
```

Railguns

Railguns shoot four projectiles at once and their total damage is approximately one third higher than a laser of similar technology. The damage falls off in the same way as lasers and their range can be extended by researching Railgun Launch Velocity. Because each shot does less damage than the total damage of an equivalent laser, the range is shorter and the damage is spread across the armour rather than penetrating in a single area. The range differential may not be an issue though if you don't have the fire control technology to take advantage of the laser's greater range. Although railguns cannot be mounted in turrets, they are still often used for point defence at lower tech levels because their high rate of fire compensates for their inaccuracy against fast moving targets.

```
20cm Railgun V4/C4
Damage Per Shot (4): 4     Rate of Fire: 15 seconds     Range Modifier: 4
Max Range 160,000 km     Railgun Size: 7 HS    Railgun HTK: 3
Power Requirement: 12    Power Recharge per 5 Secs: 4
Cost: 55    Crew: 70
```

```
Materials Required: 11x Duranium  11x Boronide  33x Neutronium
Development Cost for Project: 1175RP

10cm Railgun V4/C3
Damage Per Shot (4): 1     Rate of Fire: 5 seconds     Range Modifier: 4
Max Range 40,000 km     Railgun Size: 3 HS    Railgun HTK: 1
Power Requirement: 3    Power Recharge per 5 Secs: 3
Cost: 20    Crew: 30
Materials Required: 4x Duranium  4x Boronide  12x Neutronium
Development Cost for Project: 650RP
```

Torpedoes

Torpedoes (Particle Torpedo in v4.8) are a fixed damage weapon and therefore cause the same damage across their entire range. The technologies researched for torpedoes are Torpedo Warhead Strength, Maximum Torpedo Range and Capacitor Recharge Rate. This is a fairly long range weapon, although not quite a long-ranged as lasers, and will out-damage lasers at its maximum range. A ship armed with torpedoes should attempt to engage at longer ranges against other beam armed ships to take advantage of its fixed damage, while enemy damage decreases with range. This is a pure anti-ship weapon and would perform badly if used as a point defence weapon. It cannot be mounted in turrets.

```
Particle Torpedo-4
Torpedo Warhead 4     Rate of Fire: 10 seconds     Maximum Range: 200,000 km
Launcher Size: 7 HS    Launcher HTK: 3
Power Requirement: 10    Power Recharge per 5 Secs: 5
Cost: 70    Crew: 70
Materials Required: 14x Duranium  14x Boronide  42x Corundium
Development Cost for Project: 1550RP
```

Meson Cannon

Meson Cannon inflict only one point of damage over their range, which is approximately half that of an equivalent laser, but that damage ignores shields and armor. Like lasers, the range can be extended, in this case using Meson Focusing Technology. Meson cannon can be mounted in turrets for point defence use and are quite a popular choice, partly because they are ideal against an opponent who uses armoured missiles and partly because they are a very good anti-ship weapon at point blank range.

```
R20/C5 Meson Cannon
Max Range 200,000 km     Rate of Fire: 10 seconds     Focus Modifier: 4
Meson Cannon Size: 6 HS    Meson Cannon HTK: 3
Power Requirement: 10    Power Recharge per 5 Secs: 5
Cost: 20    Crew: 60
Materials Required: 4x Duranium  4x Boronide  12x Corundium
Development Cost for Project: 3100RP

R4.5/C3 Meson Cannon
Max Range 45,000 km     Rate of Fire: 5 seconds     Focus Modifier: 3
Meson Cannon Size: 3 HS    Meson Cannon HTK: 1
Power Requirement: 3    Power Recharge per 5 Secs: 3
Cost: 5    Crew: 30
Materials Required: 1x Duranium  1x Boronide  3x Corundium
Development Cost for Project: 900RP
```

Gauss Cannon

Gauss Cannon are primarily a point defence weapon and in that role their performance is superior to the other weapons under most circumstances. They inflict only one point of damage but fire several shots per volley. They can be mounted in turrets and on a full size ship it is unusual to see a gauss cannon that isn't turret mounted. Their background technologies are Gauss Cannon Rate of Fire, Gauss Cannon Launch Velocity and Gauss Cannon Size vs Accuracy. Unlike other beam weapons, there is no 'larger' version with a greater focal size. The max gauss cannon size remains 6 HS. However, you can reduce the size of the gauss cannon, while retaining its rate of fire, at the cost of reduced accuracy. This makes it useful as a weapon for very small spacecraft such as fighters. In a fighter vs fighter engagement the low damage output of the gauss cannon is offset by the fragility of the target. Another advantage of the gauss cannon is that it does not require reactor power in order to fire. It will always fire every 5 seconds.

```
Gauss Cannon R3-100
Damage Output 1     Rate of Fire: 3 shots every 5 seconds     Range Modifier: 3
Max Range 30,000 km     Size: 6    HTK: 2
Cost: 36    Crew: 24
Materials Required: 36x Vendarite
Development Cost for Project: 360RP
```

Plasma Carronade

The Plasma Carronade is a high damage, point blank range weapon. It has only two background technologies, Carronade Calibre and Capacitor Recharge Rate, and there is no way to enhance range beyond increasing the damage output. The calibers available are larger than those other beam weapons at a similar tech level so this is usually the weapon with the highest damage at close range. If you are outclassed technologically then build a ship with a few of these and wait for your opponent beyond a jump point. It cannot be turret mounted and is far from ideal as a point defence weapon.

```
30cm C5 Plasma Carronade
Damage Output 24     Rate of Fire: 25 seconds
Max Range 240,000 km     Carronade Size: 9 HS    Carronade HTK: 4
Power Requirement: 24    Power Recharge per 5 Secs: 5
Cost: 48    Crew: 90
Materials Required: 9.6x Duranium  9.6x Boronide  28.8x Corundium
Development Cost for Project: 2300RP
```

High Power Microwave (HPM)

In terms of design the HPM is similar to the meson cannon, in that it causes only a single point of damage and uses components such as HPM focal size, HPM focusing and capacitor recharge rate. The range of the HPM will be the same as a meson cannon with the same level of technology. However there are two important differences:

1.) The High Power Microwave is not affected by armour but it is affected by shields. However, because of the HPMs effectiveness against shields and electronic systems, the single point of damage from the HPM causes three points of damage to shields.
2.) Once the shields are down, the High Power Microwave only damages systems classed as "Electronic". This currently includes sensors, fire control systems, ECM and ECCM. The HPM is designed to blind an enemy rather than destroy him. Each class has a separate "Electronic

Only" Damage Allocation Chart (shown below the normal DAC), which is used by the HPM

The HPM can be a powerful weapon. Although it causes no damage to the majority of a ship's systems, it can damage shields and then blind the enemy, either forcing him to retreat or rendering him vulnerable to more destructive weapons. It is also quite expensive, costing twice as much as a similar size Meson Cannon, and difficult to employ effectively because of its relatively short range.

```
R20/C5 High Power Microwave
Max Range 200,000 km     Rate of Fire: 10 seconds     Focus Modifier: 4
HPM Size: 6 HS    HTK: 3
Power Requirement: 10    Power Recharge per 5 Secs: 5
Cost: 126    Crew: 60
Materials Required: 25.2x Duranium  25.2x Boronide  75.6x Corundium
Development Cost for Project: 3100RP
```

You may find advanced versions of beam weapon technology when you gain technology from ruins. They as similar to the standard technology but with enhanced capability. For example, Advanced Lasers do more damage for the same size and power requirements. This also translates to better range as the base damage is higher. Advanced Torpedoes inflict also do more damage for a given size and power system. Advanced Railguns get one additional shot (5 shots instead of 4) per cycle time and Advanced Mesons have greater range.

Close in Weapons System (CIWS)

Although it is not strictly a beam weapon in the general sense, this is a good place to introduce the CIWS, or Close-in Weapons System. This is the Aurora equivalent of the Phalanx or Goalkeeper systems that protect modern warships. It's a little complicated as it uses several different existing systems to create a single installation. The restrictions on its use are that it can only protect the mounting ship (other point defence weapons can protect other ships within their range) and it can only be used to engage missiles. The components of the CIWS are calculated as follows:

1.) The basic system is a dual half size gauss cannon. As the range is limited to 10,000 km, I have reduced the size slightly from 6HS to 5HS. As it is a dual mount, the rate of fire for the system with therefore be double the racial gauss cannon rate of fire
2.) The integral fire control system is assumed to be a 4x speed installation. The normal 4HS size is then divided by (maximum racial fire control range / 10,000) as the CIWS requires a max 10,000 km range. Finally the resulting size is halved to account for the fact this system can only defend the mounting ship, which makes things a lot simpler.
3.) Turret gears are added using the normal rules for turrets with a tracking speed equal to that of the above fire control
4.) The integral active sensor uses the size that would be required for a resolution-zero installation with a range of 30,000 km. This is longer than the max range of the system but it needs a little tracking time. Note that this is not an active sensor that will detect anything else. It is purely a point blank range missile tracker.
5.) If ECCM is available, it can be added to the CIWS and will use 0.5HS. As this is a reduced-sized system, it will have half the capability of the regular system
6.) As the gauss cannon are half size, the base chance to hit for the CIWS is 50% (modified by missile speed, crew grade and electronic warfare). This is actually slightly higher than it would be for a half-size gauss cannon with a short-range fire control but I am assuming it fires at even shorter range than other anti-missile systems.
7.) The cost of the system is based on the cost of all the individual components

You don't need to allocate point defence modes to the CIWS, allocate ECCM or allocate weapons to fire control systems. It is a fully integrated, fully automatic system. If a missile is about to hit the ship, it will open fire. Here is an example CIWS using components up to 8000 research points. I'll work through the steps and then show the completed system

1.) Dual half-size gauss cannon with a ROF of 3, which equals 6 shots in total. Size: 5 HS.
2.) Fire control system (tech 4000 km/s). This 4HS system has a tracking speed of 16,000 km/s. As the racial fire control range is 32,000 km/s, the fire control size is divided by (32,000 / 10,000), which is 1.25 HS and then halved to 0.625 HS
3.) Turret gears (tech 5000 km/s). As per the normal rules, the gear modifier = (FC Tracking Speed /Turret Tracking Speed)/10 = 0.32. Multiplying this by the weapon size of 5HS, gives a turret gear size of 1.6 HS.
4.) Active sensor (tech strength 21). A 1 HS active sensor with resolution zero would have a range of 210,000 km/s. Therefore a range of 30,000 km/s requires a sensor size of 0.1429 HS.
5.) Below are examples with and without ECCM. For the second example, I will use ECCM-2

```
CIWS-160
Rate of Fire: 6 shots every 5 seconds
Dual GC: 5HS    Turret: 1.6 HS    Fire Control: 0.625 HS    Sensor 0.1429 HS
ECCM: 0
Overall Size: 7.4    HTK: 2
Tracking Speed: 16000 km/s     ECCM Level: 0
Cost: 34    Crew: 8
Materials Required: 8x Duranium  0x Corbomite  15x Vendarite  11x Uridium
Base Chance to Hit: 50%
Development Cost for Project: 340RP

CIWS-160E
Rate of Fire: 6 shots every 5 seconds
Dual GC: 5HS    Turret: 1.6 HS    Fire Control: 0.625 HS    Sensor 0.1429 HS
ECCM: 0.5
Overall Size: 7.9    HTK: 2
Tracking Speed: 16000 km/s     ECCM Level: 1
Cost: 39    Crew: 8
Materials Required: 8x Duranium  5x Corbomite  15x Vendarite  11x Uridium
Base Chance to Hit: 50%
Development Cost for Project: 390RP
```

The size of the CIWS is rounded to the nearest 0.1 HS, rather than a full HS, so the technology of the smaller components can make a difference. The CIWS is intended to be added to non-escort warships as a last-ditch defensive system. It allows the designer to add a self-contained anti-missile system without having to worry about anti-missile-oriented sensors and fire control systems and the player doesn't have to be concerned with allocating weapons or fire control systems. They are of little use for escorts though as they can only protect the ship that mounts them. CIWS are classed as non-military as they have no offensive capability and therefore you can mount them on commercial vessels.

Ship Repair

Ships after long voyages, and combat will eventually need to be repaired due to low supplies not allowing them to repair themselves, or the amount of damage actually not allowing them to repair themselves while out on a mission. That is when you need to take your ship or ships home to be repaired.

Shipyard Repair

A ship can be repaired at any shipyard of a matching size and type. For example, to repair a military ship, the player must use a military shipyard. Whereas to repair a 12,000 ton ship, the player must use a shipyard capable of building a 12,000 ton ship. It logically follow that to repair a 12,000 ton military ship, the player must use a military shipyard capable of building a 12,000 ton ship.

Shipyards can repair ships completely with the "repair" Task Type.

The amount of time required depends on the amount of damage.

Onboard Ship Repair

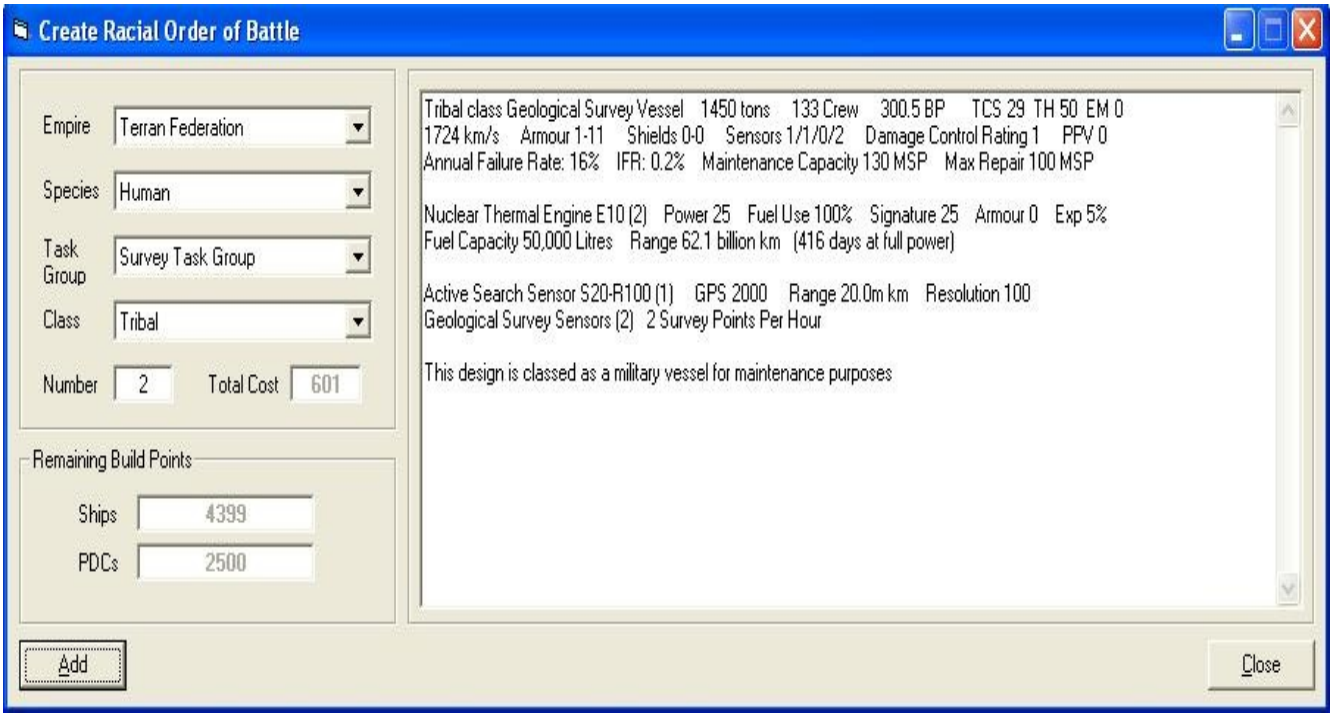
Ships can repair themselves if they have maintenance supplies. They automatically repair themselves if its a breakdown, if its due to combat damage however they will have to be assigned to repair the item via the f6 damage control screen. This is a lengthy process but it will repair all internal components with enough supplies.

This will not repair Armor, Armor damage has to be repaired at a shipyard.

Chapter 10: Fast OOB

Fast OB Creation window and Basic Fleet Orders

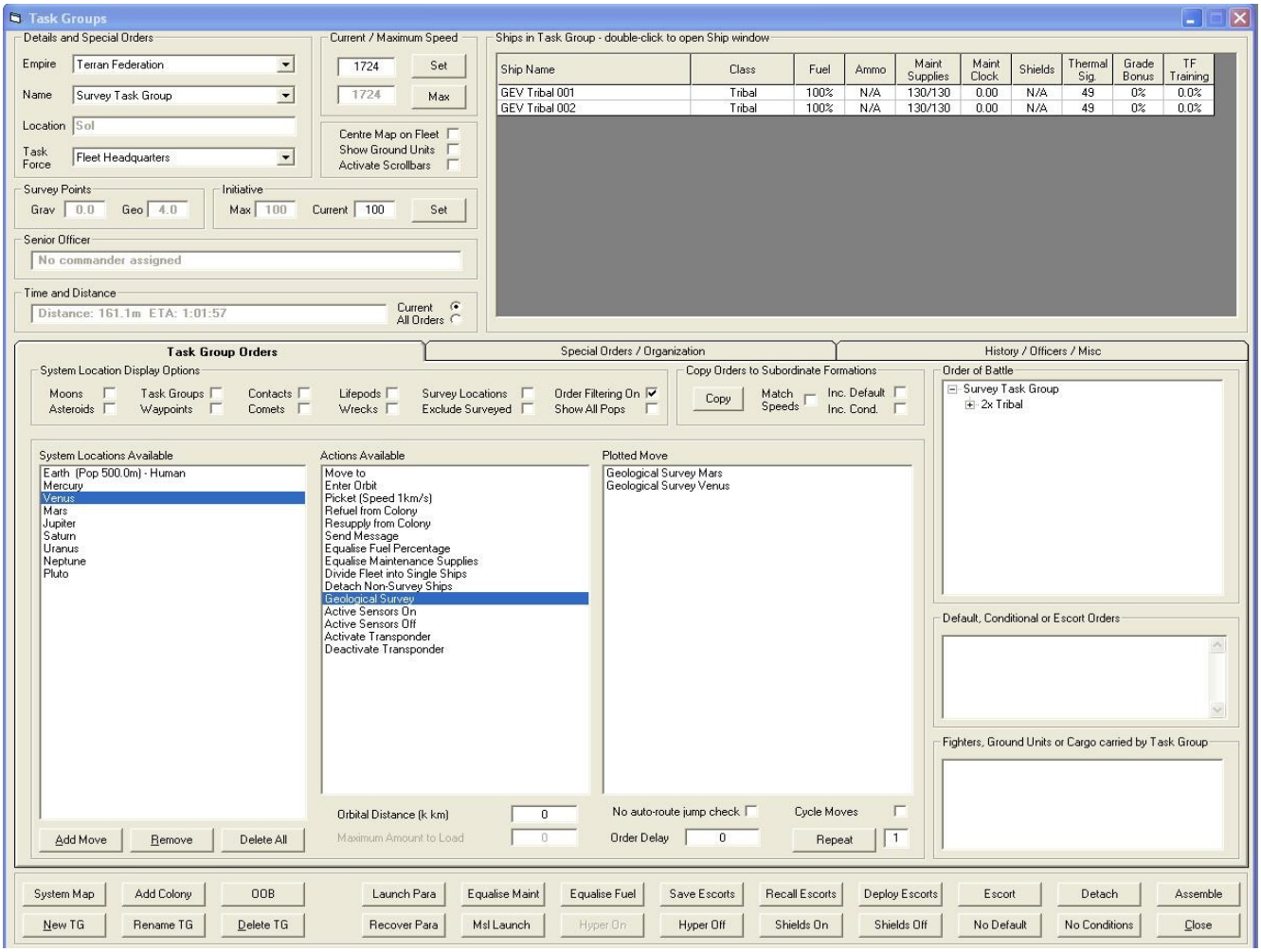
The Fast OB Creation window allows you to quickly set up your starting forces without having to build them. Go to the main menu bar and select the Fast OB Creation menu item. This opens the a small window with the title Create Racial Order of Battle. The top left section will show your Empire and Species, a dropdown with available task groups, a dropdown of available classes, a text entry box for Number and a read-only field for Total Cost. Below that is the Remaining Build Points section with a suggested amount of build points with which to create your starting forces. As you add starting forces, the amount of BPs will be deducted from these values. If you have been following the tutorial, these values will be 5000 for ships and 2500 for PDCs. Lets start by creating a couple of geological survey ships. Select the Survey Task Group and the whatever class name you used for the geosurvey ship. If you can't remember which one that is, select each class in turn and look at the right-hand panel, which displays the class summary. Type 2 in the Number field and press the Add button. The Remaining Build Points for ships will be reduced, probably to 4399.



Leave that window for now and open up the Task Groups window (F12). In Aurora, most players use the terms 'task group' and 'fleet' interchangeably so this is often called the Fleet window. You will use this window a lot and it contains many different functions. I am only going to cover a few of them right now but we will revisit this window as the tutorial progresses. In the top left is the Empire dropdown with your Empire selected. The second dropdown is a list of task groups. Select the Survey Task Group. You should now see the two survey ships listed in the grid control in the top right of the window. Several useful pieces of information are shown including the fuel and maintenance situation, their ammo and shields (if they had any), how much time they have accumulated on their maintenance clocks since their last overhaul, their thermal signature, their grade bonus and their task force training points. I'll cover the last two columns later in the tutorial

There are three list boxes in the left centre of the window entitled System Locations Available, Actions

Available and Plotted Move. System Locations contains a list of the all the places in the system where you can set an order. At the moment there will only be the nine planets listed (Aurora hasn't caught up to dwarf planets yet). There is a section called System Location Display Options above this listbox, which contains a series of twelve checkboxes. These can be toggled on and off to show addition system locations. Try clicking on Moons for example and you will see all the moons in the solar system have been added to the list. Uncheck the Moons checkbox to get rid of them. Now click on Mars in the System Locations list. A list of possible actions for the two survey ships will be shown in the Actions Available list. As an example, select Geological Survey and press Add Move. An order for Geological Survey Mars appears in the Plotted Move list. Now click on Venus. This time, instead of using Add Move, just double-click on Geological Survey. A second order now appear for Geological Survey Venus.



If we advanced time at this point, the small fleet of two ships would begin following those orders. However, there are a lot easier ways to survey the Sol system then selecting every planet in turn. Press Remove twice to delete the orders. Now change to the Special Orders / Organization tab. Down the left hand side of this tab are several options for setting up automated orders for fleets. The first section, Protect Threat Axis, is used to create formations for battle fleets and we will look at in detail later. Essentially though, it means you can select one fleet as the main body of a larger formation and set other fleets to maintain positions relative to that fleet's course or relative to both the fleet and a hostile contact. It could be as simple as telling an escort to maintain a position 200,000 kilometers from the fleet in the direction of contact xyz, extending the point defence coverage of the fleet in that direction.

You might set two escorts at 500,000 kilometers twenty degrees either side of the line of movement, or perhaps two scouts out at 10 million kilometers, forty degrees wither side of the line of movement, to act as sensor pickets, etc.. A supply ship with the battle fleet might be set 2 million kilometers away at a bearing of 180 degrees from a specified threat so it will always remain at the far side of the fleet. As the main body moves, all those fleets with formation orders will change their positions accordingly, although ships without fleet training will be shaky when it comes to holding exact formations. Each escort can be set with a different threat direction so you can create quite complex formations.

The next section, Default Orders, is the first one we are really interested in. If a fleet has no orders, it will attempt to carry out its primary default order. If that isn't possible, it will attempt to carry out its secondary default order. Look down the list of possible primary orders and select Survey Next Five System Bodies. This means that if the fleet has nothing else to do, it will choose five system unsurveyed bodies, starting with the closest to its current position, then whichever is closest to that system body and so on, until it has selected five. Then it will work its way down the list.

While we are in this section, lets set up some conditional orders as well. In the Conditional Order A section, select the Condition "Fuel less than 30%" and the Order "Refuel at Colony within 4 Jumps". Conditional Orders are checked every increment and will override any existing orders. As soon as this ship's fuel is less than 30% it will stop whatever it is doing and head for the nearest source of fuel. Once refuelled, it will have no orders so it will fall back on its default orders again.

Survey ships work best independently so lets split the fleet into two. Select one of the ships in the grid control and press the Detach button (bottom right). This is now a separate fleet. Set up the same default and conditional orders for this fleet too and then reselect the original Survey Task Group. As this is a single ship as well, press Rename TG (bottom left) and give it the same name as the ship so the two geo survey fleets have similar names. Now swap back to the Task Group Orders view. In a text box at the centre right you should see a summary of the default and conditional orders you created.

Moment of truth time. Open up the F3 System Map and press the 5 second button under Increment Time, on the far left of the upper of the two time bars. This will advance time by 5 seconds and give the two survey fleets an opportunity to work out their orders. If you check the order list for each of the two fleets, they should have selected some destinations for geological surveys. Notice that they have picked different destinations. This is because the two fleets are aware of what each other is doing and they will avoid duplication. Even if you had six fleets, they would still all work as a team. Later in the game you may meet alien races and set up geological survey treaties that mean the two Empires will share new geological survey data with each other. If survey fleets from two Empires with such a treaty are in the same system, they will also work as a team as if they were all from the same Empire. Essentially, you have setup all the orders you need for a geosurvey of the Sol system. The two ships will get on with their task, notifying you of any mineral deposits and returning to Earth to refuel as necessary. Eventually, you may receive a message that they cannot find anything else to survey, at which point you will need to decide where to send them next.

Lets now set up their gravitational survey cousins. Go back to the Fast OB Creation window and find the Gravitational Survey Design. Add two of them to the Shipyard TG task group. Now go back to the F12 task group window and open the Shipyard TG Window. Select one of the gravitational survey ships and press Detach. Set up a default order for Survey Nearest Survey Location and select the same conditional orders as the geo survey ship. Go back to Shipyard TG and Detach the second gravitational survey ship. Set up the same default and conditional orders. Advance time 5 seconds and let them pick their first destinations. These two ships will now carry out a gravitational survey of the Sol system, searching for jump points. As with the geo ships they will work as a team.

Chapter 11: Economics

Economics Window: Mining and Maintenance Tab

A quick zip through this tab as it is relatively straightforward.

There are two sections on this tab. The Mining Report shows the mineral production for the colony while the second section shows an estimate of the minerals that will be consumed by maintenance facilities, based on ships currently in orbit. The number of mines and the annual production is shown above the grid control. Moving your mouse over this area will show how the production is calculated. The columns on the Mining Report are as follows:

- Mineral: Name of the mineral
- Quantity: Amount of raw mineral remaining within the planet's core
- Accessibility: The ease of mining for that particular mineral, ranging from 0.1 to 1.0. A mineral with an accessibility of 1.0 will be mined at the same rate as the annual production shown above. Lower accessibility minerals will be mined at a lower production rate based. For example, if a colony has an annual production of 5000 tons, then 5000 tons of each accessibility 1.0 mineral will be produced but only 3500 tons of an accessibility 0.7 mineral and only 500 tons of an accessibility 0.1 mineral. For planets and moons, if a mineral's accessibility is greater than 0.1 it will begin to fall once you have mined out half the mineral. The accessibility will reach 0.1 shortly before the mineral deposit is exhausted
- Annual Production: The amount in tons of the mineral produced per year, based on the total production of the colony's mines multiplied by the accessibility of the mineral
- Years to depletion: How long it will be before this planet runs out of this type of mineral, based on the number of mines for this population only. Note if that if other races also have populations on this planet, the mineral deposit may be exhausted more quickly.
- Stockpile: The total amount of refined minerals available at this population
- Recent Stockpile: The change in stockpile since the last 5-day increment. This shows whether the stockpile is rising or falling, based on mining production and the use of minerals by factories, shipyards, etc.
- Mass Driver: The total amount of minerals delivered or dispatched by mass drivers since the last 5-day increment.
- Stockpile plus Production: An estimate of the stockpile in one year's time, based on the current stockpile plus one year's production
- Projected Usage. The projected use of this mineral based on the queues for ordnance, fighters, construction, shipyard tasks, etc

The second section on this tab shows a list of all ship classes currently using the population's maintenance facilities (if any exist) and what minerals will be used over the course of a year in

Chapter 12: Terraforming

Colony Cost and Terraforming

Firstly, lets talk atmospheres. Our own atmosphere has a variety of gases but only Nitrogen, Oxygen and Argon are 1% or above. Everything else is in tiny amounts. Aurora only bothers with the major gases in a planetary atmosphere so planets will generally start with no more than three gases in their atmosphere. Open up the Economics window and take a look at the Environment tab for Earth. The list of gases in the Atmospheric Data section shows the following information:

```
Nitrogen 79% 0.79 atm
Oxygen 20% 0.2 atm
Argon 1% 0.01 atm
Total Atmospheric Pressure: 1
```

This shows both the percentage of each gas in the atmosphere and the atmospheric pressure (atm) of each gas. As the atm amount is based on Earth's atmospheric pressure of 1, the atm figures match the percentages. Lets create a colony on Mars and compare this to its atmosphere. Open up the F9 System View window, which provides detailed information on every body in a star system (you can open this by pressing the orange sun icon at the middle top of the system map). It is useful to check this view every time you find a new system, just to see what types of planets you have found and their colony cost (more on colony cost later). If there is more than one star in the system, each star and any associated planets will be on a separate tab. If the System View is slow to load, switch to the options tab and select Hide Asteroids then switch back to the Sol-A tab. Select Mars and press the Add Colony button. Open the Economics window, or press Refresh All (middle bottom) if it is already open. You should see a new colony for Mars. Select it and take a look at the Environment tab. The atmospheric data shows:

```
Nitrogen 70% 0.007 atm
Carbon Dioxide 30% 0.003 atm
Total Atmospheric Pressure: 0.01
```

The atmospheric pressure on Mars is only about 1% of that on Earth so the atm figures are tiny. In effect, Mars has almost no atmosphere at all. The atmospheric pressure on Venus is about 100x greater than on Earth and 10,000x greater than Mars.

The principle of Terraforming in Aurora is based on changing the atmosphere in order to alter the environment of the planet so it is suitable for your species. Before getting into how that works, we should probably discuss how you know what is suitable for your species. Each species in Aurora has environmental tolerances with their midpoint being their homeworld. The habitability of planets will vary considerably depending on the species tolerances so a world that is ideal for humans may be uninhabitable for some other species and vice versa. Way back in Part 1 of the tutorial, covering game creation, we entered some values in the Species Tolerance section of the New Game window to set these values for human. As a reminder, those were a maximum deviation in oxygen pressure of 50%, a max deviation in gravity of 70%, a max deviation in temperature of 22 and a max atmospheric pressure to 4.

Fortunately you don't have to remember those as you can find them in the top right of the F9 System View Window. Open it up and take a look. The section is called Environmental Tolerances. The first item is a dropdown showing the selected species while the second shows which gas that species can

breathe. You can have methane breathers in Aurora in which case every reference to oxygen in this tutorial would read as methane. There are four rows below this showing the min/max for gravity, oxygen and temperature and the max for pressure. If you are playing through this tutorial from the start, those values should show that an ideal habitable world for humans will have a temperature between 0 and 44C, an oxygen pressure between 0.1 and 0.3 atm, a gravity between 0.3G and 1.7G and a maximum atmospheric pressure of 4.0 atm.

In addition to the individual species tolerances, the requirements for an ideal habitable world are no dangerous gases such as Chlorine or Hydrogen Sulphide and a maximum oxygen percentage of 30%. A planet that doesn't meet the gravity criterion is uninhabitable and there is nothing you can do about that. Falling outside one or more of the other criteria means the planet will have a colony cost above zero. The colony cost measures the amount of infrastructure required to support the population. The formula for required infrastructure is Population in millions x Colony Cost x 100. So a population of one million on a planet with a colony cost of 2 would need 200 infrastructure. A population of 15 million on a population with a colony cost of 0.8 would need 15 x 0.8 x 100 = 1200 infrastructure. If there is insufficient infrastructure for the population there will be negative growth, with the percentage based on how bad the shortage is, as well as unrest. You don't need to remember the formula as each population will show the max population for the available infrastructure.

Note that you can put ground bases, troops, sensors etc. on any world except a gas giant, regardless of the habitability. If you want an actual population though, which you will need to run shipyards, factories, etc,, then the planet has to be habitable or at least have enough infrastructure for the inhabitants.

The colony cost is calculated in the following way. The five checks below this paragraph are made. Whichever results in the highest colony cost, that will be the colony cost for the planet. You can see these factors in the Colony Cost Factors section in the lower left of the F9 view for the currently selected planet.

1.) If the atmosphere is not breathable, the colony cost is 2.0.
2.) If there are toxic gases in the atmosphere then the colony cost will be 2.0 for some gases and 3.0 for others.
3.) If the pressure is too high, the colony cost will be equal to the Atmospheric Pressure divided by the species maximum pressure with a minimum of 2.0
4.) If the oxygen percentage is above 30%, the colony cost will be 2.0
5.) The colony cost for a temperature outside the range is Temperature Difference / Temperature Deviation. So if the deviation was 22 and the temperature was 48 degrees below the minimum, the colony cost would be 48/22 = 2.18

In the case of Mars, the gravity is OK, the atmosphere is not breathable, there are no toxic gases, the pressure is not too high, there is no oxygen and the temperature is too low. Therefore the colony cost will either be 2.0 for the lack of a breathable atmosphere or the colony cost for the temperature differential, whichever is higher. Assuming the temperature colony cost was 2.18, which would also be the colony cost for Mars, the best way to start terraforming would be to warm up the planet until the temperature colony cost was less than 2.0, at which point the lack of a breathable atmosphere would became the main issue and you could start adding oxygen. Once the atmosphere was breathable, you would go back to worrying about temperature.

Terraformers can add or remove a small amount of a selected gas over time. The amount added is measured in atmospheric pressure (atm). Note that as you add atm for one gas, the percentages of the different gases in the atmosphere will change. A single terraforming module or single terraforming installation with basic tech can add 0.001 atm per year. In other words, it could generate Earth's

atmosphere in about 1000 years. That can be improved by researching the racial terraforming rate and by building more terraformers. Mars and Venus are both hard to terraform because their atmospheric pressure is so different to Earth's. Mars essentially has no atmosphere and you have to start almost from scratch. The first thing you need to do to make an atmosphere breathable is to ensure the atm of oxygen in the atmosphere falls within your species' tolerance for Oxygen. Assuming the tutorial values for human tolerances, on Mars you would need to create enough oxygen to get the oxygen atm to 0.1, which for one terraformer at the basic tech level of 0.001 per annum will take 100 years. If you had twenty terraformers though, it would only take five years. Increasing the Terraforming rate to 0.002 would halve the time. As you may have guessed, terraforming requires a considerable investment of time and resources.

So you get the 0.1 atm of oxygen into the Martian atmosphere. Is it breathable? Unfortunately not because pure oxygen atmospheres are a bad idea. Apart from the unfortunate consequences of striking a match, breathing pure oxygen over long periods causes lung damage. So an atmosphere in Aurora is not breathable unless the oxygen content is 30% or less. So if we need at least 0.1 atm of oxygen and that can't be more than 30% of the total atmospheric pressure, what does that total atmospheric pressure need to be? 0.1 * 100/30 = 0.333, so we need a total atm of 0.334 or another 0.234 atm, which will take another 234 years for the lonely terraformer. This can be any non-Toxic gas. Nitrogen is a reasonable choice or if you also need to change the temperature too, either up or down, you can use a greenhouse gas or an anti-greenhouse gas. For Mars, Carbon Dioxide would be ideal, although you could also use the abstract Safe Greenhouse Gas.

As you add or subtract any type of gas to/from the atmosphere, the atmosphere will be updated and that will also affect the temperature. Every system body has a base temperature and a surface temperature. The base temperature is based on the solar infall from the star (or stars in binary systems) while the surface temperature includes adjustments for atmosphere and planetary albedo (which is the reflectivity of the surface). The formulas used are shown on the Environment tab of the Economics window

Surface Temperature in Kelvin = Base Temperature in Kelvin x Greenhouse Factor x Albedo
Greenhouse Factor = 1 + (Atmospheric Pressure /10) + Greenhouse Pressure (Maximum = 3.0)

So every gas adds a little to the greenhouse factor but greenhouse gases add 10x as much. You get other benefits from warming as well. If the hydrosphere for a planet is Ice Sheet rather than Liquid Water (check the F9 view again), then at a certain point the ice will melt and form oceans. This will change the albedo because the ice that was reflecting heat back into space just melted and you will see a jump in temperature. The amount of albedo change is based on the extent of the ice sheet (F9 again) plus a random factor.

As the pressure increases, you will see the percentages of different gases changing. If there is enough oxygen in terms of atm then once the oxygen percentage drops below 30%, the atmosphere will be breathable

Venus is almost impossible to terraform in Aurora. Each species has a maximum atmospheric pressure (Check F9 again to see yours). Before anything else, you would need to reduce Venus below that point. Assuming your species tolerance is about 4 atm then reducing the Venusian atmosphere, which has a pressure for 100, to that level would take our solo terraformer 96,000 years

You best bet for terraforming is to find a planet where the conditions are much closer to those on Earth. For example, you might find one with the right temperature and sufficient atmospheric pressure but the oxygen atm is 0.08 instead of the required 0.1 (or whatever your min oxygen atm tolerance is). Making this atmosphere breathable would involve adding just 0.02 atm of oxygen, which would take the solo terraformer 20 years, or 1 year for 20 terraformers. Equally, a planet with an already breathable atmosphere that is a little too hot or too cold can be made ideal by adding/subtracting greenhouse gases

or adding anti-greenhouse gas.

Another consideration is Dangerous gases. An atmosphere will never be breathable if it contains gases such as Bromine, Chlorine, Sulphur Dioxide, Methane, Ammonia, Flourine, Carbon Monoxide, Nitrogen Oxide, Hydrogen Sulphide, etc. All these will have to be extracted from the atmosphere by your terraformers

Terraformers can even be used as weapons. If you found a planet where you wanted to loot the industry but you didn't want to bombard or invade, you could slowly extract the oxygen from the atmosphere.

The actual mechanics of using terraforming in the game interface are relatively straightforward. If you have any terraforming installations on a planet or any ships with terraforming modules in orbit, go to the Environment tab, select the gas you want and check the Add Gas checkbox if you want to add the gas rather than remove it. Terraforming installations can be built by industrial capacity and transported to a different planet with freighters. A Terraforming Ship is easy to design. Copy your freighter design, remove the cargo holds and cargo handling systems and add a Terraforming Module (or perhaps two). If you don't yet have Terraforming module tech, you can Instant it or research it using the Research tab of the Economics window. It is under Construction / Production

Chapter 13: Time Increment System

The Time Increment System

This a a very short tutorial section that provides a brief overview of how advancing time is handled in Aurora. Aurora doesn't easily fit into a description of turn-based or real-time as it is a little of both. Aurora has a choice of time increments ranging from 5 seconds to 30 days and you choose which increment to use, usually by selecting from the top row of time buttons on the System Map. Once you select an increment, events in the game will advance by that amount of time, unless there is an interrupt (which I will cover in a moment). Early in a campaign when not much is happening you may be using 5-day or even 30-day increments. During the approach phase of a battle you might select 1 hour or 20 minute increments and when you are under missile attack you will probably select 5 second increments to give your point defence systems the best chance of detecting and engaging incoming missiles.

As an increment play out, various events may occur. These are divided into two types:

1) Interrupt Events. These are the events to which you might want to react, such as detecting a new ship from an alien race, having one of your task groups finish its orders or detecting a missile coming at you. These will interrupt, and therefore shorten, the time increment that you asked for. For example, if you asked for a 1-day update and an interrupt happened 30 minutes into it, the game will only advance 30 minutes then stop so you can change your instructions. These interrupts have an opportunity to occur at the end of every sub-pulse (see below).

2) Informational Events. These are the events that you probably want to know about, but for which you don't want to stop time. One such example is finding minerals due to completion of a geo-survey, or having one of your civilian ships leave your sensor range. These don't stop the game but the message still shows up the next time the game stops.

Each increment is split into movement sub-pulses. For example, if you choose to run a 1 day increment, it will automatically be split into forty-eight 30-minute movement sub-pulses. You can choose to override this and set a larger or smaller sub-pulse if you wish using the second row of time buttons on the system map. The reason for the sub-pulses is because a sensor detection phase takes place after every sub-pulse, which allows you to spot alien ships fairly quickly even when using 1-day increments. If an interrupt event takes place during one of the sub-pulses, then the increment ends after that sub-pulse. So you may a select 1-day increment but the increment might end up being 16 hours or 2.5 hours. There are 229 event types in Aurora and, as described in the previous paragraph, not all of them will interrupt time.

Because the computer-controlled races (NPR for non-player race) play the same way as the player, they too may need a small increment size so sometimes you will select 1-day and an NPR may need 40 second increments because it is launching missiles. In that case, the short increment takes precedence. The program itself may decide to override the player and the NPRs if it determines that something is likely to happen soon. An example might be that missiles are approaching their target or that opposing groups of ships are about to enter detection range. In this case, the program will select a suitable increment size that will override the choices of individual races, including your own.

It is possible that while nothing much may be happening for you, two NPRs have decided to fight to the

death which will result in a long series of short increments. Or an increment may be cut short because an NPR has generated an interrupt event, perhaps because it just detected your homeworld . However, you do have an option called Automated Turns. If you click the automated turns checkbox before clicking an increment size, the program will keep running increments of that size until an interrupt event affecting you. So if two NPRs decide to have a long battle, set automated turns and go and have a cup of tea.

The 5-Day Construction Cycle

You get to build a lot of things in different things in Aurora and the actual construction takes place in what is commonly referred to as the 5-day increment, or 5-day construction cycle. It would affect performance if Aurora updated construction times in every 5 second increment or sub-pulse so instead the game waits until an number of increments have passed that add up to about five days and then runs all the construction code after the normal movement/detection/combat phases for that increment. Because Aurora increments rarely add up to exactly five days between construction cycles, the program uses the actual amount of time that has passed, whether it is 5 days, 12 days or 6 days, 14 hours, 12 minutes and 45 seconds. This means that the amount of 'construction' carried out in each construction cycle may vary a little between cycles. You can choose to change the trigger time for a construction cycle from the standard 400,000 seconds in the game setup if you want it to happen more or less often.

Chapter 14: Leaders

Leaders

You have four leader types, from most important to least important: civilian administrators, scientists, naval officers, and ground commanders.

Civilian Admins handle colonies and oversee sector commands, scientists head research projects, naval officers fly your ships and ground commanders handle ground invasions/defense.

I rank civilian administrators as most important because in the early phase, starting with a good president for Earth means a HUGE difference. They have the most impact on your game because they can speed up alot of things. Scientists are next up because the research bonuses are a must have if you want to get your tech up and running. Naval officers are important, and sometimes, an exceptional officer will give great bonuses to the rest of the officers. Ground commanders really aren't important at all right now, unless you get ones with good diplomacy/espionage bonuses, otherwise, they're expendable.

Leader/Commander Bonuses

You will notice that your various leaders will have certain leader/commander bonuses. There are various bonuses that are of course, more important then others, I will list some of the more important ones.

Civilian Administrators: Wealth Creation, Mining Bonus, Population Growth, Factory Prod. Bonus (These four are good for an Earth president!) Terraforming and Mining Bonus (These two are important for mining colonies where terraforming is taking place)

Scientists: It's a good idea to train scientists (give them a project with a lab) to up their % bonus and admin ratings, having one in every field should be a priority when you're 20 years or later into the game (more on this later).

Administration Rating: Used by Civilian Administrators and Scientists to indicate the size of colony / number of labs they may oversee at one time.

Communications: Used by Task Force Communications Officers to pass orders and coordinate the fleet. Important if you use 'Inexperienced Fleet Penalties'. Also assists in attempting to establish communications with alien races.

Diplomacy: Used my Diplomatic Team members to make other races/empires like you (or hate you less). Important if you ever want to do anything other than conquer & destroy. Also used by Task Force Public Relations officers to convince the gullible public that your ships are better than they are, and up their perceived Planetary Protection Value.

Espionage: Used by Espionage Team members to steal info from (designs, technology, survey data) and sabotage (installations) other races/empires, and to defend your empire from such activities by others.

Intelligence: Used by Task Force Intelligence Officers to discern enemy capabilities, interpret sensor data, and identify enemy classes & ships. Basically, everything found on the Ctrl F5 'Intelligence & Foreign Relations' window that isn't 'Political Relations'. Also used to interrogate captured enemy personnell.

Logistics: Used by Ship Commanders, PDC Commanders, Task Force Logistics Officers and Civilian Administrators to decrease the loading/unloading time* of their ships/PDCs/Task Force members/any military unit at their colony, or any civilian unit if the colony has a civilian spaceport.

- Of cargo, passengers, cryo tubes, Marines, ammo, fuel, and maintenance supplies - assuming Steve remembered to program it in for all those topics. Occasionally we discover he missed something, or added something new.

Operations: Used by Task Force Operations Officers to coordinate the fleet. Important if you use 'Inexperienced Fleet Penalties'. Also used in 'Task Group Training' to overcome said penalties

Survey: Also used by Geological Team members to discover additional, overlooked TNE on colony worlds and Task Force Survey Officers to grant a bonus to the Survey efforts of all ships in the Task Force in the same system as the TFSO.

Xenoarcheology: Used by Xeno Team members to investigate alien ruins, identify the builders, and designate 'recoverable' tech, installations, or components. Also used by Engineering Reg't (Brigade) commanders to recover the aforementioned items and put them into working order.

Wealth Creation: Used by Civilian Administrator to increase the 'wealth points' generated by population & Financial Centres under their control.

Crew Training Bonus: Used by ship commanders. The number of grade points that are added annually to the ship that this officer commands. The effects of grade points are listed in the Crew and Grade section of the rules

Factory Production Bonus: Used by planetary or sector governors and commanders of construction and salvage ships. Provides a bonus to the construction rate of construction factories, ordnance factories, fighter factories and fuel refineries for a population if this officer is the planetary governor. If the officer is a sector governor, every planet in the sector receives 1/4 of his bonus. For construction ship or salvage ship commanders, the time required to build a jump gate or salvage a wreck is reduced by the size of the bonus Fighter Operations Bonus**: Used by carrier commanders. Reduces the time required to rearm and refuel fighters**

Fleet Movement Initiative Rating: This indicates the level of initiative shown by the commander when it comes to maneuvering a fleet. A fleet or fighter group can have its initiative set at any level up to that of its commander. As fleets/FGs move in ascending order of initiative, this can be very useful when trying to intercept another fleet or fighter group.

Ground Combat Bonus: Used by ground unit commanders. Increases the strength of a ground unit by the bonus. If the officer is the senior HQ commander on the planet, his bonus applies to all ground units. Otherwise, it only applies to the unit directly under his command.

Ground Forces Training Rating: Used by the senior ground HQ commander on a planet. The annual chance that a randomly selected ground unit on the planet will receive an increase in morale of 1-10 points.

Ground Unit Construction Speed Bonus: Used by planetary or sector governors. A bonus to the rate at which ground troops are trained at the population if this officer is the planetary governor. If the officer is a sector governor, every planet in the sector receives 1/4 of his bonus.

Mining Bonus: Used by planetary or sector governors and commanders of mining and harvester ships. Provides a bonus to the production rate of mines and automated mines in a population for which this officer is the planetary governor. If the officer is a sector governor, every planet in the sector receives 1/4 of his bonus. For mining ship or harvester commanders, provides a bonus to rate of mineral or fuel

production

Political Bonus: As well as being useful in a number of different ways, all bonuses increase the chance that a commander will be promoted and larger bonus provide a greater chance. The political bonus is an exception. It has the greatest influence of all bonuses on the chance of promotion but serves no other useful purpose. This is to simulate that sometimes the ability to create the right impression is a lot more important when it comes to promotion than actual skills.

Population Growth Bonus: Used by planetary or sector governors. Provides a bonus to the population growth rate for a population if this officer is the planetary governor. If the officer is a sector governor, every planet in the sector receives 1/4 of his bonus.

Research Bonus: Used by planetary or sector governors. A bonus to the number of research points produced by the population for which this officer is the planetary governor. In addition, if the planet is currently researching a project that falls within the planetary governor's research specialization, the bonus is quadrupled. If the officer is a sector governor, every planet in the sector receives 1/4 of his bonus.

Shipbuilding Bonus: Used by planetary or sector governors. A bonus to the Shipbuilding rate for the population for which this officer is the planetary governor. If the officer is a sector governor, every planet in the sector receives 1/4 of his bonus.

Survey Bonus: Used by survey ship commanders. A bonus to the number of grav or geo survey points generated by the ship that this officer commands

Terraforming Bonus: Used by planetary or sector governors and the commanders of terraforming ships. Provides a bonus to the amount of gas produced or removed. Applies to all terraforming installations for a planetary governor and an individual ship for the commander of a terraforming ship. If the officer is a sector governor, every planet in the sector receives 1/4 of his bonus.

Team Bonuses

Each of these bonuses is used when a commander becomes a member of a team. A team comprises five members and the rating of the team is equal to the sum of the appropriate bonuses of its five members. The current teams are: Archaeological, Diplomatic and Cybernetic. A fourth team, Espionage, will be added a later date but the bonus for the commander is already in the game.

All the non-team bonuses have a chance to increase with experience and the bonuses that increase will be related to officer's current assignment. For example, an officer commanding a survey ship can advance in Crew Training, Fleet Initiative or Survey Bonus whereas a carrier commander could advance in Crew Training, Fleet Initiative or Fighter Operations. A planetary governor may advance in any of the skills that influence a population. Teams gain experience through successful actions. For example, a diplomatic team concluding a treaty or an archaeological team discovering a new tech will increase the team rating a little. - Steve Walmsley

(Version 5.02) The current teams are: Espionage, Diplomatic, Xenologist, Geology.

Assigning a staff position to naval officers

Go to the ranks and Seniority box in the upper left select Naval Officers. Select a #4 officer or higher.

Then go to the Potential Assignments area, and select the staff officers area.

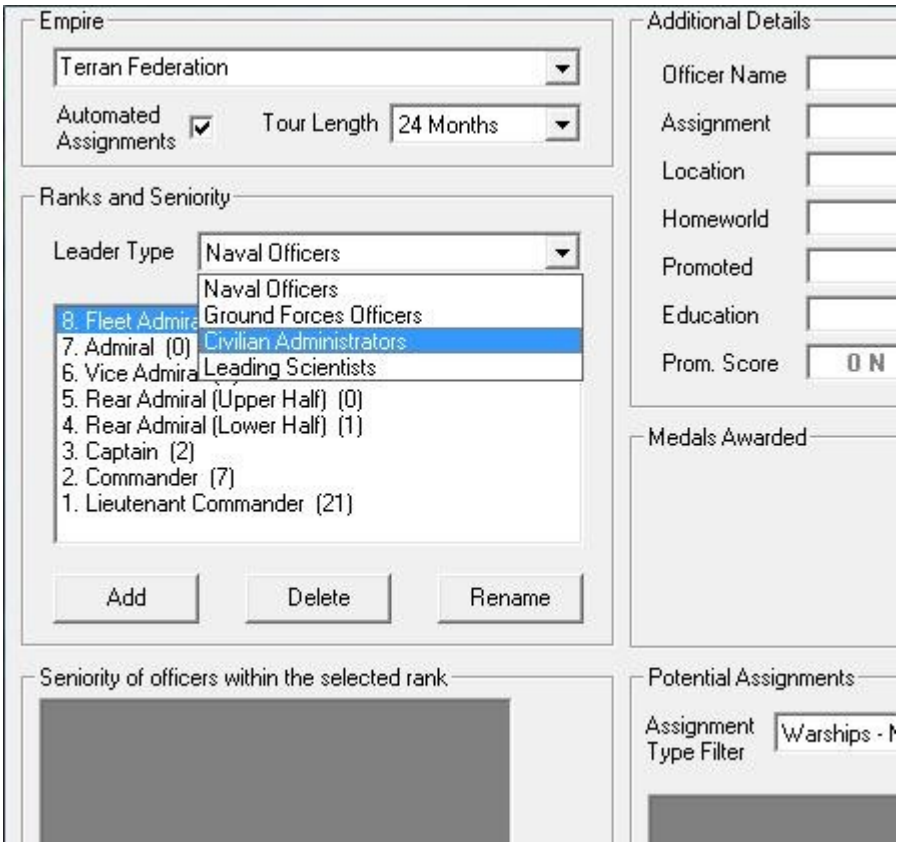
Here you can assign staff positions, these officers grant a bonus to the entire system they are in for fleets.

Select your #4 rating officer or higher and the position you want him in, and then in the lower right click assign.

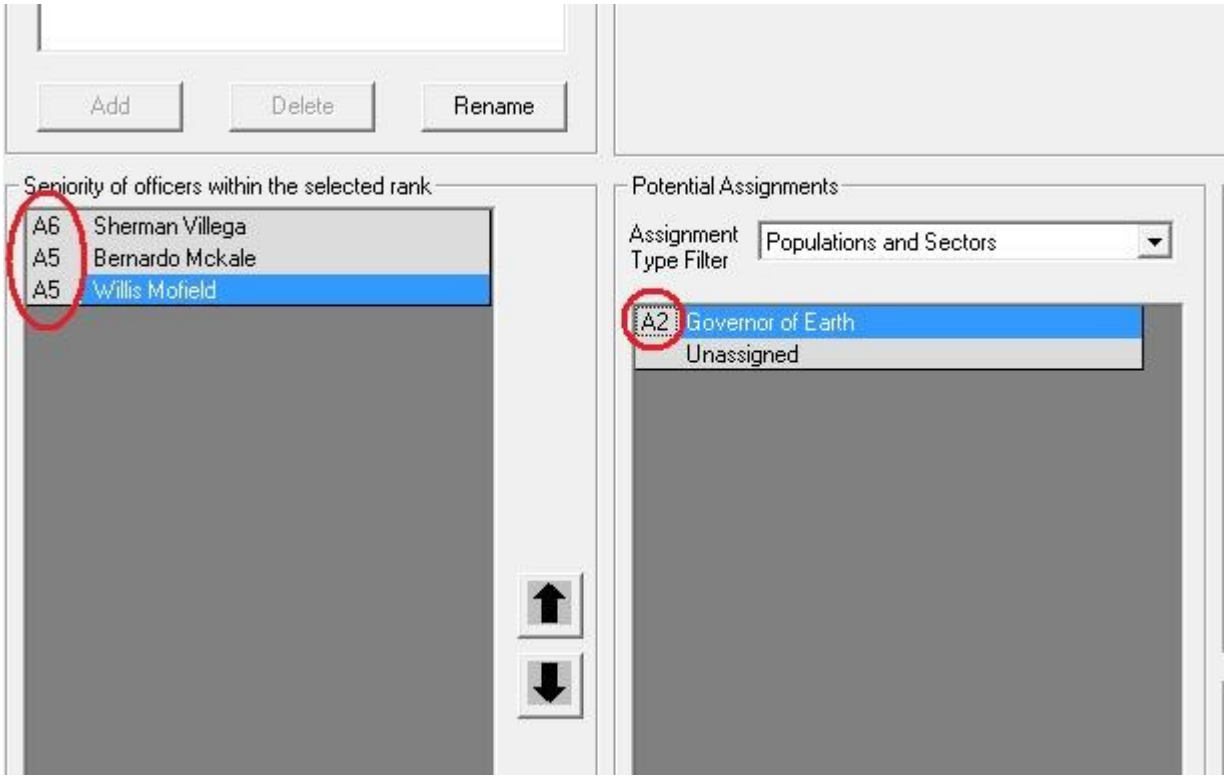
Assigning a Planetary Governor

1. Press F4 to Open the "Leaders" game window.

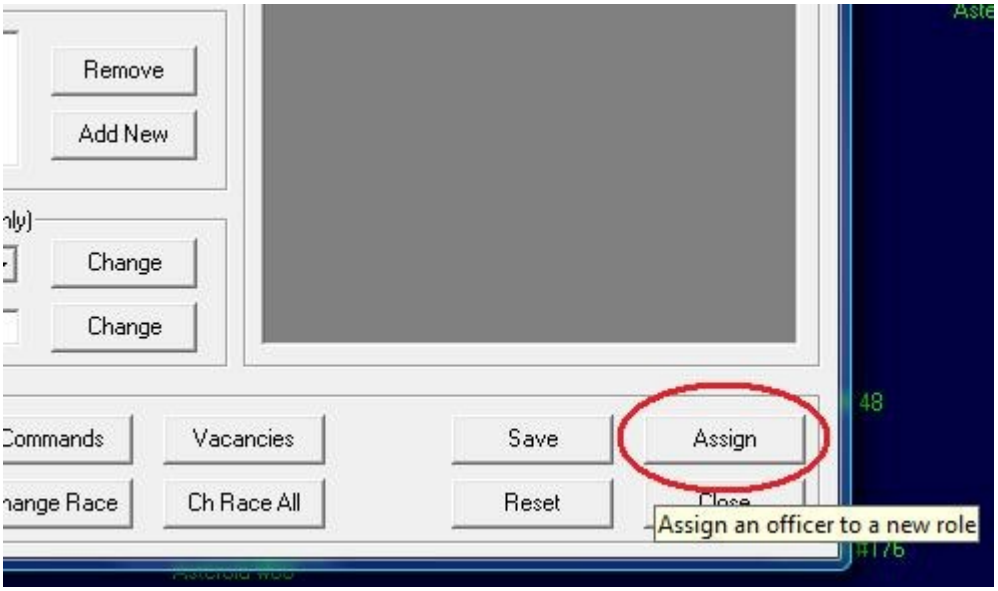
2. Go the "Leader Type" Drop down list in the upper left, and select "Civilian Administrators"



3. In the far left list titled "Seniority of officers within the selected rank", click on the leader you wish to assign. The selected leader's statistics will display in the upper right. Then, in the "Potential Assignments" segment in the middle of the window, click the planet you wish to assign the administrator to. Ensure the "A#" rating of the administrator is greater than or equal to the "A#" rating of the planet.



4. Once you have chosen a suitable leader and assigned planet, click the "Assign" button in the lower right. This will perform the actual assignment of the administrator. You can undo this action by clicking "Reset".



5. The background of the chosen administrator and selected planet will turn white, indicating they now have assignments. Additionally, the administrator's information at the top of the window will now reflect the new assignment.

Realistic Promotions Setting

Realistic Promotions

As an optional rule, the game will handle promotion of commanders. If this rule is used, the player has no control over when officers are promoted as he is assumed to be the Emperor and promotions are handled at a lower level.

During each 5-day increment, the game checks all ranks of each player's military. The number of officers in each rank is checked and then the rank above them. If the next higher rank has less than a third of the number of officers as the current rank, a number of officers are selected for promotion to bring the numbers up to one third. For rank 5 or higher, one half is used instead of a third.

When promotion is possible, each officer is rated for promotion using the following scoring system:

For most percentage bonuses, the officer scores equal to the percentage bonus squared. So an officer with Mining 10% would score 100, an officer with Survey 20% would score 400 and an officer with Research 30% would score 900

Certain bonuses are not really as useful in game terms so the percentage is halved before any calculation is performed. These include Terraforming Bonus, Ground Combat Bonus and Ground Unit Training Speed Bonus. So an officer with 30% Ground Combat Bonus would score the same as someone with 15% Mining.

The Political Bonus is more useful than any other for purposes of being promoted. Therefore it is treated as being 1.5x its actual value. So a 20% Political Bonus would be the same as a 30% Mining Bonus

For Crew Training Bonus, an officer scores equal to the bonus/5 squared. So an officer with a bonus of 50 would score 100, an officer with a bonus of 100 would score 400, etc.

For Ground Unit Training Bonus, an officer scores equal to the bonus/6 squared. So an officer with a bonus of 50 would score 70, an officer with a bonus of 100 would score 278, etc.

An officer gains a score equal to half his Initiative Rating

An officer gains 100 points per year spent at his current rank.

If an officer currently has an assignment, he gains 100 points

Once all the commanders have been given their promotion rating, a number of officers equal to the available number of promotion slots are promoted in order of descending promotion rating.

If this rule is in effect, a new race's starting commanders are created by the program and assigned appropriate ranks.

The idea of this rule is to reflect reality a little more in that you can't just take a capable officer and promote him several ranks in one go. He has to be watched as he comes through the ranks. However, for this realistic promotion to have any meaning, potential assignments have to be restricted. Therefore only certain ranks of officer are allowed to command a particular type of ship or a certain size of population. The command level for ships can be overridden on the class window but this should be treated with care for role playing reasons.

For example, an unarmed ship with no survey capability or jump drive could be commanded by any officer. A ship with a jump drive or survey capability requires a officer of rank 2, a large warship would require rank 3, etc. Fighter Squadrons require at least a rank 2 officer and rank 3 for squadrons above a certain size. Planets require an governor with a rank based on the signature rating of the population. This means you won't be able to just put all the best officers in the best slots (and promote them

immediately) and you will need to make do with what is available until the better qualified officers gain sufficient rank and experience.

Tips and Misc

1. It is important to build military academies, as they increase the number of admins/scientists/officers you get per year. I like to play conventional starts, and by year 20-25, I tend to have a military academy of 10. This guarantees a good future president to take over and gives you a nice stream of expendable naval officers and the rare genius scientists with 30% bonus (Which can open up many options for you in a short amount of time, like research a bunch of missile techs and getting a missile ship up in 5~ years)

2. When you have prospective colonies up, even with no population, go ahead and assign a good civilian administrator up to train his/her skills. This is really important, just in case your president on Sol dies early, you'll have a runner up who has been polishing his civilian bonuses.

3. Research the sector command tech ASAP, it allows you to build a sector command and assign a civilian admin to that position, which bestows bonuses on top of your planetary governor. This makes a big difference in the long run.

Chapter 15: Point Defense

Point Defense

Point Defense is the defense of a small area or object, and it is used to counter missiles, small ships, fighters that come into firing range.

Layers of point defense

A effective point defense system requires 3 layers to defend a fleet properly from the inevitable missile's attacks.

PD Missiles:

These are Missiles to counter Missiles, your first screening of incoming Missiles is made with these.

Generally these are missiles with alot of Speed and Agility to increase to hit chance and low damage and low fuel.(unless required for some odd reason)

Example below.

Point Defense Missile Designs

Mid range PD Missile	Short Range PD Missile	V. Short Range PD Missile
.2 Warhead	.2 Warhead	.2 Warhead
.4 Engine	.4 Engine	.44 Engine
.1 Fuel	.05 Fuel	.01 Fuel
.3 Agility	.35 Agility	.35 Agility

Warheads

The warhead size can vary depending on your tech level and the missiles the enemy is using against you so dont blindly follow my design decision with warheads, 1-2 dmg seems to work well afaik.

Engine and Agility

Engine and Agility are going to help the most to actually hit a fast incoming missile. While range doesnt need to be long to get to enemy missiles before they close with your ship unless you are short on ships, then more range would help you intercept more before they get into close range.

Fuel

The lower the Fuel the missile has the better its performance capabilities become and the higher to hit chance it gets due to redistribution of points. Things to always think about!

Ship Mounted Turrets:

With small rail guns, lasers, Gauss Cannons, and meson cannons mounted you can have a high tracking speed short-mid ranged weapon for Missile Interception. They can be dual use as well at short range against enemy fighters or ships that dare close in with your Point Defense mounting ships.

Ship Mounted Turrets can actually provide an inner 3 layers or more of PD fire if you so choose for the fleet by staggering weapon ranges.

You can have a mix of lasers, gauss, railgun and meson to destroy missiles at 3 distinct layers in the defense of the fleet.

Basic Examples below of fleet defensive turrets for use against missiles, Tracking speed can increase or decrease depending on what you require of course.

```
Twin 10cm C3 Near Ultraviolet Laser Turret
Damage Output 3x2      Rate of Fire: 5 seconds     Range Modifier: 3
Max Range 90,000 km    Turret Size: 8    Armour: 0    Turret HTK: 2
Power Requirement: 6    Power Recharge per 5 Secs: 6
Cost: 50    Crew: 60
Maximum Tracking Speed: 10000km/s
```

```
Twin Gauss Cannon R4-100 Turret
Damage Output 1x6      Rate of Fire: 5 seconds     Range Modifier: 4
Max Range 40,000 km    Turret Size: 15    Armour: 0    Turret HTK: 4
Cost: 87    Crew: 48
Maximum Tracking Speed: 10000km/s
```

```
Twin R3/C3 Meson Cannon Turret
Damage Output 1x2      Rate of Fire: 5 seconds     Range Modifier: 3
Max Range 30,000 km    Turret Size: 8    Armour: 0    Turret HTK: 2
Power Requirement: 6    Power Recharge per 5 Secs: 6
Cost: 18    Crew: 60
Maximum Tracking Speed: 10000km/s
```

If you increases the size of the laser focal size to 12cm you gain another 30,000 range, so you can have multiple laser hit ranges and stratify your Point Defense layers even more.

Point Defense Modes

You can select a fire control and put it on a automated Point defense firing mode.

Area Defense

Area defense occurs during the normal weapons fire segment. If the missile can cross the engagement range of a PD beam during a single movement then it will not be engaged.

Final Fire

Final defense occurs during the movement segment when the missile's should intercept their target.

So the instant before the missile hits, Final Fire mode activates and begins firing at the missiles point blank.

CIWS:

Close In Weapon System's are your final firing system against missiles. By the time that Missiles reach this point you should have very few missiles left to intercept, hence this layer of your defenses may see very little use or be overwhelmed.

These fire from 1,000 km and into your ship, a very short period of time.

Examples of a Complete Point Defense setup on a fleet

My fleets generally are very specialized into their job.

So I have a PD missile ship(long ranged), (mid Range) Area Defense PD ship and a (short ranged) Final Fire Laser PD ship

What you are wanting to do here is have your PD missiles to hit the incoming missiles multiple times before Ship Strike. Then have Area Defense ship with long range Lasers hit atliest twice before Ship Strike, then your Final Fire (and most accurate) will hit one last time before your ship is hit by a single missile.

(example ship) (example ship) (example ship)

Comments

Ideally, any PD weapon would have a rate of fire of 5 seconds. Missile PD can get away with 10 or even 15 seconds, but most likely not more than that. However if you happen to know that this particular enemy fire salvoes of very fast missiles every 40 sec you may want to have some burst Final Fire capability every 30-40 sec rather than wasting short ranged turret RoF when there are no missiles in range 80% of time.

Chapter 16: Armour and Shields

Armour

Armour is skin of the fleet, and it is by this skin that the fleet survives. Armour costs the same per strength point at the first rating (thickness) as it does at the last. However, it takes more armour to cover the ship the thicker the armour is since the ship is becoming larger with each added layer. This can be helped quite a bit by Armour tech increases. Armour has positive and negative sides, as follows:

Positive

- Armour has a great strength per ton ratio compared to other ship components.
- A ship with more armour rating can take much (deeper) hits from lasers and still have its internals intact.

Negative

- Armour slows a ship down with its weight.
- Armour adds to the breakdown chance of a ship.

General Armour and Shields Info

Now Armour's main issue is that it slows down your ship, but large heavily armored ships aren't meant to chase down the enemy and beat them, they are to meet the enemy's attack head on and beat them off while surviving the battle.

Armour on smaller ships is where this issue lies. Small ships under 10,000 tons require minimal Armour to reach high speeds.

These ships can also be considered of negligible risk to use as well so it is fine to armour them lightly for the possibility to close with

the enemy and unload their lethal cargo all the sooner. But they need to actually close with the enemy without dying which bring about the age old problem: Armour, Speed,or Firepower. Pick 2.

Ok so here we are.

I have Armour rating 13 on my ship now, that is a total weight of 4585 tons. providing a total of 1100.4 Armour strength

If i did that Tonnage amount in shields (3 strength 300 recharge shield) I would have only 276 shield strength!

92 shields x 50 weight each = 4600 tons, and the cost is actually just slightly cheaper than armor at that weight amount, 100 less cost.

but those 92 shields will regenerate 1 shield strength each every 100 seconds. (total recharge time is 300 seconds for a 3 strength shield)

so that is 92 damage you wont be taking against normal weapons every 100 seconds. Using some simple math, we know over the course of a 100 second battle,even if your shields were brought to 0 from the get-go, you'd absorb an additional 92 damage. This makes shields a good buffer for enemy attacks,especially against "Sandblaster" tactics, where high-ROF weapons are used, rather than slow-firing armour-piercing attacks. Shields also absorb all damage given to them, instead of allowing

"piercing" like armour does, shields will ALWAYS attempt to protect the ship from impacts or beams, even if they are thin.

BUT 276 total shield strength is... very anemic. that is only 50x6 strength missiles to blast right through! That is just 1 salvo from some NPR's! If you were relying on this alone against NPR's your ships would be fodder.

the break even point for these shields would be around a 800 second battle with very slow enemy attacks allowing you to recharge your shields. This almost never happens, though.

Types of Armour

Component armour

Turrets, magazines, power plants, engines, fuel tanks, etc) the armor on these components reduces the chance that a point of internal damage will destroy one HTK point on the component. The chance is equal to (armour) / (armour + HTK), so 2 points of armour on a 3 HTK turret means 40% of the time it will be undamaged by a hit.

Note that all internal damage is applied one point at a time.

Weapon Penetration Data on Armour

Lasers dig deeply into armor in a single spot they hit.

Missiles spread large triangular damage formation.

Mesons pass through with no effect.

High Power Microwaves pass right through with no effect.

Shields

Shields are the buffer between the armor and the incoming weapons fire.

Shields have a few positives and negatives as well.

Positives

Regenerate at variable speed depending on technology researched.

While they are up and running, require no maintenance to repair as they take damage.

They block High Power Microwaves giving protection to your sensors and fire controls.

Unlike armour you can prefabricate shields separately at construction factories and thus considerably reduce the ship's overall construction time.

Negatives

Strength per ton is much worse than armor at every point.

Nearly same cost as armour for worse protection.

There is no time to ready shields if you are taken by surprise e.g. after a Gate jump.

They give away your position to passive EM sensors.

General Shield Info

For weight they arent worth it at all when alone, and other than for ships that are large and meant for decade long voyages through enemy space you should think carefully about your approach to using them en mass.

shield strength tech goes from 1-15 per shield generator and recharge.

By lvl 5 strength you begin generating a noteworthy amount of protection along with recharge.

5x20 = 100 shield strength for 1000 tons

By lvl 10 strength you have a fairly decent protective field around the ship per generator. Take into account that with lvl 10 shield recharge you would have

10x20 = 200 shield strength at 1000 tons. That is the point where you can start exchanging shields for armor and easily shields would do better than armor due to regeneration technology as long as the enemies salvo's of missiles werent all bunched into a single giant strike.

each shield generator regenerates 3.3 damage per second, with 20 shield generators thats 66 dmg every 100 seconds. not too bad for only 1000 tons of shields. every 100 seconds you could be absorbing plenty of extra damage.

This also protects you from minor conflicts forcing you to use up maintenance supplies repairing the Armour on the hull.

Weapon Penetration Data for Shields

Mesons pass through shields unaffected.

High Power Microwaves do 3 damage to shields for each point of standard damage they do.

Combining Armour and Shields

A effective ship should have a mix of Armour and Shields.

Armour is always more cost effective at all levels than shields for just plain Strength.

However no damage leaks through shields (except for meson) while they have some strength left, while armour leaks even if it has 95% of its strength left due to lucky hits and certain deep cutting weapons like Lasers.

A very good idea to base a shield + Armour combo off of is the following.

You can create a damage reducing shield barrier that constantly recharges and reduces the damage done and thereby the Depth of damage done by Lasers (which gouge deeply) and Missiles (which make a big wide hole but the more damage the wider and deeper it makes it)

so if you have 20 shields x 5 strength with recharge rate 300 seconds, every 100 seconds you could bring each shield back up to 1.6 strength x 20 and reduce incoming laser and missile strikes on the armor by 32 damage every 100 seconds!

This only gets better with higher shield technology and can provide quite a buffer for the Armor Rating. Allowing a player to lighten his ships for increased speed or more firepower in a weight range.