

Aurora C# unofficial manual

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Part I

Introduction

1 What is Aurora C#

Aurora C# is turn-based 4X¹ computer game made solely by one man, Steve Walmsley as a hobby project in his spare time. It's modern version of its predecessor „Aurora 4X” (sometimes called „Aurora VB6” from Visual Basic 6, the language it was written in). Aurora C# is written in C#, a more modern programming language which resulted in a dramatic increase in performance.

Aurora C# is free game distributed thru forum under address <http://aurora2.pentarch.org/> where you can find more information about game and ask questions about mechanics to more experienced players and the developer himself.

2 About this document

This document wasn't be possible without Steve Walmsley who wrote devlogs during game development and forum community, especially user named Demonides who gave idea and started consolidation of information scattered around forum and Father Tim for helping.

This document is based on his and others work. Thank you! You can find original topic here: [C# Aurora Changes List v1.12 / Table of Contents](#)

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¹4X - eXplore, eXpand, eXploit, eXterminate

Part II

Diplomacy

3 Basic Framework

Original post can be found [here](#).

Diplomacy module

The Diplomacy Module is new for C# Aurora and replaces Diplomatic Teams. It also affects communication attempts. The module is 30 HS, costs 300 BP and requires 50 crew. The minerals required are Corbomite, Mercassium and Vendarite. It is a starting technology in both TN and conventional starts.

Communication

For communication checks to take place both sides must have ships and/or populations in the same system and both sides must be able to detect the other. Communication checks will only take place if both sides have a status of „Attempting Communication“. In other words, you can't translate their language if they refuse to talk to you. Diplomacy cannot take place until full communication is established. Alien races may take exception to your presence in this situation, based on a number of factors will be covered in a future post.

For communication attempts, the highest Communication bonus of any commander of a ship with a Diplomacy module in one or more of the contact systems will boost any positive results achieved through the communication process (which is otherwise the same as VB6). If no Diplomacy module is present in any of the contact systems or the commander has no communication bonus, any positive gains toward full communication are halved.

Basic diplomacy

Basic diplomacy follows similar principles to VB6 Aurora. Actions by each side generate positive or negative diplomatic points. As the total of diplomatic points goes above or below certain thresholds, high level treaties (trade, sharing of data, etc.) are put in place and the general level of cooperation changes (hostile, neutral, friendly, allied).

The primary method of generating diplomatic points is via the Diplomacy module. The module must be located in a system where the target alien race has ships and/or populations and both sides must be able to detect the other. Diplomacy can only take place when full communication has been established. The highest Diplomacy bonus of any commander of a qualifying ship is used. The number of points generated per year is as follows:

$$DiplomacyPoints = (DiplomacyBonus * 4 + 1) * 100 * (1 - \frac{TargetRacialXenophobia}{100})$$

For example, an officer with 20% Diplomacy trying to influence an alien race with Xenophobia of 40 would have the following calculation: $(0.2 * 4 + 1) * 100 * 0.6 = 108$ Points.

If there is contact but no Diplomacy module in a contact system or the commander has no Diplomacy bonus, then no points are generated from this process (although other factors may generate points - covered in a future post).

If there is no contact at all, even via civilian ships, then Diplomacy Points will move toward zero, from either direction. The annual rate of change is the Xenophobia of the viewing race when the starting point is positive and $100 - \text{Xenophobia}$ when the starting point is negative. For example, the view of a race with 25 Xenophobia will only fall 25 points when the starting point is positive but will rise by 75 points when the starting point is negative. Low Xenophobia races are quicker to forgive transgressions and vice versa.

Existing treaties or diplomatic statuses will improve relationships over time. Different treaties have a base influence that is measured in diplomatic points per year multiplied by $1 - \text{RacialXenophobia}/100$. For example, a trade treaty has a base influence of 100 diplomatic points per year. If two races have respective Racial Xenophobia of 30 and 60, then while a treaty is in place the view of the first race will improve by 70 diplomatic points per year while the view of the second race will improve by 40. It takes longer to build trust with higher Xenophobia races.

Trade, Geological and Gravitational treaties all have a base influence of 100. A research treaty has a base influence of 200. A diplomatic status of friendly has a base influence of 100, while a diplomatic status of allied has a base influence of 200.

Positive and Negative diplomatic points will be gained through other events, many of which will be defined in future posts. An example of a negative impact is combat. Negative diplomatic points are suffered due to damage inflicted by an alien race using the following rules:

Each point of damage from a hit that only damages shields: 0.1

Each point of damage from a hit that causes armour damage but not internal: 0.25
Each point of damage from a hit that causes internal damage: 1.0
Each point of space-based damage to populations, ground forces or shipyards: 1.0
Each ton of ground forces destroyed in ground-based combat: 0.01

If diplomatic relations are above the hostile level (-100), then even a single point of damage through combat will reduce relations to that point. However a period of mutual non-interaction following a small clash will probably return the diplomatic status to neutral. For example, if communications are established you may ask a survey ship to leave your system (mechanics in a future post). If that didn't work or you did not have communication, you can slightly damage that ship. An unarmed ship would retreat from hostile aliens and the immediate impact would be the alien race treating you as hostile. However, with no further combat in the short term, the status would soon return to a wary neutrality. Future communication and diplomacy would still be an option. Larger wars are harder to resolve but peace treaties will be covered in a future post.

4 Intrusion into NPR territory

Original post can be found [here](#).

In each construction phase, each NPR will determine a value for each known system. In order of ascending importance, the values are: Alien Controlled, Neutral, Claimed, Secondary, Primary, Core, Capital. The value is calculated on a number of different factors, including existing population and installations, whether it is a logistics node, mining potential, terraforming potential and proximity to other important systems. Neutral is the default state for a system in which the NPR has no current interest, while Alien Controlled is a system which the NPR acknowledges is in the territory of another race as a result of accepting a claim from that race (see section 5).

If you have forces or a population in a system that has at least Secondary value to an NPR, you are detected and you are currently viewed as neutral or friendly, the NPR will issue a warning which will appear as an event. This will still happen even if you haven't detected any NPR forces. You will be notified which fleet or population received the message. If communication has not been established, you will receive notification of an „unintelligible communication of unknown origin“. If you have established communication, the text will reflect the severity of the situation.

This communication can be as mild as a suggestion that your forces leave in the near future and as strong as demanding you depart immediately or be fired upon. There are five levels of severity for messages and the one chosen by the NPR primarily depends on the 'Threat Level' (see below), although it may also issue a stronger warning at lower threat levels if the NPR believes that war will soon follow without a player withdrawal.

The threat level is based on three factors; the NPR's estimate of the value of the system, any status modifiers due to the existing diplomatic relations and the Xenophobia of the NPR. This is calculated as follows:

$$ThreatLevel = BaseThreatLevel * StatusModifier * \frac{RacialXenophobia}{100}$$

Base Threat Level	
Secondary	2.5
Primary	5
Core	10
Capital	20

Status Modifiers:

Friendly Status = 0.5

Neutral with Diplomatic Points ≥ 1

Neutral with Diplomatic Points $< 0 = 2$

In addition to the messages, the threat levels generate a negative impact on diplomatic relations. The penalty in diplomatic points for intrusion into NPR territory is based on the Threat Level above plus the ships and population that the NPR can detect. The calculation for the annual point penalty is as follows:

$$DPP^2 = \sqrt{TotalDetectedShipTonnage + TotalDetectedPopulationEMSignature * 10 * ThreatLevel}$$

Each construction phase, the diplomatic penalty applied is equal to the annual penalty multiplied by $\frac{ConstructionPhaseLength}{Year}$

²DPP - Diplomatic Point Penalty

Shipping Line vessels will be ignored for this purpose if a trade treaty is in force. NPRs will treat ships without military engines that have not demonstrated any weapon capability as 10% of their normal tonnage. If at least one ship is detected, the minimum rating for Detected Ship Tonnage will be 1000 tons. If at least one population is detected, the minimum rating for Population EM Signature will be 100. NPRs deduct 10,000 tons from the tonnage of one Diplomatic Ship (see section 10) per system for threat purposes if that class type has never fired weapons and the Diplomatic Ship is in a non-Core system. If the NPR only has one system, it is not treated as core for this purpose.

This table shows the diplomatic point penalties for different ship tonnages in different value systems, assuming an NPR Xenophobia of 50. For populations, use EM Signature * 10 for 'Tonnage'.

		Annual Diplomacy Penalty				Construction Phase Penalty			
Tonnage	$\sqrt{\text{Tonnage}}$	Secondary	Primary	Core	Capital	Secondary	Primary	Core	Capital
1000	31.6	39.5	79.1	158.1	316.2	0.5	1.1	2.2	4.3
3000	54.8	68.5	136.9	273.9	547.7	0.9	1.9	3.8	7.5
10000	100.0	125.0	250.0	500.0	1000.0	1.7	3.4	6.8	13.7
30000	173.2	216.5	433.0	866.0	1732.1	3.0	5.9	11.9	23.7
100000	316.2	395.3	790.6	1581.1	3162.3	5.4	10.8	21.7	43.3
300000	547.7	684.7	1369.3	2738.6	5477.2	9.4	18.8	37.5	75.0
1000000	1000.0	1250.0	2500.0	5000.0	10000.0	17.1	34.2	68.5	137.0

The warning message is issued during the first construction phase after detection and repeated during each subsequent construction phase where the violation still exists. Allied Races do not receive warnings as they can freely enter the NPR territory. Hostile races do not receive warnings as they are attacked instead. Trading will allow some exceptions to the rules above and I'll cover that in a future post. I will also cover situations where the NPR considers claiming a system with a large existing player population in the 'Alien Controlled' update.

5 Claiming systems from NPRs

Original post can be found [here](#).

In the same way that NPRs can warn players to leave a system, a player can warn an NPR. On the Intelligence and Foreign Relations window, there is a tab for Known Systems for each NPR. You can select a system and then set a 'Protection Status' for the selected system in connection with the selected NPR. Alternatively, you can set a protection status for the system on the galactic map and that status will be set for any alien race when they are first detected in the system. The six statuses are shown below with their 'Demand Number' (0-5) and their 'Demand Strength'.

Protection Status	
0	No Protection: 0
1	Suggest Leave: 1
2	Request Leave: 1.41
3	Request Leave Urgently: 1.73
4	Demand Leave: 2
5	Demand Leave with Threat: 2.24

If you set a status for a specific combination of system and NPR, then if that NPR is detected by you in that system during a construction phase it will be informed of your demand unless it is already allied or hostile.

The impact of the message on the NPR decision to accept or reject your demand is shown by the 'Demand Strength' in the list above, which is the square root of the 'Demand Number'. A Request is 41% more likely to work than a Suggestion, while a Demand with Threat is 2.24x more effective than a Suggestion. The Demand Value represents the idea that, from the perspective of the NPR, the forcefulness of your language may represent a willingness to use force.

While the strength of your demand plays a part in the NPR decision, it also has a significant effect on relations with that NPR. So a higher demand might increase the chance the NPR will leave, but it also increases the chance of starting a war. If you demand the NPR leaves a system it doesn't care about you will cause fairly minor damage, but you could have made a polite request and it may have left with hardly any impact on relations. If you demand an NPR abandons what it regards as a primary system, that might work if you have a significant military advantage and the NPR is aware of it, but it might also cause the NPR to open fire immediately.

System Values	
Neutral	1
Claimed	2
Secondary	3
Primary	4
Core	5
Capital	6

This relationship impact is equal to

$$Impact = DemandNumber^2 * SystemValue^2 * \frac{Xenophobia}{50}$$

So a demand to leave a primary system would have the impact of $256 * Xenophobia/50$, while a request to leave a claimed system would have an impact of only $16 * Xenophobia/50$.

The demand will be rejected if the NPR has not detected populations of your race with a total EM signature of $10 * Xenophobia$ or more. The NPR will base this on actual populations, not currently detected populations, as it is assumed you will provide the necessary evidence to back up your demand.

Otherwise, the demand will be accepted based on Demand Value plus the following additional factors:

Accessible System Value

For each system that would no longer be accessible if the claim was accepted, including the target system, a value is assigned equal to $SystemValue^2/4$. For example, a Claimed system is worth 1, a Secondary system is worth 2.25, a Primary system is worth 4, etc. Each individual system value is calculated first and then the results are summed.

Military Advantage

This assessment depends on the total size of your military forces that have been detected by the NPR during the last five years in comparison to its own (with an assumption of some as-yet-unseen forces) and its assessment of relative technology based on its observation of your ships. I don't want to go into too much detail on the Player Military Advantage, but if the NPR believes the racial balance of forces is equal, Player Military Advantage will be equal to 1. For the NPR to believe you have an advantage, it will need to see some firepower. This is based on total known forces, not local known forces, so generating a high Military Advantage number is difficult unless you show off a large portion of your forces. You won't be able to simply send in a survey ship and ask the NPR to move out

Population Factor

This is equal to:

$$Factor = \sqrt[4]{\frac{TotalEMSignatureofPlayerPopulationsinSystem}{TotalEMSignatureofNPRPopulationsinSystem}}$$

However, this factor can never be higher than the fourth root of $TotalEMSignatureofPlayerPopulationsinSystem/100$. For example, if the player had 1000 EM Signature and the NPR has 200 EM Signature, the factor would be 1.78 (because the fourth root of $(1000/100)$ is lower than $\sqrt[4]{1000/200}$. This is to limit the advantage when the populations are relatively small or the NPR has no populations. Population Factor is the best 'peaceful option' as demonstrating a large population is much more likely to achieve a decision in your favour.

Resistance

$$Resistance = \frac{(Xenophobia + Militancy + Determination)}{150}$$

If the NPR has low militancy, low determination and low xenophobia, it will be much easier to push around, and vice versa. This is difficult to assess because it is an unknown factor.

If

$$MilitaryAdvantage * DemandValue * PopulationFactor > AccessibleSystemValue * Resistance$$

the NPR will accept the claim.

For example, if the NPR has militancy, determination and xenophobia all at 50, then the value to overcome for a Secondary system is 2.25. If there are no populations and you use 'Demand Leave' which is worth 2x, you will need a Military Advantage greater than 1.125. Making this demand will cause a negative relationship impact of $4^2 * 3^2 * (50/50) = 144$. If you have a significant advantage in population in the system, then you require a smaller military advantage or can use a lesser demand.

If the NPR rejects your demand to withdraw, the protection status for that system for that NPR is reset to No Protection, so that further diplomatic penalties are not incurred. If you want to re-instate the demand (at whatever level), it will generate a new penalty.

If the NPR decides it must withdraw based on its assessment of the situation, it will evacuate its ships and transfer any colonies to your control. These will start at a status of Occupied. The system will be set to 'Alien Controlled' (Player controlled) from the perspective of the NPR and it will ignore the system when deploying forces. This will change if conflict breaks out.

Note that the player vs NPR and NPR vs player functionality for claiming systems are a little different. Both sides can send messages to each other and the types of messages are effectively the same. The difference is the method of delivery and the potential reaction. This is because I wanted to give the player maximum flexibility in Diplomacy, while still proving a structured approach for the NPR. For example, the player view of the NPR in terms of diplomatic points does not drop if the NPR ignores demands to leave. The player can decide whether it is necessary to go to war.

6 NPR vs. NPR claims

Original post can be found [here](#).

NPR vs NPR Diplomacy works as a combination of NPR vs Players and Player vs NPR.

As described in section 4, when an NPR detects alien forces in a system that is claimed by the NPR, the NPR will issue a warning. When the target is a player this appears as an event message as per section 4. When the target is another NPR, the first NPR sets a protection status (in the same way as a player does in section 5 that corresponds to the same demand level as it would send to a player.

For example: An NPR detects an alien force in a system that it claims and decides this represent a threat level of 12. If the alien is a player, the NPR will send a message to the player that will appear as an event. The message will be on the lines of "We demand you leave" and that message will continue to be sent each construction phase. If the target is another NPR (let's call this NPR-B), then NPR-A will set a protection status of 'Demand Leave' instead.

Next phase (or in some cases later in the same phase), NPR-B will see the withdrawal demand from NPR-A, just as it would see a similar demand from a player. It will react to that demand in exactly the same way except for one crucial difference; NPR-B will not reduce the diplomatic points for NPR-A.

So why all the messing about with slightly different methods for Player vs NPR, NPR vs Player and NPR vs NPR? Because NPRs, even though they are much smarter in C#, will still not have the human capability to make intuitive estimates weighing the strategic benefit of claiming a system claim vs the potential downsides of reduced diplomatic relations. This strategic deficit in AI vs human ability is handled by the different reactions to claims.

- Player vs NPR: The NPR will generally react negatively to being asked to leave a system, as that is a relatively easy to understand situation, and it can make a reasonable estimate of whether to abandon that system. The player does not react negatively to the NPR refusing to leave in game mechanics terms because the human player can make decisions himself about whether to treat the NPR differently. This also means that continual messages can be sent to remind the player without diplomatic penalties in-game.
- NPR vs Player: The NPR will react negatively to player forces being in one of its systems, as that is also a relatively easy to understand situation. The negative impact is based on the importance of the system and the size of the player force. The player does not react negatively to the NPR asking him to leave in game mechanics terms because the human player can make decisions himself about whether to leave or treat the NPR differently.
- NPR vs NPR: NPR-A will react negatively to NPR-B forces being in one of its systems, as that is also a relatively easy to understand situation. The negative impact is based on the importance of the system and the size of the NPR-B force. NPR-B will decide whether to leave the system but will not react negatively to being asked to do so. This allows the protection level to be reset each time without negative impact (so the NPR doesn't have to consider the huge variety of factors on when to make a new demand). Also, NPR-B may well regard the system as one of its own and will be making its own demand of NPR-A, in which case it will react negatively to a refusal from NPR-A.

The difference is that the NPR is always faced with an immediate decision and does not have to consider wider implications. The player has the ability to take those wider implications into consideration and is free to make his own decisions on relationships. When NPRs do confront each other, either one will leave because the system is not important or they will start making demands of each other, which takes care of the dual negativity. I know it sounds complex, but I think it the best option to handle the different situations.

7 Restrictions on NPR claims

Original post can be found [here](#).

There are several situations where NPRs will not make territorial claims:

- If the NPR and the alien race share a capital system, no claims will be made in the capital system or in any adjacent system
- The NPR will not make claims against an alien race with whom it shares a Fixed Relationship due to a Truce Countdown
- The NPR will ignore claims from an alien race with whom it shares a Fixed Relationship due to a Truce Countdown and there will be no diplomatic penalty
- The NPR will not claim a system if there are alien populations with a total EM signature greater than $10\% * (Xenophobia/100)$ of its own capital's EM signature and also greater than the total EM signatures of any AI populations in that system. The existence of populations will be based on intelligence data rather than current contacts.

The above is based on the concept that an AI is unlikely to claim a system where it knows there is a good chance that claim will cause a war. Note that from the NPR perspective an 'alien race' includes player races.

8 Independence

Original post can be found [here](#).

In C#, you can declare a colony independent using a button on the Economics window. Colonies may also become independent in other situations, such as a rebellion following high unrest. Independence is far more complex than it first sounds, because the population will be under the control of a new race that is essentially a copy of the original race. The process is as follows:

- The title of the new race will be based on the name of the newly-independent population.
- A new flag will be auto-selected and random naming themes chosen for classes, systems, etc.. Commander name themes will remain the same as the original race.
- The ranks of the new race will copy the ranks of the original race.
- Any ground forces at the population will be transferred to the new race.
- It is possible that an NPR population can become independent, in which cases it will retain the same tech but create a new design philosophy.
- The new race will start with an amount of wealth equal to $TotalOriginalRaceWealth * IndependentPopSize / TotalOriginalRacePopSize$ which will be transferred from the original race.
- The new race will start with a number of commanders equal to original race number of $Commanders * IndependentPopSize / TotalOriginalRacePopSize$ (before independence). These are new commanders and not transferred from the original race.
- A top-level admin command will be created at the population.

The new race will gain the following knowledge from the original race:

- The same galactic map, including map labels.
- All geological and gravitational survey data.
- All tech systems.
- How to build all ship components and missiles.
- All class designs.
- All ground unit class designs.
- All ground formation templates.

- All intelligence data, including alien races, classes, ships, sensors, weapons, populations and ground forces.
- A complete set of intelligence information on the original race which will be set up as a new alien race, with known systems, ships, etc.
- Control Race flags on galactic map.
- Protection Status settings for different combination of alien races and systems.
- Locations of ruins, anomalies, wrecks, etc..
- Event colours.

For manual independence, any naval forces will have to be transferred using the Transfer Fleet option. In the case of a rebellion, some ships may be transferred automatically.

9 Banned bodies

Original post can be found [here](#).

If a non-spoiler NPR has a relationship of neutral or higher with another race, it will generally avoid approaching 'banned bodies'.

An NPR will decide for itself which bodies are banned, but in general these will include:

1. Bodies that have an alien race population of approximately ten million or more
2. Bodies that are moons of any bodies in (1)
3. Bodies that are moons and share the same parent body as any body in (1)
4. Bodies on which the NPR already has a population will be exempt from the above rules

NPRs will not create populations on banned bodies and will not attempt to conduct geological surveys on those bodies. The NPR will not generate points of interest within a few million kilometres of banned bodies. It is still possible that NPR ships will approach due to other considerations, such as moving between two points unrelated to banned bodies, but in general this should prevent the VB6 situation of NPR battle fleets making port visits to your home world.

The banned bodies list is updated at game launch and during each construction phase. Banned bodies do not exist for populations of races with which the NPR has a hostile relationship. If there are two populations on a planet, one of which is hostile to the NPR and one neutral, the body will not be banned.

For example, in the Space 1889 campaign, the Martians will generally avoid Venus, Earth, Luna, all the moons of Jupiter and all the moons of Saturn. They will still survey the Trojan asteroids and they still may pass close to the banned bodies when on an unrelated mission.

NOTE: *I looked at various ways of applying this in reverse. The NPR would generate a list of important planets and check for player race ships within a certain range, perhaps ten million kilometres. If they were detected, that would trigger a response, even if the NPR would otherwise not object to the player being in the system. The problem is that the player would have to be checking each ship path to ensure that didn't happen. I even added code to avoid this problem by only flagging player ships that remained within ten million in two consecutive construction phases, but even that is not foolproof. Essentially, the player knows the NPRs is trying to avoid his populations and will react to NPR movements accordingly, but understanding that is much more difficult for the AI. In the end the game play benefit is outweighed by the considerable micro-management required on the part of the player, or by the amount of code that would be needed to avoid accidentally passing through restricted zones. In most situations, the player would want to avoid being detected anyway so this situation would usually only be relevant where a truce countdown is in effect and the player and the NPR share the same home system. The player can RP that situation if needed.*

10 Diplomatic ships

Original post can be found [here](#).

A Diplomatic ship is any ship equipped with a Diplomacy Module. These can be built by the player or by NPRs.

Diplomacy Modules and therefore Diplomatic Ships are important for communication attempts and essential for basic diplomacy (influencing an alien race to view your race more positively). See section 3 for more details.

When a Diplomatic Ship is involved in diplomacy or communication attempts, the opposing race will know the origin of those messages. If the Diplomatic Ship is on opposing sensors, the identity of that ship will be noted in an event for the opposing race and its parent class will be flagged as a diplomatic vessel. If diplomacy is underway, the name of the Ambassador will also be passed to the opposing race.

If the Diplomatic Ship is not on opposing sensors, the location of the signal from that ship will be communicated to the opposing race. This may be a system body, a jump point or simply a point in space.

Any damage to NPR Diplomatic ships, regardless of whether the opposing race knows that status, will be treated as triple damage for the purposes for affecting diplomatic relations. If a diplomatic ship is attacked without an existing hostile relationship, the relationship will fall to -300 from the perspective of the owner of the ship (rather than the normal -100 for attacking when not hostile).

11 Modifying stars

C# Aurora allows you to manipulate star systems in SM Mode. While it would be difficult to design a system during the original generation process, due to the complexities involved, you can now add or modify stars and system bodies. This post covers modifying stars.

Star Setup

Spectral Class: K1-V

Orbit (AU): 23

Bearing: 337.31

☒ Orbit Primary

Colour: Orange

Size: Main Sequence Star

Luminosity: 0.39

Mass: 0.79

Temperature: 4,850

Diameter (km): 1.25m

OK Cancel

Figure 1: Star Setup

System Generation and Display

Name	Spectral	Diameter	Mass	Luminosity	Parent Star	Period	Distance	Planets	Moons	Asteroids	Comets	Habitable	Near-Hub	Breathe Gas	Oxygen	Gravity
Alpha Centauri-A	G2V	1.39m	1.02	0.87	-	-	-	5	15	2	0	0	1/2	Breathe Gas	Oxygen	0.1G to 1.9G
Alpha Centauri-B	K1-V	1.25m	0.79	0.351	Alpha Centauri-A	82	23	6	47	35	0	0	2/22	Breathe (atm)	0.1 to 0.3	-10C to 38C
														Safe Level	30%	Max Pressure 4 atm

☐ All Moons
 ☐ With Minerals
 ☐ Hide Moons
 ☒ All Asteroids
 ☐ With Minerals
 ☐ Hide Asteroids
 ☐ All Comets
 ☐ With Minerals
 ☐ Hide Comets
 ☒ Minerals
 ☒ No Survey
 ☒ Ground Survey Potential
 ☐ OM Eligible
 ☐ Show Max Colony Cost

Name	Type	Colony Cost	Population (m)	Terrain	Hydro	Atmosphere	Pressure	Temp (C)	Gravity (G)	Distance	Diameter	Total Lock	Max Pop
Alpha Centauri B I	Planet - Dwarf	2.00 LG	-	-	-	-	-	-	-	-	-	-	-
Alpha Centauri B II	M Planet - Terrestrial	2.29	Elan Vannin 0.26 m	Tundra	Ice Sheet 97%	Nitrogen - Oxygen (0.18)	0.486F	-65.8	0.0231	76m	400	Yes	2.156
Moon B-II 1	M Moon - Large	3.13	-	-	-	-	-	-86	0.107	11k	3,400	-	653
Alpha Centauri B III	M Planet - Dwarf	2.38	-	-	Ice Sheet 25%	-	-	-67	0.217	174m	4,000	Yes - M	1.180
Alpha Centauri B IV	M2 Planet - Terrestrial	3.00	-	Mountain	Ice Sheet 83%	Nitrogen - CO2	1.21F	-82	1.13	293m	26,000	-	33,901
Moon B-IV 1	M Moon - Small	4.36 LG	-	-	-	-	-	-115	0.00141	56k	20	Yes - M	0.05
Moon B-IV 2	M Moon - Small	3.30 LG	-	-	-	-	-	-89	0.075	153k	1,600	Yes - M	189
Moon B-IV 3	M Moon - Small	5.04 LG	-	-	-	-	-	-131	0.0061	359k	60	Yes - M	0.27
Moon B-IV 4	M Moon - Small	5.04 LG	-	-	-	-	-	-131	0.0163	840k	160	Yes - M	1.89
Alpha Centauri B V	M Planet - Gas Giant	N/A	-	-	-	-	-	-184	3.83	724m	148,000	-	-
Moon B-V 1	M Moon - Small	7.53 LG	-	-	-	-	-	-191	0.00251	254k	80	Yes - M	0.47
Moon B-V 2	M Moon - Terrestrial	7.21	-	-	-	Nitrogen - Methane	0.16F	-183	1.29	329k	16,400	Yes - M	19,835
Moon B-V 3	M Moon - Small	6.57 LG	-	-	-	-	-	-168	0.0125	484k	160	Yes - M	1.89
Moon B-V 4	M Moon - Small	7.98 LG	-	-	-	-	-	-202	0.0155	578k	180	Yes - M	2.38
Moon B-V 5	M Moon - Small	7.01 LG	-	-	-	-	-	-178	0.0082	761k	140	Yes - M	1.45
Moon B-V 6	M Moon - Small	6.60 LG	-	-	-	-	-	-168	0.00363	758k	60	Yes - M	0.27
Moon B-V 7	M Moon - Small	8.06 LG	-	-	-	-	-	-203	0.0078	2.12m	200	Yes - M	2.95
Moon B-V 8	M Moon	7.91 LG	-	-	-	-	-	-200	0.0219	2.43m	800	Yes - M	47.2
Moon B-V 9	M Moon	7.79 LG	-	-	-	-	-	-197	0.0384	4.04m	1,400	Yes - M	145
Moon B-V 10	M Moon - Terrestrial	8.04	-	-	Crustal 25%	Nitrogen - Methane	0.052F	-203	0.351	4.51m	12,800	Yes - M	12,083
Moon B-V 11	M Moon - Small	7.94 LG	-	-	-	-	-	-201	0.00313	4.54m	100	Yes - M	0.74
Moon B-V 12	M Moon	7.87 LG	-	-	-	-	-	-199	0.0353	4.86m	1,000	Yes - M	74
Alpha Centauri B VI	M Planet - Gas Giant	N/A	-	-	-	-	-	-195	2.77	956m	116,000	-	-
Moon B-VI 13	M Moon - Large	7.72	-	-	Crustal 9%	-	-	-195	0.132	69k	2,800	Yes - M	578
Moon B-VI 14	M Moon												

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Figure 5: Engineering Example 2

12 Adding stars

Original post can be found [here](#).

Adding a new star is straightforward. You click Add New Star. The dialog below pops up and allows you to select spectral class, orbital distance, bearing and parent star.

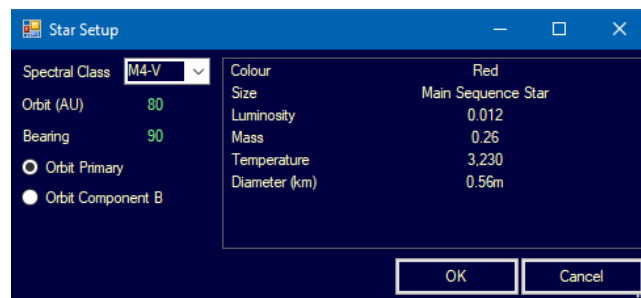


Figure 6: Adding Star

This screenshot shows the result of adding the above star to the Alpha Centauri system. New stars do not have any planets or other system bodies. These are added separately and will be covered in a future post.



Figure 7: Adding Star Result

13 Modifying system bodies

Original post can be found [here](#).

Modifying system bodies is a more complex process than stars due to the number of factors involved. There are factors that are tied to each other, such as mass, radius, density and gravity, plus certain types of bodies have different rules (planets vs moons, gas giants vs rocky worlds).

Therefore, the following factors can be changed; distance to parent body, diameter, density, hydro extent, albedo, atmospheric composition and dominant terrain. The dominant terrain is restricted to those terrains permitted by the other factors. Factors such as colony cost, gravity, temperature, atmospheric pressure, length of year, maximum population, tidal lock status, atmospheric retention, time required to stabilise a Lagrange point, etc. will all be derived from the factors that can be changed. For example, if you change the diameter or density, the mass and gravity will automatically change. If you change the distance to parent, the temperature and year will change and perhaps the tidal lock status. Finally, factors such as escape velocity, magnetic field, etc. are not shown here because they have no current game play impact, even though escape velocity will change as a result of modifications to density or diameter.

The basic type of system body (terrestrial, dwarf, etc.) cannot be changed, but it will be possible to delete one system body and add a new one of the desired type. This is to ensure all system bodies follow the basic rules of their type, even if they are later modified.

Below is the System Body Modification popup window. You can change the green fields in the top left, the dominant terrain dropdown and can add and remove atmospheric gases by choosing a gas and the desired atm (0 to remove). As you make each change, everything else updates.



Figure 8: System Body Modification

For example, here is what happens if the diameter is halved. Gravity, mass and max population all fall, while the terraform rate vs Earth and the time to stabilise a Lagrange point both increase.



Figure 9: System Body Modification Result

14 Deleting stars and system bodies

Original post can be found [here](#).

Deletion of stars or system bodies is straightforward. Click on the target object and then click Delete Body or Delete Star. You will be given two popup warnings and then the object will be deleted. Deleting a star will remove any system bodies in orbit. Deleting a planet will remove any moons of that planet. Any populations on affected system bodies will be deleted. Deleting the primary star is not possible.

When a star is deleted, any remaining stars will be renamed accordingly. For example, if you delete the B component of a primary, the original C component will now become the B component. When a planet or moon is deleted, the orbit numbers of the planets or moons will be adjusted accordingly.

For example, here are the before and after views of the Alpha Centauri-A system when the fourth planet is deleted.

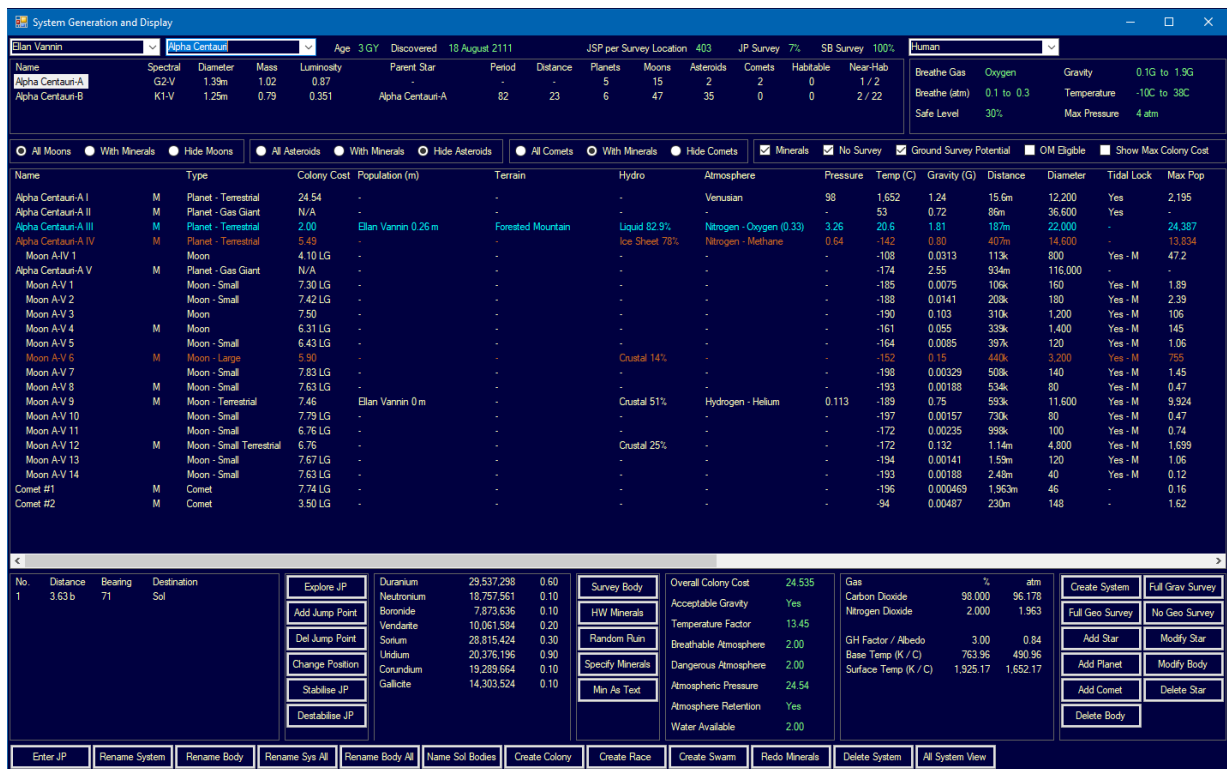


Figure 10: Deleting Stars And System Bodies



Figure 11: Deleting Stars And System Bodies 2

15 Adding planets, comets and asteroid belts

Original post can be found [here](#).

Below is the form for adding all new system bodies except for additional moons. You choose a system body from the drop down, which includes Terrestrial, Dwarf Planet, Gas Giant, Superjovian, Comet and Asteroid. Each body type has a distance parameter plus one or more other additional options.

- For terrestrial and dwarf planets you have a toggle for automatic moon generation and can choose a specific or random number of moons.
- For gas giants and superjovians, you have the above moon options plus similar options for Trojan asteroids (on/off, random/specific).
- For comets, you choose the starting distance and maximum distance.
- For asteroid belts, you can choose a random or specific number of asteroids and the specific or random width of the belt (how far an asteroid can be generated from the centre of the belt).

Once the planet parameters are selected, press OK and the new body or bodies will appear in the System View. You can select them and use Modify Body to customise if desired.

The various zones shown at the top affect how Aurora determines parameters such as atmosphere, hydrosphere, mineral deposits, albedo, density, number of moons, total mass of asteroid belts and a variety of other factors. There is far too much detail to list, but generally bodies in the life zone will have better conditions and mineral deposits, followed in decreasing order by Inner, Outer and Extreme. These zones also exist in VB6. Of course, those factors only affect initial generation so you can override that by directly modifying a body post-creation.

	m km
Life Zone Start	105.05
Life Zone End	196.1
Inner System End	560.29
Outer System End	7,003.57
Extreme	Beyond Outer

Planet - Gas Giant

Orbital Distance (m km) 100

☐ Generate Moons Number of Moons (0 = Random) 0

☐ Generate Trojans Number of Trojans (0 = Random) 0

OK Cancel

Figure 12: Add Planet Example

16 Adding moons and Lagrange points

Original post can be found [here](#).

Below is the form for adding moons to existing planets. During planet creation you can specify appropriate moons to be created at the same time using standard moon generation based on the type of planet and its orbital distance. This form, accessed via the Add Moons button, is for creating additional moons which do not have to obey normal size restrictions. The form allows the addition of up to five moons (the drop-downs all start with no moon) with type and distance specified. If more than five moons are needed, the form can be used multiple times for the same parent planet.

After initial generation you can use Modify Body to specify additional detail if required.

The Add Lagrange button adds a Lagrange point to the currently selected body, even if it would not normally qualify for one.

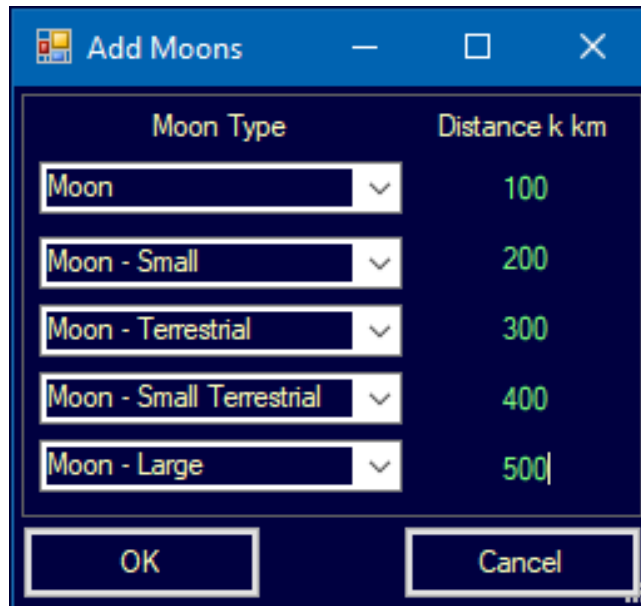


Figure 13: Add Moons Example

17 Deleting asteroids and Lagrange points

Original post can be found [here](#).

Deleting individual asteroids can be done by using the Delete Body button. To delete an entire asteroid belt or all the Trojan asteroids for a particular planet, click one of the asteroids in the belt or one of the Trojans and click Delete Asteroids. There will be two warnings before all the affected asteroids are deleted.

Lagrange Points can be removed by selecting the parent system body and clicking Remove Lagrange.

Below is the final version of the System View in SM mode with all system engineering buttons present.

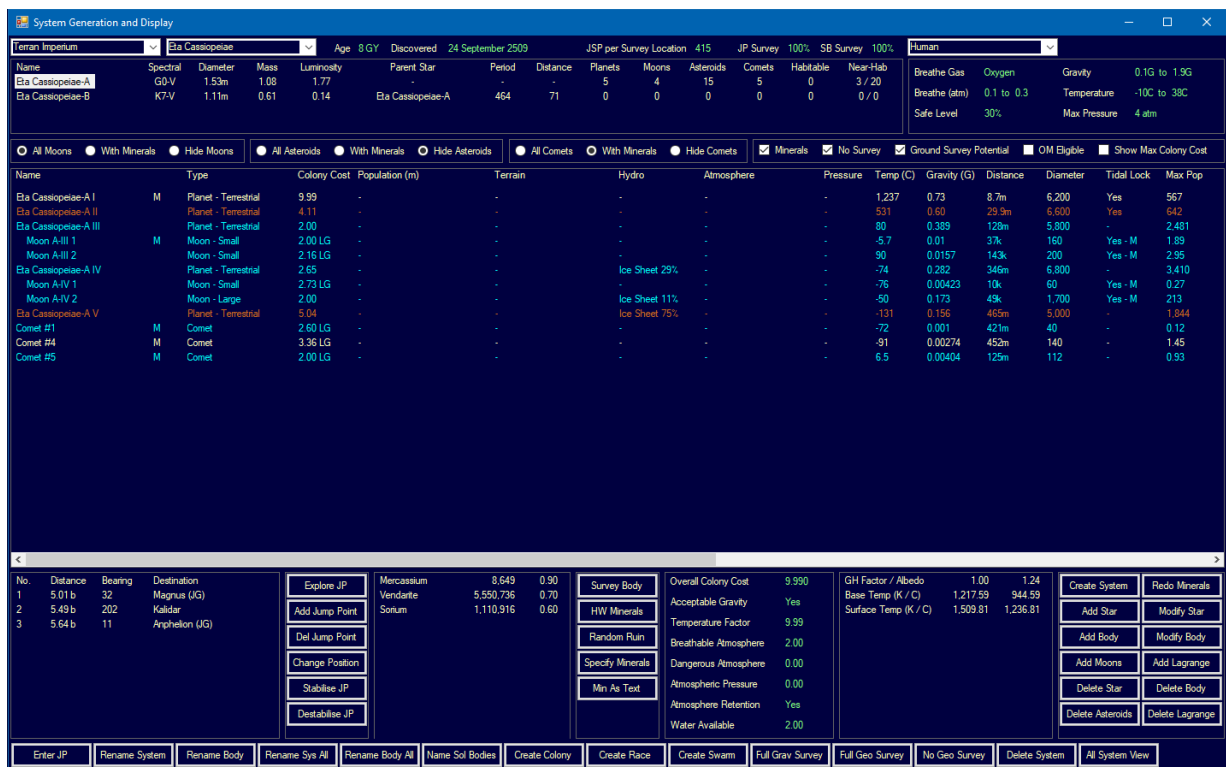


Figure 14: Deleting Lagrange Points

Part IV

Weapons

18 Missiles

18.1 Missile updates

Original post can be found [here](#).

The following changes will be made to missiles in C# Aurora:

1. Missile Armour has been removed.
2. Laser warheads have been removed (I may add these back at some point in the future).
3. ECM is now a fixed 0.25 MSP for missiles. The 'Missile ECM' tech line has been removed and if a missile is equipped with ECM it will have the same ECM capability as the current racial ECM technology, The missile design will maintain that ECM capability and will not be upgraded if the racial tech improves. For each level of ECM, the missile will be 10% harder to hit with energy weapons and will reduce the lock of missile fire controls by 10%. This can be negated by linking a similar level of ECCM to the point defence fire controls.
4. Missiles can be equipped with ECCM, which is a fixed 0.25 MSP. The missile ECCM level will be equal to the current racial ECCM tech. In C# Aurora, the ECCM of missile fire controls will only affect the range at which the fire control can lock on. The ECCM of the missile itself will affect the chance of the missile striking its target, if that target has active ECM.
5. Any missile sensor (active, thermal, EM or Geo) has to be a minimum of 0.25 MSP or it will have no effect.
6. Missile series have been removed. Instead, there will be more detailed class loadout options.

These changes will make electronic warfare much more important for missile combat. Missiles with ECM will become harder to shoot down and missiles without ECCM will have a reduced chance to hit targets equipped with ECM. Anti-missile missiles will either be less effective, or larger, vs ECM-protected missiles, while anti-ship missiles are likely to increase in size (and therefore reduce salvo sizes). Large volleys of size-1 missiles will be less effective in a heavy EW environment and no longer have a huge advantage in launching speed (due to the missile launcher changes).

18.2 Missile engines

Original post can be found [here](#).

In C#, Missile Engines follow the same size-based fuel consumption rules as Ship Engines using the formula:

$$FuelConsumption = \sqrt{\frac{10}{EngineSizeinHS}}$$

The above increases the fuel consumption of missile engines based on size alone. However, VB6 also had a flat x5 multiplier for the overall fuel consumption for missile engines as they were treated as a different engine type than ship engines. As C# is aiming for consistency between ship and missile engines, this x5 multiplier cannot remain as it was before. Removing the x5 multiplier entirely would cancel out the fuel consumption increase resulting from the changes in the size-based fuel consumption calculation. As one of the objectives of C# is a reduction in missile ranges, a new rule is required that increases fuel consumption but that is still consistent with ship engines.

Therefore, the calculation for fuel consumption based on boosting engines will now include an additional multiplier if the boost being used is higher than the maximum racial boost tech. Only missile engines have the capability to use higher boosts than the racial maximum, so this still allows consistency between ship and missile engines in the spectrum where they both operate. Once you move outside of the boost range possible for ships, additional fuel consumption can be added without breaking consistency. This rule adds a linear multiplier

from 1x to 5x depending on the level of boost beyond the racial maximum. The formula is as follows:

if $BoostUsed > MaxBoostMultiplierTech$ then

$$HighBoostModifier = \frac{BoostUsed - MaxBoostMultiplierTech}{MaxBoostMultiplierTech} * 4 + 1$$

So if a race has Max Boost Tech of 2x, any missile with a Boost Level of 2x or less will use the standard boost fuel modifier calculation of $BoostLevel^{2.5}$.

Above a Boost Level of 2x, the linear High Boost Modifier will come into effect, reaching a maximum of 5x fuel consumption at 4x Boost Level.

Here is a comparison between VB6 and C# using MPD engines and an engine size of 1 MSP. The Max Boost Tech for this race is 2x:

VB6 Missile Engine with 2x Boost

Engine Power: 1.6 Fuel Use Per Hour: 81.51 Litres
Fuel Consumption per Engine Power Hour: 50.944 Litres
Engine Size: 1 MSP Cost: 0.4
Thermal Signature: 1.6
Materials Required: 0.4x Gallicite
Development Cost for Project: 80RP

C# Missile Engine with 2x Boost Engine Power 1.60 Fuel Use Per Hour 76.8 Litres
Fuel Consumption per Engine Power Hour 48.0 Litres
Size 1.00 MSP (2.5 tons) Cost 0.80
Development Cost 80 RP

Materials Required
Gallicite 0.80

VB6 Missile Engine with 4x Boost

Engine Power: 3.2 Fuel Use Per Hour: 922.18 Litres
Fuel Consumption per Engine Power Hour: 288.182 Litres
Engine Size: 1 MSP Cost: 0.8
Thermal Signature: 3.2
Materials Required: 0.8x Gallicite
Development Cost for Project: 160RP

C# Missile Engine with 4x Boost

Engine Power 3.20 Fuel Use Per Hour 4344.5 Litres
Fuel Consumption per Engine Power Hour 1357.6 Litres
Size 1.00 MSP (2.5 tons) Cost 1.60
Development Cost 160 RP

Materials Required
Gallicite 1.60

18.3 Missile launcher changes

Original post can be found [here](#).

Missile Launchers have undergone significant changes in C# Aurora.

1. Fractional-size launchers can be created. The minimum is still 1 HS but a launcher can now be 1.1 HS, 2.7 HS, etc.
2. The reduced-size launcher techs are all available immediately and do not need to be researched. This means box launchers are available from the start. The progression for reduced size launchers has been altered slightly:

0.75 HS	2x Reload
0.6 HS	5x Reload
0.4 HS	20x Reload
0.3 HS	100x Reload
0.15 HS	100x Reload (Box Launcher) ³

If a box launcher containing a missile is damaged, the missile will explode. The chance of this happening can be reduced by a new tech line. The first step reduces the explosion chance to 70% for 1000 RP and the last step reduces to 5% for 120,000 RP. In addition, Box launchers can only be reloaded in a hangar, or at an Ordnance Transfer Point (a Spaceport, Ordnance Transfer Station or Ordnance Transfer Hub). Reloading at an Ordnance Transfer Point is 10x slower than in a hangar (similar to the penalty for maintenance facilities in VB6 Aurora).

The base reload rate for all missile launchers is now:

$$MissileReloadRate = \frac{\sqrt{MissileSize} * 30seconds * ReducedSizeModifier}{ReloadRateTech}$$

Assuming a race has reload rate tech of 3, a normal size 1 launcher will reload in 10 seconds, a size 4 will reload in 20 seconds and a size 9 will reload in 30 seconds. This change will dramatically reduce reload times for larger launchers.

The change for box launcher reload rate from x15 to x100 is not as dramatic as it seems for larger missiles due to the new reduced reload times for larger missiles. However, it is still a significant increase from VB6. A size 4 missile mounted on a box launcher will now take about 1h 40m to reload in a hangar and about 17 hours for an ordnance transfer point. A size 6 is about 2 hours and 20 hours respectively.

These changes are intended to:

1. Reduce the disadvantage of larger missiles
2. Remove the realism issue of not having box launchers available at low tech yet make box launchers a more difficult decision vs standard-type launchers

18.4 Box launcher reloading

Original post can be found [here](#).

In VB6 Aurora, box launchers can be reloaded in a hangar or at maintenance facilities. For C# Aurora, box launchers can only be reloaded in a hangar, or at an Ordnance Transfer Point (a Spaceport, Ordnance Transfer Station or Ordnance Transfer Hub). Reloading at an Ordnance Transfer Point is 10x slower than in a hangar (similar to the penalty for maintenance facilities in VB6 Aurora).

Because of the changes to maintenance facilities in C# Aurora, it will be a lot easier to forward deploy facilities for full-size warships, both on planets and in space, which would increase the potential of box launchers if they could still use those facilities to reload, especially given they are immediately available in C#. The introduction of ordnance-specific facilities for C# provides a good alternative.

The existing changes post for Missile Launchers section 18.3 has been updated to take account of this new rule.

18.5 Missile thermal detection

Original post can be found [here](#).

In VB6 Aurora, the thermal detection of missiles is based on the following formula:

$$ThermalSignatureVB6 = \frac{MissileSize}{20} * \frac{Speed}{1000}$$

I have no idea why I coded thermal detection for missiles to be based on size, although I am sure it seemed like a good idea at the time :). For C# Aurora, missiles will use the same formula as ships for thermal signature:

$$ThermalSignatureC\# = MaxEngineOutput * \frac{CurrentSpeed}{MaxSpeed} * ThermalReduction$$

³Note that reload for this was x15 in VB6

As missiles (for now anyway), don't have thermal reduction or an option to travel below maximum speed, their thermal signature is equal to the power of their engines. Combined with the changes to passive detection, this means that missiles in C# Aurora will probably be detected by thermal sensors at much greater distances than in VB6 Aurora.

18.6 Magazine design

Original post can be found [here](#).

There are several changes to magazine design for C# Aurora.

- The 'ejection' tech line has been replaced by the Magazine Neutralisation System. It is functionally identical but in technobabble terms this is a system design to render missile warheads permanently inert in the event of damage to the magazine.
- Magazines have a base HTK number equal to the square root of their size (rounded down). in VB6 Aurora, all magazines have a base HTK of 1, regardless of size. It is still possible to add extra HTK in C# by sacrificing internal space.
- The explosion chance for a magazine is divided by the square root of its size. For example, if a size 1 magazine has a base explosion chance of 15%, the equivalent tech size 5 has an explosion chance of 6.71%, the size 10 is 4.74% and the size 20 is 3.35%.
- If the ship has a Chief Engineer, any explosion chance (for magazines or engines) is reduced by his Engineering Bonus. So a 5% explosion chance would be reduced to 3.5% by a Chief Engineer with an Engineering bonus of 30%.
- When a magazine is hit, a proportion of the remaining ordnance will be destroyed (based on $\text{DestroyedMagazineCapacity} / \text{TotalShipMagazineCapacity}$). Any destroyed ordnance will explode with its full warhead strength. In VB6, only ordnance beyond the remaining magazine capacity explodes and only at 20% strength.

In summary, magazine explosions in C# Aurora will be much rarer, especially for larger ships, but far more devastating when they do occur.

18.7 Missile engines integrated into missile design

Original post can be found [here](#).

In VB6, you research missile engines first and then use that engine within a missile design. This can be tedious, especially if you are not sure exactly what engine size you need. Therefore, for C# the missile engine design has been removed from the Create Research Project window and integrated directly into the Missile Design window.

The best engine and fuel efficiency tech will automatically be used, so the player decides on the engine size and power boost. The engine design takes place behind the scenes and is confirmed when you design the missile. This means you can play around with the engine design and missile design at the same time. See first screenshot below

If no engine is required, just tick the No Engine option. See second screenshot.

Colonial Coalition | Load Previous | Freeze Name

	MSP	Value
Warhead Strength	1	5
Fuel Capacity	1	2,500
Agility	0	0
Reactor	0	0
Active Sensor	0	0
Thermal Sensor	0	0
EM Sensor	0	0
Geo Sensor	0	0
Active Resolution	100	
ECM	<input type="checkbox"/>	0
ECCM	<input type="checkbox"/>	0
Enhanced Radiation	<input type="checkbox"/>	1
No Engine	<input type="checkbox"/>	

Engine Power: 400% Fuel Consumption: 160
 Engine Size: 2.00 MSP Fuel Consumption: 10

Engine Power: 4.8 Total Engine Cost: 2.4
 Fuel Efficiency: 1,120 Fuel per EPH: 5,376

Second Stage:
 Number: 0 Separation Range (k): 150
 Missile Size: 0 Missile Cost: 0
 Total Size: 0 Total Cost: 0

Defiant Anti-Ship Missile

Missile Size: 4.00 MSP (10,000 Tons) Warhead: 5 Radiation Damage: 5 Manoeuvre Rating: 10
 Speed: 24,000 km/s Fuel: 2,500 Flight Time: 27 minutes Range: 40.10m km
 Cost Per Missile: 3.65 Development Cost: 365
 Chance to Hit: 1k km/s 240% 3k km/s 80% 5k km/s 48.0% 10k km/s 24.0%

Materials Required
 Titanium: 1.25
 Gallite: 2.40
 Fuel: 2500

Warhead Strength per MSP: 5
 Missile Agility per MSP: 48
 Engine Power per MSP: 0.6
 Fuel Consumption per EPH: 0.7
 Max Power Boost: 2
 ECM Strength: No Tech
 ECCM Strength: No Tech
 Active Sensor Strength per MSP: 0.6
 Thermal Sensor Strength per MSP: 0.25
 EM Sensor Strength per MSP: 0.3
 Geo Sensor Strength per MSP: 0.01
 Reactor Power per MSP: 0.225
 Enhanced Radiation Modifier: No Tech

Create Instant Company Name

Figure 15: Missile Design Example 1

Colonial Coalition | Load Previous | Freeze Name

	MSP	Value
Warhead Strength	0	0
Fuel Capacity	0	0
Agility	0	0
Reactor	0.5244	0.118
Active Sensor	0	0
Thermal Sensor	0	0
EM Sensor	1.9756	0.59
Geo Sensor	0	0
Active Resolution	100	
ECM	<input type="checkbox"/>	0
ECCM	<input type="checkbox"/>	0
Enhanced Radiation	<input type="checkbox"/>	1
No Engine	<input checked="" type="checkbox"/>	

Engine Power: 400% Fuel Consumption: 160
 Engine Size: 2.00 MSP Fuel Consumption: 10

Engine Power: N/A Total Engine Cost: N/A
 Fuel Efficiency: N/A Fuel per EPH: N/A

Second Stage:
 Number: 0 Separation Range (k): 150
 Missile Size: 0 Missile Cost: 0
 Total Size: 0 Total Cost: 0

Sensor Bouy

Missile Size: 2.5000 MSP (6,25000 Tons) Warhead: 0 Radiation Damage: 0 Manoeuvre Rating: 10
 Speed: 0 km/s Fuel: 0 Flight Time: 1 seconds Range: 0 km
 EM Sensor Strength: 0.59 Detect Sig Strength 1000: 6,072,479 km
 Cost Per Missile: 0.944 Development Cost: 94
 Chance to Hit: 1k km/s 0% 3k km/s 0% 5k km/s 0% 10k km/s 0%

Materials Required
 Boronide: 0.354
 Urdium: 0.59

Warhead Strength per MSP: 5
 Missile Agility per MSP: 48
 Engine Power per MSP: 0.6
 Fuel Consumption per EPH: 0.7
 Max Power Boost: 2
 ECM Strength: No Tech
 ECCM Strength: No Tech
 Active Sensor Strength per MSP: 0.6
 Thermal Sensor Strength per MSP: 0.25
 EM Sensor Strength per MSP: 0.3
 Geo Sensor Strength per MSP: 0.01
 Reactor Power per MSP: 0.225
 Enhanced Radiation Modifier: No Tech

Create Instant Company Name

Figure 16: Missile Design Example 2

18.8 Tracking time bonus vs missiles

Original post can be found [here](#).

Energy weapons and beam fire controls engaging missiles can gain a bonus to their tracking speed based on how long the missile has been on active sensors. Similar functionality was added to VB6 but is not working. The benefit of this has been toned down a little from the planned functionality in VB6 as fuel considerations in C# will reduce the max boost used for anti-ship missiles and avoid the late game missile speed vs tracking speed disparity.

The gain in tracking speed is equal to one percent for every five seconds a missile is continually tracked by active sensors. This is subject to a maximum time based on the associated tracking time tech. The starting tech costs 1000 RP and adds tracking bonus for the first 30 seconds. The tech name format is: Max Tracking Time for Bonus vs Missiles: 30 Seconds (6%)

This time increases with subsequent tech to 45, 60, 80, 120, 160, 200, 250, 320 and 400. Each tech is approximately double the cost of the previous one.

Note this is a bonus to tracking speed, not the base to-hit chance. If the tracking speed is already higher than the missile speed, this bonus will not improve the chance to hit.

I considered adding this to all energy-weapon fire for consistency, but decided it was reasonable to keep it to missiles only, given their more predictable courses.

19 Guns

19.1 Meson update

Original post can be found [here](#).

Mesons have the following changes for C# Aurora:

1. Their cost is based on the same principles as a laser, so mesons will cost the same as an equivalent laser of the same tech level.
2. Mesons penetrate shields as before but their ability to penetrate armour is now limited.
3. A new tech line exists, Meson Armour Retardation, which is the chance for each layer of armour to stop the meson. This starts at 50%, then 40%, 32%, etc. finishing at 7% for TL 12
4. If armour does stop the meson, it scores 1 point of damage on the armour.
5. If the meson hits a damaged armour location, it only has to penetrate the remaining armour in that location.
6. Mesons will destroy missiles without penalty, as missiles are no longer armoured in C# Aurora.

As with everything else, these changes are subject to play test.

19.2 Turret update

Original post can be found [here](#).

A minor update. The benefits of multiple energy weapons in turrets have been doubled. A twin turret now has a 20% reduction in crew vs two solo weapons and has a 10% reduction in gear size. A quad turret has a 40% reduction in crew vs four solo weapons and has a 20% reduction in gear size.

In addition, I found an error in the VB6 code for turret design that meant a turret needed four times more armour than a ship of equivalent size. This has been corrected for C# Aurora, which means armoured turrets are now much more viable.

19.3 Beam weapon recharge

Original post can be found [here](#).

In VB6, if a power plant is damaged, it slows down the recharge rate of all weapons by a proportionate amount.

In C# Aurora, power is allocated weapon by weapon until the available power is exhausted. This means that some weapons may not be recharged, but the others will be recharged at the maximum rate. Weapons are charged in order of ascending power requirement. Once a weapon is recharged, it will require no more power and other weapons can begin the recharge process.

This should allocate power in the most effective way to keep a ship in the fight.

19.4 Weapon failure

Original post can be found [here](#).

At the point when any weapon (energy-based or missile launcher) fires, there is a 1% chance the weapon will suffer a failure. If sufficient maintenance supplies are available, the weapon will be instantly repaired and will fire normally. If maintenance supplies are not available, the weapon will be damaged and unable to fire.

This is partially to simulate the stress of combat on weapon systems, but also as a balance to other rule changes.

19.5 Plasma carronades

Original post can be found [here](#).

1. The development cost of Plasma Carronade focal size has been halved. For example, a 30cm Carronade is now 4000 RP.
2. The building cost of Carronades has also been halved.

These two changes should make Carronades more viable. A powerful and inexpensive weapon but very short-ranged.

19.6 Particle lance

Original post can be found [here](#).

This is a copy of a post in the VB6 7.2 Changes List. I didn't release the updated VB6 version so this is still a change from the released VB6 Aurora.

The Particle Lance is a large, potentially devastating weapon that is variant of the Particle Beam.

Once Particle Beam Range 200,000 km and Particle Beam Strength 6 have both been researched, the Particle Lance can be researched for 30,000 RP. The Lance is a modification of the normal Particle Beam and is an extra option in the design window.

The Particle Lance modification affects the Particle Beam in the following ways:

2x Damage

2x Size

2x HTK

2x Crew

2.5x Power Requirement

3x Cost

2x Development Cost

As well as the above modifications, which essentially creates a weapon twice as large, that recharges 2.5x more slowly and costs 3x as much, the damage template of the Particle Lance is a single column of armour, rather than the Particle Beam which has a template between that of missiles and lasers. The Particle Lance retains the constant damage of the Particle Beam, creating a weapon that can penetrate enemy armour at significant range.

Here are examples of similar tech level Particle Beam, Particle Lance and Laser.

Particle Beam

Beam Strength 6 Rate of Fire: 15 seconds Maximum Range: 240,000 km

Particle Beam Size: 8 HS Particle Beam HTK: 4

Power Requirement: 15 Power Recharge per 5 Secs: 5

Cost: 94 Crew: 24

Materials Required: 18.8x Duranium 18.8x Boronide 56.4x Corundium

Development Cost for Project: 2250RP

Particle Lance

Beam Strength 12 Rate of Fire: 38 seconds Maximum Range: 240,000 km

Particle Beam Size: 16 HS Particle Beam HTK: 8

Power Requirement: 38 Power Recharge per 5 Secs: 5

Cost: 282 Crew: 48

Lance Weapon

Materials Required: 56.4x Duranium 56.4x Boronide 169.2x Corundium

Development Cost for Project: 4500RP

25cm Far Ultraviolet Laser

Damage Output 16 Rate of Fire: 20 seconds Range Modifier: 5

Max Range 800,000 km Laser Size: 8 HS Laser HTK: 4

Power Requirement: 16 Power Recharge per 5 Secs: 5

Cost: 100 Crew: 24

Materials Required: 20x Duranium 20x Boronide 60x Corundium
Development Cost for Project: 1000RP
(laser will have 320,000 km range with equivalent tech level fire control)

Comparison of Damage Templates at 240,000 km	
Particle Beam (6)	2, 3, 1
Particle Lance (12)	12
Laser (3)	3

Two Particle Beams or 25cm Lasers can be installed in the same hull space as the Particle Lance. The Lasers are devastating at close range, the Particle Beams inflict more damage at long range (in terms of DPS), while the Particle Lance penetrates much more armour at long range.

The Particle Lance is intended as a powerful anti-ship weapon that requires a large investment in a particular tech line, lacks the flexibility of lasers or railguns and provides a different armour penetrating option to mesons, although mesons are still superior against shields. Mainly though it is to boost the Particle Beam as a serious weapon choice.

The Particle Lance is not tested under normal battle conditions yet so I may change it a little after play-testing.

20 Other

20.1 Point defence

Original post can be found [here](#).

In C# Aurora, fire controls set to 'Final Defensive Fire' or 'Final Defensive Fire (Self Only)' will fire on hostile missiles, regardless of whether the fire control is set to 'Open Fire'. Fire controls set to Area Mode or for AMMs will only fire defensively when that fire control is set to 'Open Fire'.

When a missile reaches its target, a target ship will use its CIWS first. If that is insufficient, it will use any weapons linked to fire controls set to 'Final Defensive Fire' or 'Final Defensive Fire (Self Only)'. If that is still insufficient, ships of the same race or an allied race with fire controls set to 'Final Defensive Fire' will be checked in increasing order of distance from the target ship.

A target population will use any ground units assigned to point defence to shoot at incoming missiles. If that is insufficient, the same process as for ships will take place, checking same race or allied ships within point defence range of the planet.

20.2 Ordnance transfer mechanics

Original post can be found [here](#).

In C# Aurora, transferring ordnance is no longer instant and ships without specialised equipment cannot exchange ordnance in space. A ship can only receive ordnance at a Spaceport, an Ordnance Transfer Station, a ship with a Ordnance Transfer System, a base with a Ordnance Transfer Hub or in a military hangar bay.

A new technology line - Ordnance Transfer Systems - provides the basis of the rate of ordnance transfer and allows ships to mount systems to transfer ordnance to or from other ships. The baseline system (Ordnance Transfer System: 40 MSP per Hour) sets the racial ordnance transfer rate at 40 MSP per hour and allows the use of the first ship-mounted Ordnance Transfer System. There are ten further steps in the tech progression with the highest tech system allowing ordnance transfer at 400 MSP per hour.

Spaceports, Ordnance Transfer Stations or Ordnance Transfer Hubs will always use the highest tech ordnance transfer rate and can transfer ordnance to or from an unlimited number of ships simultaneously. However, the ships involved must be stationary. Hangar Bays also use the highest tech ordnance transfer rate (mainly to avoid multiple hangar bay types).

Spaceports have increased in cost to 3600 BP but can now be moved by freighters. They are equal to four research facilities for transport purposes (or 80 factories). They retain their existing bonuses to loading and unloading cargo.

Ordnance Transfer Stations are a new installation with a cost of 1200 BP. They do not require workers and can be moved by freighters. They have a transport size equal to 10 factories. Essentially, they are a cut-down version of a spaceport intended to facilitate ordnance transfer in forward areas, transferring ordnance between the surface of a planet and ships in orbit. They have no bonuses for loading or unloading cargo.

An Ordnance Transfer Hub can be mounted on a ship. It is a commercial system with a research cost of 10,000 RP, build cost of 2400 BP and a size of 100,000 tons. In practical terms, this is likely to form part of a large, deep-space station, due to the size and cost, rather than being deployed on ammunition colliers that will accompany fleets.

A Ordnance Transfer System is 500 tons and has a cost ranging from 20 BP to 200 BP, depending on the tech level. A ship with an Ordnance Transfer System can transfer ordnance to or from a single ship at once, so it will take some time to replenish a whole fleet, although this will improve with higher technology. At the early tech levels, the Ordnance Transfer System can only be used if both ships (collier and target ship) are both stationary. Underway Replenishment allows the transfer to take place while both ships are in the same fleet and underway. Priorities can be set for the ordnance transfer order when multiple ships are involved. The first Underway Replenishment tech allows ordnance transfer at 20% of the normal rate (2500 RP), rising to 100% with the highest tech (40,000 RP).

Ordnance transfer order types will be adjusted to deal with the new requirements (which I will list in a separate post). Ordnance will be transferred during each movement increment as time passes until the target ship has full magazines.

20.3 Ordnance transfer orders

Original post can be found [here](#).

With the new ordnance transfer rules, I am changing how some of the ordnance transfer orders work.

The first major change is that a collier within a fleet can be set to automatically transfer ordnance to or from other ships in the fleet. You can flag a collier as being at one of seven ordnance transfer statuses; None, Load Fleet, Replace Fleet, Remove Fleet, Load Sub-Fleet, Replace Sub-Fleet, Remove Sub-Fleet.

When this flag is set to Load Fleet or Load Sub-Fleet, each collier will load ordnance into the magazines of non-colliers within its own fleet (or sub-fleet) as that fleet continues with its normal orders (the transfer itself is not an order). Essentially, the collier will keep the fleet's magazines topped up. The rate of ordnance transfer will be based on the ordnance transfer system of the collier multiplied by the parent race's underway replenishment tech (unless the fleet is stationary). The missiles being loaded will be based on what is missing from the ship's magazine when compared to the class loadout, starting with the largest missiles first (although smaller missiles will be loaded if there is insufficient time in the sub-pulse to load a larger one). However, missiles will only be added using this order and missiles that do not match the current class loadout will not be removed.

When this flag is set to Replace Fleet or Replace Sub-Fleet, each collier will remove any missiles that do not match the current class loadout and replace them with those from the class loadout (assuming the collier has a sufficient stockpile) for any non-colliers within its own fleet (or sub-fleet). The collier will remove non-loadout missiles from the target ship while it has magazine space remaining, then add class loadout missiles to create space. Essentially, the collier will alternate loading and unloading as necessary to create the correct loadout.

When this flag is set to Remove Fleet or Remove Sub-Fleet, the collier will unload all missiles from non-colliers within its own fleet (or sub-fleet), as long as it has space to store them.

The current 'Provide Ordnance to Fleet' order has been replaced with several new orders to facilitate the above. These include:

- Join and Add Ordnance to Fleet
- Join and Add Ordnance to Sub-Fleet
- Join and Replace Ordnance in Fleet
- Join and Replace Ordnance in Sub-Fleet
- Join and Remove Ordnance from Fleet
- Join and Remove Ordnance from Sub-Fleet

The fleet containing the collier will become part of the target fleet and switch to an appropriate ordnance transfer status depending on the order. You can also use an 'Absorb' order to collect a collier with an existing status set. I may look at adding ship-level conditional orders (rather than fleet) so that colliers/tankers can detach when empty and return home without player supervision.

A new 'Load from Ordnance Transfer Hub' order has been added. This order requires a second fleet containing at least one ordnance transfer hub as the destination. On arrival, any ships in the fleet with magazines will receive ordnance according to their class loadouts until all magazines are full, or the ordnance

transfer hub runs out of ordnance. No ordnance will be removed by the hubs. All ships in the fleet will receive ordnance, including colliers. Once completed, the fleet will move on to its next order. If the fleet containing the ordnance transfer hub has any movement orders, the ordnance transfer will not take place and the ordnance transfer order will be marked as completed. Multiple hubs in the target fleet will not increase the rate of ordnance transfer but they can all contribute ordnance.

A new 'Replace at Ordnance Transfer Hub' order has been added. This order functions in a similar way to above except that any ordnance not in the class loadout will be removed by the hubs. The mechanics of this process are the same as the ordnance transfer within fleets above.

A new 'Unload to Ordnance Transfer Hub' order allows colliers to deliver ordnance to the hubs.

The existing 'Load Ordnance from Colony' order will remain but can only be used at colonies that have either a Spaceport or an Ordnance Transfer Station. On arrival, the fleet will receive ordnance until all its magazines are full, or the colony runs out of appropriate ordnance. All ships in the fleet will be receive ordnance, including colliers. Once completed, the fleet will move on to its next order. Multiple spaceports or ordnance transfer stations at the colony will not increase the rate of ordnance transfer.

The 'Unload Ordnance to Colony' order also remains but can only be used at colonies that have either a Spaceport or an Ordnance Transfer Station.

Any order involving the transfer of ordnance to or from a colony or ordnance transfer hub will use the current racial ordnance transfer tech to determine the rate of transfer.

Note this means that significantly more planning will be required in this version of Aurora to ensure missile-armed ships can be reloaded at the frontier. It will no longer be possible to dump ordnance on the nearest available rock. Colonies will require a spaceport or an ordnance transfer station before they can support missile-armed fleets. Alternatively, colliers can accompany fleets, or a deep space base with an ordnance transfer hub can be established.

20.4 Automated weapon assignment

Original post can be found [here](#).

C# has a more intelligent auto-assignment for weapons and fire controls. You can set up a ship with a single click and then adjust as necessary. The code assumes that:

- Any missile fire control with a resolution of 1 is an anti-missile fire control
- Any missile fire control with a resolution greater than 1 is a 'normal' missile fire control
- Any beam fire control with a tracking speed at least 2x racial speed is a point defence fire control (some leeway here for older ships)
- Other beam fire controls are for offensive weapons
- Weapons within the given category (missile PD, missile offensive, beam PD, beam offensive) are split equally between fire controls of the same category
- More powerful beam weapons are assigned first
- ECCM is assigned as available with the priority order of offensive launcher, PD launcher, offensive beam, PD beam

The assignment code will take account of damage to the ship and adjust accordingly. In most cases, the above will be sufficient (and will be used for NPR designs). For more bespoke and unusual player ships, some tweaking may be necessary.

As a simple example, the escort cruiser below has six twin turrets and three fire controls. Clicking the button assigns two turrets to each fire control and sets the point defence to final fire.

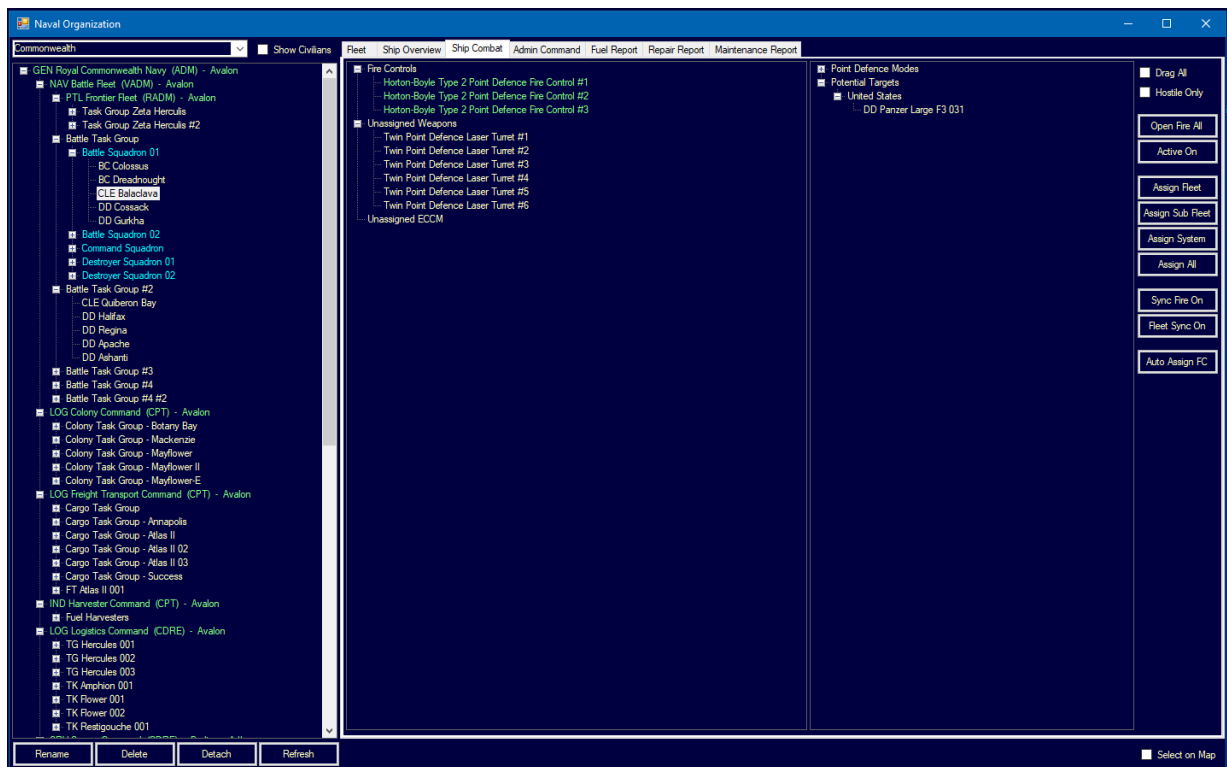


Figure 17: Automated Assignment Example 1

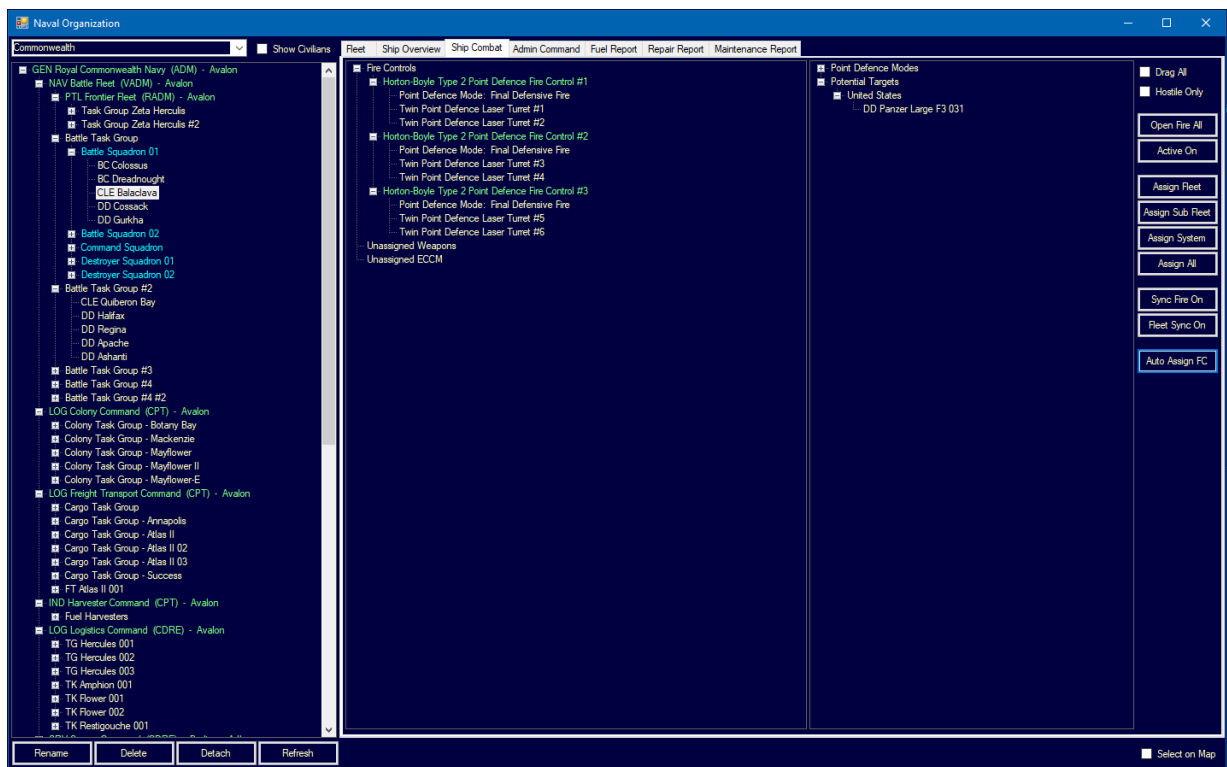
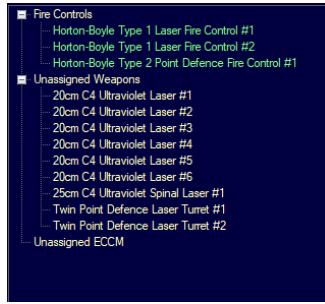
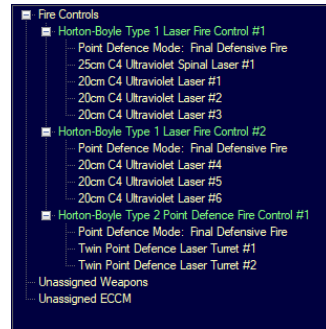


Figure 18: Automated Assignment Example 2

This ship has a mixture of point defence and offensive lasers, plus fire controls for each. The auto-assign determines which weapons should be assigned to which fire control. All beam fire control are set as final fire so the ship will use all available weapons to defend against missile attack.

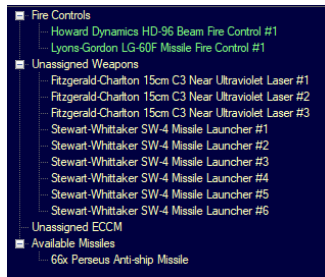


(a) Automated Assignment Example 3

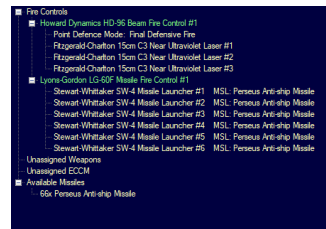


(b) Automated Assignment Example 4

This ship has a mixture of missiles and offensive lasers. Note that missiles are automatically assigned to launchers.

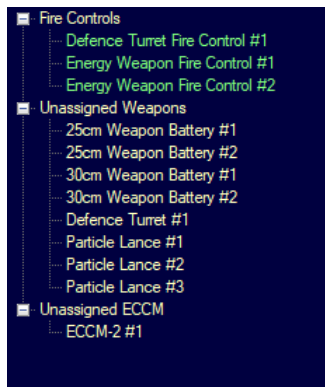


(a) Automated Assignment Example 5

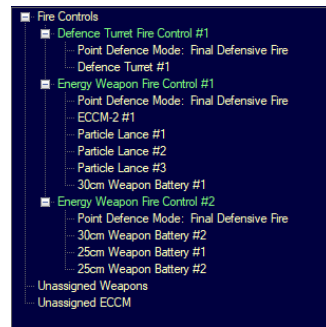


(b) Automated Assignment Example 6

This ship has a point defence turret and multiple types of offensive beam weapons, plus an ECCM system.

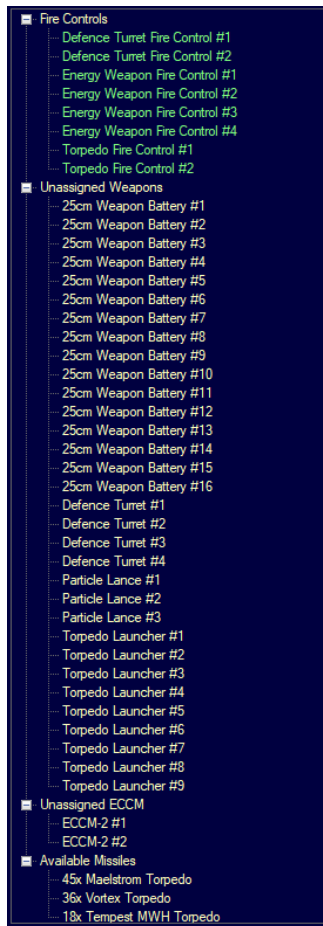


(a) Automated Assignment Example 7

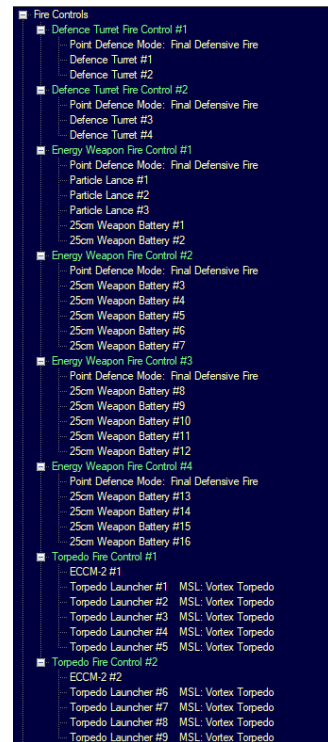


(b) Automated Assignment Example 8

An extreme example!



(a) Automated Assignment Example 9



(b) Automated Assignment Example 10

20.5 Atmosphere and energy weapons

Original post can be found [here](#).

In C# Aurora, there is no penalty for energy weapons firing in or through an atmosphere.

20.6 Planetary bombardment

Original post can be found [here](#).

In C# Aurora, populations can be attacked by missiles and energy weapons. However, because missile warheads are area-effect weapons, they are much more effective at destroying the civilian population and any installations.

Each installation type has a Target Size. The chance of each attack (either a missile or a single energy weapon) destroying an installation is equal to: $\text{Weapon Damage} / \text{Target Size}$. For example, a construction factory has a Target Size of 20, so a 10cm laser fired from orbit would have a 15% chance to destroy the target ($3 / 20$). For the purposes of this check, missile warheads are treated as equal to 20x warhead strength. Therefore, a single 1 point warhead has a 100% chance to destroy a construction factory.

A single energy weapon can destroy only one target per hit. A missile warhead is applied until all damage is used. For example, a 5-point missile warhead is counted as 100. If the first installation hit is a construction factory, that factory is destroyed and the remaining damage reduced to 80. That damage is then applied the next installation hit and so on.

Missile warheads cause radiation and dust levels to increase by an amount equal to their warhead size. Energy weapons increase the dust level by 5% of their damage amount.

Missile warheads inflict civilian casualties at the rate of 100,000 per point of damage. Energy weapons inflict civilian casualties at the rate of 2,000 per point of damage.

Populations will no longer surrender purely due to orbital bombardment. You have to land ground formations to force a surrender.

Energy weapons now provide a way to destroy the industry and infrastructure of a target population, without causing radiation or using up ordnance. However, this will require considerable effort for a large population and consume maintenance supplies due to weapon failures. It will also bring you within range of any ground-based energy weapons. Of course, it will usually be more beneficial to conquer the planet and gain the installations instead of destroying them.

Name	Target size
Automated Mine	20
Cargo Shuttle Station	200
Civilian Mining Complex	200
Construction Factory	20
Conventional Industry	20
Deep Space Tracking Station	40
Fighter Factory	20
Financial Centre	20
Forced Labour Construction Camp	80
Forced Labour Mining Camp	80
Fuel Refinery	20
Genetic Modification Centre	400
Ground Force Training Facility	400
Infrastructure	2
Low Gravity Infrastructure	2
Maintenance Facility	20
Mass Driver	20
Military Academy	400
Mine	20
Naval Headquarters	400
Ordnance Factory	20
Ordnance Transfer Station	200
Refuelling Station	200
Research Lab	400
Sector Command	400
Spaceport	1000
Terraforming Installation	100

Part V

Ground Forces

21 Unit design

Original post can be found [here](#).

Ground Forces and Ground Combat are undergoing a huge expansion in C#. The VB6 Ground Unit becomes the Formation and the VB6 Ground Unit Type becomes the Formation Template. However, there are no longer any fixed unit types or unit values. Instead, there is endless scope for Formations and Formation Templates, based on a detailed design process at the Formation level and below. This will allow the simulation of ground forces from many science fiction genres. As this is a long topic, I am going to break it into several posts each covering a different topic.

The most granular level is the Ground Unit Class, which is an individual soldier or vehicle. One or more of the same Ground Unit Class are grouped into Formation Elements, which in turn are grouped into Formations. Formations remain intact for movement purposes, but combat involves each individual unit (each soldier or vehicle). As individual units are now tracked for casualty purposes, readiness no longer exists. Morale is tracked at the Formation Element level (which is a group of the same unit class), so the infantry in a Formation may have a different morale than the anti-tank guns or artillery.

The process of design starts with the Ground Unit Class. Two important factors in this design process are the Racial Armour Strength and Racial Weapon Strength, shown at the top of the Ground Forces window.

Racial Armour Strength is based on the strength of the highest racial armour technology. Conventional Armour is 3, Duranium Armour is 5, et cetera. For this screenshot, the Commonwealth has researched Ceramic Composite, which has a strength of 10.

Racial Weapon Strength is based on the highest tech level (TL) among Laser Focal Size, Railgun Type, Meson Focal Size, Particle Beam Strength and Carronade Calibre. For example, 15cm Laser Focal Size is TL3 as it is the third tech of that type. Racial Weapon Strength is the value of armour at the same tech level. In this case, the Commonwealth has researched 20cm Laser Focal Size, which is TL4. The fourth Armour Tech is Ceramic Composite, which has a strength of 10, so the Racial Weapon Strength is 10. The reason for using Armour as the basis of Weapon Strength is partly because that means Ground Armour and Ground Weaponry are aligned, and partly because it is a straightforward way to assign value based on very different weapons.

The Ground Unit Design tab of the new ground Forces window is shown below. First, a 'base type' is chosen, which is infantry, several sizes of vehicle, or static. Static in this sense is a weapon that is not self-mobile, such as a towed anti-tank gun, towed artillery, et cetera. Static weapons remain in place when firing so they are easier to hit than infantry or vehicles. Each base type has six main characteristics:

1. Size (in tons): Size is the basis for transport requirements and cost, although there are other modifiers to cost (discussed below).
2. Hit Points: Unit hit points are compared to weapon damage during combat to determine the chance of destruction (the Damage Check). The chance of a weapon destroying a unit is $(WeaponDamage/HitPoints)^2$.
3. Slots: The number of component slots available for the base type.
4. To-Hit Modifier: Used to modify the chance of the unit being hit during combat (based on the mobility of the unit). This only applies if the unit is not fortified.
5. Maximum Fortification: The maximum strength to which the unit can be fortified by construction factories or construction units. The Chance to Hit for a firing unit is divided by the Fortification Level of the target unit.
6. Maximum Self-Fortification: The maximum strength to which the unit can be fortified without construction factories or construction units.

The next section is Armour Type. The Armour of a unit is compared to the Armour-Penetration (AP) value of a weapon. The chance to penetrate is equal to $(AP/Armour)^2$. For example, a weapon with AP 4 attacking a unit with Armour 6 has a 45% chance to penetrate. The overall process for checking if a shot destroys a target is Chance To-Hit, followed by Armour Penetration Check, followed by Damage Check. All three must be successful to destroy the target. Each type of Armour has two values.

1. Base AR: The Base Armour Rating is multiplied by Unit Size (including components below) to determine cost. So a unit with 6 armour would be 50% more expensive than the same unit with 4 armour.

2. Racial AR: Racial Armour Rating is the Base Armour Rating multiplied by the Racial Armour Strength (shown at top of window).

Below the base type and armour is a large section showing Components. Infantry, static and light vehicles all have one 'component slot', vehicles and heavy vehicles have two slots, while super-heavy and ultra-heavy vehicles have three and four slots respectively. Each slot can hold one component from the list and the same component can be put into multiple slots. Certain components are only available with certain base types. For example, the Super-Heavy Anti-Vehicle component can only be used by super-heavy and ultra-heavy vehicles. The primary component is selected from the main table, while any additional components are selected from the dropdown(s) below the main table. Each component has a name and an abbreviation and is rated in nine different areas:

1. Size: The size in tons is added to the size of the base unit type.
2. Armour-Penetration (AP): If the component is a weapon, the chance to penetrate a target's armour is $(AP/Armour)^2$. The AP Rating is the underlying AP of the component (not shown), multiplied by the Racial Weapon Strength.
3. Damage: If the component is a weapon, the chance to destroy a target after the armour has been penetrated is $(WeaponDamage/HitPoints)^2$. The damage value is the underlying damage rating of the component (not shown), multiplied by the Racial Weapon Strength.
4. Shots: The number of times a weapon will fire during each ground combat phase.
5. CIWS: 'Y' indicates this component is a Close-in-Weapon-System, capable of defending the planet (on which the unit is based) from missile attack. This CIWS will use the values in the CIWS section, which will become visible when a CIWS component is selected. More on this in a later rules post.
6. STO: 'Y' indicates this component is a Surface-To-Orbit energy weapon, capable of engaging ships in space within weapon range of the planet on which the unit is based. The weapon type used for the STO component can be selected in the section to the centre right, which will become visible when an STO component is selected. More on this in a later rules post, although see the second screenshot.
7. HQ: The headquarters capacity of the component in tons. This is the total size of the formation (or formation hierarchy) that can be effectively controlled by a commander based in a unit with this component. To assign a commander to a formation, one of the units within that formation requires a headquarters component. More details on command hierarchies will be provided in a future rules post.
8. FFD: 'Y' indicates this component is a Forward Fire Direction (FFD) component. Forward Fire Direction allows a front-line unit (more on that later) to direct the fire of bombardment units from a formation in a support position, fighters on close air support missions, or ships in orbit. A later rules post will explain this function.
9. Const. The construction value of the component in Construction Factory Equivalents (CFEs).

At the top-right of the window is the Capability section. One or more Capabilities can be selected for the Unit Class. The Boarding Combat capability is required for a Unit to be able to board another ship. For all other capabilities, the Chance to Hit is doubled in the environment specified. If a unit has multiple capabilities, such as Mountain Warfare and Jungle Warfare on a world with a dominant terrain of Jungle Mountain, the bonus is cumulative (i.e. 4x to-hit in this case). Each capability selected for a Unit will increase the cost by the multiple specified. Some capabilities are only available for infantry units.

In the bottom right section, a summary of the unit is shown in a similar style to the Class Summary for naval designs. When the sizes of all the units in a formation are aggregated, that is the transport requirement for that formation in tons. Cost is in BP. When the costs of all the units in a formation are aggregated, that is the build point requirement to construct the formation. Armour and Hit Points have been described previously. Below that is a list of components, followed by the materials required for construction and the research cost to develop the unit once designed.



Figure 23: Ground Forces Example 1

This screenshot shows a static unit with an STO component selected. The chosen weapon (which is any non-turreted weapon developed for shipboard use) is selected on the right. Spinal Weapons can be selected for ground use without penalty. The STO mount includes the weapon, a reactor of the exact size needed for the recharge rate, an active sensor with range greater than the weapon range and a built-in beam fire control with a 4x range modifier. The cost is equal to the static platform, the weapon, the reactor, the active sensor and half the fire control. STO weapons have a 25% bonus to fire control range. The damage shows two numbers, which is the damage at minimum and maximum range.

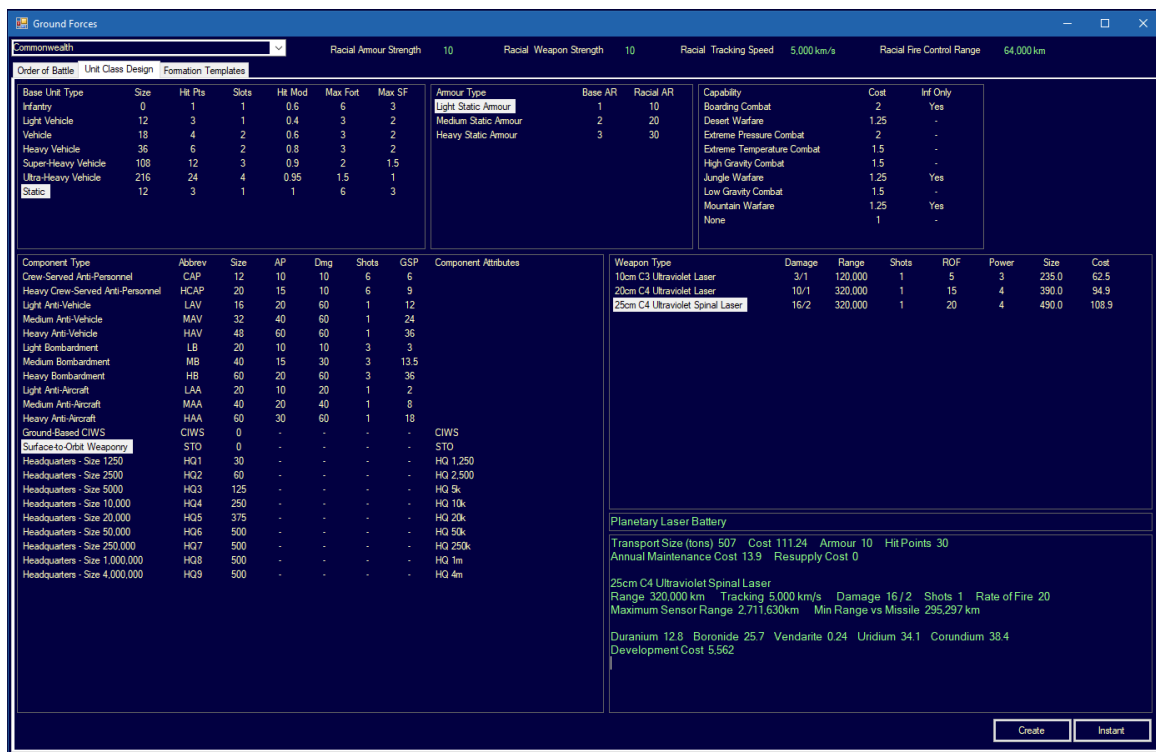


Figure 24: Ground Forces Example 2

22 Formation templates

Original post can be found [here](#).

The screenshot below shows the Formation Templates tab of the Ground Forces window. Formation Templates are the equivalent of VB6 Ground Unit Types, although it might be easier to think of them as serving the same function as Ship Classes. They are a detailed design that serves as a template for building Formations based on that same design, which is the same relationship as Ship Classes to Ships.

This tab is split into two halves. On the left is a list of available Ground Unit Classes created using the Unit Class Design tab (as explained in the previous rules post). All of these were created using TL4 technology, with three exceptions. For comparison purposes, the Challenger 2 Main Battle Tank and the Warrior AFV were created using Conventional, rather than Trans-Newtonian, technology, while the Challenger Base TN Upgrade was the Challenger design with TL1 technology. It should be possible to simulate most modern army units with the new C# Aurora ground combat, so you could theoretically be landing on an alien world with Abrams and Bradleys or T-14 and T-15 Armatas. The ten columns for the Unit Class List are as follows:

1. Type: An abbreviation for the Base Type (infantry, Vehicle, Heavy Vehicle, etc.)
2. Name: The name assigned during Unit Class Design. This can be changed using the Rename Unit button.
3. Size: Transport size in tons.
4. Cost: Cost in Build Points.
5. Arm: The Armour Strength of the Unit. This is based on the armour available at the time of design and is not upgraded when newer technology becomes available (as with ship designs).
6. HP: The Hit Points of the Unit. This is set at design time and does not change.
7. Components A to D: Abbreviations for each of the components included in the Unit Class. These are the same abbreviations as used on the Components table in the Unit Class Design tab. As with armour and hit points, any components use the technology available at the time of unit design. To see the detailed view of the components, click on the Unit. The Unit Summary will be shown in the bottom section on the left hand side.

As an example, the Leman Russ Battle Tank is a Heavy Vehicle of 104 tons, with 60 Armour and 60 Hit points, costing 12.48 BP. The components are Heavy Anti-Vehicle (HAV) and Heavy Crew-Served Anti-Personnel (HCAP). Looking at the summary, the HAV has 1 shot per combat phase with Penetration 60 and Damage 60, while the HCAP has 6 shots with Penetration 20 and Damage 10.

The right-hand half of the tab shows Formation Templates. A new Formation Template is created by clicking the New button. In this case, four have already been created. Each Template comprises one or more Template Elements, shown in the bottom right section. Each Template Element has a specific number of specific Ground Unit Class. For example, the Guard Armoured Regiment is currently selected, which has four template elements: 60x Leman Russ Battle Tank, 1x Macharius Command Tank, 12x Hydra Flak Tank and 24x Hellhound Anti-Infantry Tank.

Each template element has the following attributes:

1. Name: The Unit Class for this element.
2. Units: The number of units of that Unit Class in this element.
3. Size: The total size in tons of this element. For example, 60 Leman Russ Battle Tanks at 104 tons each is 6,240 tons.
4. Cost: The total cost in Build Points for this element.
5. HP: The total aggregate hit points for the element.
6. HQ: The headquarters capacity of the elements Unit Class in tons. If there are multiple units in a template element, only one is considered for the headquarters capacity. Any additional units are for redundancy. The headquarters capacity is the total size of the formation (or formation hierarchy) that can be effectively controlled by a commander based in a unit with this component. In the case of the Macharius Command Tank, it has an HQ capacity of 10,000 tons.

7. FFD: The total number of Forward Fire Direction (FFD) components in the template element. Forward Fire Direction allows a front-line unit to direct the fire of bombardment units from a formation in a support position, fighters on close air support missions, or ships in orbit.
8. Const. The construction value of the element in Construction Factory Equivalents (CFEs).
9. CIWS: The number of Close-in-Weapon-System components in the template element, capable of defending the planet (on which the unit is based) from missile attack.
10. STO: The number of Surface-To-Orbit energy weapon components in the template element. STOs are capable of engaging ships in space within weapon range of the planet on which the unit is based.

The totals for each Template Element are added together to create the total for the Formation Template as a whole, shown in the top right section. In the example shown, the Guard Armoured Regiment has a total size of 8,942 tons, which is the combination of all four template elements. The Formation Template list has an additional column for Rank. A default rank will be suggested by the program, although this can be overridden by the player. This rank will be used by Automated Assignment process for any Formations built using this Formation Template.

To add new Template Elements to a Formation Template, use the Add Units button in conjunction with the adjacent text field to specify the number of units in the new element. This number can be subsequently edited by selecting the element and clicking the Edit Amount button. Both Formation Templates and Element Templates can be deleted using the appropriate buttons.

This screenshot shows the Macharius Command Tank on the left and the Brigade Headquarters formation template on the right. The Macharius is a super-heavy vehicle, with two super-heavy anti-vehicle weapons and an HQ4 component, which provides a headquarters capacity of 10,000 tons. This is a large and expensive vehicle at 518 tons and 93.24 BP, but is well-protected as the loss of the HQ in a formation will result in the loss of any commander bonuses (and maybe the commander himself).

Ground Forces

Commonwealth

Racial Armour Strength10

Racial Weapon Strength10

Racial Tracking Speed5,000 km/s

Racial Fire Control Range64,000 km

Order of BattleUnit Class DesignFormation Templates

Type	Name	Size	Cost	Arm	HP	A	B	C	D	Abbr	Name	Units	Size	Cost	HP	HQ	FFD	Const	CIWS	STO	Rank
INF	Autocannon Anti-Tank Team	16	0.64	20	10	LAV	-	-	-	BRG	Brigade Headquarters	150	5,268	226	2,580	50k	-	-	-	-	BG
INF	Desert Raider	5	0.25	20	10	PW	-	-	-	DIV	Divisional Headquarters	62	9,472	1,176	3,600	250k	-	-	-	-	MG
INF	Frag Missile Team	20	0.8	20	10	LB	-	-	-	ARM	Guard Armoured Regiment	57	8,942	1,017	5,160	10k	-	-	-	-	COL
INF	Guard Brigade Headquarters	500	30	30	10	HQ6	-	-	-	GRD	Guard Infantry Regiment	1097	6,882	275	10,970	10k	-	-	-	-	COL
INF	Guard Regimental Headquarters	250	10	20	10	HQ4	-	-	-												
INF	Guardman	5	0.2	20	10	PW	-	-	-												
INF	Heavy Bolter Team	20	0.8	20	10	HCAP	-	-	-												
INF	Punisher Gatling Cannon Team	12	0.48	20	10	CAP	-	-	-												
VEH	Hellhound Anti-Infantry Tank	42	3.36	40	40	CAP	CAP	-	-												
VEH	Hydra Rak Tank	98	7.84	40	40	MAA	MAA	-	-												
HVH	Basilisk Self-propelled Artillery	156	18.72	60	60	HB	HB	-	-												
HVH	Challenger - Base TN Upgrade	62	4.96	20	30	MAV	CAP	-	-												
HVH	Challenger 2 Main Battle Tank	62	4.96	12	18	MAV	CAP	-	-												
HVH	Leman Russ Annihilator	132	15.84	60	60	HAV	HAV	-	-												
HVH	Leman Russ Battle Tank	104	12.48	60	60	HAV	HCAP	-	-												
SHV	Baneblade Super-heavy Tank	224	40.32	90	120	HAV	HAV	HCAP	-												
SHV	Macharius Command Tank	518	93.24	90	120	HQ4	SHAV	SHAV	-												
SHV	Shadowword Tank Destroyer	348	62.64	90	120	SHAV	SHAV	SHAV	-												
SHV	Stormblade Divisional Command Tank	716	128.88	90	120	HQ7	HAC	HAC	-												
SHV	Stormlord Brigade Command Tank	716	128.88	90	120	HQ6	HAC	HAC	-												
STA	25cm Ground-based Laser	502	109.14	10	30	STO	-	-	-												
STA	Earthshaker Cannon	72	1.44	10	30	HB	-	-	-												
STA	Missile Defence Installation	425	40.74	10	30	CIWS	-	-	-												
STA	Plasma Cannon	60	1.2	10	30	HAV	-	-	-												
L VH	Warrior AFV	32	1.28	6	9	HCAP	-	-	-												

Leman Russ Battle Tank

Transport Size (tons) 104 Cost 12.48 Armour 60 HP Points 60

Heavy Anti-Vehicle: Shots 1 Penetration 60 Damage 60

Heavy Crew-Served Anti-Personnel: Shots 6 Penetration 20 Damage 10

Vendetta 12.48

Development Cost 624

Name	Units	Size	Cost	HP	HQ	FFD	Const	CIWS	STO
Leman Russ Battle Tank	60	6,240.0	748.80	3600	-	-	-	-	-
Macharius Command Tank	1	518.0	93.24	120	10k	-	-	-	-
Hydra Rak Tank	12	1,176.0	94.08	480	-	-	-	-	-
Hellhound Anti-Infantry Tank	24	1,008.0	80.64	960	-	-	-	-	-

Rename Unit

Add Units

10

New

Edit Amount

Rename Temp

Delete Temp

Delete Element

Change Rank

Figure 25: Formation Templates Example 1

The Brigade Headquarters formation template includes two Guard Brigade Headquarters units, in case one is destroyed, plus thirty-six large artillery pieces, twelve flak tanks and a company of Guardsman. Combat involves three locations. Front-Line, Support or Rear-Echelon. Units in a Support position can only attack using bombardment weapons, or defend themselves against air attack. This formation is intended to serve in the Support location and is organising accordingly. However, it is possible for a Support Formation to temporarily find itself moved into a Front-Line position, so the Guardsman Element will provide additional protection in that case.

Ground Forces

Commonwealth

Racial Armour Strength10Racial Weapon Strength10Racial Tracking Speed5,000 km/sRacial Fire Control Range64,000 km

Order of BattleUnit Class DesignFormation Templates

Type	Name	Size	Cost	Arm	HP	A	B	C	D	Abbr	Name	Units	Size	Cost	HP	HQ	FFD	Const	CIWS	STO	Rank
INF	Autocannon Anti-Tank Team	16	0.64	20	10	LAV	-	-	-	BRG	Brigade Headquarters	150	5,268	226	2,580	50k	-	-	-	-	BG
INF	Desert Raider	5	0.25	20	10	PW	-	-	-	DIV	Divisional Headquarters	62	9,472	1,176	3,600	250k	-	-	-	-	MG
INF	Frag Missile Team	20	0.8	20	10	LB	-	-	-	ARM	Guard Armoured Regiment	97	8,942	1,017	5,160	10k	-	-	-	-	COL
INF	Guard Brigade Headquarters	500	30	30	10	HQ6	-	-	-	GRD	Guard Infantry Regiment	1097	6,882	275	10,970	10k	-	-	-	-	COL
INF	Guard Regimental Headquarters	250	10	20	10	HQ4	-	-	-												
INF	Guardsman	5	0.2	20	10	PW	-	-	-												
INF	Heavy Bolter Team	20	0.8	20	10	HCAP	-	-	-												
INF	Punisher Gatling Cannon Team	12	0.48	20	10	CAP	-	-	-												
VEH	Hellhound Anti-Infantry Tank	42	3.36	40	40	CAP	CAP	-	-												
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HVH	Basilek Self-propelled Artillery	156	18.72	60	60	HB	HB	-	-												
HVH	Challenger - Base TN Upgrade	62	4.96	20	30	MAV	CAP	-	-												
HVH	Challenger 2 Main Battle Tank	62	4.96	12	18	MAV	CAP	-	-												
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HVH	Leman Russ Battle Tank	104	12.48	60	60	HAV	HCAP	-	-												
SHV	Barblade Super-heavy Tank	224	40.32	90	120	HAV	HAV	HCAP	-												
SHV	Macharius Command Tank	518	93.24	90	120	HQ4	SHAV	SHAV	-												
SHV	Shadowword Tank Destroyer	348	62.64	90	120	SHAV	SHAV	SHAV	-												
SHV	Stormblade Divisional Command Tank	716	128.88	90	120	HQ7	HAC	HAC	-												
SHV	Stormlord Brigade Command Tank	716	128.88	90	120	HQ6	HAC	HAC	-												
STA	25cm Ground-based Laser	502	109.14	10	30	STO	-	-	-												
STA	Earthshaker Cannon	72	1.44	10	30	HB	-	-	-												
STA	Missile Defence Installation	425	40.74	10	30	CIWS	-	-	-												
STA	Plasma Cannon	60	1.2	10	30	HAV	-	-	-												
LHV	Warrior AFV	32	1.28	6	9	HCAP	-	-	-												

Macharius Command Tank
Transport Size (tons) 518
Cost 93.24
Armour 90
Hit Points 120
Headquarters Size 10,000
Super-Heavy Anti-Vehicle: Shots 1
Penetration 90
Damage 90
Super-Heavy Anti-Vehicle: Shots 1
Penetration 90
Damage 90
Vandarte 93.24
Development Cost 4,662

NameUnitsSizeCostHPHQFFDConstCIWSSTO

Guard Brigade Headquarters21,000.060.002050k-- --

Guardsman100500.020.001000-- --

Hydra Rak Tank121,176.094.08480-- --

Earthshaker Cannon362,592.051.841080-- --

Rename UnitAdd Units10

NewEdit AmountRename TempDelete TempDelete ElementChange Rank

Figure 26: Formation Templates Example 2

23 Alien ground unit intelligence

Original post can be found [here](#).

As you fight alien ground forces, you will gain intelligence on the alien ground unit classes. This intelligence is displayed on the Diplomacy and Intelligence window alongside intelligence on alien ships, classes, sensors and populations.

For each different type of ground unit class you engage, you may gain intelligence if you have your own ground forces on the same ship or system body. New intelligence is gained under the following circumstances:

- If the alien unit fires on you, you will gain intelligence on its weapons
- If you score twenty hits on that type of unit, you will identify its base type (infantry, light vehicle, etc.)
- If you penetrate the armour of that type of unit twenty times, you will learn its armour strength
- If you destroy twenty of that type, you will learn its hit point

I might change the 20x multiplier based on play testing.

24 Base ground combat rules

Original post can be found [here](#).

Ground combat is conducted after the naval combat phase of each increment. One combat round will be performed for every eight hours that passed in the increment. Combat potentially takes place on any system body where populations exist from two or more hostile powers. If only one side has ground forces present, there may be a conquest (rules and code TBD). If ground forces are present from two or more hostile powers, ground combat will take place.

Ground forces can be assigned one of four field positions; front line attack, front line defence, support and rear echelon. Units in support and rear echelon positions cannot directly attack hostile forces but if they possess elements with bombardment weapons they may be assigned to support a front line formation. Support and rear

echelon formations can also potentially provide anti-air cover (more in a rules post on ground-space interaction) and supply to front line units. Only formations with all elements supplied can be placed in front line attack mode. Formations placed in front line attack mode lose any fortification bonus.

Each race involved in a combat on a system body creates a list of its own formations on that system body (even if in multiple populations), plus a list of hostile alien formations, even if they are from multiple alien races in multiple populations. Hostile formations are checked for their weighted size. This is based on actual size for front line size, 25% for support and 5% for rear-echelon. Each hostile formation is given a range for potential selection, based on its weighted size.

Each front line friendly formation randomly targets a hostile formation. Friendly units with front line defence can target hostile front line formations. Friendly units with front line attack can target any hostile formation, although support and rear echelon are less likely given their smaller weighted size. In fact, the more formations that are pushed into front line positions, the less likely it is that rear areas will be attacked.

Support and Rear Echelon formations that contain formation elements with bombardment weapons can be assigned to support front line formations that are part of the same organisation. Formations in a support position with light bombardment weapons will fire with the front line formations (see next paragraph). Formations in a support position with medium/heavy bombardment weapons or formations in a rear echelon position with heavy bombardment weapons will fire in a subsequent phase - see below.

Once a front line formation (or a light bombardment element in the Support position) has been matched against a hostile formation, each friendly individual unit (a soldier or vehicle) in that formation engages a random element in the hostile formation, with the randomisation based on the relative size of the hostile formation elements. The targeting on an individual unit level represents that the different elements in a front line formation will generally be attacking in conjunction (infantry supporting tanks, etc.).

Once all front line attacks have been concluded, each unit in each element providing supporting bombardment will engage either the hostile formation being targeted by the friendly formation they are supporting, or one of the hostile formation's own supporting elements (counter-battery fire). If the hostile formation is targeted, each unit in the supporting artillery element engages a random element in the hostile formation, with the randomisation based on the relative size of the hostile formation elements (the same as front-line vs front-line). If a hostile supporting element is targeted, all fire is directed against that element. This represents the difference between providing supporting fire in a combined arms front-line battle and targeting specific hostile artillery for counter-battery fire. The decision to target the hostile front-line formation vs hostile support elements is based on the relative sizes.

Supporting medium artillery will choose between hostile forces in Front-Line or Support field positions (and will ignore any elements in Rear Echelon field position for purposes of relative size), while heavy artillery can select targets in any field position. In other words, if the enemy has supporting heavy artillery in a rear echelon position, you will only be able to target those elements with your own heavy artillery (or ground support fighters, or orbital bombardment support).

Once all the initial combat is complete, there is a chance for a breakthrough. Each defending formation is checked according to the following procedure:

1. A Cohesion Damage value is determined for each formation element using the following formula: $\text{ElementClassSize} * \text{UnitsDestroyedinCombatPhase} * 100 / \text{ElementMorale}$
2. The total Cohesion Damage is summed for all elements in the formation and compared to the formation size. This value, from 0 to 100%, is the Formation Cohesion Rating
3. For each front line formation that attacked the defending formation, a Breakthrough Value is determined for each formation element
4. Static elements have zero Breakthrough Value. Vehicle elements use the following formula: $\text{ElementClassSize} * \text{ElementUnits} * \text{ElementMorale} / 100$. Infantry elements use the same formula as vehicles with a further modifier of 0.5.
5. The total Breakthrough Value is summed for all elements in the attacking formation and compared to the formation size. The value is multiplied by 2 if the formation has a field position of Front Line Attack. This value, from 0 to 200%, is the Formation Breakthrough Rating
6. A Breakthrough Potential value is determined for the attacking formation by multiplying the defending Formation Cohesion Rating by the attacking Formation Breakthrough Rating. If this value is equal to or greater than 30%, a breakthrough has occurred for that attacking formation.
7. Each formation that creates a breakthrough mounts a second attack. This attack does not benefit from supporting artillery or fighter support. However, it functions as if the attacking formation has a field position of Front Line Attack, which means all hostile formations are potential targets, not just those on the front line.

The breakthrough rules mean that defending formations that suffer casualties may allow attacking formations to penetrate their lines and conduct a second attack. This is more likely under the following circumstances: A single defending formation is attacked by multiple attacking formations, the defender suffers a high casualty percentage in a single ground combat round (potentially because the formation is small in size), the defender suffers disproportionate casualties to elements with larger unit classes, the defender is low morale, the attacker is primarily vehicle-based, the attacker is on front-line attack, the attacker is high morale.

When a formation element is engaged in combat against a hostile formation element, supply is checked. If supply is not available, the number of units firing will be 25% of normal. Each attacking unit uses the following process:

1. The To Hit Chance is determined. The base chance is 20% multiplied by the 'Dominant Terrain To Hit Modifier', the firing element morale / 100 and, if the target is not fortified, the base to hit chance for the target element unit class.
2. The Fortification Modifier for the target element is determined, which is the current fortification level of the target multiplied by the 'Dominant Terrain Fortification Modifier'. If the target is not fortified, the Fortification Modifier is 1.
3. The Environment Modifier is calculated, taking into account gravity, pressure and temperature and whether the firing element has capabilities in those environments. Each environment for which the element is not trained has a x2 modifier.
4. The Terrain Capability Modifier is calculated. If the element is trained to fight in the dominant terrain, the modifier is 0.5.
5. The Final Chance to Hit is calculated as $ToHitChance / FortificationModifier * EnvironmentModifier * TerrainCapabilityModifier$
6. The unit fires each weapon it has (except for non-bombardment weapons on units bombarding from support and rear-echelon field positions). If the to-hit roll is equal or less than the final chance to hit, the weapon has struck the target.
7. If a hit is scored, the armour-piercing (AP) value of the weapon is checked against the armour of the target. If AP is equal or greater than armour, the shot has penetrated. If AP is less than armour, the percentage chance to penetrate armour is $(AP / Armour)^2$.
8. If the shot penetrates armour, the percentage chance of destroying the target is equal to $(WeaponDamage / TargetHitPoints)^2$.
9. If a target is destroyed, the firing element gains morale and the target element suffers a loss of morale. This morale gain/loss is doubled if the firing unit is in front-line attack mode.

All combat is conducted simultaneously and losses are applied once all firing is completed. Because of the way the above is structured, multi-way conflicts with multiple races on each side are possible.

I will post separately on how spacecraft interact with ground combat.

25 Ground combat events

Original post can be found [here](#).

Ground combat in C# is very detailed with many things happening in each combat round. There are a number of new events at varying levels of detail to serve as combat reports. Note that a formation (such as an Imperial Guard Regiment) consists of several formation elements, each containing one or more units of a single ground unit class.

1. Element vs GUC: This is the most granular and reports the results of attacks from one formation element against one type of hostile ground unit class, providing number of shots, hits, armour penetrations and kills. If a formation element engages in combat against five types of enemies, that element will have five Element vs GUC reports
2. Ship vs GUC. This is similar to the above and reports the results of attacks from a single ship against one type of hostile ground unit class, providing number of shots, hits, armour penetrations and kills. If a ship attacks five types of enemies, that ship will have five Ship vs GUC reports

3. GUC vs GUC Summary: A summary of the results of attacks from one type friendly ground unit class against one type of hostile ground unit class, providing number of shots, hits, armour penetrations and kills. For example, if there are five friendly types of ground unit class, each of which attack five types of hostile ground unit class, there will be twenty-five reports of this type. This is useful if you want to see how well certain types match-up - are your AT Guns able to knock out hostile tanks for example.
4. Attack vs GUC Summary: A summary of the results of attacks from all friendly ground forces against one type of hostile ground unit class, providing number of shots, hits, armour penetrations and kills. For example, if six types of hostile types of ground unit class have been attacked by ground forces there will be six reports of this type.
5. Orbital vs GUC Summary: A summary of the results of attacks from all friendly ships against one type of hostile ground unit class, providing number of shots, hits, armour penetrations and kills. For example, if six types of hostile types of ground unit class have been attacked by ships there will be six reports of this type.
6. Formation Attack Summary: A list of the type and number of hostile units destroyed by a specific friendly formation
7. Ground Attack Summary: A list of the type and number of hostile units destroyed by all friendly surface and orbit forces
8. Element Loss Summary: Reports the results of enemy attacks against a single friendly formation element, providing number of shots, hits, armour penetrations and kills.
9. Formation Loss Summary: A list of the type and number of friendly units lost in a specific formation
10. Ground Defence Summary: A list of the type and number of friendly units in all formations destroyed by all hostile forces
11. Breakthrough Achieved: Reports that a specific formation achieved a breakthrough

There may be other events as a result of more play-testing. The above may be too granular for some players so you can filter out the events you don't want to see, or you can see very granular detail for role-playing and AAR purposes.

26 Ground combat hostile force intelligence

Original post can be found [here](#).

I've already posted the rules regarding how you learn about the different classes of hostile ground units in section 23.

This post covers intelligence regarding the size and composition of the hostile force in a given ground combat zone. After each combat round, an update is provided on the estimated hostile force. The estimate becomes more accurate as time passes. For each type of hostile ground unit on the combat zone, the following process is used:

$$IntelErrorRange = \frac{200}{NumberOfCombatRounds}$$

$$IntelError = 1 + \frac{Random(IntelErrorRange)}{100}$$

50% of the time, the actual number of alien units is multiplied by the Intel Error and 50% of the time the actual number of alien units is divided by the Intel Error.

For example, if there are 1000 units of a particular alien class, the intelligence following the second combat round could indicate between 500 and 2000 units. After 10 combat rounds, the intelligence reporting range will be 833 to 1200 units.

27 Ground commander bonuses

Original post can be found [here](#).

Ground force commanders have a much greater variety of bonuses in C# Aurora. The most straightforward are:

- Ground Combat Defence (GCD): When elements of a formation are fortified, their fortification level is increased by the formation commander defence bonus
- Ground Combat Offence (GCO): Increases the to-hit chance of all direct-fire weapons in the formation
- Ground Combat Artillery (GCA): Increases the to-hit chance of all indirect-fire weapons in the formation
- Ground Combat Anti-Aircraft (GCAA): Increases the to-hit chance of all anti-aircraft weapons in the formation
- Ground Combat Logistics (GCL): Represents the chance that a formation element will not draw supply during a combat round.
- Ground Combat Manoeuvre (GCM): Increases the chance that a formation will make a breakthrough in combat
- Ground Combat Occupation (OCC): Boosts the occupation strength of a formation
- Survey (SURV): Increases the output of geosurvey modules in ground units
- Production (PROD): Increases the output of construction modules in ground units
- Xenoarchaeology (XEN): Increases the chance of successfully recovering abandoned installations

In addition to the above, each ground commander has a 'Ground Combat Command' rating, which represents the size of the formation he can effectively command. This rating is given a relatively high score for promotional purposes so officers with high command ratings will tend to progress through the ranks.

If an officer is commanding a formation that is larger than his command rating, the effectiveness of his other bonuses will be reduced by $CommandRating/FormationSize$. For example, an officer with a 20% defence bonus and a command rating of 5000 is commanding a regiment with a size of 7000. The defence bonus is reduced to 14.3%. In addition, if the largest HQ in a formation has a rating less than the formation size, the effectiveness of the formation commander's bonuses will be reduced by $HQrating/FormationSize$. These penalties (command rating and HQ rating) are cumulative. Note that if all HQ capacity in a formation is eliminated, no commander bonuses will apply.

Finally, ground forces officers have a Ground Combat Training bonus, which affects morale. Each construction phase, any formation element with less than 100 morale will regain that morale at a rate of 100 per year, plus the commander training bonus (so a 20% bonus would increase morale recovery to 120 per year). Formation elements can continue to improve morale above 100, using the following process:

1. The training bonus percentage (after any reduction for command rating and HQ rating penalties) is converted into a morale bonus at 1% = 1 morale point (so 10% training bonus = 10 morale bonus).
2. Maximum formation element morale is 100 plus 5x the morale bonus
3. Formation element morale increases at a rate equal to the morale bonus per year multiplied by the 'Morale Gain Modifier'
4. The 'Morale Gain Modifier' is calculated as $1 - ((ElementMorale - 100)/(MaximumMorale - 100))$

For example, a formation element has 140 morale and the commander of the parent formation has a Ground Combat Training bonus of 30%. However, he is commanding a formation that is slightly too large for his Ground Combat Command rating, so he has a Command Modifier of 0.8. The training bonus is 24% (30% x 0.8), which converts to a morale bonus of 24. The maximum morale for the formation is therefore $(100 + (5 \times 24)) = 220$. The morale gain modifier is $1 - ((140 - 100)/(220 - 100)) = 0.667$. Therefore, the formation will gain morale at $24 \times 0.667 = 16$ points per year.

28 Ground force fortification

Original post can be found [here](#).

Fortification happens at the element level. Formation elements can fortify to different levels, depending on the base type of the unit class. That level is also affected by whether the element is restricted to fortifying itself or if it has assistance from construction vehicles. The level of self-fortification and maximum fortification is as follows:

Infantry, Static: Self 3, Max 6.

Light vehicle, Medium Vehicle, Heavy Vehicle: Self 2, Max 3.

Super-Heavy Vehicle: Self 1.5, Max 2

Ultra-Heavy Vehicle: Self 1.25, Max 1.5

All elements move from non-fortified to their maximum self-fortification level in 30 days without outside assistance. This progress is linear and happens automatically for all formation elements when their parent formation is not set to front line attack.

Construction elements will work on any element in their own formation or that formation's subordinate hierarchy that has already reached its max self-fortification level. If the construction element's formation has no subordinate, the Construction elements will work on any element in their own formation's parent formation or in that parent formation's subordinate hierarchy that has already reached its max self-fortification level. This means you can attach a construction-based formation directly to a formation you need fortified, or you can attach to a HQ and it will fortify every formation descending from that HQ. Construction elements can only assist elements that are on the same system body (they can be in different populations on the same body).

Given sufficient capacity (see below), a construction element can fortify any other element from its maximum self-fortification level to the maximum fortification level in 90 days.

The capacity of a construction element is equal to the construction rating of the elements unit class * number of units * race construction rating * commander production bonus * 100 tons. For example, a formation of 50 construction vehicles, each with 0.1 construction rating (2 const components at 0.05) for a race with 16 construction which is part of a formation with commander with 10% production bonus would be: $0.1 * 50 * 16 * 1.1 * 100 = 8800$ tons. BTW a construction battalion of this type would cost 636 BP to build.

All construction elements are ordered by descending order of construction capacity. Each one determines the list of elements that they can assist (using the above criteria), excluding any that have been assisted by a previous construction element. The list of target element is ordered by Construction Rating (so construction units fortify themselves last), then descending tracking speed (so point defence STO and then normal STO), then by field position (so front line defence, then support, then rear echelon), then by descending max fortification (so infantry, static first), then by descending cost (elements with more expensive units first), then by descending morale.

The construction element cycles through the list of target elements using the following process:

1. The total size of the target element is determined $ElementUnitSize * NumberOfUnits$
2. This is compared to the remaining construction capacity of the construction element. If its is greater, then the remaining construction capacity of the construction element is reduced by the size of the target element. If it is less, remaining construction capacity is reduced the zero and a Size Vs Capacity Modifier equal to $RemainingConstructionCapacity/TargetElementSize$ is applied below
3. The amount of fortification that could be accomplished in ninety days is determined by deducting the target element self-fortification level from the target element max fortification level
4. The amount of fortification that could be accomplished within the current period is determined by $90DayFortificationAmount * CurrentPeriod/90Days * Size Vs Capacity Modifier$
5. The fortification for the current period is applied. If this would surpass the target element maximum fortification, then that value is set instead
6. If the construction element has capacity remaining, it moves on to the next target element in its list

Note that because of the way this is applied, it will take the same amount of time to move infantry from fortification level 3 to level 6 as it does for armour from 2 to 3.

This process will allow the player to either directly manage construction elements by attaching their formation to the desired target formation, or to attach the formation to a high level HQ and have the process happen automatically. If a construction element is used to fortify other elements, it will not contribute its construction capacity to its parent population during the next construction phase.

In combat, if the fortification level of a formation element is greater than 1, it is multiplied by the fortification bonus of the dominant terrain.

29 Ground force logistics

Original post can be found [here](#).

Ground Units have two separate logistics requirements. The first is Maintenance, which applies to all units at all times and has a wealth cost equal to 12.5% of Ground Unit cost per annum. The second is Ground Supply Points (GSP), which applies only to combat units during ground combat.

The GSP requirement for a weapon component is equal to $PenetrationValue * DamageValue * Shots$. For example, Personal Weapons is $(1x1x1) = 1$. Crew Served Anti-personnel is $(1x1x6) = 6$. Medium Anti-Vehicle is $(4x6x1) = 24$. Heavy Bombardment is $(2x6x3) = 36$.

The GSP requirement for a Ground Unit Class is the sum of its weapon components. For example, a tank with a Medium Anti-Vehicle component and a Crew Served Anti-personnel component would have a GSP requirement of 30. The GSP requirement for a Formation Element is the GSP for the Ground Unit Class in the element multiplied by the number of units. The GSP requirement for a Formation is the sum of the GSP for its constituent Formation Elements. In all these cases, that is the GSP cost to provide sufficient supply for ten combat rounds.

Two new ground unit components have been added; the Logistics Module, which is Size 50 and provides 500 GSP, and the Logistics Module - Small, which is Size 10 and provides 100 GSP. The standard module is available for light vehicle and infantry base types, while the small module is only available to infantry. Here is an example of a light vehicle with the Logistics Module.

The screenshot shows the 'Ground Forces' software interface. The top bar displays various racial attributes: Racial Armour Strength 10, Racial Weapon Strength 10, Racial Tracking Speed 5,000 km/s, and Racial Fire Control Range 64,000 km. The main window is divided into several panels. The left panel shows a list of units with columns for Base Unit Type, Size, Hit Pts, Slots, Hit Mod, Max Fort, and Max SF. The right panel shows a list of components with columns for Component Type, Abbrev, Size, AP, Dmg, Shots, and GSP. The bottom right panel shows the 'Supply Vehicle' details, including Transport Size (tons), Cost, Armour, Hit Points, Annual Maintenance Cost, Resupply Cost, and Logistics Module. The 'Logistics Module' is highlighted in blue.

Base Unit Type	Size	Hit Pts	Slots	Hit Mod	Max Fort	Max SF
Infantry	0	1	1	0.6	6	3
Light Vehicle	12	3	1	0.4	3	2
Vehicle	18	4	2	0.6	3	2
Heavy Vehicle	36	6	2	0.8	3	2
Super-Heavy Vehicle	108	12	3	0.9	2	1.5
Ultra-Heavy Vehicle	216	24	4	0.95	1.5	1
Static	12	3	1	1	6	3

Component Type	Abbrev	Size	AP	Dmg	Shots	GSP
Crew-Served Anti-Personnel	CAP	12	10	10	6	6
Heavy Crew-Served Anti-Personnel	HCAP	20	20	10	6	12
Light Anti-Vehicle	LAV	16	20	60	1	12
Light Bombardment	LB	20	10	10	3	3
Light Anti-Aircraft	LAA	20	10	20	1	2
Light Autocannon	LAC	24	12	20	3	7.5
Forward Fire Direction	FFD	60	-	-	-	-
Headquarters - Size 1250	HQ1	30	-	-	-	-
Headquarters - Size 2500	HQ2	60	-	-	-	-
Headquarters - Size 5000	HQ3	125	-	-	-	-
Headquarters - Size 10,000	HQ4	250	-	-	-	-
Headquarters - Size 20,000	HQ5	375	-	-	-	-
Headquarters - Size 50,000	HQ6	500	-	-	-	-
Headquarters - Size 250,000	HQ7	500	-	-	-	-
Headquarters - Size 1,000,000	HQ8	500	-	-	-	-
Headquarters - Size 4,000,000	HQ9	500	-	-	-	-
Logistics Module	LOG	50	-	-	-	GSP 500

Component Attributes
FFD 1
HQ 1,250
HQ 2,500
HQ 5k
HQ 10k
HQ 20k
HQ 50k
HQ 250k
HQ 1m
HQ 4m
GSP 500

Supply Vehicle
Transport Size (tons) 62
Cost 2.48
Armour 20
Hit Points 30
Annual Maintenance Cost 0.31
Resupply Cost 0
Logistics Module - Ground Supply Points 500
Vendante 2.48
Development Cost 124

Figure 27: Supply Vehicle Example 1

Ground units with either logistics module can be added to any level of the ground force hierarchy, either embedded with the front line combat formations or held at a superior formation, such as a headquarters.

Each Ground Unit has sufficient inherent supply points to fight ten rounds of combat (currently one round takes place every eight hours). After that point, only one quarter of units in a formation element that is out of supply will fire in each round. In addition, a formation with out of supply elements cannot use a field position of 'Front Line Attack' (more on this when I publish the full ground combat rules). However, if units with logistics modules are available, ground units can draw supply to both fight the current combat round and replenish supplies used in previous combat rounds.

Ground Units will attempt to draw supply from the formation that sits highest in their hierarchy and is at the same population. If no supply is available, they will move down the hierarchy to their own parent formation, checking at each stage. However, when drawing supply from outside their own formation, units can only draw

on logistic modules mounted on light vehicles. Logistics modules with an infantry base type can only supply their own formation.

For example, a formation element of 10 tanks engaged in combat is part of an armoured formation with a brigade HQ formation above it and a division HQ formation above that. The tanks will check for a vehicle-based logistics element within the division formation first, then a vehicle-based logistics element within the brigade formation and finally either type of logistic element within their own parent formation. If no logistic elements are available, the tanks will use their inherent supply, although they can only use that inherent supply for ten combat rounds, unless resupplied. If a unit does not require a full resupply (for example, it still has sufficient inherent supply for eight combat rounds), it will only draw an appropriate fraction of its normal GSP requirement (in this case 20%).

When a formation element of logistics units provides supply, a number of units will be consumed based on the supply required. For example, assume the 10 tanks above each have a GSP requirement of 100, which is 1000 for the whole element. If they draw on a logistics element using light vehicles with normal logistics modules (which have 500 GSP each), two of those logistics vehicles would be consumed. When the GSP requirement does not neatly fit into the 500 point granularity, there is a chance of an additional logistics vehicle being consumed. This chance is dependent on the fraction of supplies required. For example, if there were 12 tanks with a requirement of 1200, then two logistic vehicles would be consumed and there is 40% chance ($200 / 500$) than a third vehicle will be consumed. This adds an element of uncertainty, as supplies may be consumed faster or slower than normal (although it will average out over time), plus it avoids any tracking of partial supplies per vehicle.

Below is an example of a Formation Template for a Brigade Headquarters that includes 50 Supply Vehicles.

Type	Name	Components	Size	Cost	Am	HP	GSP
INF	Autocannon Anti-Tank Team	LAV	16	0.64	20	10	12
INF	Desert Raider	PW	5	0.25	20	10	12
INF	Frog Missile Team	LB	20	0.8	20	10	3
INF	Guard Brigade Headquarters	HQ6	500	30	30	10	0
INF	Guard Regimental Headquarters	HQ4	250	10	20	10	0
INF	Guardman	PW	5	0.2	20	10	1
INF	Heavy Bolter Team	HCAP	20	0.8	20	10	12
INF	Punisher Galling Cannon Team	CAP	12	0.48	20	10	6
VEH	Atlas Construction Vehicle	2x CON	318	12.7	20	40	0
VEH	Helhound Anti-Air Tank	2x CAP	42	3.4	40	40	12
VEH	Hydra Rak Tank	2x MAA	98	7.8	40	40	16
HVH	Basilek Self-propelled Artillery	2x HB	156	18.7	60	60	72
HVH	Challenger - Base TN Upgrade	MAV CAP	62	5	20	30	30
HVH	Challenger 2 Main Battle Tank	MAV CAP	62	5	12	18	30
HVH	Leman Russ Annihilator	2x HAV	132	15.8	60	60	72
HVH	Leman Russ Battle Tank	HAV HCAP	104	12.5	60	60	48
SHV	Baneblade Super-heavy Tank	2x HAV HCAP	224	40	90	120	84
SHV	Macharius Command Tank	HQ4 2x SHAV	518	93	90	120	162
SHV	Shadowword Tank Destroyer	3x SHAV	348	63	90	120	243
SHV	Stormblade Divisional Command Tank	HQ7 2x HAC	716	129	90	120	60
SHV	Stormlord Brigade Command Tank	HQ6 2x HAC	716	129	90	120	60
STA	25cm Ground-based Laser	STO	502	109	10	30	0
STA	Earthshaker Cannon	HB	72	1.4	10	30	36
STA	Missile Defence Installation	CIVS	485	41	10	30	0
STA	Ramjet Cannon	HAV	60	1.2	10	30	36
LVT	Supply Vehicle	LOG	62	2.5	20	30	0
LVT	Warrior AFV	HCAP	32	1.3	6	9	0

Abbr	Name	Units	Size	Cost	HP	GSP	Template Attributes	Rank
BRG	Brigade Headquarters	199	7,868	320	4,070	1,588	HQ 50k LOG 25k	BG
DIV	Divisional Headquarters	62	9,472	1,176	3,600	3,480	HQ 250k	MG
ARM	Guard Armoured Regiment	97	8,942	1,017	5,160	3,522	HQ 10k	COL
GRD	Guard Infantry Regiment	1097	6,882	275	10,970	1,792	HQ 10k	COL

Name	Units	Size	Cost	HP	GSP	Element Attributes
Guard Brigade Headquarters	1	500	30.0	10	0	HQ 50k
Guardman	100	500	20.0	1000	100	
Hydra Rak Tank	12	1,176	94.1	480	192	
Earthshaker Cannon	36	2,592	51.8	1080	1,296	
Supply Vehicle	50	3,100	124.0	1500	0	GSP 25,000

Figure 28: Supply Vehicle Example 2

Below is an order of battle for a divisional formation. At the divisional level are 240 Supply Vehicles, indicated by LOG 120k (120,000 supply points) in the Formation Attributes column, with smaller numbers within each brigade headquarters formation. The GSP column shows the resupply requirement for each formation or formation element. The total divisional organisation requires 40,338 GSP for a complete resupply and there are sufficient supply vehicles (410) in that organisation to resupply five times. With the inherent supply as well, the entire division can stay in combat for sixty rounds before additional supply vehicles are required.

Ground Forces

Commonwealth

Racial Armour Strength10Racial Weapon Strength10Racial Tracking Speed5,000 km/sRacial Fire Control Range64,000 km

Order of BattleUnit Class DesignFormation Templates

Location HierarchyField Position

DIV Divisional Headquarters

BRG First Imperial Guard Brigade

ARM 2nd Epsilon Tokugawa Regiment

GRD 1st Tallam Raiders

GRD 2nd Tallam Raiders

GRD 3rd Tallam Raiders

BRG Second Armoured Brigade

ARM Arcadian 9th Armoured Regiment

ARM Arcadian 9th Armoured Regiment

ARM Bokkeld Hellhounds Armoured Regiment

GRD Tenth First and Only

BRG Third Imperial Guard Brigade

ARM Othonian First Armoured

ARM Othonian Heavy Armour

GRD Fasadian 4th Infantry

GRD Fasadian 4th Infantry

BRG Fifth Imperial Guard Brigade

GRD Framingham Rifles

GRD Geno Five-Two Chilled

BRG Fourth Imperial Guard Brigade

GRD Durellian 4th Regiment

GRD Durellian 6th Regiment

GRD Faebum Vanquishers

ARM Golokov 3rd Armoured Cavalry Regiment

GRD Glavian Skirmishers

Avalon (Barnards Star)

No commander assigned

Abbr	Name	Units	Supply	Morale	Size	Cost	HP	GSP	Formation Attributes	AR	RR
Formation and Direct Attachments											
DIV	Divisional Headquarters	302	100%	100	24,352	1,771	10,800	3,480	HQ 250k LOG 120k	-	MG
BRG	First Imperial Guard Brigade	3,342	100%	100	35,856	2,109	39,490	9,998	HQ 50k LOG 20k	-	BG
BRG	Second Armoured Brigade	2,142	100%	100	46,844	3,866	36,670	14,644	HQ 50k LOG 40k	-	BG
BRG	Third Imperial Guard Brigade	2,588	100%	100	40,016	2,934	36,340	12,216	HQ 50k LOG 25k	-	BG
Total Organization		8,374	100%	100	147,068	10,679	123,300	40,338	HQ 250k LOG 205k		
Formation Unit List											
LHV	Supply Vehicle	240	-	100	14,880	595	7,200	0	LOG 120k		
HVH	Basilisk Self-propelled Artillery	36	100%	100	5,616	674	2,160	2,592			
SHV	Stomblade Divisional Command Tank	2	100%	100	1,432	258	240	120	HQ 250k		
HVH	Leman Russ Battle Tank	12	100%	100	1,248	150	720	576			
VEH	Hydra Rak Tank	12	100%	100	1,176	94	480	192			
Complete Organization Unit List											
HVH	Leman Russ Battle Tank	372	100%	100	38,688	4,643	22,320	17,856			
INF	Guardman	6,600	100%	100	33,000	1,320	66,000	6,600			
LHV	Supply Vehicle	410	-	100	25,420	1,017	12,300	0	LOG 205k		
VEH	Hydra Rak Tank	120	100%	100	11,760	941	4,800	1,920			
STA	Earthshaker Cannon	108	100%	100	7,776	156	3,240	3,888			
VEH	Hellhound Anti-Infantry Tank	144	100%	100	6,048	484	5,760	1,728			
HVH	Basilisk Self-propelled Artillery	36	100%	100	5,616	674	2,160	2,592			
SHV	Macharius Command Tank	6	100%	100	3,108	559	720	972	HQ 10k		
INF	Guard Brigade Headquarters	6	-	100	3,000	180	60	0	HQ 50k		
INF	Heavy Bolter Team	150	100%	100	3,000	120	1,500	1,800			
INF	Frag Missile Team	150	100%	100	3,000	120	1,500	450			
INF	Autocannon Anti-tank Team	138	100%	100	2,208	88	1,380	1,656			
INF	Punisher Gatling Cannon Team	126	100%	100	1,512	60	1,260	756			
INF	Guard Regimental Headquarters	6	-	100	1,500	60	60	0	HQ 10k		

Leman Russ Battle Tank

Transport Size (tons) 104Cost 12,48Armour 60Hit Points 60

Annual Maintenance Cost 1.6Resupply Cost 48

Heavy Anti-Vehicle: Shots 1Penetration 60Damage 60

Heavy Crew-Served Anti-Personnel: Shots 6Penetration 20Damage 10

Cost

Size

Units

Name

Type / Size

Type / Cost

RenameField PositionTransfer Alien

Change RankScrap

Figure 29: Order of battle for divisional formation

Finally here is a view of a single population, with the order of battle tab in Location mode.

Ground Forces

Commonwealth

Racial Armour Strength10Racial Weapon Strength10Racial Tracking Speed5,000 km/sRacial Fire Control Range64,000 km

Order of BattleUnit Class DesignFormation Templates

Location HierarchyField Position

Barnards Star

Avalon

DIV Divisional Headquarters

BRG First Imperial Guard Brigade

ARM 2nd Epsilon Tokugawa Regiment

GRD 1st Tallam Raiders

GRD 2nd Tallam Raiders

GRD 3rd Tallam Raiders

BRG Second Armoured Brigade

ARM Arcadian 5th Armoured Regiment

ARM Arcadian 9th Armoured Regiment

ARM Bokkellid Hellhounds Armoured Regiment

GRD Tenth First and Only

BRG Third Imperial Guard Brigade

ARM Othonian First Armoured

ARM Othonian Heavy Armour

Barnards Star-A III

GRD Fasadian 4th Infantry

GRD Fasadian 4th Infantry

Pendragon

Pendragon

BRG Fourth Imperial Guard Brigade

GRD Durellian 4th Regiment

GRD Durellian 6th Regiment

GRD Faebum Vanquishers

Sol

Earth

BRG Fifth Imperial Guard Brigade

GRD Framingham Rifles

GRD Geno Five-Two Chilled

ARM Golokov 3rd Armoured Cavalry Regiment

GRD Glavian Skirmishers

Avalon (Barnards Star)

No commander assigned

Abbr	Name	Units	Supply	Morale	Size	Cost	HP	GSP	Formation Attributes
Total Population Forces		6,180	-	-	133,304	10,129	101,360	36,754	HQ 250k LOG 205k
Formation Unit List									
HVH	Leman Russ Battle Tank	372	100%	100	38,688	4,643	22,320	17,856	
LHV	Supply Vehicle	410	-	100	25,420	1,017	12,300	0	LOG 205k
INF	Guardman	4,600	100%	100	23,000	920	46,000	4,600	
VEH	Hydra Rak Tank	120	100%	100	11,760	941	4,800	1,920	
STA	Earthshaker Cannon	108	100%	100	7,776	156	3,240	3,888	
VEH	Hellhound Anti-Infantry Tank	144	100%	100	6,048	484	5,760	1,728	
HVH	Basilisk Self-propelled Artillery	36	100%	100	5,616	674	2,160	2,592	
SHV	Macharius Command Tank	6	100%	100	3,108	559	720	972	HQ 10k
INF	Guard Brigade Headquarters	6	-	100	3,000	180	60	0	HQ 50k
INF	Heavy Bolter Team	102	100%	100	2,040	82	1,020	1,224	
INF	Frag Missile Team	102	100%	100	2,040	82	1,020	306	
INF	Autocannon Anti-tank Team	90	100%	100	1,440	58	900	1,080	
SHV	Stomblade Divisional Command Tank	2	100%	100	1,432	258	240	120	HQ 250k
INF	Guard Regimental Headquarters	4	-	100	1,000	40	40	0	HQ 10k
INF	Punisher Gatling Cannon Team	78	100%	100	936	37	780	468	

Basilisk Self-propelled Artillery

Transport Size (tons) 156Cost 18,720Armour 60Hit Points 60

Annual Maintenance Cost 2,300Resupply Cost 72

Heavy BombardmentShots 3Penetration 20Damage 60

Heavy BombardmentShots 3Penetration 20Damage 60

Cost

Size

Units

Name

Type / Size

Type / Cost

RenameField PositionTransfer Alien

Change RankScrap

Figure 30: Order of battle tab in Location mode

30 Ground forces construction complex

Original post can be found [here](#).

For C# Aurora, the Ground Force Training Facility becomes the Ground Force Construction Complex. They remain the same size as a research facility and now require one million population to operate.

The build rate for the complex starts at 250 BP per year and can be increased through research. For example, 500 BP per year is 8000 Research Points and 1000 BP per year is 60,000 Research points.

These changes reflect the amount of effort that will be required to construct, train and support the new ground forces.

31 Ground forces detection

Original post can be found [here](#).

In C#, as in VB6, ground forces are treated as size-1 for the purposes of detection, so are best detected with resolution-1 sensors.

For C#, the ground forces signature is equal to the total signature of all ground formation elements on a planet, divided by 100.

$$SignatureOfEachElement = \frac{UnitSize * UnitNumber}{FortificationLevel * DominantTerrainFortificationModifier}$$

In other words, well-fortified ground forces will have a smaller signature than those out in the open, so you won't always know if you face a small force, or a well-fortified larger force.

32 Ground forces replacements

Original post can be found [here](#).

There can be a lot of micromanagement involved in re-organising ground forces after combat, especially if you have a very detailed OOB. Therefore, I have added an automated replacement process for v1.12

Each formation can be assigned a Replacement Template. By default, this is the template used to construct the formation initially. It can be changed using the 'Change Temp' button on the Order of Battle tab of the Ground Forces window. The current Replacement Template for each formation is shown on the same tab when it is selected. When you change to a different template, you have the option to change all formations with the same current template to the new template. Note the new template may have a different composition of units than the original template. You might do this to add extra capabilities or even stop replacing certain types of unit.

Each formation can be assigned a replacement priority on the same tab. When replacements are available, they are assigned to formations in descending order of priority. The default priority for a new formation is 10.

You can also flag a formation as 'Use for Replacements', in which case the Replacement Template is removed for that formation. During the Ground Replacement Phase, which happens in each construction phase and after ground combat, units are moved from designated replacement formations to any formations at the same population that are in need of replacements.



Figure 31: Ground Forces Replacements Example 1

Over time, new ground units will be designed and will often be improved versions of existing designs. For example, in my current game, I have four different versions of the Chimera, a light vehicle armed with a crew-served anti-personnel weapon. Therefore you can organise similar ground unit designs into Unit Series using a new tab for that purpose. To do so, just drag and drop from the list of non-assigned units to the desired Unit Series. Dropping on to the series name will place the unit at the top of the series. Dropping on to an existing unit in the series will place the dropped unit below the target unit. Dragging an assigned unit into empty space will remove it from a Unit Series.

When replacements are required, the replacement process will use the Unit Series of each unit in the Replacement Template, rather than the actual unit. For example, assume I have a formation that was built using Chimera MK IIs and still has that same original template. When that formation looks for replacements, it will work down the Unit Series of the Chimera MK II looking for the highest unit available. In this case, the Chimera MK IV would be the preferred option, followed by the MK III, etc. This means you don't have to update Replacement Templates when you create a new version of a build template with upgraded designs.

This system should add a lot more flexibility and automation, while maintaining the realism aspect of shipping out replacements to the frontier. You can still use the existing drag and drop functionality for manual replacements.

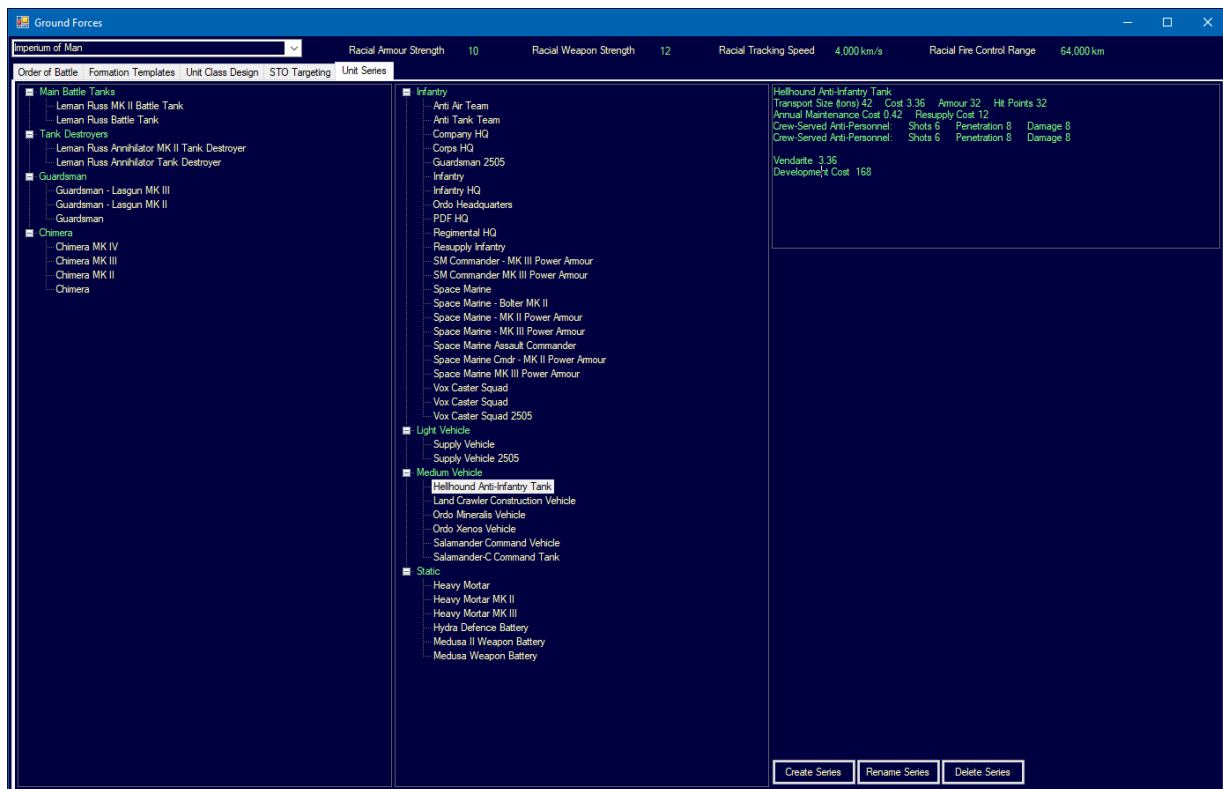


Figure 32: Ground Forces Replacements Example 2

33 Ground forces text summary

Original post can be found [here](#).

The 'Temp as Text' button on the Formation Templates tab of the Ground Forces window will pop up a window with a text version of the selected template composition, which can be copied using Ctrl+C and pasted into an AAR. Format is as follows:

Colonial Marine Battalion

Transport Size: 4,914 tons
 Build Cost: 156.4 BP
 400x Colonial Marine
 96x Colonial Marine - LMG
 12x Mortar Section
 24x Anti-Tank Section
 4x Forward Air Control Party
 16x Centaur AFV
 8x Supply Section
 2x Marine Battalion HQ

The 'Total Force Text' button on the Order of Battle tab of the Ground Forces window will pop up a window with a text version of your entire ground force, which can be copied using Ctrl+C and pasted into an AAR. Format is as follows:

Total Ground Forces

Total Formations: 116
 Total Transport Size: 439,767 tons
 Total Cost: 30,210 BP

21,600x Colonial Marine

5,184x Colonial Marine - LMG
 1,440x Colonial Marine Raider
 1,140x Anti-Tank Section
 760x Centaur AFV
 570x Mortar Section
 448x Supply Vehicle
 396x Medium Howitzer
 380x Supply Section
 360x Colonial Marine Raider - LMG
 348x Minotaur Battle Tank
 190x Forward Air Control Party
 132x Manticore Medium AA
 120x Marine Battalion HQ
 104x Sphinx Planetary Defence Installation
 52x Hydra Planetary Defence Installation
 48x Marine Raiding Force HQ
 12x Minotaur Command Tank
 11x Regimental HQ
 4x Marine Company HQ

34 Ground formation element transfer UI

Original post can be found [here](#).

Below is the same screenshot as the previous post but with the Elements option selected. Now the formation elements for each Ground Formation are shown in the hierarchy. For formations with no subordinate formations, the formation elements are shown directly under the parent formation. For formations with subordinate formations, the formation elements are shown under their own node, to avoid cluttering the tree view.

To move elements between formations, you can drag and drop elements from one formation to another, although they must be on the same system body. Normally, the whole element is transferred. However, if the Amount checkbox is checked, a popup box will appear after the drag-drop, allowing you to transfer only a portion of the element. If the receiving formation already has an element with the same ground unit class, the additional units will be added to the existing element.



Figure 33: Formation transfer UI

35 Ground support bonus

Original post can be found [here](#).

This is a new bonus in C# for naval officers commanding fighters on ground support, search & destroy and flak suppression missions. The to hit chance is modified by the bonus.

The bonus is also used for orbital bombardment support (explained in a future rules post), with the Tactical Officer contributing 100% of his bonus and the Ship Commander contributing 50% of his bonus.

36 Ground support fighters

Original post can be found [here](#).

Fighters equipped with fighter pods can provide support to ground unit formations during ground combat.

To be eligible, a fleet with fighters is given an order to "Provide Ground Support" with a friendly population as the destination. This order functions in a similar way to a 'Follow' order, with the order remaining in place until removed by the player. On the Ground Combat Window, eligible fleets appear in their own section for each population. These fleets can be dragged and dropped on to formations in the same way as superior and subordinate formations. Fleets with this order that are at their target population cannot be targeted in normal naval combat or by STO weapons.

In combat, the ground support fighters attack at the same time as bombardment elements and have the same target selection options as heavy bombardment.

Ground support fighters have the same chance to hit as ground units, although they are not affected by any negative environmental modifiers (such as high gravity or extreme temperatures). Each fighter's to hit chance is affected by its own crew grade and morale.

Each Forward Fire Direction component in a formation allows support from up to six ground support fighters. If more fighters are assigned to a formation than can be supported, the chance to hit is modified by $NumberOfFFD * 6 / NumberOfFighters$.

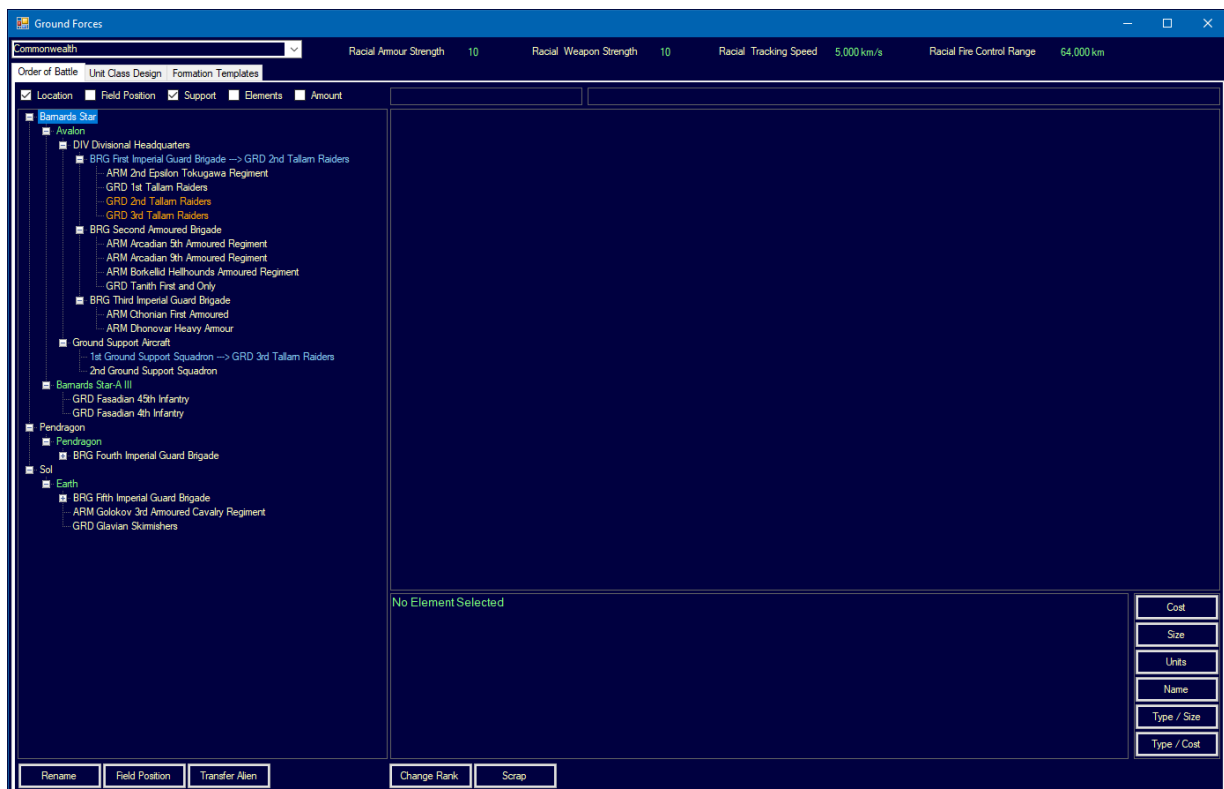


Figure 34: Ground Support Fighters Example

37 Ground-based AA fire

Original post can be found [here](#).

AA units take part in ground combat normally, using their ground combat values. If an AA unit takes part in both ground-ground and ground-air combat, it will draw supply twice.

Once all direct combat, bombardment support and ground support fire has been resolved, but before damage is allocated, all AA units will be checked to see if they can fire on hostile aircraft, using the following rules:

1. All AA units in a formation that was directly attacked by aircraft will each select a random aircraft from those that attacked that formation.
2. Medium or Heavy AA units in a formation that was not directly attacked by aircraft but is the direct parent of a formation that was attacked will each select a random aircraft from those that are attacking the subordinate formations.
3. Heavy AA units that are not included in the two categories above will fire on a random hostile aircraft, including those on CAP that are not directly engaged in attacking ground units.

An Environment Modifier is calculated, taking into account gravity, pressure and temperature and whether the firing AA unit has capabilities in those environments. Each environment for which the element is not trained has a x2 modifier. There are no terrain modifiers.

$$ChanceToHit = 10\% * \frac{TrackingSpeed}{AircraftSpeed} * \frac{Morale}{100 * EnvironmentModifier}$$

If a hit is scored, the damage vs the fighter is $(GroundDamageValue/20)^2$ rounded down. For example, an AA unit with a ground damage value of 40 would have AA Damage of $(40/20)^2 = 4$.

All AA damage is applied after all attacks have been resolved.

38 Ground-based geological survey

Original post can be found [here](#).

Geological Survey Teams do not exist in C# Aurora.

Instead, a new ground unit component (100 tons) provides 0.1 survey points per day. Ground units with this component may be added to ground formations to provide a geological survey capability. All formations at the same population with a geological survey capability will combine their survey points to conduct a ground-based survey. This can only take place after the orbital survey is complete.

Once the orbital survey of a system body is completed, the potential for a further ground survey will be revealed (None, Minimal, Low, Good, High, Excellent). The ground survey requires the same survey points as the orbital survey, except they are generated by ground forces. Only system bodies with a diameter of at least 4000 km will be eligible for a ground-based survey (in Sol that is Mercury, Venus, Earth, Mars, Ganymede, Callisto and Titan).

Normal mineral generation (at system body creation) has three phases:

1. An overall roll for the potential for minerals to be present, based on radius, density and system abundance. If this roll fails, the body has no minerals.
2. A roll for each type of mineral to be present, based on density and abundance. Duranium has twice the chance of any other mineral.
3. A roll for the accessibility of each mineral generated in step 2). This is based on radius.

Once the ground survey is completed (assuming potential is Minimal or higher), a new mineral generation roll will take place. For this roll: Step 1 is the same regardless of the potential. Step 2 is modified by the potential. Minimal is 25% normal, Low is 33% normal (same as teams in VB6), Good is 50% normal, High is 100% normal and Excellent is 200% normal. Step 3 is modified by High (+ 0.1) and Excellent (+ 0.2). All others are same as normal.

If a deposit of a mineral that didn't previously exist is generated by the ground survey, that deposit is added to the system body. If a mineral deposit is generated by the ground survey and a deposit of that mineral already

exists on the system body, the existing deposit is changed to match the amount or accessibility (or both) of the ground survey deposit if the latter is greater.

The chances that an eligible body (4000 km diameter) will have ground survey potential is equal to: None 60%, Minimal 20%, Low 10%, Good 6%, High 3%, Excellent 1%.

For reference, in the Colonial Wars campaign, there are 2145 eligible bodies in 495 systems, so in general about 1.7 worlds per system will have potential of at least Minimal. About 1 system in 23 would have an Excellent potential world.

39 Ground-based Xenoarchaeology

Original post can be found [here](#).

Xenology Teams do not exist in C# Aurora.

Instead, a new ground unit component (100 tons) provides 0.5 xenoarchaeology points. Ground units with this component may be added to ground formations to provide a xenoarchaeology capability. All formations at the same population with a xenoarchaeology capability will combine their xenoarchaeology points.

The annual chance for a race to successfully translate the alien language and symbology is equal to the xenoarchaeology points on the planet. For example, a Xenoarchaeology Vehicle is created with 2 components, giving it 1 xenoarchaeology point (cost about 9 BP). If a formation has forty such vehicles, the annual chance would be 40%. The chance in any given construction phase is equal to the $AnnualChance * ConstructionPhaseLength / Year$.

40 Naval bombardment of ground forces in naval combat phase

Original post can be found [here](#).

Ground forces can be bombarded by naval forces as part of normal naval combat. Note this is not the same as Orbital Bombardment Support, which involves ships in orbit working in conjunction with ground forces to deliver precision energy weapon strike like described in section 41.

Instead, Naval Bombardment of Ground Forces (NBG) is a mass bombardment of ground-based sensor contacts using either missile weapons or energy weapons, which does not require friendly ground forces on the target body or fire direction support and is an adjunct to Planetary Bombardment (see section 20.6)

For the purposes of bombarding ground forces, each weapon type on each ship is treated separately for targeting purposes. For example, a ship with both 10cm and 15cm railguns would make two separate rolls to select a target formation, one for each weapon type, and therefore target all weapons of the same type on the same formation. Target formations are selected based on a weighted random roll, with the weighting based on formation size. Once a formation is selected as a target, each shot against that formation selects a random element within the formation, again using a weighted random roll.

Ship using energy weapons for NBG have one third of the chance to hit compared to using Orbital Bombardment Support (as in the latter case they are being directed by FFD units) and do not benefit from any ground support bonus from the ship commander or tactical officer. Their to-hit chance is the base ground combat to hit chance (20%), reduced by two thirds, multiplied by the to-hit modifier of the planet's dominant terrain and divided by both the fortification of the target formation elements and the fortification modifiers of the planet's dominant terrain. In summary, blind-firing energy weapons at general concentrations of enemy forces is not a very effective way of destroying them, especially in difficult terrain, although it can be done given sufficient patience and maintenance supplies. When firing at Detected STO units, the two-third reduction in to-hit chance is not applied, as the STO units have given away their general location.

Ships using missiles for NBG have a 100% base chance to strike their targets, as nuclear warheads require considerably less precision than energy weapons, and may hit multiple targets. This is modified by the to-hit modifier of the planet's dominant terrain and divided by both the fortification of the target formation elements and the fortification modifier of the planet's dominant terrain. One attack is made with the missile's full warhead damage. Two attacks are made with one half damage, four attacks with one quarter damage etc. This division continues while the damage is higher than 1 point of warhead strength. Each of these attacks can also hit multiple smaller targets, such as infantry. The number of sub-attacks is equal to $50 / \text{target size}$.

This means that a single 8 point missile warhead targeted on infantry will make 15 attacks ($1 + 2 + 4 + 8$) and each attack will be directed against 10 units, for a total of 150 infantry attacked. However, bear in mind that if the infantry are fortified normally that will reduce the normal 100% chance to hit by a third. If they have help from construction units and are in difficult terrain such as mountains, the chance to hit could be

much lower so many of them could survive the attack. Missiles also cause environmental damage so if you plan to use the planet afterwards, this may not be the best approach.

The ground combat damage for an naval weapon is equal to 20x the square root of the damage at the same range in ship-to-ship combat. Armour penetration is equal to half the that damage. Fractions are retained. For example, the AP/Damage ratings would be 10/20 for a 10cm railgun round or gauss cannon, 17.3/34.6 for a 10cm laser, 30/60 for a 9-point missile warhead, 40/80 for a 25cm laser. Weapons roll for failure in the same way as in naval combat.

Any weapon used for NBG has the same environmental impact as it would for planetary bombardment. Missile warheads cause radiation and dust levels to increase by an amount equal to their warhead size. Energy weapons increase the dust level by 5% of their damage amount and have no effect on radiation.

Each NBG shot has a one third chance to also strike the population itself, inflicting installation damage and population losses accordingly (see section 20.6). Conversely, each energy weapon or missile used for general Planetary Bombardment attack has a one third chance to also attack any ground forces on the planet (using the above rules), regardless of whether those ground forces have been detected. Note that all the to hit modifiers vs ground still apply so the chance of accidentally hitting any ground unit with an energy weapon for example is still very low.

41 Orbital bombardment support

Original post can be found [here](#).

Ships equipped with energy weapons can provide support to ground unit formations during ground combat.

To be eligible, a fleet with energy weapons is given an order to "Provide Orbital Bombardment Support" with a friendly population as the destination. This order functions in a similar way to a 'Follow' order, with the order remaining in place until removed by the player. On the Ground Combat Window, eligible fleets (those in orbit and with this order) appear under their own section of the tree view for each population, with a parent node of "Orbital Bombardment Support". The ships in those fleets can be dragged and dropped on to formations in the same way as ground support fighters. Fleets with this order can still be targeted in normal naval combat or by STO weapons (they do not have the same protection as fighters on ground support missions).

In combat, the orbital bombardment ships attack at the same time as bombardment elements and have the same target selection options as heavy bombardment. Orbital bombardment ships have the same chance to hit as ground units, although they are not affected by any negative environmental modifiers (such as high gravity or extreme temperatures). Each ship fires its weapons once per ground combat phase. Each ship's to hit chance is affected by its crew grade and morale, plus 100% of the ground support bonus of the tactical officer and 50% of the ground support bonus of the ships commander.

The damage in ground combat for an energy weapon is equal to 20x the square root of its point blank damage in ship-to-ship combat. Armour penetration is equal to half the damage. Fractions are retained. For example, the AP/Damage ratings would be 10/20 for a 10cm railgun round or gauss cannon, 17.3/34.6 for a 10cm laser, 40/80 for a 25cm laser. Weapons roll for failure in the same way as in naval combat.

Ships cannot perform orbital bombardment in the ground combat phase if they fired in the preceding naval combat phase of the same increment.

Each Forward Fire Direction (FFD) component in a formation allows support from a single ship in orbit or up to six ground support fighters. If a ship is providing orbital bombardment support and the formation loses its FFD capability, the ship will try to find another formation at the same population with available FFD.

Orbital bombardment is a powerful aid to any ground combat, although the ships will be vulnerable to hostile STO weapons and require fire direction from the surface. Ships conducting Orbital Bombardment Support will be firing far less than often than a ship conducting general planetary bombardment, but will do so with more accuracy. This is because the ship will be firing on specific targets as directed by ground-based controllers when the right opportunity arises.

42 Queued ground formation training tasks

Original post can be found [here](#).

Training Tasks can be queued for ground formations.

Using Create Task when no GFCC is available will add the formation to the queue for the population. Items can be moved up and down the queue, deleted from the queue and renamed while in the queue.

When a GFCC becomes available, the highest queued formation will begin training and an event will be generated. The build cost is not fixed until training begin, so you can change the templates for formations that are still in the queue.

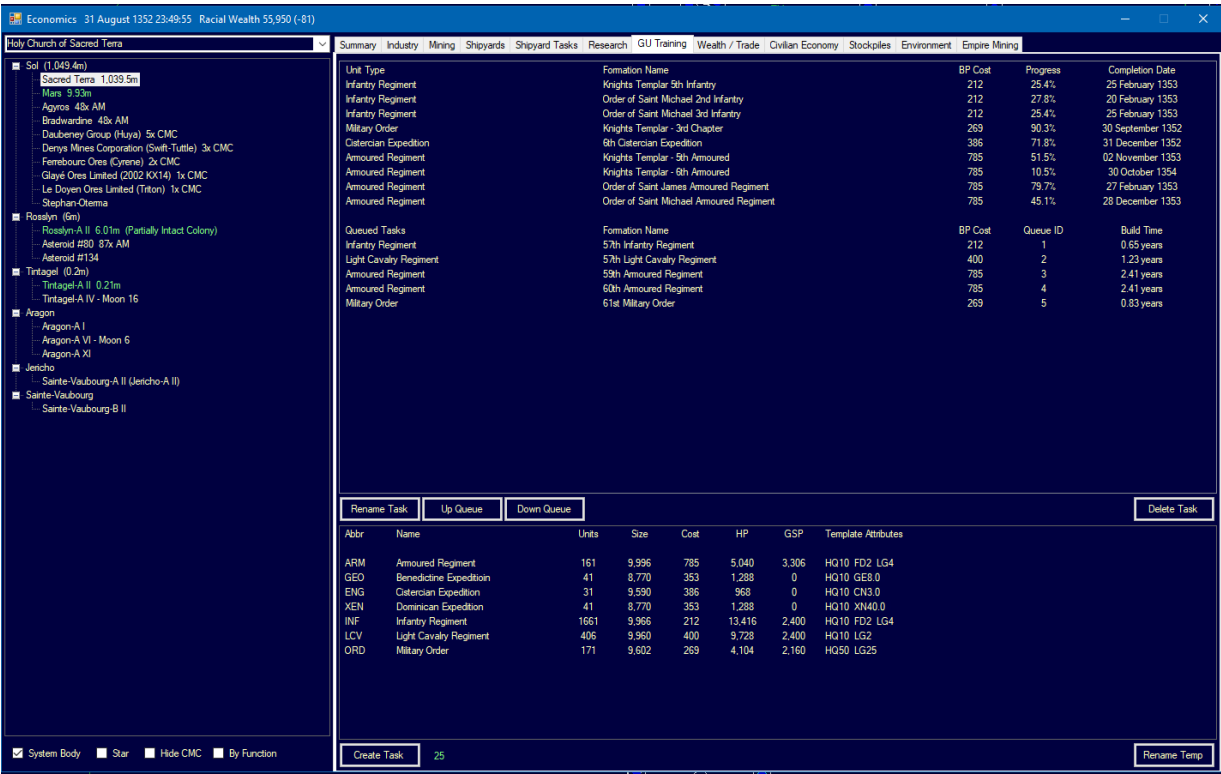


Figure 35: Ground Formation Training Example

43 Setting ground formation support

Original post can be found [here](#).

Here is a screenshot of the UI for setting support relationships between superior and subordinate formations. You drag the superior formation on to the subordinate formation. If the Support checkbox is checked, the supporting formation is shown in blue-grey with the name of the supported formation. Any supported formation is shown in orange. Support can only be provided when the supporting formation is a superior formation in the hierarchy of the supported formation, or is directly subordinate to a superior formation in the hierarchy of the supported formation and does not itself have any subordinate formations (an independent artillery formation for example). Supporting formations must be on the same system body as the supported formation. In combat, the support relationship will only function if the supporting unit has suitable bombardment units and is in a support or rear echelon position and the supported unit is in a front line position.

The drag-drop is intelligent and can distinguish between setting support relationships, reassigning formations to a new headquarters, removing headquarters assignments, moving formations from one population to another (on the same system body) and moving elements between formations (more on that last option in section 34).

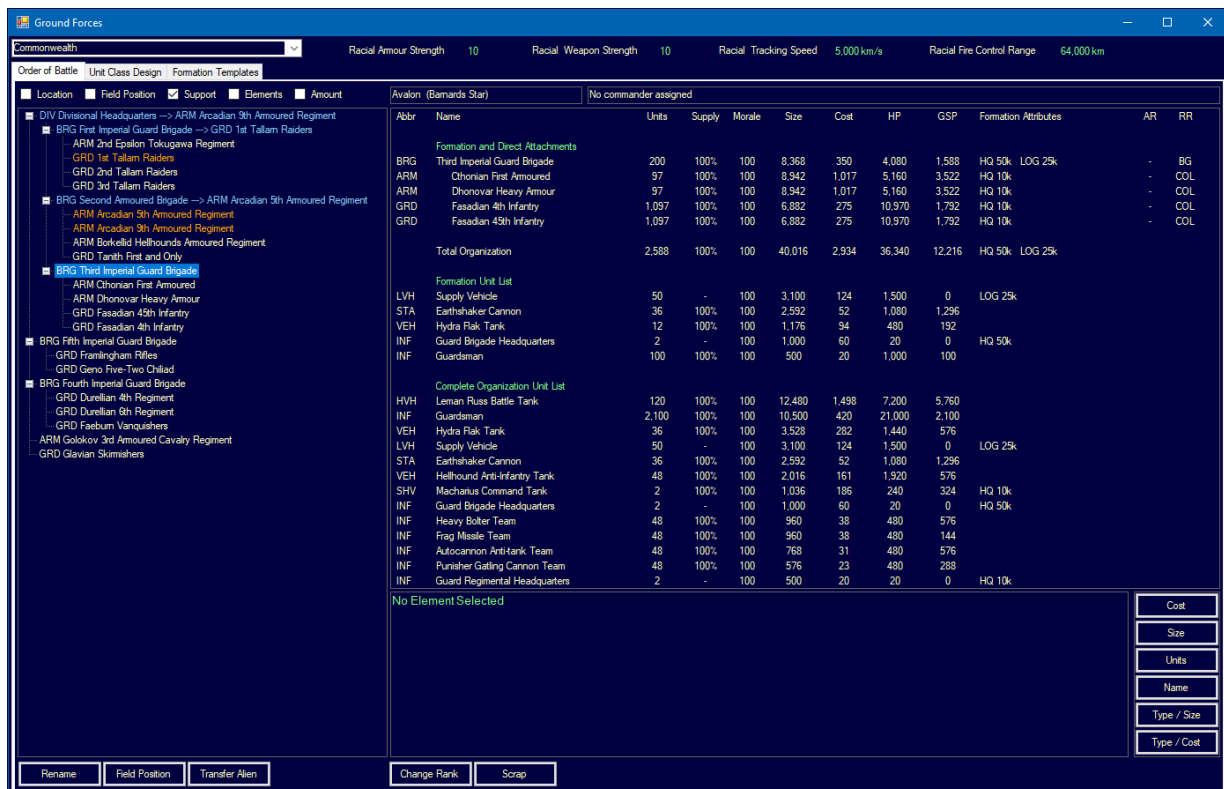


Figure 36: Ground Formation Support Example

44 Surface-to-Orbit ground forces contact

Original post can be found [here](#).

STO elements that have not fired are detected with other ground forces as a ground forces contact.

When an STO element fires, any races that are currently detecting it as part of normal ground forces will flag it as an STO element. Thereafter, those races will detect that element as an 'STO Ground Forces' contact, which is a new contact type. All known STO elements on a planet are grouped as a single STO Ground Forces contact. Players can choose to target either the known STO elements or the normal ground forces (which may contain undetected STO elements).

An STO element may be known to some races and detected accordingly, while still being part of the normal ground forces contact for other races.

The active sensors of STO elements are detected by EM sensors in the same way as any other active sensor. However, this is not sufficient to flag the STO element.

45 Surface-to-Orbit weapons

Original post can be found [here](#).

A ground unit class has an option to mount a surface-to-orbit component. If this option is selected, the class must also select a weapon type. The weapon can be of any type researched by the owning race, including turrets and spinal weapons. Additional systems will be automatically added based on the weapon chosen, creating an integrated component (similar in concept to CIWS). These systems include:

Beam Fire Control: For normal weapons, this will be created using options for 4x Racial Fire Control Range and 1x Racial Tracking Speed. If the Point Defence Weapon checkbox is clicked, the fire control will be created using options for 1x Racial Fire Control Range and 4x Racial Tracking Speed. In all cases, the beam fire control will have a 25% range bonus vs a ship-mounted equivalent. The cost and size of the fire control will be 50% of the ship version due to its dedication to a single weapon.

Active Sensor: This sensor will be resolution 1 and have range at least equal to the maximum range of the weapon. The minimum size will be 5 tons. The sensor is fully functional and will detect targets in general,

not just for the weapon. Size and cost are normal.

Reactor: This component will be designed to generate sufficient power for the weapons capacitor. Size and cost are normal.

ECCM: This is optional and can be added by checking Include ECCM checkbox. Size is 50 tons and cost is half normal to reflect the dedication to a single weapon.

Those ground elements containing units with STO capability can set a number of different targeting options. For the moment, targeting and firing is handled automatically although I may add a manual targeting option as well. For those targeting options directed at ships, the player may also select the number of weapons per target, with zero being all weapons. When a number other than zero is chosen, the targets are cycled until all weapons are fired. Targets must be detected, hostile and in range to be eligible.

The target settings are as follows:

- Do Not Fire
- Target Random Ship: Eligible Ships are given a random order and the targeting cycles through them (or targets the first if number of weapons is zero). The targets will be cycled through multiple times if required for all weapons to fire.
- Target Largest Ship: Eligible Ships are arranged in descending order of size
- Target Smallest Ship: Eligible Ships are arranged in ascending order of size
- Target Fastest Ship: Eligible Ships are arranged in descending order of speed
- Target Slowest Ship: Eligible Ships are arranged in ascending order of speed
- Target Easiest Ship: Eligible Ships are arranged in descending order of chance to hit
- Target Shipyards: The largest eligible shipyard contact is targeted
- Target Populations: The largest eligible population contact is targeted. Populations on the same system body as the STO element cannot be targeted.
- Target Ground Forces: The largest eligible ground forces contact is targeted. Ground forces on the same system body as the STO element cannot be targeted.
- Target STO Ground Forces: The largest eligible STO ground forces contact is targeted. STO ground forces on the same system body as the STO element cannot be targeted.
- Final Defensive Fire: When a salvo is about to hit a target within range of the STO weapon, the element will be eligible for point defence fire in the same way as a ship. This allows the STO element to protect itself and other ground forces, any populations on the surface, orbital shipyards and any nearby ships.
- Final Defensive Fire (Surface Only): Same as Final Defensive Fire except that only salvos attacking surface targets will be intercepted
- Area Point Defence: The STO units will shoot at any hostile missiles currently in range.

When an STO element targets missiles, it will only fire until the missiles are destroyed. For the purposes of tracking weapon fire and recharging, each STO unit within the element is tracked separately.

Ground Forces

Commonwealth

Order of Battle

Formation Templates

Unit Class Design

STO Targeting

Racial Armour Strength

10

Racial Weapon Strength

10

Racial Tracking Speed

5,000 km/s

Racial Fire Control Range

64,000 km

Base Unit Type	Size	Hit Pts	Slots	Hit Mod	Max Fort	Max SF
Infantry	0	1	1	0.6	6	3
Light Vehicle	12	3	1	0.4	3	2
Vehicle	18	4	2	0.6	3	2
Heavy Vehicle	36	6	2	0.8	3	2
Super-Heavy Vehicle	108	12	3	0.9	2	1.5
Ultra-Heavy Vehicle	216	24	4	0.95	1.5	1
Static	12	3	1	1	6	3

Armour Type	Base AR	Racial AR
Light Static Armour	1	10
Medium Static Armour	2	20
Heavy Static Armour	3	30

Capability	Cost	Inf Only
Boarding Combat	2	Yes
Desert Warfare	1.25	-
Extreme Pressure Combat	2	-
Extreme Temperature Combat	1.5	-
High Gravity Combat	1.5	-
Jungle Warfare	1.25	Yes
Low Gravity Combat	1.5	-
Mountain Warfare	1.25	Yes
None	1	-

Component Type	Abbrev	Size	AP	Dmg	Shots	GSP
Crew-Served Anti-Personnel	CAP	12	10	10	6	6
Heavy Crew-Served Anti-Personnel	HCAP	20	15	10	6	9
Light Anti-Vehicle	LAV	16	20	30	1	6
Medium Anti-Vehicle	MAV	32	40	40	1	16
Heavy Anti-Vehicle	HAV	48	60	60	1	36
Light Bombardment	LB	20	10	20	3	6
Medium Bombardment	MB	40	15	40	3	18
Heavy Bombardment	HB	60	20	60	3	48
Light Anti-Aircraft	LAA	20	10	20	1	2
Medium Anti-Aircraft	MAA	40	20	40	1	8
Heavy Anti-Aircraft	HAA	60	30	60	1	18
Surface-to-Orbit Weapon	STO	0	-	-	-	-
Headquarters - Size 1250	HQ1.25	30	-	-	-	-
Headquarters - Size 2500	HQ2.5	60	-	-	-	-
Headquarters - Size 5000	HQ5	125	-	-	-	-
Headquarters - Size 10,000	HQ10	250	-	-	-	-
Headquarters - Size 20,000	HQ20	375	-	-	-	-
Headquarters - Size 50,000	HQ50	500	-	-	-	-
Headquarters - Size 250,000	HQ250	500	-	-	-	-
Headquarters - Size 1,000,000	HQ1M	500	-	-	-	-
Headquarters - Size 4,000,000	HQ4M	500	-	-	-	-

Component Attributes
STO
HQ 1.25
HQ 2.5
HQ 5
HQ 10
HQ 20
HQ 50
HQ 250
HQ 1M
HQ 4M

☐ Point Defence Weapon
☒ Include ECCM

Weapon Type	Damage	Range	Shots	ROF	Power	Size	Cost
10cm C3 Ultraviolet Laser	3/1	120,000	1	5	3	235.0	62.5
20cm C4 Ultraviolet Laser	10/1	320,000	1	15	4	390.0	94.9
25cm C4 Ultraviolet Spinal Laser	16/2	320,000	1	20	4	490.0	108.9
Gauss Cannon R3-100	1/1	30,000	3	5	0	355.0	68.6
Twin Point Defence Laser Turret	3/1	120,000	2	5	6	514.00	101.0

Planetary Laser Battery

Transport Size (tons) 557 Cost 121.24 Armour 10 Hit Points 30
Annual Maintenance Cost 152 Resupply Cost 0

25cm C4 Ultraviolet Spinal Laser
Range 320,000 km Tracking 5,000 km/s Damage 16/2 Shots 1 Rate of Fire 20
Maximum Sensor Range 2,711,630km Min Range vs Missile 295,297 km
ECCM 20

Duranium 12.8 Corbomite 10 Boronide 25.7 Vendarite 0.24 Uridium 34.1 Corundium 38.4
Development Cost 1,212

Create

Instant

Figure 37: Surface-to-Orbit Weapons Example 1

Ground Forces

Commonwealth

Order of Battle

Formation Templates

Unit Class Design

STO Targeting

Racial Armour Strength

10

Racial Weapon Strength

10

Racial Tracking Speed

5,000 km/s

Racial Fire Control Range

64,000 km

Base Unit Type	Size	Hit Pts	Slots	Hit Mod	Max Fort	Max SF
Infantry	0	1	1	0.6	6	3
Light Vehicle	12	3	1	0.4	3	2
Vehicle	18	4	2	0.6	3	2
Heavy Vehicle	36	6	2	0.8	3	2
Super-Heavy Vehicle	108	12	3	0.9	2	1.5
Ultra-Heavy Vehicle	216	24	4	0.95	1.5	1
Static	12	3	1	1	6	3

Armour Type	Base AR	Racial AR
Light Static Armour	1	10
Medium Static Armour	2	20
Heavy Static Armour	3	30

Capability	Cost	Inf Only
Boarding Combat	2	Yes
Desert Warfare	1.25	-
Extreme Pressure Combat	2	-
Extreme Temperature Combat	1.5	-
High Gravity Combat	1.5	-
Jungle Warfare	1.25	Yes
Low Gravity Combat	1.5	-
Mountain Warfare	1.25	Yes
None	1	-

Component Type	Abbrev	Size	AP	Dmg	Shots	GSP
Crew-Served Anti-Personnel	CAP	12	10	10	6	6
Heavy Crew-Served Anti-Personnel	HCAP	20	15	10	6	9
Light Anti-Vehicle	LAV	16	20	30	1	6
Medium Anti-Vehicle	MAV	32	40	40	1	16
Heavy Anti-Vehicle	HAV	48	60	60	1	36
Light Bombardment	LB	20	10	20	3	6
Medium Bombardment	MB	40	15	40	3	18
Heavy Bombardment	HB	60	20	60	3	48
Light Anti-Aircraft	LAA	20	10	20	1	2
Medium Anti-Aircraft	MAA	40	20	40	1	8
Heavy Anti-Aircraft	HAA	60	30	60	1	18
Surface-to-Orbit Weapon	STO	0	-	-	-	-
Headquarters - Size 1250	HQ1.25	30	-	-	-	-
Headquarters - Size 2500	HQ2.5	60	-	-	-	-
Headquarters - Size 5000	HQ5	125	-	-	-	-
Headquarters - Size 10,000	HQ10	250	-	-	-	-
Headquarters - Size 20,000	HQ20	375	-	-	-	-
Headquarters - Size 50,000	HQ50	500	-	-	-	-
Headquarters - Size 250,000	HQ250	500	-	-	-	-
Headquarters - Size 1,000,000	HQ1M	500	-	-	-	-
Headquarters - Size 4,000,000	HQ4M	500	-	-	-	-

Component Attributes
STO
HQ 1.25
HQ 2.5
HQ 5
HQ 10
HQ 20
HQ 50
HQ 250
HQ 1M
HQ 4M

☐ Point Defence Weapon
☒ Include ECCM

Weapon Type	Damage	Range	Shots	ROF	Power	Size	Cost
10cm C3 Ultraviolet Laser	3/1	120,000	1	5	3	235.0	62.5
20cm C4 Ultraviolet Laser	10/1	320,000	1	15	4	390.0	94.9
25cm C4 Ultraviolet Spinal Laser	16/2	320,000	1	20	4	490.0	108.9
Gauss Cannon R3-100	1/1	30,000	3	5	0	355.0	68.6
Twin Point Defence Laser Turret	3/1	120,000	2	5	6	514.00	101.0

Planetary Point Defence Battery

Transport Size (tons) 531 Cost 103.34 Armour 10 Hit Points 30
Annual Maintenance Cost 129 Resupply Cost 0

Twin Point Defence Laser Turret
Range 120,000 km Tracking 5,000 km/s Damage 3/1 Shots 2 Rate of Fire 5
Maximum Sensor Range 2,711,630km Min Range vs Missile 295,297 km

Duranium 19 Boronide 26 Vendarite 0.24 Uridium 34.1 Corundium 24
Development Cost 1,033

Create

Instant

Figure 38: Surface-to-Orbit Weapons Example 2

Part VI

Tips & Tricks

Part VII

YouTube content creators