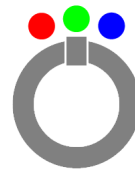# Adanaxis

Welcome to Adanaxis! The world's first real-time shooter in four spatial dimensions. The game world has the usual three dimensions (left/right, up/down and forward/back) plus another new direction in space. We don't have this dimension in our physical world but it's possible to simulate a fourth dimension, so this is what Adanaxis does. The game takes a while to learn, but you can soon become a natural. It's a bit like learning to play a first person shooter for the first time, and once you get it, you might not want to go back…

Support Spatial 4D Gaming!

If you like this take on 4D gaming, I need you to spread the word. Right now spatial 4D is unlikely to attract big name developers because its mass appeal is unknown so it's seen as high risk. One way to change this is with posts to and reviews on gaming sites, blogs, video sites, etc. If these can include the words *spatial 4D* then Googling for "Spatial 4D" (with the quotes) should give us a list to wave at developers and publishers and hopefully tempt them into this type of 4D gaming.

Getting Started

The game intro will explain the 4D control system, and the rest of the keys are set up like a normal first person shooter. Shoot the red baddies, don't shoot the blue goodies, collect the power ups, and try to stay alive. If you like what you see you can get the full version with 30 missions from the Mushware web site.

Weapons Briefing

Weapon upgrades and ammunition are found by collecting the boxes shown below.
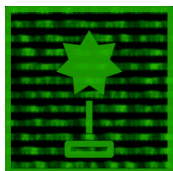
The basic Plasma Spitter is self-recharging but does minimal damage. Projectiles are guided, so once your crosshairs have registered a target (by turning blue or red) these projectiles will be guided to that target.
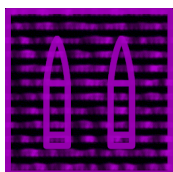
The Machine Cannon provides more rapid fire than the base weapon. Damage is minimal and projectiles are unguided. Useful at close to medium range on lightly armoured targets.
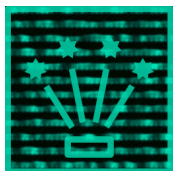
The short range Plasma Flak variant of the Spitter. Very effective at point blank range or in a target-rich environment.
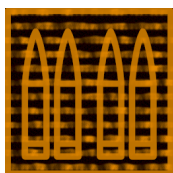
The Machine Cannon provides a rapid rate of fire that overwhelms its target quickly. It also rapidly exhausts its ammunition.
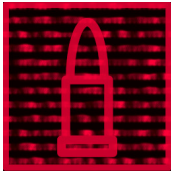
Heavy Cannon projectiles are simple and effective. Dense and fast moving, their repeated impact does enormous damage and can rapidly destroy targets.
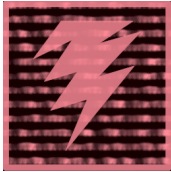
The range and power of Beam Artillery makes it ideal for long-range engagements. There is a downside to that power - it will destroy anything that the target is carrying along with the target.
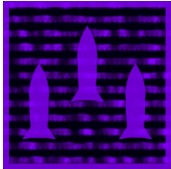
Guided Ordnance is a medium range guided missile. Ideal for picking off a number of distant lightly armoured craft, or deployed *en masse* against a larger target.
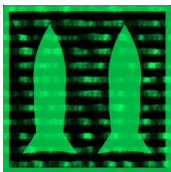
Heavy Guided Ordnance carries a high yield warhead and will damage both the target and surrounding objects. Also has excellent seek characteristics, long range and rarely loses a target.
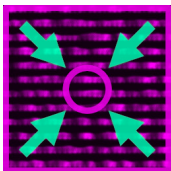
A captured device named the Gravity Sink. Precise characteristics are unknown. The weapon appears to be gravitational in nature, but has never been seen in operation.

The Heavy Demolition Charge is cumbersome and slow to deploy, but the results are astounding. Fitted with a five second fuse. Its enormous blast radius makes it unwise to hit the target and cause early detonation. Aim to miss.

Health and Shield
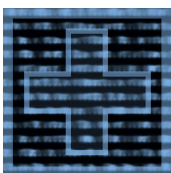
The health display shows the basic condition of your craft, and when it reaches zero your craft can't go on any more. Health boxes can be collected to improve the state of things.
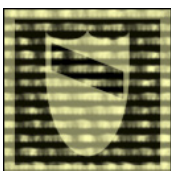
Your shield protects your health from damage. Collecting shield boxes increases the shield strength to provide better protection.

Control Briefing

Adanaxis is played like a normal shooter with one exception. It's 4D, so as well as aiming left/right and up/down, you need to aim in the third, hidden axis, by holding down the right mouse button (or space bar if you don't have a two-button mouse) and dragging the mouse left/right. The scanner in your craft gives each target a three-dot marker (like the one below) showing where it is in 4D space.

Green: y axis.
Move mouse up/
down to aim

Red: x axis. Move
mouse left/right to aim

Blue: z or hidden axis. Move
mouse left/right whilst holding
down the right mouse button or
space bar to aim
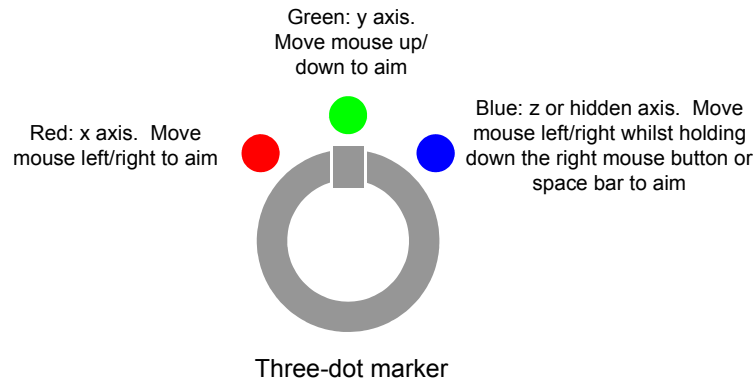
Three-dot marker

These markers help you to aim. When all three dots are lined up at the top of the marker, you are aiming directly at the object. The red and green dots will take care of themselves, as if a target is in the crosshairs these dots will already be in the right place. The blue hidden axis d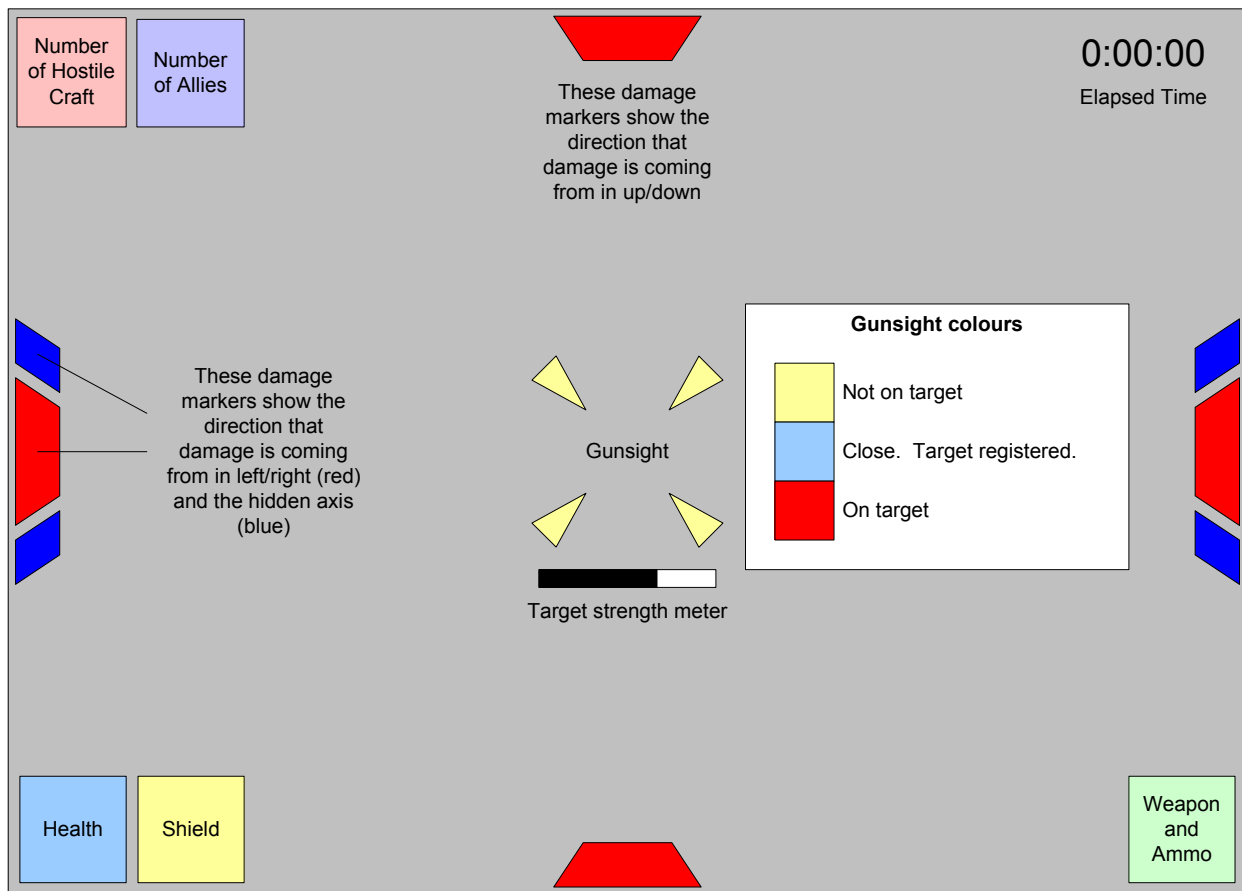ot also needs to be at the top, and you get it there by dragging the mouse left and right whilst holding the right mouse button or space bar down.

The gunsight changes colour when you're lined up on a target. It turns blue when your aim is close to a target. At this stage your guided weapons will lock on to that target, and stay locked to it even if you move away, until you aim at another target. For unguided weapons, you'll need to improve your aim until the gunsight turns red and starts to spin. This means that a part of the target is directly in your line of fire.

It's easy at first to miss in the hidden axis. Your weapons appear to go through the target but have no effect. This is usually because they're a little bit off in the hidden axis – the fourth direction that you can't see directly.

Screen Layout

Number of Hostile Craft	Number of Allies

These damage markers show the direction that damage is coming from in up/down

0:00:00

Elapsed Time

These damage markers show the direction that damage is coming from in left/right (red) and the hidden axis (blue)

Gunsight

Target strength meter

Gunsight colours

	Not on target
	Close. Target registered.
	On target

Health	Shield

Weapon and Ammo

The damage markers are a little special in 4D. If the left red marker lights, move the mouse left to find the target that's shooting at you. If the left blue marker lights, hold down the right mouse button or space bar, and move the mouse left, to change your aim in the hidden axis. It's similar for the right markers.

Default Controls

The demo can be played with just a few controls.

- **Mouse (left) click :** Fire
- **Arrow or W, A, S, D keys :** Move forward, back, left, right
- **Mouse left/right :** Aim left and right
- **Mouse up/down :** Aim up and down
- **Hold right mouse button or space bar down, move mouse left/right :** Aim in hidden axis
- **Wheel up/down (or top row number keys):** Change weapon

The full set of 4D controls can be found on the configuration menus. Holding down the **Q** or **E** keys whilst moving the mouse provides the other three rotations of the craft, These are not usually needed to play, but give an interesting take on the 4D aspects of game world.

Joysticks with a twist control are good, as the hidden axis can be controlled by twisting the stick. It is possible to play with a touchpad, but if your laptop touchpad has a 'palm check' or 'prevent

accidental pointing' feature you might need to turn that off, otherwise the touchpad may freeze for a few seconds every now and then.

Options

It's best to leave texture compression and compiled shaders switched on unless the game isn't working. Adanaxis used compiled shaders to move 4D calculation onto your graphics card. This is a good thing because the game is around ten times slower when these calculations have to run on the main CPU instead. It only works if your graphics card supports OpenGL Shading Language – otherwise this setting will be unavailable.

Info

- It may seem strange for a 4D game, but Adanaxis is designed to minimise the visibility and impact of 4D on the player. With just one extra control required, the game looks and plays a lot like a 3D shooter, with another aiming stage added on.

- Adanaxis is played close up, with slow-moving craft engaging at point-blank range. This suits 4D because there's a lot more *space* around you in four dimensions, and objects can easily get lost.

- Each of the aiming axes works in exactly the same way. When your controls are moving the red, green and blue dots around a three-dot marker your craft is doing the same thing in 4D space with each one. It's only the stage of producing an image in the real 3D world that makes moving the blue dot do different things to moving the red and green dots.

- The 4D rendering in the game is a pale approximation of what a real image would look like. To do things properly, the power of your graphics card would need to increase by roughly the width or height of the screen in pixels for every dimension added. That's around 1000 times just for 4D! Adanaxis does render more that just a 3D slice of the 4D world though. It squashes a 4D volume onto the screen, so that you can see a large chunk of the world and things don't get lost.

- The textures (i.e. the graphical look of the other craft) are generated mathematically. It's difficult to draw these textures by hand (and to make them more interesting) because each facet has to join seamlessly to its many neighbours in the 4D mesh.

- The hidden axis is the direction where the position of objects in that direction in 4D space makes no difference to the position of those objects on the screen. Its direction changes as you rotate your craft, so nothing is permanently hidden. In Adanaxis you can expose the hidden stuff using the rotations you get by moving the mouse whilst holding down the **E** key.

- The explosions and backdrop of planets, galaxies etc. aren't drawn in 4D at all. They have 4D positions but are drawn using single 2D textures. I haven't yet found a way to draw explosions and galaxies as 4D objects without needing some of the thousand-fold performance increase I mentioned.

- For most people (myself included) experiencing a 4D environment is, if you like, *one of the simplest things you can't do*. It's a limitation that you don't know you have until you realise that there's something beyond that limitation.

- In 4D there is no 'axis of rotation' like there is in 3D, where every point on the line of that axis stays where it is. In fact, you can spin a 4D object so that it never returns to its original position, no matter how long you leave it for.

Technical Details

Instead of the usual six degrees of freedom in 3D there are ten in 4D; four directions and six rotations. Three directions are mapped onto the screen just like 3Dm and these are chosen so that the x axis is left/right, the y axis is up/down, and the w axis is away from you into the screen. There's no direction left to use for the z axis, so the game represents z in three ways:

- Tinting the object red (negative z) or green (positive z) to show where it is in z.
- Using the three-dot markers to show where the object is in x, y and z.
- Fading objects as they move away from the view axis in z.

There's also another reason for the last one, as it makes the z axis more consistent with x and y. You can't see objects with large x or y values (compared to w, their distance away from you) because they go off the screen, and the fading does the same for z. The fading essentially gives you a *viewing angle* in the zw plane that is roughly the same as that in xw and yw.

In 3D there is one rotation that will leave you pointing in the same direction and aiming at the same thing; it's the *roll* rotation in xy. In 4D there are three rotations that work like this, in xy, xz and yz, and these can be seen by holding down the **Q** or **E** key whilst moving the mouse.

Aiming at moving targets can be tricky. In 3D you need to aim ahead of the target, aiming at where the target will be instead of where it is now. It's the same in 4D, but if the object is moving in z you need to aim at where the object will be in z as well. The movement of the blue dot can help there.

Intro to Mushware

Since 1997 Mushware Limited has existed so that I can work as a freelancer, writing embedded software for various electronics and telecommunications companies. It's a single-man company. I'm lucky right now in that I only need to work for other companies for three quarters of the year to pay the bills for the whole year. So, I get to work on my own projects for the rest of the time, and Adanaxis is the result of that work over the past five years (although 4D aspects first appeared in 2005). As you might imagine I'd like to reach that Nirvana-like state where the money coming in from Adanaxis lets me spend all of my time on working on it.

Finding More Info

For general 4D, the web site tetraspace.alkaline.org has some good stuff. If you want to get technical, there are some technical documents about this game at www.mushware.com in the download section, and details about how to create new levels and objects. For developers, the *Projection and Rendering* paper has details and diagrams about the 4D rendering method used in Adanaxis.

This Release

This is the first release of Adanaxis with full graphics and gameplay, but only a few levels. You can post bug reports in the Mushware Bug forum.

About Recovery Mode

Adanaxis can be started in Recovery or 'Safe' mode by holding down the shift key as the game starts up. This can be used to recover things when, for example, a display mode has been chosen that the monitor cannot display. Usually this will not be necessary, and normal mode should be used because it gives much better performance. In both safe and normal mode, Ctrl-Esc is the kill-switch and will exit the game at the next opportunity.

Version History

1. 2005-08-04: Release for Adanaxis Control Demo (version 0.0.1).
2. 2006-08-02: Release for Adanaxis Rendering Demo (version 0.1.1).
3. 2007-04-19: Release for Adanaxis Alpha (version 0.7.0).