

Karma® - The Flight Trainer

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While every effort is expended to ensure the accuracy of the information contained in this manual, Karma is subject to continuous development and refinement and consequently such information become out of date.

This manual was entirely produced using Impression II, from Computer Concepts. Karma® was written in ARM assembler and ANSI C, under RISC OS and RISC iX, and was assembled / compiled using Acorn's Objasm and ANSI C release 2, 3 and 4. The data for Karma was produced by Periscope's in-house conceptual sketchpad system ('Dialogue') and compiled using the Periscope ANSI C Dialogue compiler.

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1. Preface

What is Karma?

Karma is a highly sophisticated four dimensional space simulation consisting of several layered models which, when they interact, present a **Virtual Reality**.

Every effort has been expended during Karma's four years of development to ensure the highest technical and artistic quality.

The Flight Trainer is a subset of the full Karma product.

This version

This version of Karma is Release 1.00, The Flight Trainer. The purpose of this version is to provide the player with an environment free from the greater complexity of the full implementation, and thus allow him/her to gain experience of flight, ship management, and the physical environment. Many of the concepts and procedures described in this manual are common to all releases of Karma. Where information specific to the Flight Trainer is given, this is clearly indicated. This manual is a subset of the full manual which is provided with the full releases of Karma.

Page 1.1

1. Preface

Image Files

Karma stores all the information relating to a particular session in an Image File. A default image file is included as part of the Karma product, and you should use this when you first play Karma. This image file must then be saved under a different name to preserve the original. You may keep an unlimited number of image files.

Page 1.2

2. Installation and getting started

Use of RISC OS

This manual assumes you have a reasonably sound knowledge of how to manipulate files etc under the **RISC OS Desktop**. If you are unsure about this, please consult the **User Guide** supplied with your computer.

Memory size

The Karma Flight Trainer will run on Archimedes computers with at least one megabyte of RAM.

Installing Karma onto a Hard disk (!SysMerge and !Install)

Karma is supplied with two applications which are used to install the product onto a hard disk. The first of these applications is **!SysMerge**. This application will merge the contents of the **!System** directory supplied on the **Karma Global Disk** with the **!System** already resident on the hard disk. To run **!SysMerge**, double-click on its application icon in the directory viewer. A window will appear, inviting you to 'Drag the original **!System** into this window.' Locate the **!System** directory on the hard disk and drag it to this window. You will then be invited to 'drag the new **!System** into this window'. Drag the **!System** directory supplied on the **Karma Global Disk**. After a short time, you will be advised that the merging process has been completed. The window may then be removed in the usual way. Note that your existing **!System** application may be overwritten during this process. Now reset your computer by holding down the control key and pressing the reset button. **We strongly recommend that you delete**

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2. Installation and getting started

any existing version of Karma from your hard disk prior to installation of this new software. To install Karma itself onto a hard disk, use **!Install**. Double-click on **!Install** in the usual way to place it on the icon bar. Then create a directory on the hard disk at the desired position. Drag this directory to **!Install's** icon (on the icon bar). You will be prompted to insert disks as required. After installation, quit **!Install** in the usual way (from the icon bar menu). Karma is now ready to run from your hard disk. You will notice that a directory called '**Images**' has been created under your chosen directory in which to store image files. You may (if desired) also store image files on floppy disks or in other directories on your hard disk.

Using Karma with floppy disks

Use of Karma from floppy disks requires no special installation. You will be prompted whenever Karma requires a different floppy disk to be loaded. At present there is no support for dual floppy disk drives. A default Image file is provided on the global disk (named '**Default**'), you should copy this to another disk before use, and when saving after your first session, change the name of the Image file.

Starting a Karma session

Karma is run in the normal way, under the desktop.

- * To load Karma without an image file, double-click on the **!Karma** application directory
- * To load Karma **and** an image file, double-click on any Image file

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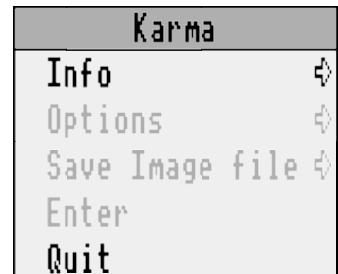
Loading and Replacing Image files

- * Drag an image file to Karma's icon (on the icon bar).
- * Where no image file is loaded, double-click on any Image file.

You will be prompted to insert disks as necessary.

The !Karma icon bar menu

If you click the 'menu' mouse button over the **!Karma** icon, the icon bar menu will be displayed.



Save Image file

To save an image file, move the pointer to the arrow next to the 'Save Image file' option. A dialogue box will appear with a Karma image file icon in it. Refer to the next section entitled 'The Save Image file dialogue box'.

Enter

To enter Karma, choose the **Enter** option. Alternatively, click on the Karma icon (on the icon bar). To suspend Karma and return to the desktop, press <escape>. You may subsequently re-enter.

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2. Installation and getting started

The 'Save Image file' dialogue box

You may save the Image file without changing the name or directory by clicking on the **OK** icon. You may edit the filename using the keyboard, in the normal way. Alternatively you may drag the Image file icon to a directory viewer. Press <escape> to cancel the operation.



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3. Introduction

Memo : **Star date: 40/012/843/227-11/24.14**
Status : **Top Secret - Need to know basis only**

Re : **Flight Training Manual**

From : **Galactic Council**
To : **Recruits to the Training Program**

The Universe has started to contract, and the threat this poses to our home galaxy has provoked an ambitious plan - a pathfinding mission to the outer regions of the universe in search of new galaxies for colonisation. In preparation for this, you, as a new recruit are asked to complete a 'flight training' course in a space simulating your destination galaxy. You will need to gain proficiency in flying and managing your Pioneer Class Mothership in this environment and become skilled in use of the available sensory, navigation and communications ship systems. If you prove yourself capable you will be granted the use of a 'Hopper' space vehicle with which to become familiar before you embark on your 10 billion year journey to your target galaxy.

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3. Introduction

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4. Physics

To be an effective pilot, it is necessary to understand some of the basic concepts and terms used in this field. If you already have an understanding of this subject, you may like to skip this chapter and go on to the next.

Mass and weight

Mass is a term used to describe a measure of the **amount of matter** present in a given body. Mass is measured in **kilogrammes** or multiples/submultiples thereof. Mass differs from weight; the latter is the force exerted by a body of a given mass under a gravitational effect, and is measured in **newtons** (which is a unit of force). For example, a ball 10 kilogrammes in mass will have a force of approximately 100 newtons exerted upon it when on Earth. However, should that ball be placed on the surface of the Moon, it will have only 16 newtons exerted upon it, and consequently will weigh only a sixth of what it did on Earth. The mass of the ball, however, remains the same. It is an unfortunate confusion that weight is often measured in kilogrammes as weighed on the earth's surface.

Distance

Distance is measured in metres, or multiples/submultiples thereof. In space, very large distances are measured in light seconds or light years; ie multiples of the distance travelled by light in a second, or a year respectively. One light second is approximately 300,000 kilometres, and one light year approximately 9,460,000,000,000 kilometres (over nine million million kilometres)!.

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4. Physics

Speed and velocity

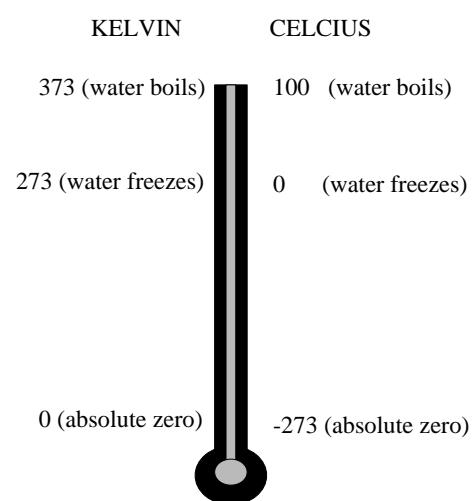
Speed and velocity are measured in distance and time, ie. the amount of distance covered in a given time. the difference between velocity and speed is that velocity involves **direction**.

The 3 states of matter

Most matter can exist in 3 states, **solid, liquid and gaseous**. A few chemicals can not exist in the liquid state. Each different chemical has its own temperature at which a transition occurs between these states.

Temperature

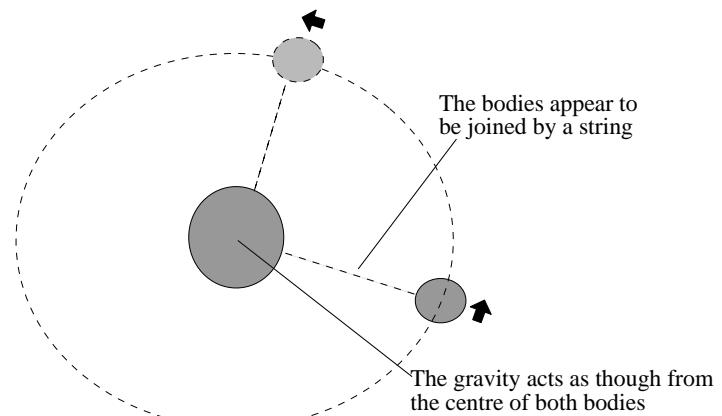
Temperature is measured in degrees Celcius (centigrade), or degrees Kelvin. The Kelvin scale is exactly the same as the Celcius scale, excepting that it starts from absolute zero, rather than the freezing point of water. It is theorised that a body with absolutely no heat will be at approximately -273 degrees Celcius, or 0 degrees Kelvin. This is called **absolute zero** and is the coldest temperature theoretically possible. The background radiation of the Universe is equivalent to a temperature approximately 2.6 degrees Kelvin. The radiation is residual from the big bang, and therefore the temperature represents the minimum that can be encountered in practice.



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Gravity and orbits

All bodies (regardless of mass) exert gravity on all other bodies. The amount of gravity exerted is dependent on (and proportional to) the mass of the bodies. For bodies of relatively little mass (less than several million kilogrammes) the gravity is almost immeasurably small. For more massive bodies (like suns, planets and moons) the gravity can be quite substantial. Without gravity no orbits would ever be attainable. The closer two bodies become to each other, the greater the gravity experienced. This increase becomes much stronger as the two bodies draw closer.



Conservation of momentum

If a body is given a push in a certain direction it will travel in that direction for ever, unless another force is applied to it. For example, if one were to roll a ball in a given direction it would continue in that direction until the end of time, so long as no other force was applied to it.. This probably contradicts

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4. Physics

everyday experience; one would expect the ball to stop after a period of time (even if it did not appear to hit anything). What is overlooked is the effect of **air resistance** which acts as a force against the movement of the ball, and the **friction** between the ball and the ground on which it is rolled. In a total vacuum (no air resistance) and on a perfectly smooth surface (no friction) the ball would, indeed, roll on forever. Space is almost a total vacuum, therefore a body which is given a push in a certain direction will continue in that direction almost indefinitely.

Summary of Units used

DISTANCE

Unit	Abbreviation	Meaning
Centimetre	cm	1/100 of a Metre
Metre	m	1 Metre
Kilometre	km	1000 Metres
Light-Second	LS	The distance travelled by light in one second
Light-Minute	LM	The distance travelled by light in one minute
Light-Hour	LH	The distance travelled by light in one hour
Light-Day	LD	The distance travelled by light in one day
Light-Year	LY	The distance travelled by light in one year

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SPEED and VELOCITY

Unit	Abbreviation	Meaning
Centimetre	cm/s	Number of centimetres travelled, per second
Metre	m/s	Number of metres travelled, per second
Kilometre	km/s	Number of kilometres travelled, per second
Light speed	C	The speed of light
Kilo light speed	KC	One thousand times the speed of light

TEMPERATURE

Unit	Abbreviation	Meaning
Kelvin	K	One Kelvin
KiloKelvin	KK	One thousand Kelvin
MegaKelvin	MK	One million Kelvin

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TIME

Unit	Abbreviation	Meaning
Second	S	An amount of time equivalent to one second
Minute	M	60 seconds
Hour	H	60 minutes
Day	D	24 hours
Year	Y	365.25 days
Mega Year	MY	One million years
Billion Year	BY	One thousand million years

MASS

Unit	Abbreviation	Meaning
Gram	G	1000 Grammes
Kilogramme	KG	1000 Kilogrammes
Tonne	T	1000 Tonnes
Kilotonne	KT	1 Million tonnes
Megatonne	MT	1 Billion tonnes (one thousand million)
Billion tonne	BT	

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DENSITY

Unit	Abbreviation	Meaning
Milligrammes per cubic metre	MG/M ³	The number of milligrammes of matter in one cubic metre
Grammes per cubic metre	G/M ³	
Kilogrammes per cubic metre	KG/M ³	
Tonnes per cubic metre	T/M ³	
Kilotonnes per cubic metre	KT/M ³	
Megatonnes per cubic metre	MT/M ³	
Billion tonnes per cubic metre	BT/M ³	

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4. Physics

ACCELERATION

Unit	Abbreviation	Meaning
Centimetres per second squared	CM/S ²	Number of centimetres per second change in velocity in one second
Metres per second squared	M/S ²	Number of metres per second change in velocity in one second
Kilometres per second squared	KM/S ²	Number of kilometres per second change in velocity in one second
Light speed squared	C ²	Change in velocity measured in light speed multiples in one second

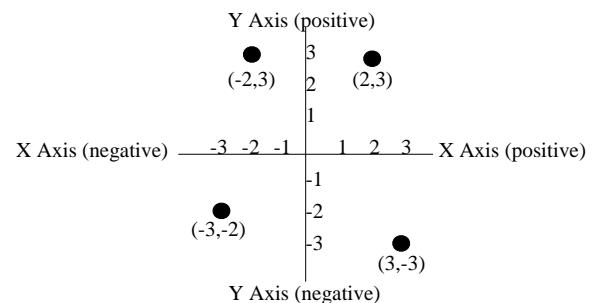
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5. Geometry

To be an effective pilot, and to understand your ship fully, you will need a fundamental understanding of some of the geometric terms and concepts used. If you have an understanding of three dimensional geometry, you may prefer to go straight on to the next section.

Two and three dimensions

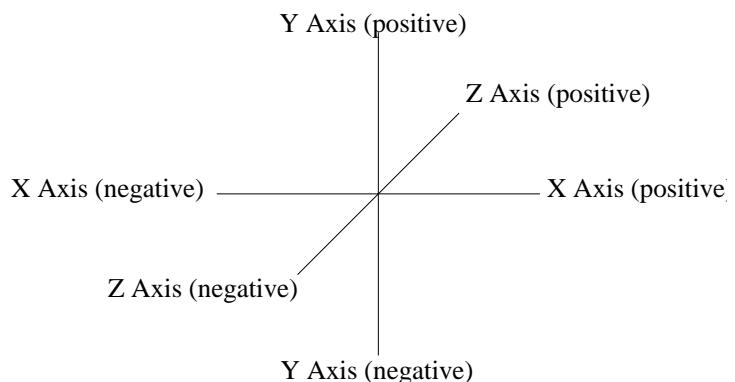
Most people are familiar with the method of locating a position on a (two dimensional) map, using **grid references**. These references are actually **coordinates in two dimensional space**. The value of each reference indicates the distance along each axis where a point can be found. The diagram opposite shows four points with their coordinates in two dimensional space.



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5. Geometry

The diagram opposite shows the axes used in three dimensional geometry. The X and Y axes are the same as in two dimensional space, but what may not be apparent is that the Z axis is supposed to run **into and out of** the page. Restated, it can be seen that a point lying on your X axis will either be to your right, or your left. A point lying on your Y axis will be either above or below you. A point lying on your Z axis will be either in front, or behind you. Therefore, a combination of X, Y and Z axes is all that is required to be able to pinpoint any position in three dimensional space.



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Galaxies - evolution

When galaxies first form they do so out of clouds of gas mainly comprised of about two thirds hydrogen and about one third helium. The stars that first form are comprised of these gases only, and are called **first generation** stars. If they have any bodies in orbit around them then these will be **gas worlds**, again comprised of hydrogen and helium. As such stars progress they will create heavier elements in their cores, and when they experience a ‘supernova’ explosion even heavier elements are formed, many of which will be ejected into space to enrich the composition of interstellar gases.

Stars that condense from this enriched gas and dust are called **second generation** stars and any bodies they possess will contain many elements, some will still be gas worlds, but **rock worlds** will also appear. The older first generation stars will tend to be found in the centre of a galaxy, or orbiting at the galactic limits, whereas younger second generation stars will tend to appear everywhere else.

The Target Galaxy

Scale and composition

The Target Galaxy is about 8000 light years in diameter and contains 2400 solar systems. Many, but not all, of these systems contain associated bodies including planets, moons, binary companion stars, boulders, dust and gases.

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Shape and structure

The Target Galaxy is of the **barred spiral** type, indicating that it has a central core with two diametrically opposed bars extending outward and becoming two spiral arms. Toward the outer edge of the galaxy there exists an associated satellite cluster of stars in orbit about the centre.

Galactic Locations

The Target Galaxy has roughly definable areas or locations within which stars can occur.

Galactic Core

This is the centre of the Galaxy, which mainly comprises of very old first generation stars. It is definable by an inner zone and an outer zone, within which younger stars may also be found.

Galactic Bar

There are two Galactic Bars which extend outwards from and on either side of the Galactic Core. They contain many very old stars but at their extremities they may contain young or developing stars where they merge into the Spiral Arms.

Inner Galactic Field

This area surrounds the ends of the Galactic Bars and the beginning of the Spiral Arms. Some fully mature stars should be located here.

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Spiral Arm

There are two Spiral Arms which extend from the ends of each Galactic Bar in a spiral pattern to the Outer Galactic Field, where they become diffuse and their structure breaks down. The Spiral Arms consist mostly of the interstellar dust and gases of the Galaxy, and are where new stars form.

Nursery Clusters

These formations are to be found closely associated with the Spiral Arms and contain stars in their early stages of development.

Outer Galactic Field

This area extends from where the Spiral Arms begin to disintegrate, outward almost to the edge of the Galaxy. Most fully mature stars will exist here.

Galactic Limits

The edges of the galaxy in all directions are termed the Galactic Limits. These places will be sparsely populated by very old first generation stars.

Satellite Cluster

The Satellite Cluster is likely to have a structure similar to the Galactic Core with similar stars being present. This is also definable by inner and outer zones.

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Satellite Cluster Star Ladder

The area between the disc of the galaxy and the associated Satellite Cluster has a 'ladder' of stars joining them. Mature and very old stars are likely to be found here.

Stars - evolution

Stars form when a cloud of interstellar dust and gas contracts by mutual gravitational attraction until the centre is hot enough to initiate thermonuclear reactions. They will develop through blue, yellow and red phases, then they experience a massive explosion called a 'Supernova' after which they exist in remnant white, neutron or black phases. The whole process may take from about 25 billion years up to about 38 billion years, depending on the mass and generation of the star. In general the more mass a star has, the faster it will burn and the quicker it will progress through its phases. Some clouds of contracting gas will not possess enough mass to become stars at all, whereas some will be so massive that they will not have enough time to form associated bodies such as planets and moons before they reach their final phase. First generation stars can become very old as they are mainly composed of hydrogen and take a long time to produce heavier elements in the core and so progress to higher temperature reactions which generally precede Supernova explosions.

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Stars - types

Embryonic Clouds

These are clouds of interstellar dust and gas which are in the early stages of contraction caused by a combination of a weak magnetic whirlpool effect and increasing gravitational pressure. They tend to form in the Spiral Arms of a galaxy where this dust and gas is most plentiful.

Proto-Stars

When an **Embryonic Cloud** has condensed sufficiently, its core will heat up considerably and be more clearly defined. At this stage it is identifiable as a **Proto-star**. When the core is dense enough to produce temperatures of about 1 billion degrees, thermonuclear fusion can begin and the star will progress to its blue phase.

Blue Dwarfs & Blue Giants

Blue stars are very hot, violent stars. The emerging thermonuclear fusion causes occasional explosions which rip through their solar systems. The first formation of planets and moons may happen in this relatively short phase. Their mass will determine whether they are Giants or Dwarfs. By this time the stars tend to be found in Nursery Clusters. Their surfaces will eventually cool down and contract as they progress to their yellow phases.

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Yellow Dwarfs & Yellow Giants

As the reactions in the core settle down and the shell temperature cools, the stars become yellow in appearance. By this time any planets and moons have become well established, however the shell temperatures will cool down some more before such a solar system experiences its first major period of stability. Yellow Giants come from Blue Giants, and Yellow Dwarfs from Blue Dwarfs. The giants will be found mainly in Nursery Clusters because of their younger age, whereas the dwarfs may be found also in the Galactic Fields.

Main Yellows

More fully known as Main Sequence Yellows, this is the first phase which is stable for long enough to enable life to evolve, should conditions on any world prove favourable. Most of these stars should be found in the Galactic Fields. In general, stars are in this phase for a long time, as this is when the thermonuclear fusion burns mostly hydrogen, the major stellar constituent. When the hydrogen runs low, the star will burn helium also, thereby increasing its core temperature and eventually expanding in size and darkening in colour to become a Late Yellow star.

Late Yellows

This phase marks the transition from a Main Yellow to a Red Giant and is accompanied by an increase in core temperature, an increase in size and the burning of heavier elements such as carbon and oxygen. Life existing on any worlds around such stars may be destroyed by an increase in their surface temperatures or by being engulfed by the growing star. When these stars become very large their outer

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shells become detached and cool down. This causes them to change colour to red.

Red Giants

These are second generation stars in their final phase before they experience the destructive effects of a Supernova. They will burn still heavier elements such as silicon and nickel, eventually producing iron, so causing even higher core temperatures. The high thermal pressure from the core will push the detached outer shell further out. If there is a reduction in the output from the core, then the gravitational pressure in the shell will force the star to contract again, causing the core reaction to increase once more. They can go on oscillating in size for a long time, but the time will come when the core reaction can hold up no more, and the star will rapidly contract, causing a massive increase in core temperature which blasts up to half the star's mass into space. This most violent of phenomena is a Supernova, which marks the star's transition to its next phase. Red Giants can exist for a long time and during their expansion, they may destroy life and worlds in much the same way the Late Yellow stars do, as well as by the Supernova itself. However, it is also possible that previously cold worlds could now be warm enough for life to evolve. The life may not have time to evolve very far, but other life forms could colonise such worlds if their homes have become uninhabitable.

Red Supergiants

When first generation stars reach their red phase they grow to enormous sizes; small solar systems could be contained within some of them. These sizes mean that their radii are usually measured in light seconds (the distance travelled by light in one second) as opposed to kilometres. Their progress is similar to Red Giants except that they tend to live longer. This phase is the earliest phase available to first generation

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stars as the age of the galaxy makes predecessors impossible.

Stellar Remnants

Red Giants with very low masses will be left with insufficient mass to become anything other than a cooling cinder in space after a Supernova. This phase is called a Stellar Remnant. They may be massive enough to have orbiting bodies, but as with all post Supernova worlds, these will tend to be cold and dead.

White Dwarfs

Red Giants with average masses will tend to become White Dwarfs. These are dense and small, averaging about 8 to 10 thousand kilometres in radius. These are essentially lumps of Iron, the high core density causing the creation of steadily heavier Iron isotopes.

Neutron Stars & Pulsars

Red Giants with above average masses will tend to become Neutron Stars. These are even more dense than White Dwarfs and their radii typically range from a few thousand to a few hundred kilometres. These stars are so compact that they crush the atoms within them, forcing protons and electrons to combine into neutrons and, leaving the star comprising mainly of neutrons. In heavier and therefore smaller neutron stars, even the neutrons will begin to collapse. Most Neutron Stars spin quite quickly; but some have a period measurable in milliseconds, when their electromagnetic emissions become like pulses and hence are called Pulsars.

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Red Holes

If a Neutron Star is too massive to remain in that phase it will steadily collapse, its colour slowly changing as light is bent and thus prevented from escaping. These are called 'Red Holes' and will eventually become so dense and the gravitational pull so great, that light will not be able to escape.

Black Holes

The heaviest Red Giants and Red Supergiants will tend to become Black Holes as their final phase. This is a body which has no apparent size, but an enormous mass. The gravitational pull does not let light out and they are visible as black holes in space. The size of the visible black area describes the '**event horizon**' within which light is trapped. The average radius of such event horizons is about 500 kilometres, although they can exist down to a few tens of kilometres. Being in close proximity to a Black Hole is not advised.

Binary stars

Some stars may have a Binary Companion Star. These stars are likely to be in the same phase as the primary star or perhaps a phase earlier. In many binary systems the stars would have evolved from the same cloud of gas. However some older binaries may have developed through a massive star attracting a nearby star and incorporating it into its own system.

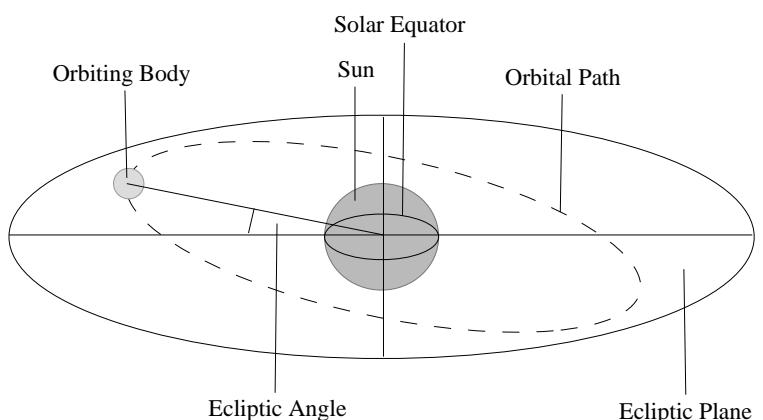
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6. Astronomy

Solar Systems

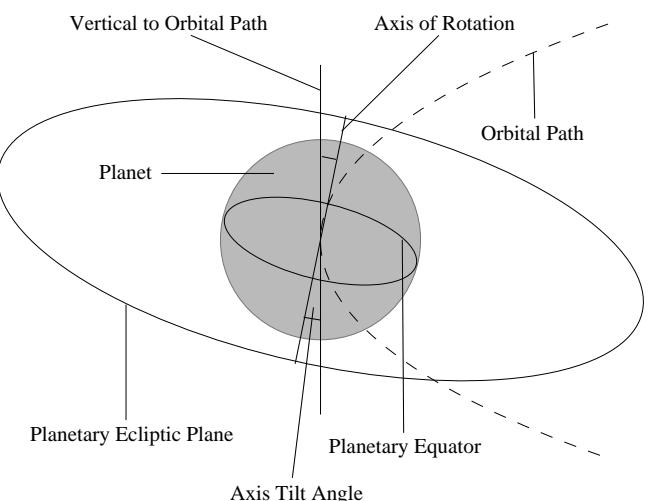
Planes and Angles

A sun is considered to be sitting in the middle of a plane which intersects the body at its equator, this is called the Ecliptic Plane. Planetary or binary bodies tend to orbit the sun very close to this plane, giving solar systems a disc-like appearance. The primary suns of all systems are inclined at various angles to the disc of the galaxy, or galactic plane, so causing the systems to be tilted to varying extents.



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Planets and binaries orbit at measurable angles to the Ecliptic Plane, and also spin on axes which are tilted at measurable angles to a vertical taken from their orbital path. Since these bodies possess their own ecliptic planes, similar to suns, these angles indicate the degree to which each is inclined. Moons orbiting a planet or binary body therefore do so at measurable angles to their primary's ecliptic plane. Moons may also spin on axes tilted to their orbital path.



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6. Astronomy

Solar systems - Spatial Areas

A solar system can be considered in terms of areas of space.

Sub-Orbital Space

This is the area of space surrounding a body extending from the lowest comfortably attainable orbit, down to the body's surface. With atmospheric bodies this will include the atmosphere.

Orbital Space

This denotes the area within which orbiting bodies most often occur around the primary sun.

Planetary System Space

A planet, even if it does not possess a system of moons, is deemed to have a system space which extends from the orbital space out to where the gravitational effects of the body become very low. If moons are present then they will wholly occur inside the orbital space. Orbits are possible within the planetary system space but they will be long and very distant from the planet being orbited.

Planetary System Border & Solar System Border

A small region of space at the edge of a solar/planetary system is considered to be the solar/planetary system border.

Inner Solar System Space

This region extends from the primary sun outwards to include the orbit of the outermost planet or

Page 6.12

asteroid belt. When no planets or binaries are present a region of similar extent is still referred to as the Inner Solar System Space.

Outer Solar System Space

This area extends from the outer edge of the inner solar system to the solar system border. This distance is often 1 to 2 times the radius of the inner solar system and would contain any distantly orbiting globe of boulders that may be present.

Asteroid Belt Space

Asteroid belts are thin bands of boulders which orbit the primary sun. The bands may be many thousands of kilometres in width but only a few hundred in thickness. All of this space is called asteroid belt space.

Inner & Outer Asteroid Belt Border

These are the thin bands of space denoting the inner and outer edges of the asteroid belts.

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6. Astronomy

Solar systems - shape

Many different shapes of solar systems are expected to be discovered, distinguishable by the spread of matter around the primary sun when orbiting bodies began to form. A typical example would comprise of a number of rock planets orbiting close to the sun, followed by a number of gas planets orbiting farther out and ending with a small number of rock planets orbiting out near the edge of the inner solar system. This example will appear with many variations in the masses of the bodies, but still following that basic distribution. In another shape of system, most of the matter available may have coalesced very close to the primary sun, causing the formation of a massive gas planet or even a binary star in a very close orbit. Frequently, in this case, the rest of the system would have had little mass available to form planets, so there may be a very small number of rock planets in orbit farther out and possibly nothing but asteroid belts thereafter. Other shapes are bound to occur.

Solar systems - bodies

Gas Planets

Gas planets have no definable surface but instead very large, dense atmospheres extending down to the core materials. Gas planets tend to be large, often from tens of thousands to hundreds of thousands of kilometres in radius. They often have extensive moon systems associated with them.

Rock Planets

Rock planets tend to be much smaller than gas planets, from a few tens of kilometres to perhaps a few

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thousand kilometres in radius. Some of the larger ones may sustain atmospheres of varying types. They may possess moons but these will often be small and few in number. The term is applicable to planets that contain rocky materials, but can also be applied to those that comprise mostly of ice.

Gas Moons

Gas moons can exist, but they are likely to be found associated with first generation suns or binaries.

Rock Moons

Nearly all moons are of the rock type. Their sizes as small as a few kilometres in radius, although moons orbiting gas planets or binary suns can be as large as large planets.

Asteroids

A solar system may have many boulders associated with it. Most obviously, one must expect them to exist in asteroid belts, however other occurrences are possible.

Cometary Nuclei

In the outer solar system space there will often be a globular cloud of icy boulders in distant orbits around their sun. These boulders remain virtually unchanged from the system's beginnings up to when a supernova occurs, when most of them are pushed out of the system by the force of the explosion. What are commonly known as comets come from these clouds, perhaps when a passing star causes a gravitational interaction which dislodges a cometary nucleus from its stable orbit and attracts it onto a new highly elliptical path toward its sun.

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6. Astronomy

Stellar Fragments

Large boulders of material may be ejected from a sun during a supernova and some of these may remain afterward in the outer solar system. They will be rich in heavy elements.

Solar systems - Nebulae

Hydrogen Nebulae

These are associated with young suns such as embryonic clouds and proto-stars. They tend to occupy all of the inner and outer solar system areas. As the name suggests, these nebulae are rich in hydrogen.

Ice Nebulae

After a sun reaches its blue phase, the hydrogen nebula will tend to be pushed away from the sun by the increase in radiant output from the new reactions taking place. This will tend to leave a nebula existing in the outer solar system comprising of heavier materials such as ices.

Planetary Nebulae

After a supernova explosion, much heavy material is ejected from the sun into the outer solar system the finer particles creating what is called a planetary nebula. This will tend to be rich in heavier elements.

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7. The natural environment

Structure and composition of planets and moons

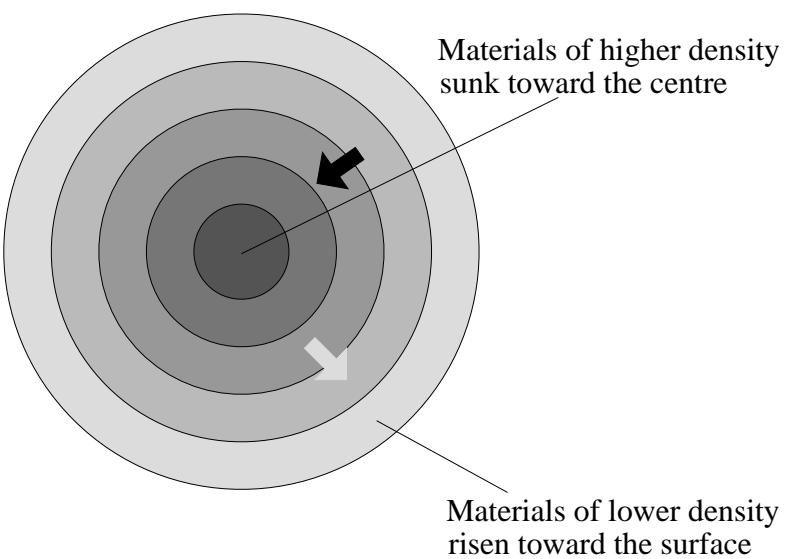
After the formation of a central sun, wherever sufficient concentrations of matter exist to 'seed' them, planets and moons will tend to form through mutual gravitational attraction. **The distance from the sun at which a given substance is able to form part of a planet is dependent on the temperature at which that substance becomes a gas.** It follows therefore, that substances with higher boiling points tend to be able to form planets at closer distances to the sun.

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7. The natural environment

The diagram opposite shows the way in which constituents of a body arrange themselves during formation.

A small body can be completely broken up by impacts from meteors. The debris from such a body will spread out around its orbit, but may eventually collect together again as previously described. In this scenario the structure will be disordered until the constituent materials have sorted themselves out again.



Page 7.2

Seismology

If the internal temperature of a rock body is high enough, some structural components may be molten, resulting in magma beneath the surface crust. The activity of these worlds could be sufficient to produce quakes or active volcanoes. Some icy bodies with warm internal temperatures may experience tremors caused by expansion and contraction, or from the process of rearrangement of the internal components. Where the surface temperature of a nitrogen ice world is close to that of the freezing point of nitrogen and the internal temperature is quite warm, liquid nitrogen can exist below a frozen, icy crust. The pressure exerted on the crust can build up to a point where the liquid erupts forming a volcano of rapidly freezing nitrogen.

Topography

Rock bodies have detectable surfaces, and thus also possess examinable topography. The causes of features can be internal or external in origin. The internal causes include seismic activity and structural composition, the external ones mainly from meteor bombardment and changes in surface temperature. On rock worlds these factors can create folding and fracturing of the crust causing fault valleys and mountain ranges, volcanic cones and craters, and meteor impact craters. The presence of an atmosphere will tend to slowly erode any features present by the action of wind, and possibly rain, snow and frost. Ice worlds can possess faults, cliffs and mountains formed by movements in the icy crust.

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7. The natural environment

Evolution and Time

Bodies such as planets and moons usually coalesce between 80,000,000 and 230,000,000 years after the formation of the primary sun. If they form close by their sun then they will often be molten during the early period of their existence. Further out they will tend to be cooler, and toward the edge of the solar system, the coldest bodies will form containing most of the ices of the system. When their sun enters its first stable phase, that of a main yellow, the temperatures of the bodies in the system will stabilise and, where conditions are appropriate, life may evolve. As the sun expands to its red giant phase, the bodies will be warmed, some will be absorbed and probably disintegrated by the sun, others may reach conditions where new life may evolve. When the sun experiences a supernova the system will change dramatically; rock bodies will have any atmosphere that they possess blown away into space, any surface liquids will be lost and, naturally, any life forms will be eliminated. Small bodies may be destroyed altogether by the explosion. After this event, solar systems become uneventful, dead places, possibly centering on a very compact star such as a black hole, the most dangerous gravitational phenomenon known.

Internal temperature

The internal temperature of a world is largely dependent on its mass and density; the heavier and more dense it is, the higher the temperature. In general, gas worlds can have far greater internal temperatures than their rock counterparts, perhaps by a factor of ten. The other major factor that can raise the internal temperatures of rock moons is the tidal gravity forces exerted on them by the planets they orbit. These forces are strongest where the planet is a gas planet and the orbit of the moon is quite close.

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Surface temperature

The surface (or cloud top for gas worlds) temperature of bodies within a solar system are mainly dependant on their distance from any strongly radiating sun, be it a primary or binary sun. Rock bodies close to hot suns may have surfaces of molten rock some thousands of degrees in temperature. For very distant planets, or those orbiting cold suns, the surface temperature is likely be close to that determined by the background radiation of the universe, see the section entitled **physics**. The surface temperature can be increased by a high internal temperature, or for a rock world the presence of a dense atmosphere. The temperature may vary greatly over the surface of a body, the night side and the poles being colder than the day side. The amount by which these vary is reduced where an atmosphere exists but can become extreme in bodies close to a hot sun and where planets have a captive rotation (i.e. where the rotation period is close to the orbit period resulting in one hemisphere of a planet being almost constantly facing its sun).

Electromagnetic effects

Bodies which form around an iron core are likely to exhibit a magnetic field. These will vary in strength depending on the mass and density of the body. Where this field is of sufficient strength and where the system has a strongly radiating central sun, charged particles from the solar wind can be trapped and form radiation belts extending far out into the surrounding space. If a moon has a strong magnetic field and passes through the radiation belts of the planet that it is orbiting, then it can picked up charge on its surface. The buildup of charge during an orbit by the moon can become large enough for it to discharge to the planet by what is known as a flux tube - an extremely rare phenomenon.

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7. The natural environment

Surface ice

Ice frequently exists on the surfaces of cold bodies within any solar system. In some cases, a rock world can be completely covered by ice, in others it may possess only ice caps over the poles. If oceans exist on the surface, it may be possible to detect icebergs. Where a body has large layers of ice as part of its internal structure, these layers will merge with the surface ice giving a genuine **ice world**. The composition of surface ices is largely dependent on the surface temperature and the freezing points of the various chemicals.

Illustrative table of freezing points of some commonly found chemicals

Nitrogen	63 K
Oxygen	70 K
Carbon Monoxide	74 K
Methane	91 K
Formaldehyde	171 K
Ammonia	195 K
Carbon Dioxide	216 K
Hydrogen Cyanide	259 K
Water	273 K

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Surface rock

Where no layers of ice exist in the core of a rock world, the surface crust will consist of one or more rock types, even if that crust is covered by ice. After formation the surface rocks of these worlds will often be igneous in type. Where the origin of the world has been very hot or where magma has existed (or still exists) beneath the surface, metamorphic rocks may be created. If the seismic activity is great, and active volcanoes have existed, volcanic igneous rocks may be present along with some other chemicals like sulphur which may be associated with them as accretionary rocks. If surface liquid has existed (or still exists) then it is possible that sedimentary rocks could have been formed. The rocks within these basic types (igneous, metamorphic, sedimentary and accretionary), such as basalt, granite and coal, will be detectable and the possible occurrence of elements such as gold can be predicted. The rocks will contain ores, minerals and crystals which will only be detectable upon much closer examination.

Surface liquid

For liquids to occur on the surface of a body, an atmosphere must be present. The composition of surface liquids will often be dependent on the atmosphere and the ambient temperature. Where the surface temperature is close to, or within the range delimited by the freezing and boiling points of pure water and this chemical exists in the atmosphere as water vapour, it becomes the most abundant chemical component of any oceans. These will tend to have other chemicals in solution, such as salts. At much colder temperatures, where methane can exist as a liquid and is abundant in a fairly deep atmosphere, it is possible for oceans of methane to occur. Surface liquids can form great oceans partially or wholly covering the surface, creating oceanic worlds, possibly with river systems and marshes on any land.

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7. *The natural environment*

Meteorology

Bodies that possess an atmosphere may have detectable wind and cloud patterns, and sometimes other phenomena such as electrical and dust storms may occur. Where temperature and atmospheric chemical composition are appropriate, liquid can condense and fall as rain, or freeze and fall as snow.

Atmospheres around gas worlds

All gas worlds, by definition, possess atmospheres. The large masses of these worlds provide them with sufficient gravitational acceleration to hold volatile chemical elements and compounds within their atmospheres. These atmospheres are very deep, frequently hundreds of kilometres, extending down to the any structural layer of the body which will usually be liquid hydrogen. Hydrogen and helium, are the most common interstellar gases, so they form the largest proportion of the embryonic cloud of gas and dust from which a solar system forms. Additionally, they are usually the most abundant elements of gas atmospheres, and are the only components in atmospheres of gas worlds orbiting first generation suns. Other major chemicals likely to be found are methane, ethane, ethene, ammonia and noble gases such as argon, krypton and neon. Other chemicals may appear in minute quantities, such as phosphine, hydrogen cyanide, and acetylene.

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Atmospheres around rock worlds

Only the heaviest and largest rock worlds, whose suns have not yet experienced a supernova, will have sufficient gravitational attraction to retain atmospheres, and these will tend to mainly comprise of the heavier elements and compounds that can exist in gaseous forms at the temperatures and pressures of their worlds. The depths of these atmospheres are frequently low, perhaps only some tens of kilometres. The major chemicals of these atmospheres can create widely different surface environments, some producing conditions suitable for a variety of life forms to evolve, others being poisonous to any known form. Nitrogen, oxygen, methane, ammonia, carbon dioxide and carbon monoxide are examples of chemicals around rock worlds. Other chemicals that may occur in smaller amounts are sulphur dioxide, ozone, argon, krypton, neon and water.

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7. The natural environment

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8. Mothership fundamentals

General description

The Pioneer Class Mothership is a very powerful and flexible craft.

Drives

The Mothership is equipped with three drives.

Primary drives (Advanced Timeslip)

The primary drives fitted to the Mothership are used for interstellar flight only.

Secondary drives (Advanced Unification)

The secondary drives fitted to the Mothership are for use within the boundaries of solar systems.

Manoeuvring Thrusters (Advanced unification)

The manoeuvring thrusters are used when small amounts of thrust are required, and are useful to achieve stable orbits, or to rendezvous with other craft.

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8. Mothership fundamentals

Basic keyboard control

Linear Thrust -Keyboard control



Angular Thrust

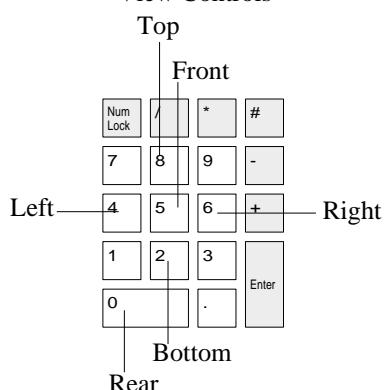
Dive (forward, about X)



Roll (clockwise, about Z) — ← ↓ → — Roll (anticlockwise, about Z)

Climb (up, about X)

View Controls



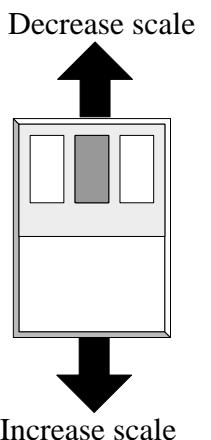
Page 8.2

The Scanner

The Mothership is equipped with a variable-scale scanner capable of resolving three dimensional distances in the range of 1cm - 8000 light years. Bodies are detected by their gravitational 'footprint', so in crowded spaces, the sensitivity of the scanner is reduced.

Scanner scale

Owing to the very large range of distances over which the scanner is expected to operate, this device is able to limit its view of space to a user-defined radius. As the radius of scan decreases, (a reduction in scale), the scanner becomes more sensitive. To increase the scale of the scanner (zoom out), depress the middle button and move the mouse down. To decrease the scale (zoom in), hold the middle button down and move the mouse up. The vertical bar to the left of the scanner indicates the current scale setting. **Note: When decreasing the scanner scale the effective maximum range of the scanner is reduced. When viewing a trace in one view (eg. plan), and decreasing the scale, the trace may move out of range in the other view, causing it to disappear.**



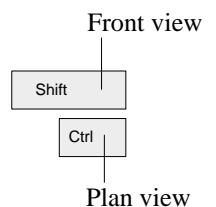
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8. Mothership fundamentals

Scanner positions

The scanner can display its traces in one of two views.

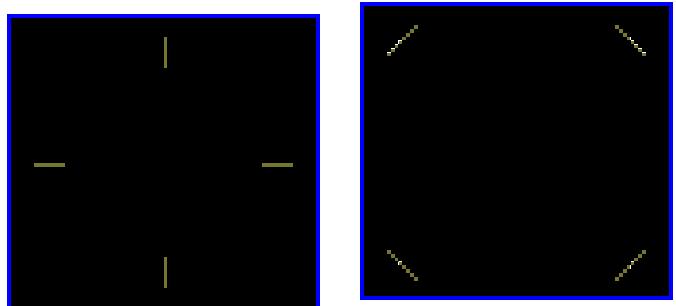
- * Front view - as though looking straight ahead
- * Plan view - as though looking from above



Front

Plan

The marks on the scanner window indicate the currently selected view. As the view is changed (using the right-hand shift and control keys) the scanner can be seen to rotate to the new angle.



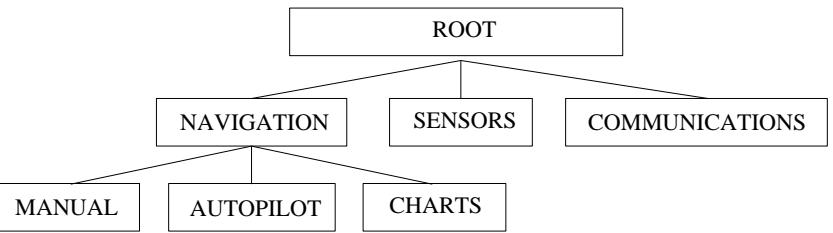
Page 8.4

System pages

The Mothership has numerous **system pages** arranged in tree form (shown below).

NOTE: In this release of the software, only seven of the system pages are actually available. These pages are shown opposite.

At the top of the tree is the **Root** or **Main** page (shown overleaf). From this page, all other pages are selectable. Each page below the root has a small arrow in its top right-hand corner. Clicking on this will select the 'parent' page.



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8. Mothership fundamentals

The Root Page

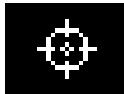
This page is used to gain access to the tree of pages below it. To make a selection, simply click on the chosen icon. The Root page will then disappear, and be replaced by the selected page.



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Target Icons

Some systems pages provide information or perform actions based on the position of another body in space. Such pages will therefore require a body to be selected and will consequently need to provide a **Target Icon** to facilitate this. Target icons display a graphic representation of the body to which they have been targeted.



No target



Sun



Planet



Moon



Artificial

To target a body in space, position the pointer **exactly** over the body in the viewer, or the trace of the body on the scanner. Then drag the body to the target icon. The target icon should then display the appropriate graphical representation. You may drag another body at any time, the old one will be replaced. To cancel a target, simply double click **select** on the target icon.

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8. *Mothership fundamentals*

The Navigation Page

The Navigation page is used solely to gain access to the pages underneath it. It is shown below. To make a selection, simply click on the chosen icon. **Please note that all systems pages are accessible by 'keyboard short cuts' - see the appendix at the end of this manual 'A summary of keyboard controls'.**



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9. Manual flight of the Mothership

Manual flight of a craft such as the Mothership is a skill which is relatively easy to gain at a superficial level, but far more difficult to master. In addition to an explanation of the **manual flight page**, this section gives some hints and tips which may assist you in the earlier stages of learning to fly.

Application of linear (forward, back, etc..) thrust in the mothership is a two stage process. Firstly, the pilot uses the **manual flight page** to select the drive (using the drive selection icons) and the power for that drive (using the **thrust** control). Then, when required, the thrust is applied using the appropriate keys, or the **Forward / Reverse** thrust icons.

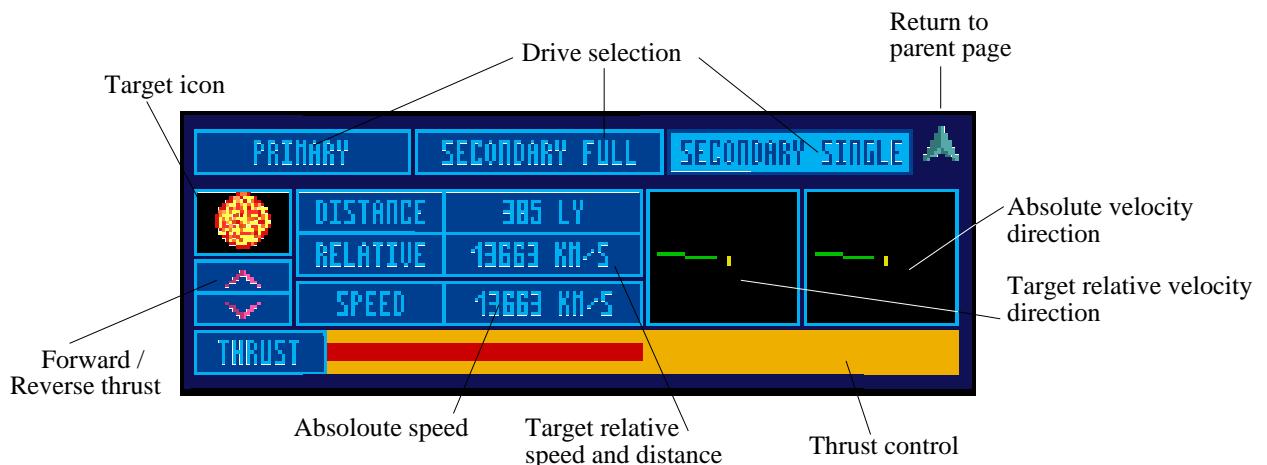
Note that where the manual flight page refers to speed, it uses the proper physical definition of the term (see the section entitled **Physics**), that is 'movement without reference to direction'. The nett effect of this is that the speed readings from this page reflect the **total** or **resultant** speed - ie. the sum of the velocity in all directions.

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9. Manual flight of the Mothership

The Manual Flight page

The manual flight page is shown below. Although at first glance it may seem complicated, the flight page will soon become 'second nature'. Please note that the target and 'return to parent page' icons are common to several pages and have been described in a previous section.



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Drive selection

Click on the appropriate icon to select the desired drive.

Thrust control

This slider is used to display and modify the power of the selected drive. Clicking anywhere on this bar will change the current setting.

Forward / Reverse thrust icons

These icons apply the specified thrust, using the specified drive. The **Page up** and **Page down** keys may also be used for this purpose. The thrust is only applied while the mouse button is held down.

Absolute speed

This is a numeric representation of your current speed. In the context of the flight page, the term **absolute** means 'relative to the solar system'. You may consider this speed as your **real** speed. When outside a solar system, this term means 'relative to the galaxy'.

Target relative speed and distance

The speed indicated here is your speed relative to that of your target. Put another way, this speed is the **difference** between your speed and that of your target. The distance shown here is the distance between you and your target. **Note that where appropriate you may click on the 'distance' icon to toggle to an 'altitude' reading.** These two figures only appear when a target has been selected.

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9. Manual flight of the Mothership

Absolute velocity direction and Target relative velocity direction

The two diagrams shown here are fundamentally the same in operation. In each diagram the green (left hand) trace shows the direction of your **X and Y** velocity components. The yellow (right hand) trace shows the direction of your **Z** velocity component. For an explanation of these terms (X Y and Z) please refer to the section entitled **geometry**.

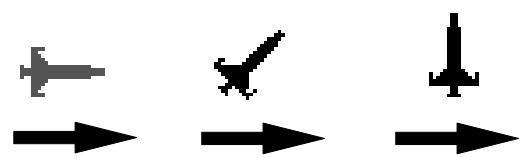
Direction of travel	X trace	Y trace	Z trace
Directly forward		dot	line upward
Directly backward	dot	dot	line downward
Directly to the right		line to right	dot
Directly to the left	line to left	dot	dot
Directly up		dot	line upward
Directly down		dot	line down

From this table you should get a feel for the nature of these traces. The representation of directions is a lot harder to explain than it is to understand; the best way of getting used to it is to fly, and experiment. The left hand diagram represents your **target relative** velocity direction (ie., the **difference** between your velocity and that of your target), and the right hand diagram shows your **absolute** velocity direction.

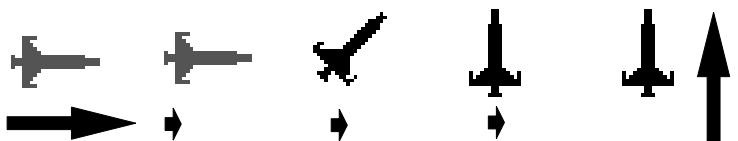
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Changing direction

When flying in space changing direction is not merely a process of pointing in a different direction. Any speed you have built up in a previous direction must be reduced to a negligible level first. For example, imagine that you were flying straight ahead at light speed, and wished to change direction and fly upward. Merely orienting your craft upward would not change your direction at all (see diagram).



The correct approach would need be to slow down first (or stop - but this is seldom done), re-orientate and accelerate in the new direction (see diagram).

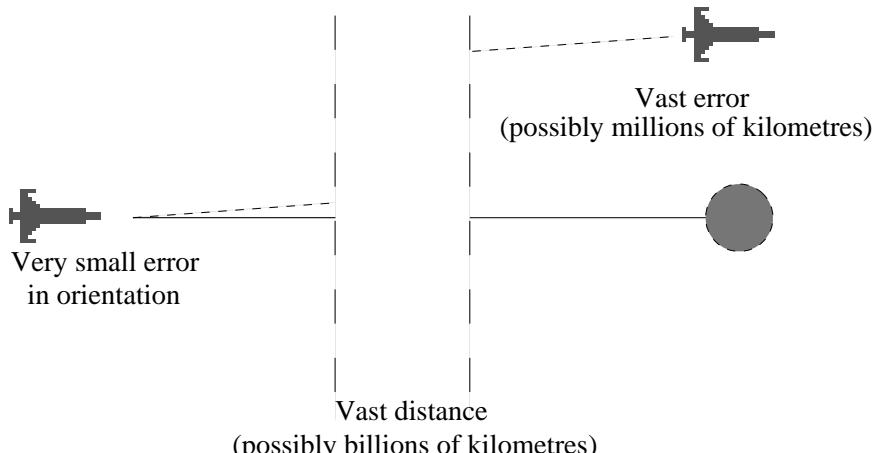


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9. Manual flight of the Mothership

Flying to distant objects

Space is big. Very big. Your destination may be billions of kilometres away. Therefore it is impossible to simply aim your craft in the general direction and expect to fly there in one leg (any tiny inaccuracy in your aim would lead to massive errors of position as you cover the vast distance between your starting position and your target).



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Legs

Flying to a distant object will probably require you to break the journey down into many, more manageable, **legs**. Using the scanner (at the appropriate scale), you should aim the craft as best you can and fly toward the target. You will probably want to switch to the **plan** view on the scanner in order to monitor your progress. Decrease the scanner scale as you approach, and you will begin to see the errors in your original aim. It is then necessary to stop, re-orientate and repeat the process. Bear in mind that any speed you build up as you accelerate will need to be countered by a period of deceleration. You may have to perform several legs before the target object is visible through the viewer, at which point you may choose to continue your journey without the aid of the scanner by sight alone. This is an art best learned by experience.

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9. Manual flight of the Mothership

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10. Automatic flight of the Mothership

The Mothership provides an **Autopilot** to facilitate automated flight. The Autopilot control page appears below. The Autopilot is able to perform several functions. All such functions with the exception of **Angular Halt** require a target to have been selected using the target icon (refer to the previous section on **Target Icons**). To select or cancel any function of the Autopilot, simply click on the chosen icon.



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10. Automatic flight of the Mothership

Angular Halt

The Autopilot will use the angular thrusters to eliminate any angular (rotational) movement.

Orientate

The Autopilot will use the angular thrusters to orientate the craft to the specified target. The icons to the right of the **Orientate** icon are used to select the attitude of orientation. Simply click on the desired attitude.

Station Keeping

The Autopilot will use the linear drives to eliminate any relative movement of the craft with respect to the target. The **X Y Z** icons to the left of the **Station Keeping** icon are used to specify the axes in which movement is to be eliminated. For example, if the **X** and **Y** axes are selected all movement will be eliminated in these axes.

Navigate

The Autopilot will use a combination of the other three functions to navigate the craft to the selected target as quickly as possible.

Page 10.2

Advice on use of the Autopilot

The Autopilot system may be used in several ways to assist the pilot. Primarily, the **Navigate** function is used for completely automated flight where the pilot has only to occasionally monitor the progress of the journey to avoid collisions, etc. **Station Keeping** is often used with all axes enabled, to counter the effects of gravity without needing to achieve a stable orbit and to help maintain rendezvous between craft. Used with the **X** and **Y** axes enabled, and in conjunction with manual flight, the **Station Keeping** function is very helpful when navigating large distances, as all drifting is eliminated (see the section on manual flight).

Note: When in close proximity to other bodies (particularly large ones) and under the control of the autopilot (particularly at the beginning a navigation) the pilot should be aware of the possibility of collision, as the autopilot does not account for the presence of such bodies.

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11. Interstellar flight in the Mothership

The pilot who looks into space will invariably see a vast number of stars. The more distant of these are in other galaxies, and these generally appear white in colour. The pilot will often be able to see stars which are brighter and more colourful than these distant stars. Such stars are very likely to be within the local galaxy. When within solar system space, the scanner aboard the Mothership is unable to resolve the positions of these stars, as the bodies in the local system reduce the sensitivity of the 'gravity footprinting' technology. However, as the Mothership leaves solar system space, the local stars become resolvable on the scanner and another change occurs; the **Primary Drives** are automatically enabled (these are necessarily disabled when within the confines of a solar system as the vast temporal flux created by such drives can dangerously interfere with the time continuum in the local area). The Mothership is then free to navigate to other stars within the galaxy. On approaching a target solar system, the pilot must reduce the velocity of the Mothership to a level compatible with the **Secondary Drives** as the **Primary Drives** may automatically disable themselves. Fortunately for the novice pilot, the Autopilot system is capable of navigating these vast distances, and is a good demonstrator of the skills required for interstellar flight.

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11. Interstellar flight in the Mothership

Interstellar Navigation - the Galactic Map and the Charts Page

Due to the vast distance involved in interstellar flight, the Mothership is equipped with a dynamic, three dimensional galactic map. The coordinates of the stars within this map have been determined by the Galactic Council's scientists with the aid of deep space scans. The galactic map is controlled by the Charts page; to select this, click the 'Charts' icon on the Navigation page (see the section entitled **The Navigation Page**). The charts page is shown below. An explanation of each icon and its use follows, but please note that in this release of the software there are several icons on the page which are unimplemented, these are 'map' and the small icon above it.



Page 11.2

Explanation of charts page icons

Note that the target icon and the up arrow are common to several pages and have been explained in a previous section. When enabled, the galactic map replaces the view of space in the main window.

Galaxy

Click this icon to display the whole galaxy. Click again to cancel this.

Sectors 0-6

Click on the icons to display the chosen sector. Click once again to cancel. Note that if a sector is selected in conjunction with the **Galaxy** icon, the whole galaxy is displayed, with the chosen sector highlighted.

Local

Click this icon to highlight the local group of stars, the white star is the closest.

A star may be dragged from the map to the target icon on the Charts page to reveal some information about its nature and distance. In addition, stars may be dragged to the target icon from the scanner, and in some cases, from the viewer. When in interstellar space, local stars may be dragged from the map to other pages which require a physical position, such as Autopilot, Flight Page, and Sensors.

Page 11.3

11. Interstellar flight in the Mothership

Moving the map

The galactic map can be manipulated by the user. Three functions are available: **Rotate**, **Scale**, and **Translate**. The desired function is selected by clicking on the appropriate icon on the charts page. When the chosen function has been selected, the map can be moved by holding down the **right button** and moving the mouse. An explanation of each of these functions follows.



Rotate

- mouse movement causes the map to rotate



Scale

- mouse movement reduces / increases the scale



Translate

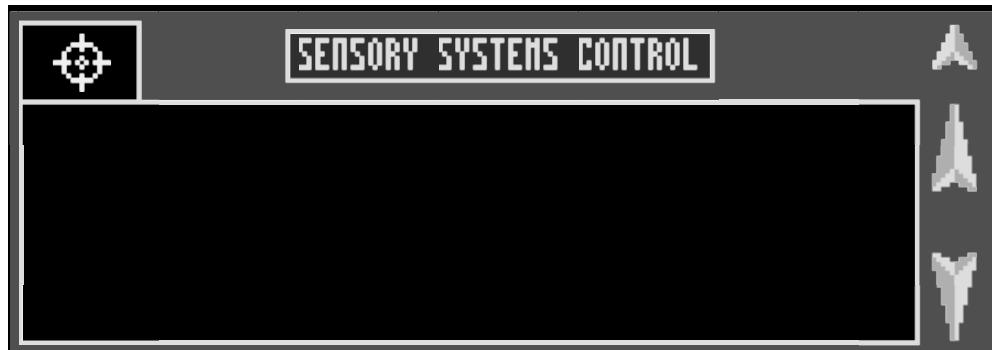
- moving the mouse causes the map to move linearly

Click on the **Home** icon to reset the map back to its original state.

Page 11.4

12. The Mothership's sensory systems

The Mothership is equipped with a very powerful systems for sensing bodies in space, and providing information to the pilot resulting from such activity. The sensory systems are accessible through the **Root Page**, via the **Sensors** Icon. The sensor page is shown below.



Page 12.1

12. The Mothership's sensory systems

The sensory system requires a target to be dragged to its target icon before any operations can be performed. When a target has been provided, the title icon ("Sensory Systems Control") may be clicked to toggle between the report page and the appropriate menu. The exact contents of the menu will depend on the nature of the body targeted and the distance of the Mothership from that body. **Pilots should therefore note that the level of detail available from the sensor systems is dependent on the distance between the Mothership and the targeted body.** Items within the menu may be clicked upon, some will reveal sub-menus, and others will provide a report. To obtain the parent menu from a sub-menu, click on the menu title icon. The two large arrows to the right of the report window may be used to scroll the text in the report window up and down, this is useful to view portions of a report which have disappeared off the top of the window. When a new report is generated, the report window is automatically moved to the bottom of its buffer in order to facilitate viewing of the most recent additions. Refer to the sections on **Astronomy**, **The natural environment**, **Physics** and **Geometry** for explanations of the terms used within these reports, and the nature of the bodies being examined.

Page 12.2

13. The Mothership's communications system

The Flight Trainer is equipped to simulate a small subsection of the communications system available onboard the Mothership. The communications system page is shown below. Use of aspects of the communications system is similar to that of the sensory system. An explanation of this use follows.



Page 13.1

13. The Mothership's communications system

General use of the communications page

The menu system used in communications is identical to that of the **sensory** system. The title bar is used to toggle between a menu and the underlying text window. The text window appears after a menu selection has been made. The arrow icons to the left are used to scroll the text up and down. The small arrow in the top right hand corner is the 'return to parent page' icon, and has been described in a previous section.

Establishing a communications carrier

A communications **carrier** is a connection between two communications systems. The existence of a carrier does not imply a conversation, nor does it state that either party need be aware of its existence. It is **merely a link between two communications systems and is vital if any subsequent conversation is to be entered into**. A communications carrier is established in one of four ways:-

1. **You target a body whose communications system is free.** In this case, a carrier is established instantaneously, and the target icon on your communications page will show the nature of the body targeted.
2. **You target a body whose communications system is busy.** Here, your chosen target cannot immediately set up its half of the carrier and you will need to wait until it becomes free. Your target icon will flash until a carrier is established, and will then revert to the normal mode which indicates the nature of the body targeted.

Page 13.2

3. **Another body targets you, and your communications system is free.** In this scenario, your communications system will automatically provide its half of the carrier protocol and such a carrier will be immediately established. Your target icon will show the nature of the body responsible for the origination of the carrier.
4. **Another body targets you, and your communications system is busy.** Your communications system is unable to set up a carrier in this case, and you will be warned of this condition by the target icon which will flash until you drop the current carrier. When this is done, your communications system will allow the new carrier request to be satisfied and your target icon will show the nature of the body responsible for the origination of the new carrier.

Standard introduction protocol

After the carrier is established it is standard protocol for the originator of that carrier to send a **hail** message, the reply to which is an **acknowledge** message. This exchange allows the communications systems of both parties to configure their **conceptual matrix translation software** appropriately.

Sending messages

A message is sent by summoning the communications menu (click on the title bar) and selecting the desired option. The menu will then disappear and the text of the message will be written to the screen in its place.

Page 13.3

13. The Mothership's communications system

Receiving messages

When an incoming message is received the text of that message will be shown in the window.

Standard sign-off protocol

It is polite to finish all conversations with the **sign-off** message. On receipt of this message the other party will generally drop their communications carrier.

Dropping a communications carrier

A communications carrier is dropped (or cut) by double-clicking on the target icon. Note that it is very impolite to do this without first issuing the standard sign-off protocol.

Page 13.4

14. The Hopper craft - fundamentals

The Hopper craft is a small, highly manoeuvrable craft which is carried within the Mothership. It is moved in and out of the Mothership by means of the **transporter**. The Flight Trainer has only a limited simulation of the transporter system. The Hopper is totally dependent on the Mothership for its survival. The pilot who finds him/herself aboard the Hopper in space with the Mothership destroyed or permanently disabled is doomed to a slow death by any, or combinations, of the following: asphyxiation, cold, heat, starvation, etc...

The primary use for the Hopper is flight which requires greater manoeuvrability than that offered by the Mothership. This may include close quarter combat, certain types of rendezvous etc. The Flight Trainer provides only a very limited simulation of the Hopper craft, with much functionality missing, notably the combat systems.

Page 14.1

14. The Hopper craft - fundamentals

Page 14.2

15. Flying the Hopper craft

When you have mastered the control systems of the Mothership, recruits should experience no difficulty in manoeuvring the Hopper craft.

Page 15.1

16. The Hopper craft systems

The systems of the Hopper include two basic drives and scanning and viewing capabilities. These are consistent with, but more limited than, those of the Mothership.

Page 16.1

16. The Hopper craft systems

Page 16.2

17. The Flight Training Programme

The Galactic Council introduced this training programme to enable new recruits to acquire the knowledge and basic skills essential to graduate as Pilots and to depart on their inter-galactic adventure. In order to increase the chances of success on arrival at the target Galaxy, the training missions have been designed to encourage familiarity with the simulated sector of the Target Galaxy, space navigation in general, and this Manual. The Training Programme is divided into two training missions. They both involve:

- Using Star Charts for locating and navigating between solar systems
- Piloting your Mothership using Manual Flight controls and AutoPilot
- Controlling your sensory devices in order to examine natural bodies
- Using your communications system for interaction with artificial objects you encounter
- Identifying and avoiding hazards to your craft.

The First and Second Missions

The goal of the first Mission is to discover and retrieve the **Hopper**, which is parked in orbit somewhere within the simulated sector. The second Mission involves operating your Hopper craft within solar systems as well as utilising skills gained during the first Mission, thereby providing the recruit with rounded experience. The goal of the second Mission is to discover the **Galactic Council Training Post** in the simulated sector and thereby graduate from the programme.

Page 17.1

17. The Flight Training Programme

Artificial Objects

A large number of artificial objects exist within the simulated sector. Many are hazardous. Many others respond to communications and contain Mission Instructions within their control systems. The Hopper is a unique artificial object. Another is the Galactic Council's Training Post in which Representatives of the Galactic Council await your arrival.

Mission Instructions

A Mission Instruction describes environmental phenomena associated with the location of an artificial object.

The tasks for the recruit are:

- To identify possible destinations within the simulation where the environmental phenomena may exist
- To use navigation and sensing systems to attempt to discover an occurrence of the phenomena
- To use the scanner to verify the presence of any artificial object in the region
- To communicate with that object and receive the Mission Instruction it contains.

The final Instruction in a Mission implies the location of the artificial object which is the goal of that Mission.

Page 17.2

Mission Progression

You will progress smoothly in your missions by wise selection of destinations and successful discovery of the appropriate artificial objects. However, recruits are likely to encounter many objects which are either not the next object in the Mission Progression, or are not associated with the Mission Instructions at all. If an object is part of the Mission Progression and contains a Mission Instruction, but is not an example of the next object you seek, it will refuse to transmit its data. Recruits are advised to take note of its location and of any environmental phenomena sensed in the region, as this information could improve your efficiency.

Commencement of Training

You will commence your mission by entering the mothership which the simulator has located within a solar system in the Outer Galactic Field of the simulated sector.

Page 17.3

17. The Flight Training Programme

Galactic Council Mission Instruction

Galactic Council to Pilot Cadet. Greetings.

Environmental Phenomenon: A Gas World

Occurrence: Common

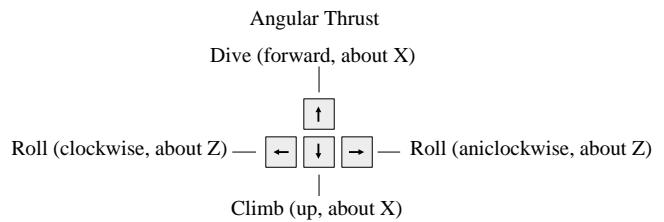
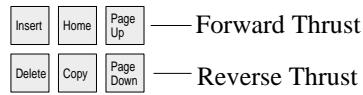
Target Object : Beacon

Local Position: Planetary Border Space

Page 17.4

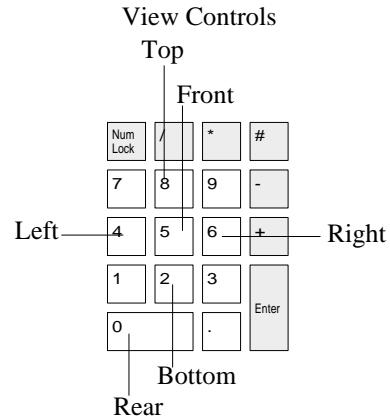
Appendix A. Summary of keyboard controls

Linear Thrust -Keyboard control



Keyboard Shortcuts to systems pages

f1	Root page
f2	FlightB
shift/f2	Autopilot
ctrl/f2	Charts
f9	Communications
shift/f9	Sensors
f12	Hopper In / Out
Left hand shift	Prevent key repeat
Escape	Return to desktop



Appendix A.

Appendix A. Summary of keyboard controls

Appendix A.

Appendix B. Technical Specifications

Karma is based on a 3 dimensional, 64bit model, the fundamentals of which are programmed in ARM assembly code. The angular increment of this model is 0.1 degree. Full newtonian gravity is supported at the highest accuracy affordable.

The facet based objects are plotted using Periscope's in-house concave-capable rendering software, and are shaded according to the position of the light source(s). The object rendering software is programmed in ARM assembly code, and where possible in ANSI C.

The Karma galaxy is approximately 8000 light-years across. It contains approximately 2400 solar systems, each of which is about 45,000,000,000 kilometres in radius, but all are modelled to an accuracy of 0.0035 centimetres. There exists a mechanism allowing for almost continuous flight between any stars, and during interstellar flight the full resolution of the model is applied to the vast distances involved. Sector Zero, which is supplied with the Flight Trainer contains approximately 335 stars, and around 8000 bodies.

Appendix C. Acknowledgements

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Appendix C.

Appendix C. Acknowledgements

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BBCtv

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