

# Propeller

A propeller rotates around a spinning driveshaft which acts a torque onto the propeller. In the Aerofly FS 2 there are two kinds of propellers: the `propeller` class implements a propeller behavior in a rotating reference frame, attached to a rotating `PropellerBody` ([rigidbody](#)) whilst an `aeropropeller` uses a stationary `Body` and rotates itself. In all default Aerofly FS 2 aircraft only the `propeller` class is used.

## Other Aerodynamic classes

[airfoil](#), [aerowing](#), [aerofuselage](#), [airbrake](#), [aerodrag](#)

## Body and EngineRotationSpeed

A `propeller` object will use the velocity of its `Body` ([rigidbody](#)) and the `EngineRotationSpeed` from the `driveshaft` and calculate a thrust value from that and a torque value to create that amount of thrust. It then adds that force and torque onto the `Body` which will accelerate/decelerate the body and speed it up or slow it down over time.

## Airfoil

The same [airfoil](#) class is used for the [aerowing](#) and the propeller class. Using the properties of the `AirfoilPropeller` it is possible to fine-adjust the torque and thrust produced by the propeller. A typical propeller airfoil is designed for a lift coefficient of about 0.5.

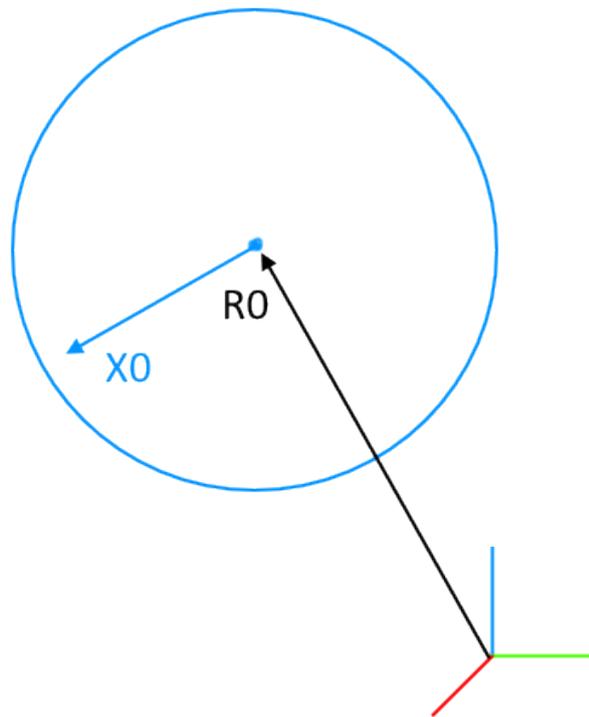
## Geometry

### R0, X0, Y0, Z0

The position of the propeller hub is defined by the  $R_0$  position vector.

- $X_0$  is the local forward,
- $Y_0$  is the local left,
- $Z_0$  is the local upwards direction.

In the example of the Extra 330 LX below the propeller is slightly angled to the right (side thrust).



## Radius

The Radius of the propeller class is the physical radius of the actuator disk in meters. When converting from inches to meters simply multiply the radius in inches by 0.0254 m/inch. The radius of the propeller is of course half the diameter, which is usually given in the specifications.

$$\text{Radius} = 0.5 * \text{Diameter}$$

## Pitch

The pitch of a propeller is roughly the blade angle at 75% of the radius. The pitch is the distance in meters that the propeller corkscrews through the air in one full rotation (geometrically). If a propeller pitch is given in inches multiply that figure by 0.0254 m/inch to convert it to the meter length unit used here. With a given blade angle (alpha) and a radius  $r$  the blade pitch is calculated to:

$$\text{Pitch} = 2 * \pi * r * \tan(\alpha)$$

## PitchControl

The name is self-descriptive here. A input can be given to change the pitch of a propeller. That way a constant speed propeller can be controlled by a [governor](#), reversed into beta or reverse thrust or

feathered.

## CutOut

This is the fraction of the radius (or maybe the fraction of the area) that is not part of the propeller because of the propeller hub and spinner. The model used in the Aerofly FS 2 accounts for that bladeless portion by the CutOut scalar.

## Aerodynamic Parameters

### AspectRatio

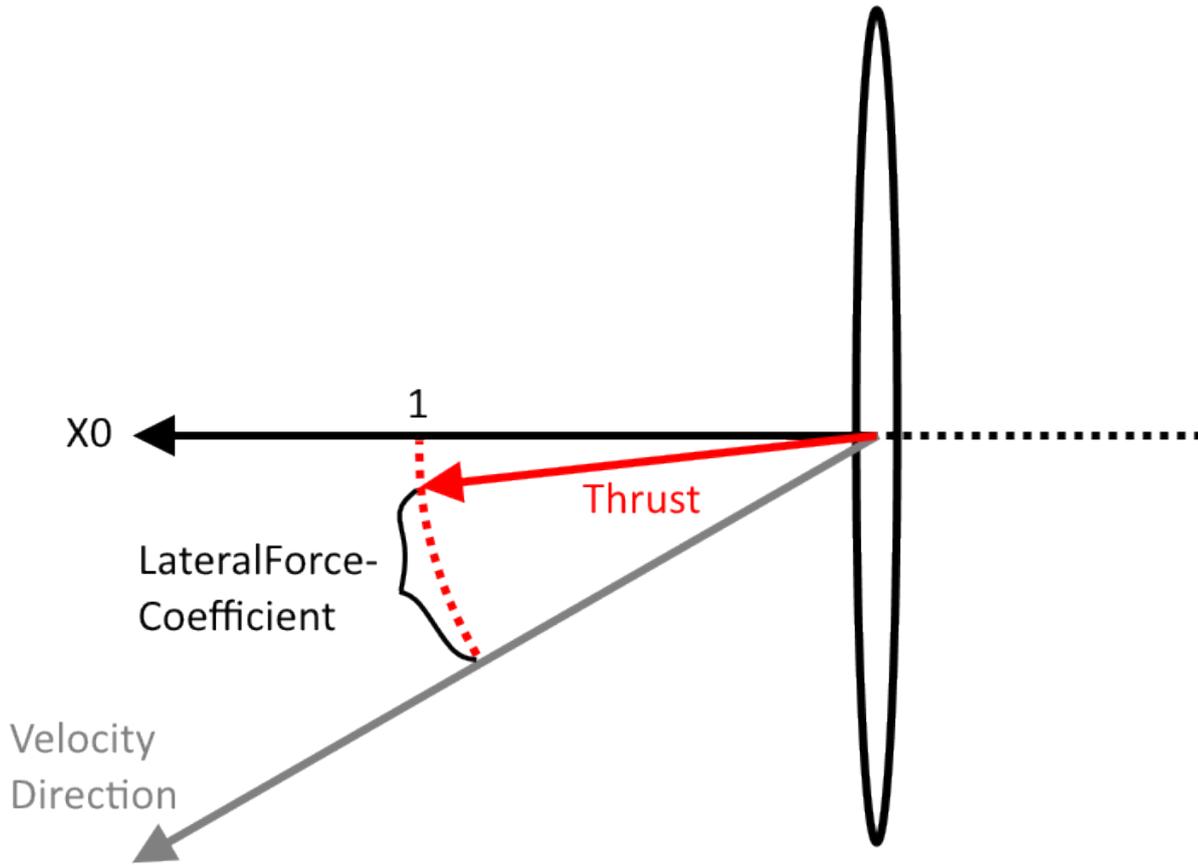
The AspectRatio of a propeller is a factor that can be used to influence the rotationspeed - velocity relationship. Physically it describes the ratio of the blade radius and the mean chord length of a blade.

### LateralForceCoefficient

The LateralForceCoefficient determines how much the thrust is pointing in the forward direction  $X_0$  of the propeller (most likely the general forward direction in an aircraft). A LateralForceCoefficient of 1.0 makes it so that the thrust of the propeller always points in the direction of  $X_0$ . On the opposite side a LateralForceCoefficient of 0.0 would permit a side thrust of the propeller and its thrust is always pointing in the direction of flight.

The lower the value the more rudder is required in a static knife edge flight at full power.

A value between 1.0 and 0.85 could be considered realistic.

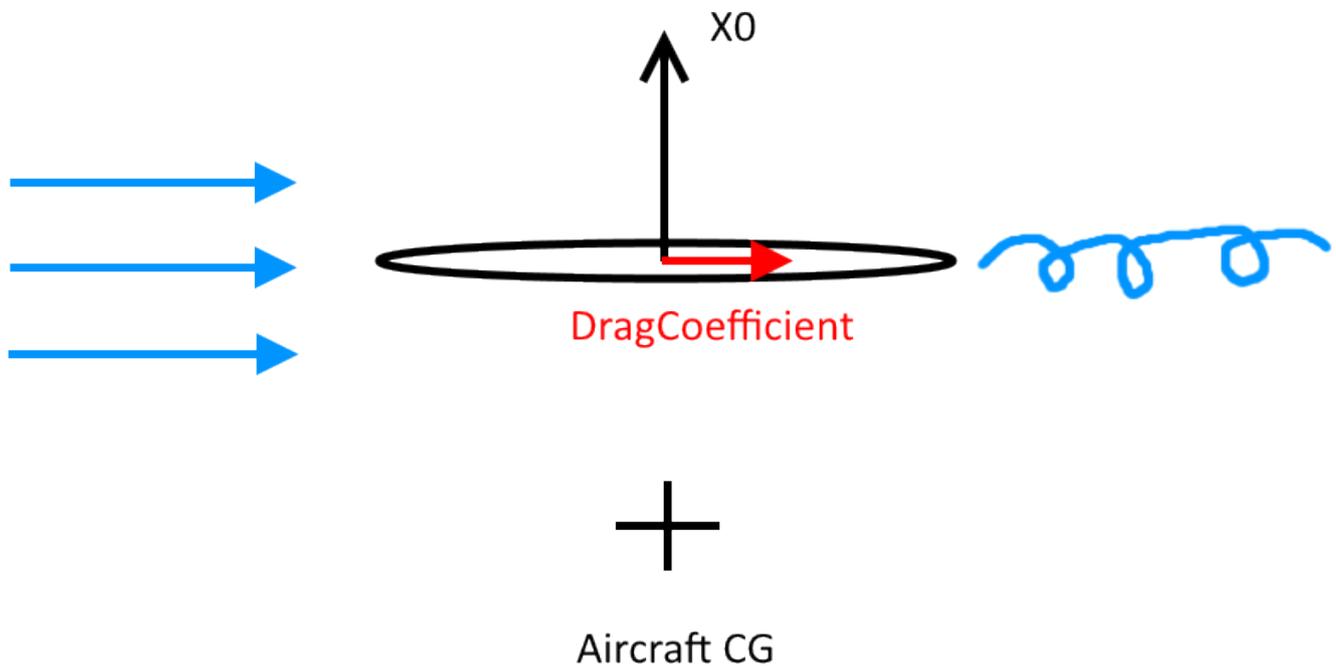


### LateralDragCoefficient

The LateralDragCoefficient can be seen as a drag coefficient that is only applied to the lateral component of the velocity, not in the direction the propeller is pointing at. In a very high angle of attack or in a very high attitude knife edge flight a higher value creates a lot of torque around the aircrafts center of gravity and the aircraft “drags” to the side violently.

A higher value makes it much easier to enter a static torque roll. If the value becomes unrealistically high the torque roll is so stable that it cannot be stopped. Also high values tend to throw the aircraft around so that it flies backwards for a short time, not a very realistic looking behavior.

Stay below 0.1 to prevent high instabilities.



## Example Code

### C172 - Fixed Propeller

**Caution:** Requires a [rigidbody](#) called PropellerBody as well as an [airfoil](#) object with the name AirfoilPropeller and inside the dynamics section of the [tmd](#).

```
<[propeller][Propeller][
  <[string8][Body][PropellerBody]>
  <[string8][Airfoil][AirfoilPropeller]>
  <[string8][EngineRotationSpeed][DriveShaft.RotationSpeed]>
  <[string8][DamageOnCrash] [Engine.Damage]>
  <[tmvector3d][R0][2.872302 0.0 0.000406]>
  <[tmvector3d][X0][1.0 0.0 0.0]>
  <[tmvector3d][Y0][0.0 1.0 0.0]>
  <[tmvector3d][Z0][0.0 0.0 1.0]>
  <[uint32][NumberBlades][2]>
  <[float64][Radius] [0.965]>
  <[float64][Pitch] [1.52]>
  <[string8][PitchControl][0.323]>
  <[float64][CutOut] [0.2]>
  <[float64][AspectRatio] [7.0]>
  <[float64][LateralForceCoefficient][1.0]>
```

```

    <[float64][LateralDragCoefficient] [0.0]>
    <[float64][TorqueReduction][0.95]>
  >

```

## Extra 330 LX - Constant Speed Propeller

**Caution:** Requires a [rigidbody](#) called PropellerBody as well as an [airfoil](#) object with the name AirfoilPropeller and inside the dynamics section of the [tmd](#).

```

  <[propeller][Propeller][
    <[string8][Body][PropellerBody]>
    <[string8][Airfoil][AirfoilPropeller]>
  <[string8][EngineRotationSpeed][DriveShaft.GetRotationSpeed]>
    <[string8][DamageOnCrash] [Engine.Damage]>
    <[tmvector3d][R0][1.9004 -0.0037 0.0064]>
    <[tmvector3d][X0][0.990279 -0.069798 0.000000]>
    <[tmvector3d][Y0][0.069798 0.990279 -0.000000]>
    <[tmvector3d][Z0][0.000000 0.000000 1.000000]>
    <[uint32][NumberBlades][3]>
    <[float64][Radius] [0.99]>
    <[float64][Pitch] [1.8]>
    <[string8][PitchControl][Governor.Output]>
    <[float64][AspectRatio] [9.0]>
    <[float64][CutOut] [0.2]>
    <[float64][LateralDragCoefficient] [0.005]>
    <[float64][LateralForceCoefficient][1.0]>
    <[float64][TorqueReduction][0.0]>
  >

```

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