# REDHAWK DUELS

## - Engineers in space…

### Background

In the year 2512 A.D. spaceflight is possible, but science fiction of past got it mostly wrong for the human race, particularly space battles. Sure there are space battles (mostly in the form of sporting events), but the reality is that in the depth of space you hear no explosions and see no enemy, mainly, because it’s space.

The good news, though, is engineers still play a fundamental role in building things in the universe as we know it. And for some strange reason, modern sport is a game of engineer(s) against engineer(s) in an effort to design and control the best ship. Celebrities are no longer the best at using an implement to hit an object through a poll. No, they’re the minds that create tactics such as the infamous double loop evasion and shot to win the duel in the match “RedhawkIV versus Queen’s Liberty” circa 2505 A.D.

### Premise

Version 0.0 of Redhawk Duel puts you in charge of designing, controlling, and maintaining your ship in a battle against an opposing duelist. Each ship is physically configured the same, and consists of two engines on the back, a cannon mounted on the front, a laser finder on top, a power cell, and control. The controlling engineers are responsible for designing the control for the ship.



The above figure shows the conceptual configuration and size of the ship. The fire engines are the blue squares and the arrows coming from these engines show the direction of generated thrust. The purple triangle represents the cannon, and the orange semi-circle represents the laser finder.

The controller is a combination of human control and electrical control. For example, to steer the ship, the human controller could turn on a single switch that would send 100% thrust to one of the engines resulting in the ship moving in an uncontrolled spin. Therefore, the controller needs to be built to allow the user to adjust and modify how they are moving, to display the information from the sensor, to fire the cannon, etc.

The following document describes each piece of the ship, the control functionality of the ship, and the dueling field.

### Ship

The ship as shown above has the dimensions 20 meters by 20 meters by 20 meters. This is enough room for all the equipment for the sensors and actuators and a maximum 3 person crew. The ship has a mass of 2,000,000 kilograms.

### Power Cell

Both the cannon and the engines are driven by the power cell. The power cell is a modern power source based on energy amplification through a crystal substance (similar to the concepts of a laser amplification). Each time energy passes through a crystal the power source is magnified. However, this affect is not a simple linear concept. Each crystal when initially installed goes through a process in which a crystal is refined (via a magnetic field) to allow for maximum amplification when matched (paired) with similar crystal. The process of adding fields to the crystals (much like silicon manufacturing) does not create uniformly matched crystals. For example, imagine that a power source is passed through crystal one and crystal two such that the original power source 10kW/m (kilo-watt minute) is amplified to 20kW/m (a +10kW rating). A different pairing might result in an amplification of only (18kW/m).



Therefore, if you had four crystals of various matching properties (with one another) and a power source (as shown above) depending on how you configured how the power source amplifies the signal through each of the crystals, you will get varying power amplifications at the end.



For the above diagram, if you configured the crystals with the path A to D to C to B you get 32kW/m (10+8+9+5) versus the path A to B to D to C where you get 33kWm (10+7+7+9). Crystals can only be routed through once, and all crystals in a power cell need to be routed through once.

What’s even worse is that the cannon mounted on each ship do not cause physical damage to the opposing ship, but instead, the cannon is specifically designed to degrade the amplification fields of the crystals.



The diagram above shows a theoretical impact of a cannon on our for crystal network. Now the path A to B to D to C only gets 29kW/m compared to 33kW/m in before being shot.



The power cell within a simple ship consists of 10 crystals as show above. Each crystal can connect to each other cell, but as described earlier, the power source comes into A and each crystal must be routed through only once and at least once or the resulting power generated is 0kW/m. The maximum power output of the 8 crystal power cell is 90kW/m. This means that every minute a perfect configuration of crystals will generate 90kW per minute as your power budget.

The per minute power budget generated by the crystal array is transferred to a reservoir that can be used over the next minute while the next minutes power budget is generated. As long as the ship only uses less than the reservoirs power budget everything is fine. After a minute, the remaining power in the reservoir is instantaneously lost, meaning it cannot be saved or added to the incoming power generated.

If, however, the power ship goes over the reservoirs allowed budget (asking a engine or laser to use more than what is still available) then the ship will stall for the next two minutes as the power cell reinitializes itself. During this time the power budget available is 0.

Also, note that basic life support, sensors, control circuitry, and the power cell itself requires a minimum of 10kW to run. Therefore, the power budget available to other devices must take this into account.

### Engine

Each engine on the ship, in terms of thrust output, accelerates the ship at .1m2/s in the opposite direction of its’ output thrust. The cost of this full power thrust in terms of power is 1kW/s. Therefore, in a minute you can spend 60kW towards thrust if you have a sufficient power budget.

In a non-gravitational environment, such as deep space (roughly 0 gravitational pull), note that acceleration will result in velocity that is maintained since there is nothing to slow down your ship except obstacles or other ships. The dueling field of play has special dampening fields installed. These will stop your ship instantly, and additional thrust pushing you in the direction of a dampening field will not result in any movement and just wasted energy.

### Sensor

The sensor is a simple device that sends out a laser pulse and responds to that pulse if it bounces off an object. The sensor, when it finds something will tell you what it is and how far it is. In terms of what it is it will tell you if it is another ship, an object, or a boundary. Since the field is enclosed it is guaranteed that there is always a response of what and distance from the sensor. The sensor result is updated once per second.

The sensor is mounted in the center of the ship and can be rotated 360 degrees in steps of a half degree (.5 degrees). The angle 0 and 360 both point towards the front of the ship defined by the direction the cannon is mounted.

The power cost of the sensor is (essentially) 0kW as it is included in the 10kW/m overhead for the entire ship.

### Cannon

The cannon, as described briefly in the power cell section, is used to degrade the opposing ships power cell. The cannon is mounted on the front of the ship and fires in a straight line at the speed of light, and therefore, a firing of the cannon is considered to be instant (once the command reaches the laser). The fire power of the cannon can be set to anything from 0 to 1000 in steps of 1, where each power level costs the equivalent in kW. Therefore, a single shot with a power of 23 will cost 23kW of the current power budget in the reservoir.

The impact of the weapons power on the opposing ship, in an instance of a hit, is the amount of power allocated to the shot \* 3. This value is then randomly subtracted from the amplification paths in the crystal.



The above diagram shows what could happen for a 4-crystal power cell that got hit by a shot of power 6.

### Dueling Field



The dueling field is a 2-dimensional map. On this map there are the ships, immovable objects, and a boundary. Any collision with objects, ships, or boundaries result in an instantaneous stopping of the ships involved due to dampening fields. Any acceleration that results in continued contact with the dampening field will result in no movement and wasted energy.

### Conditions of winning

A ship that cannot generate 10kW/min over a 2 minute period will self-destruct. Also, each ship has the choice to self destruct.

* Basic game:
  + Winner: The remaining ship when the other ship self destructs.
  + Draw: Neither ship fires or moves over 5 minutes.

### Controller Technical Details:

The previous section described the mechanics behind the various pieces of the machine. In this section we describe how to control the various units of the ship.