

# PROPELLER SYSTEM

**1<sup>st</sup> - Look at how lift is generated**

**Then see how it applies to propellers**

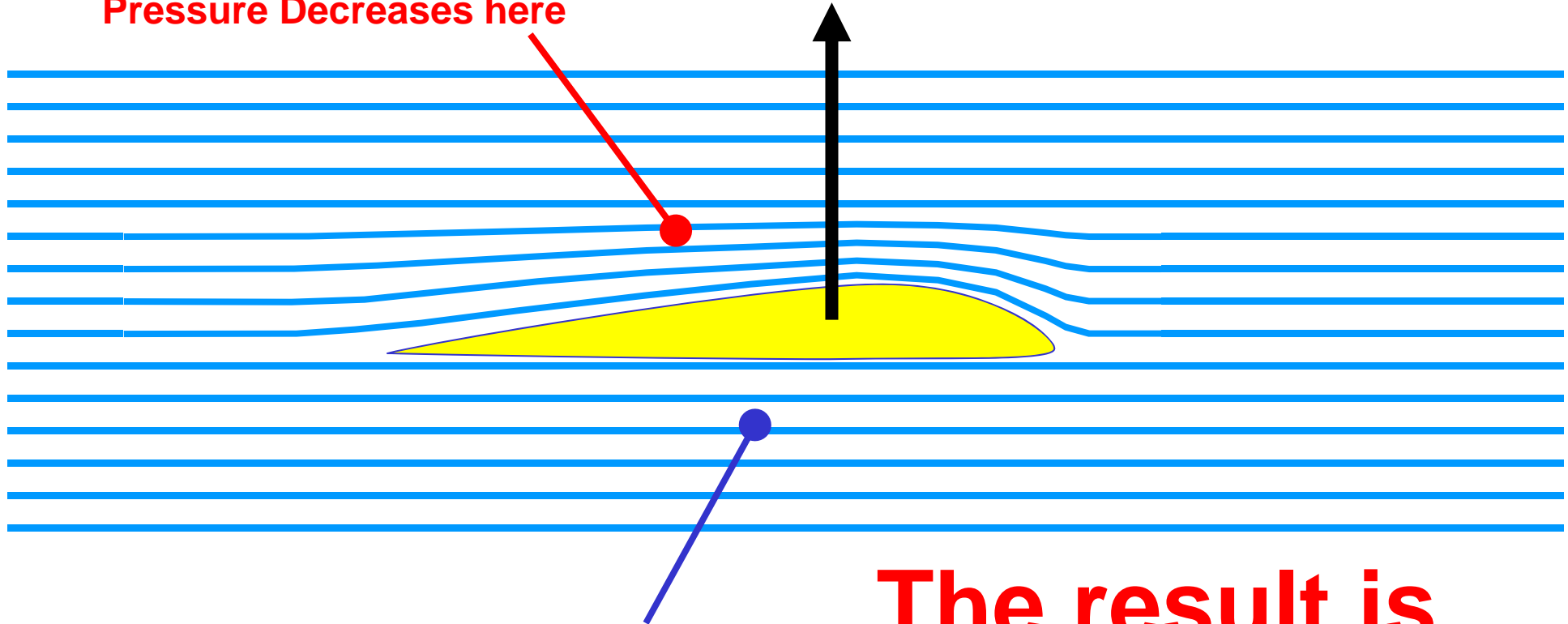


**How lift is generated**  
**PROPELLER SYSTEM**

In this example

Pressure Decreases here

In this direction



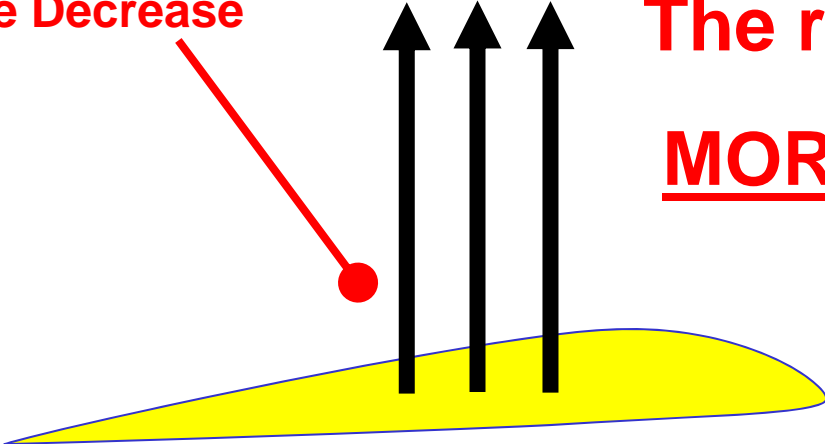
Pressure Remains Constant here

The result is  
LIFT

How lift is generated  
**PROPELLER SYSTEM**

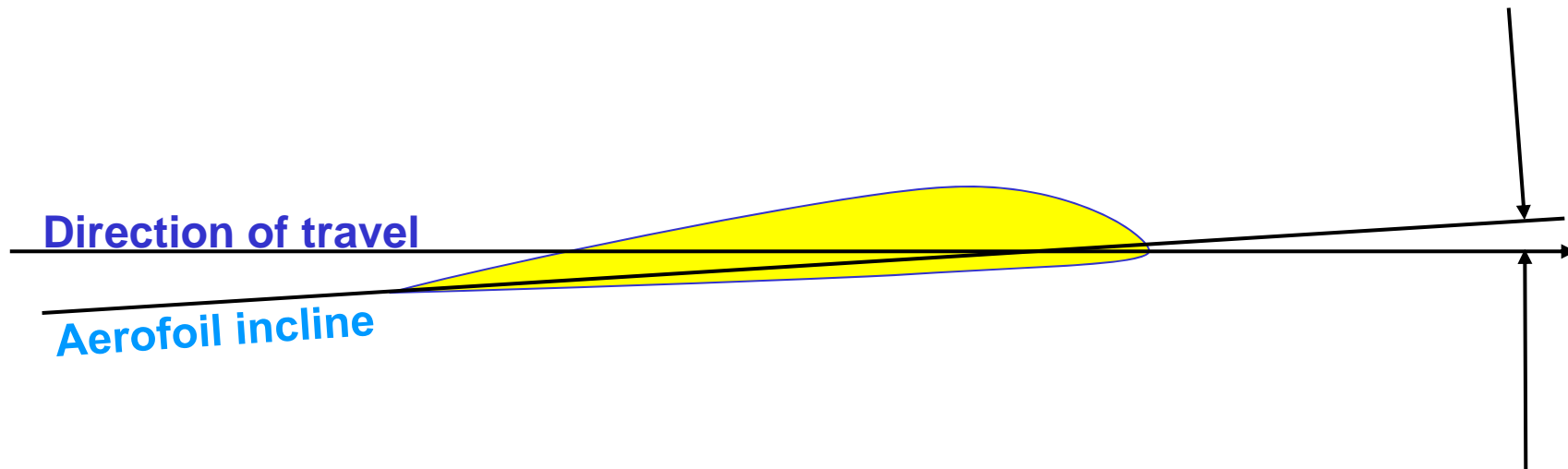
Greater Pressure Decrease here

The result is MORE LIFT



Small Pressure Increase here

How lift is increased  
**PROPELLER SYSTEM**



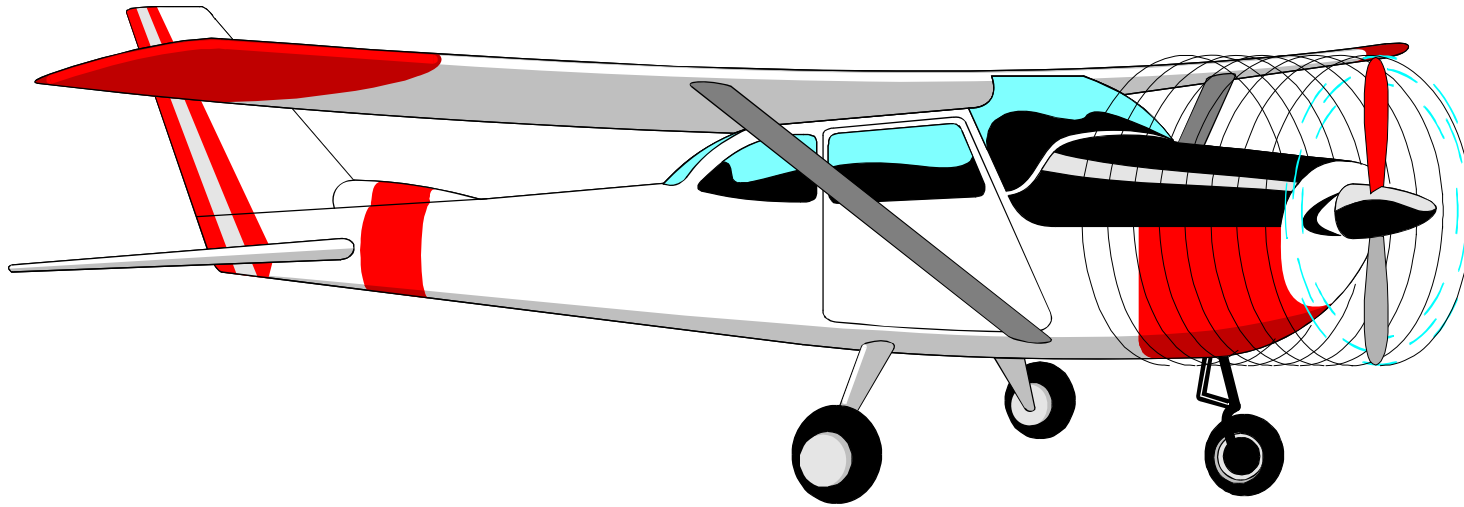
The difference in **direction of travel** and **aerofoil incline** is called:-

# The **ANGLE** of **ATTACK**

How lift is increased

**PROPELLER SYSTEM**

# How does lift apply to **PROPELLORS**?



On Propellers, LIFT is called **THRUST**

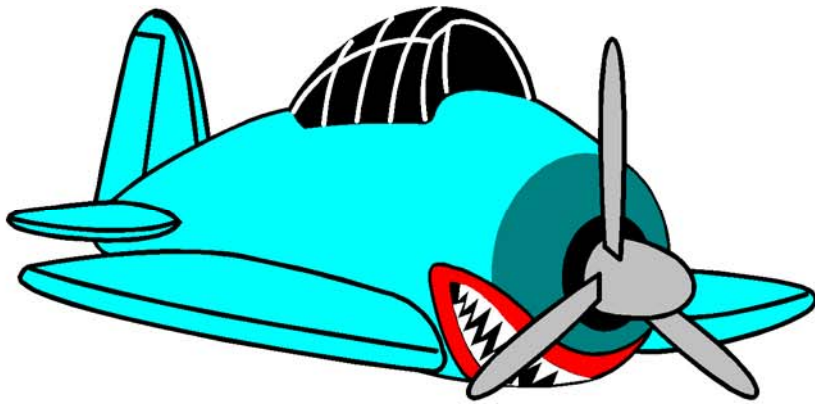
And propeller Blades work the same way as aircraft wings

When a propeller spins and the aircraft moves forward, the tips of the propeller blades move in a 'corkscrew' path

This path is called a **HELIX**

**PROPELLER SYSTEM**

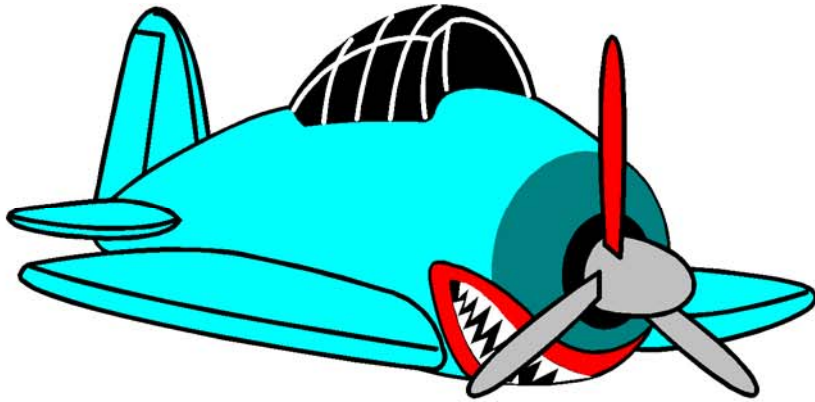
How the **HELIX ANGLE** is generated



How the blade tip travel produces the **HELIX ANGLE**

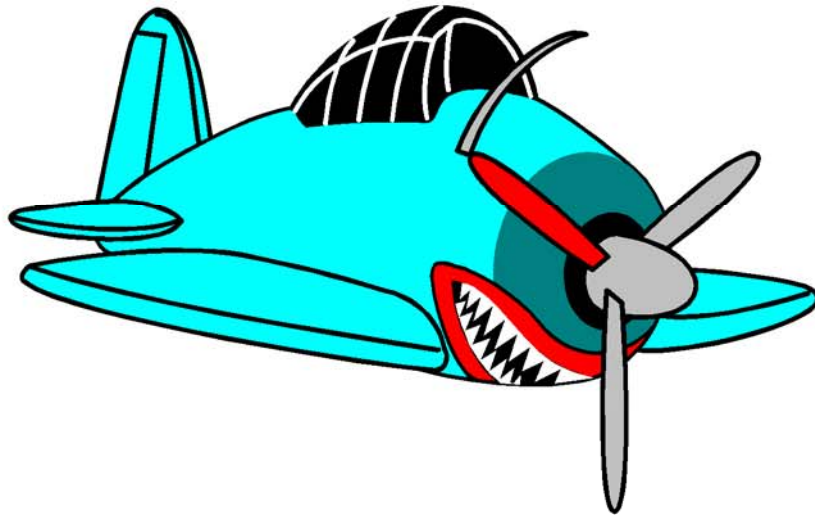
**PROPELLER SYSTEM**





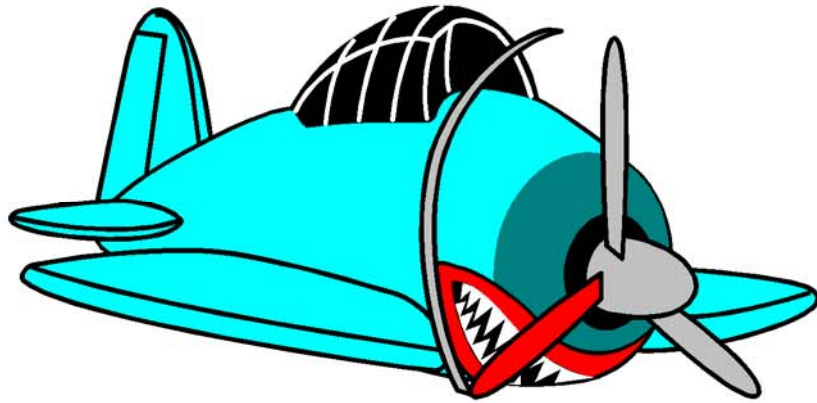
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**PROPELLER SYSTEM**



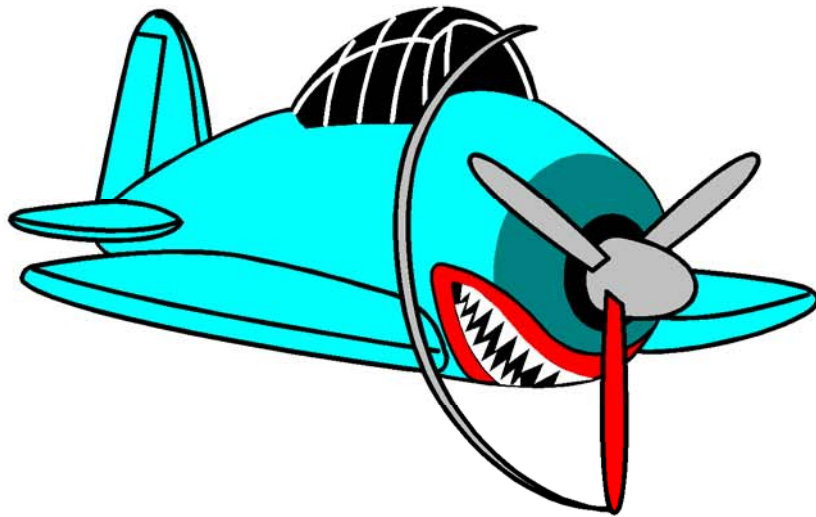
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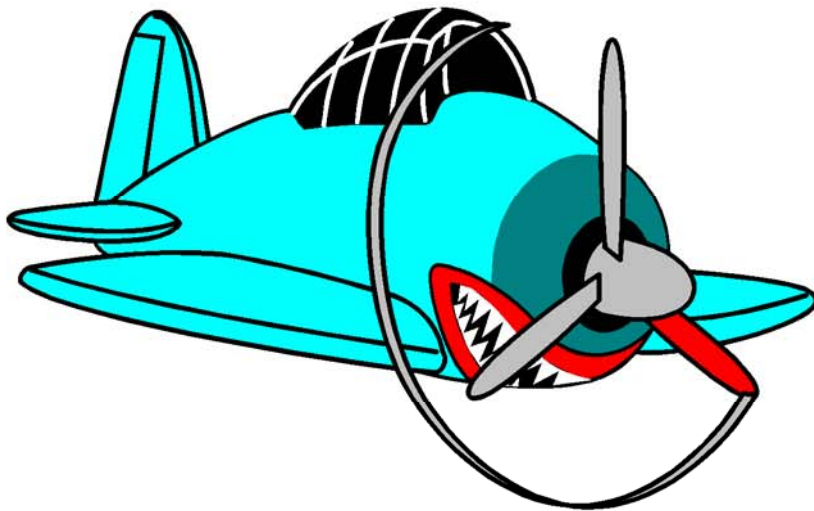
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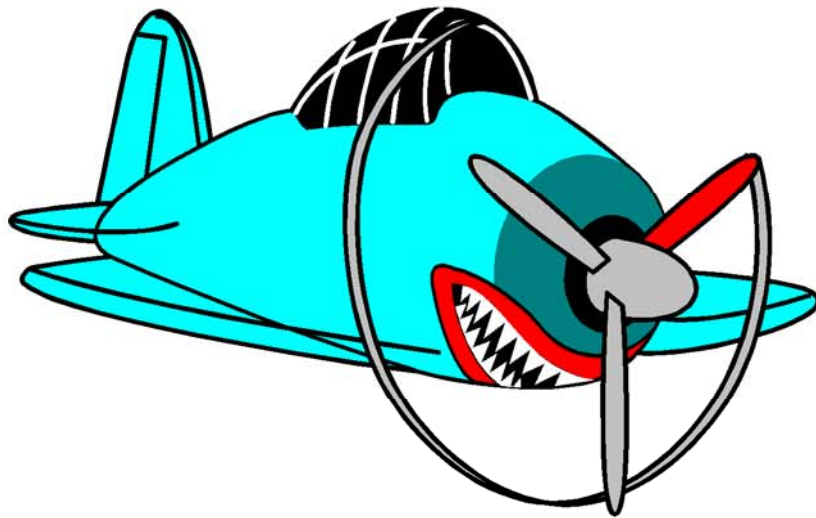
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**PROPELLER SYSTEM**



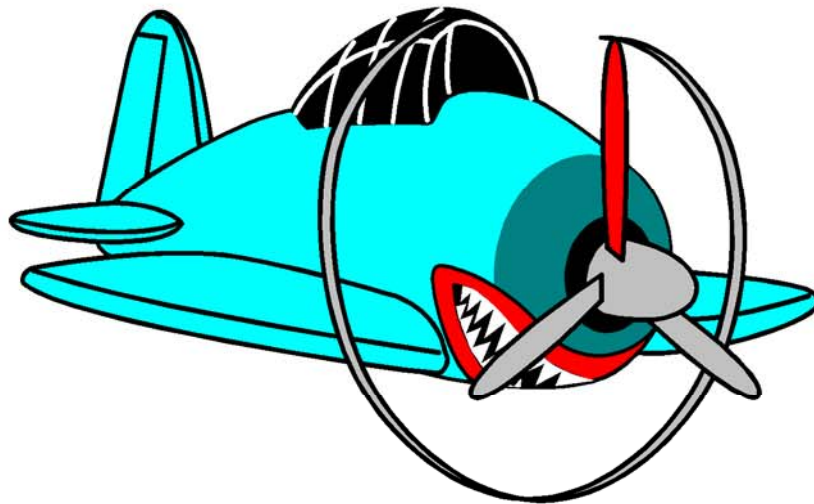
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**PROPELLER SYSTEM**

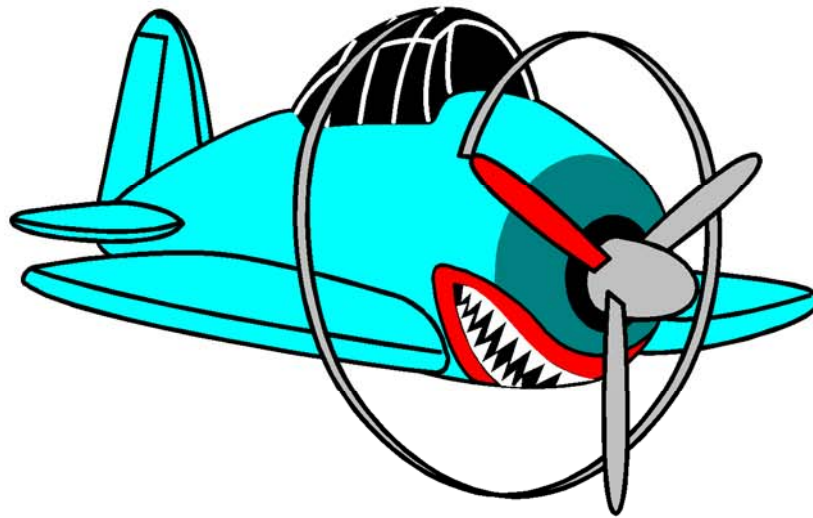


How the blade tip travel produces the **HELIX ANGLE**

**PROPELLER SYSTEM**



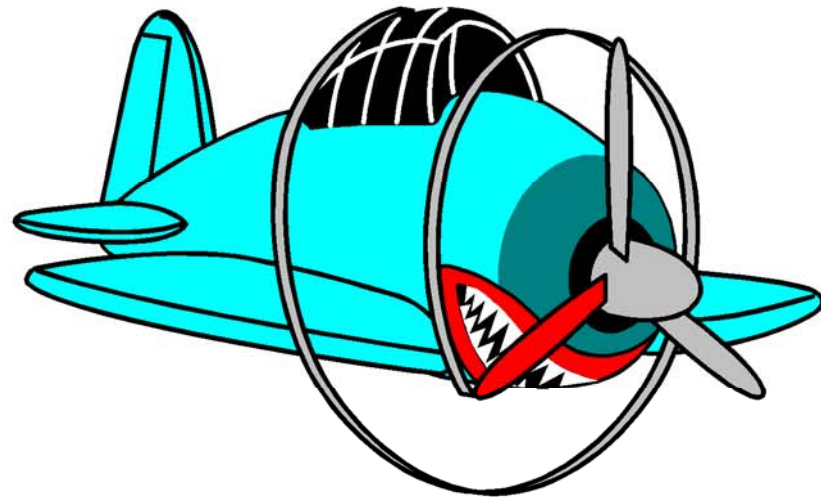
How the blade tip travel produces the **HELIX ANGLE**  
**PROPELLER SYSTEM**



How the blade tip travel produces the **HELIX ANGLE**

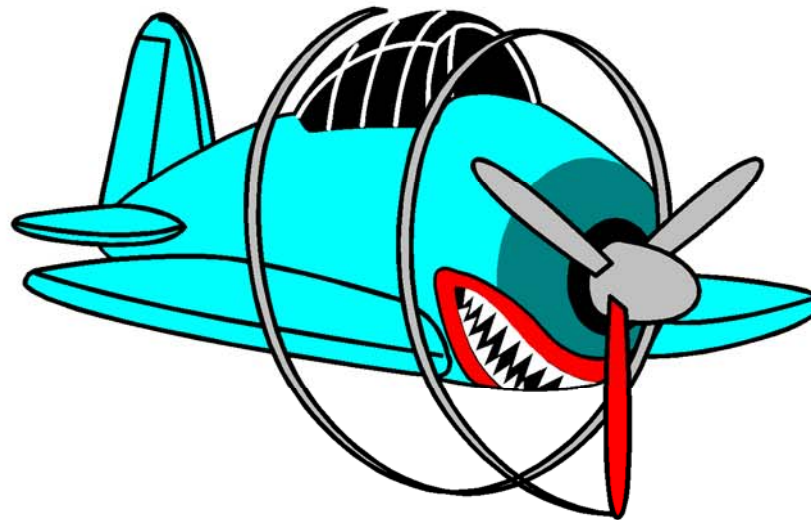
**PROPELLER SYSTEM**



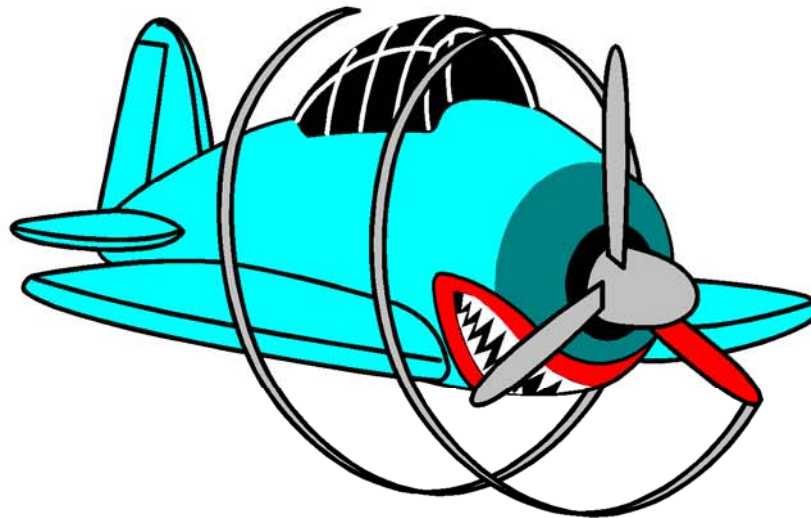


How the blade tip travel produces the **HELIX ANGLE**

**PROPELLER SYSTEM**

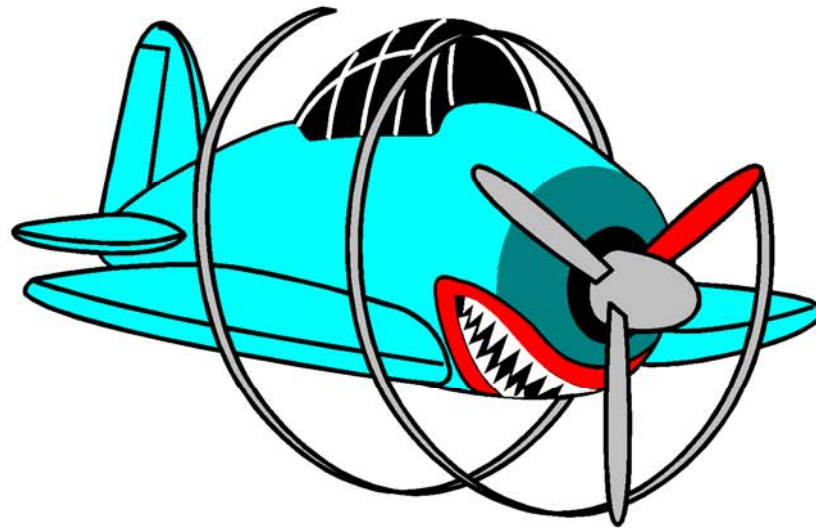


How the blade tip travel produces the **HELIX ANGLE**  
**PROPELLER SYSTEM**



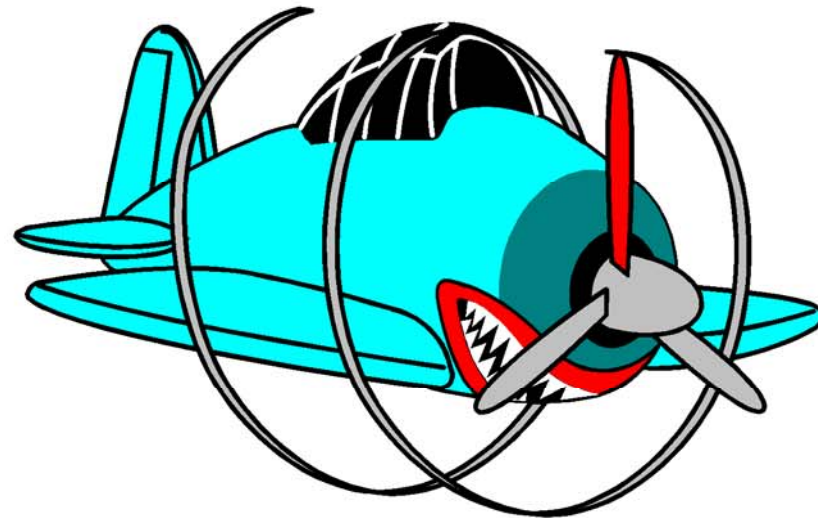
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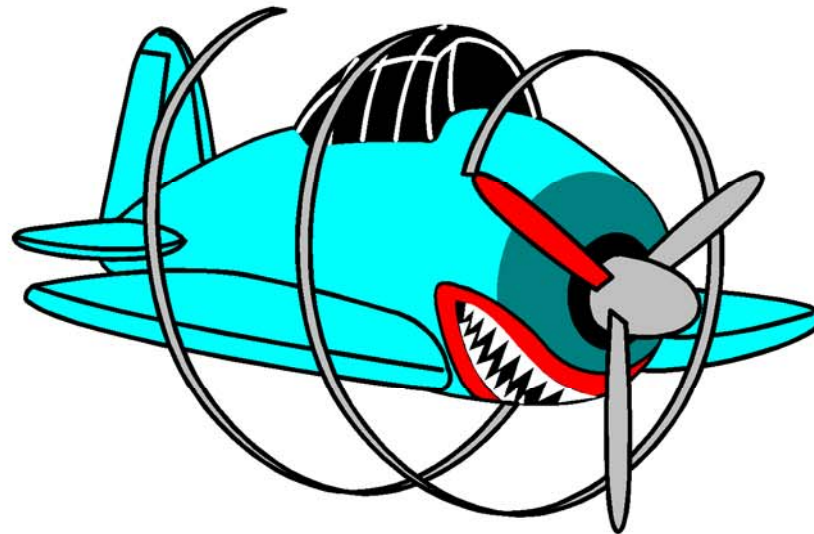
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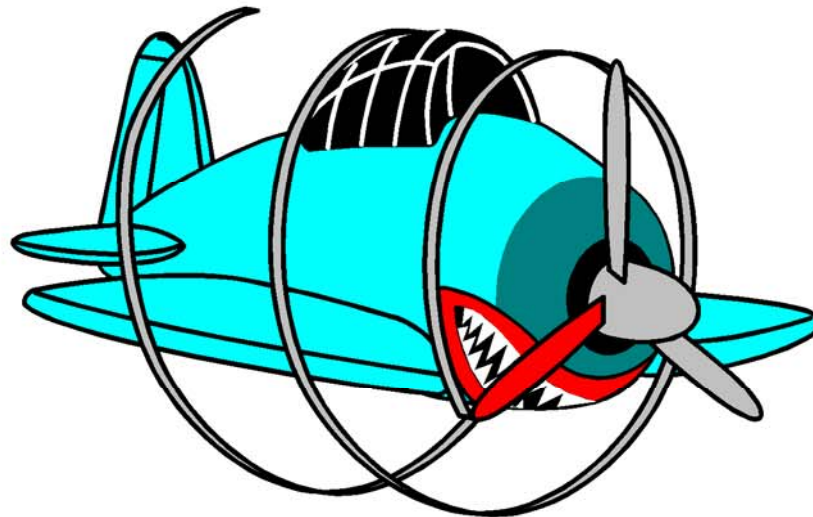


How the blade tip travel produces the **HELIX ANGLE**

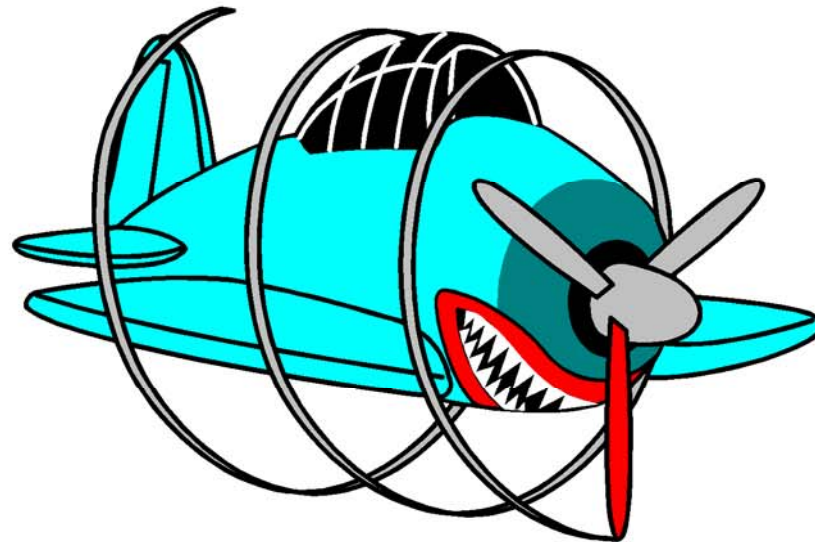
**PROPELLER SYSTEM**



How the blade tip travel produces the **HELIX ANGLE**  
**PROPELLER SYSTEM**

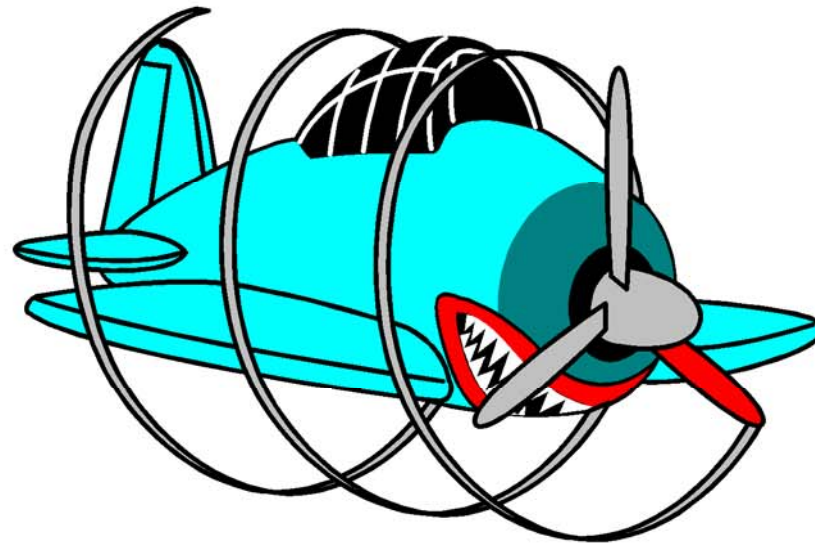


How the blade tip travel produces the **HELIX ANGLE**  
**PROPELLER SYSTEM**



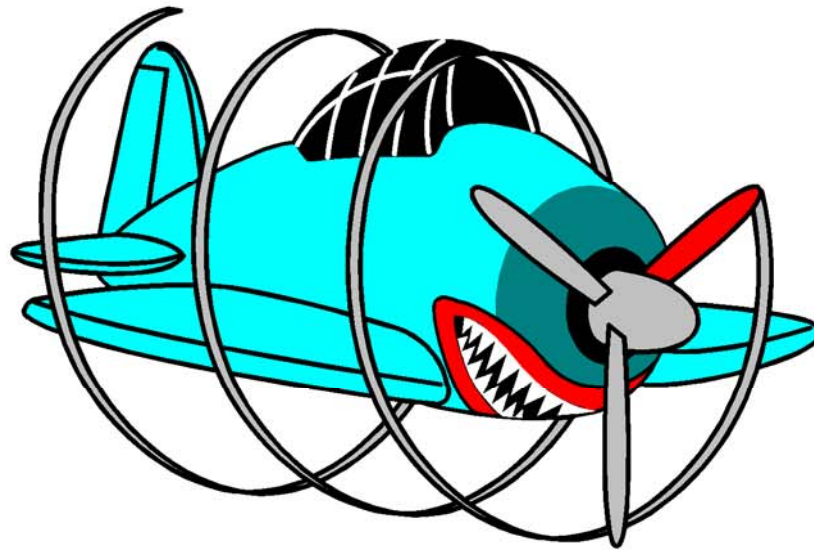
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**PROPELLER SYSTEM**





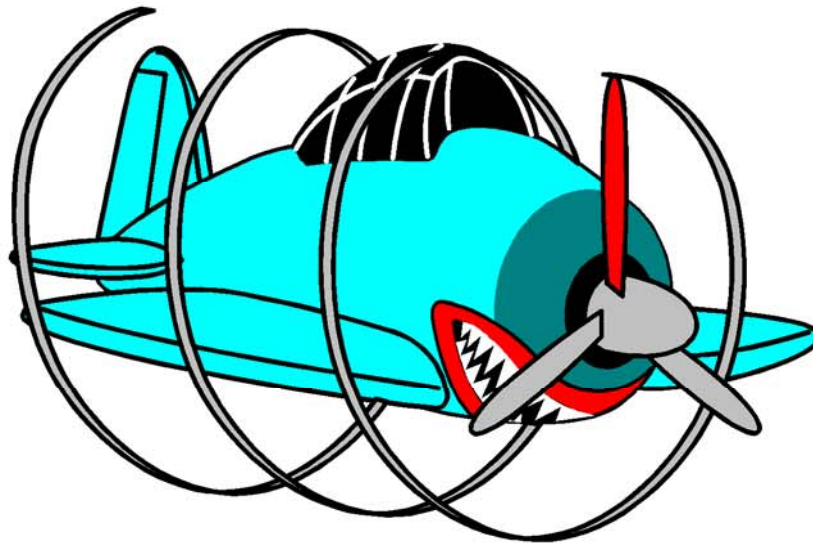
How the blade tip travel produces the **HELIX ANGLE**

**PROPELLER SYSTEM**



How the blade tip travel produces the **HELIX ANGLE**

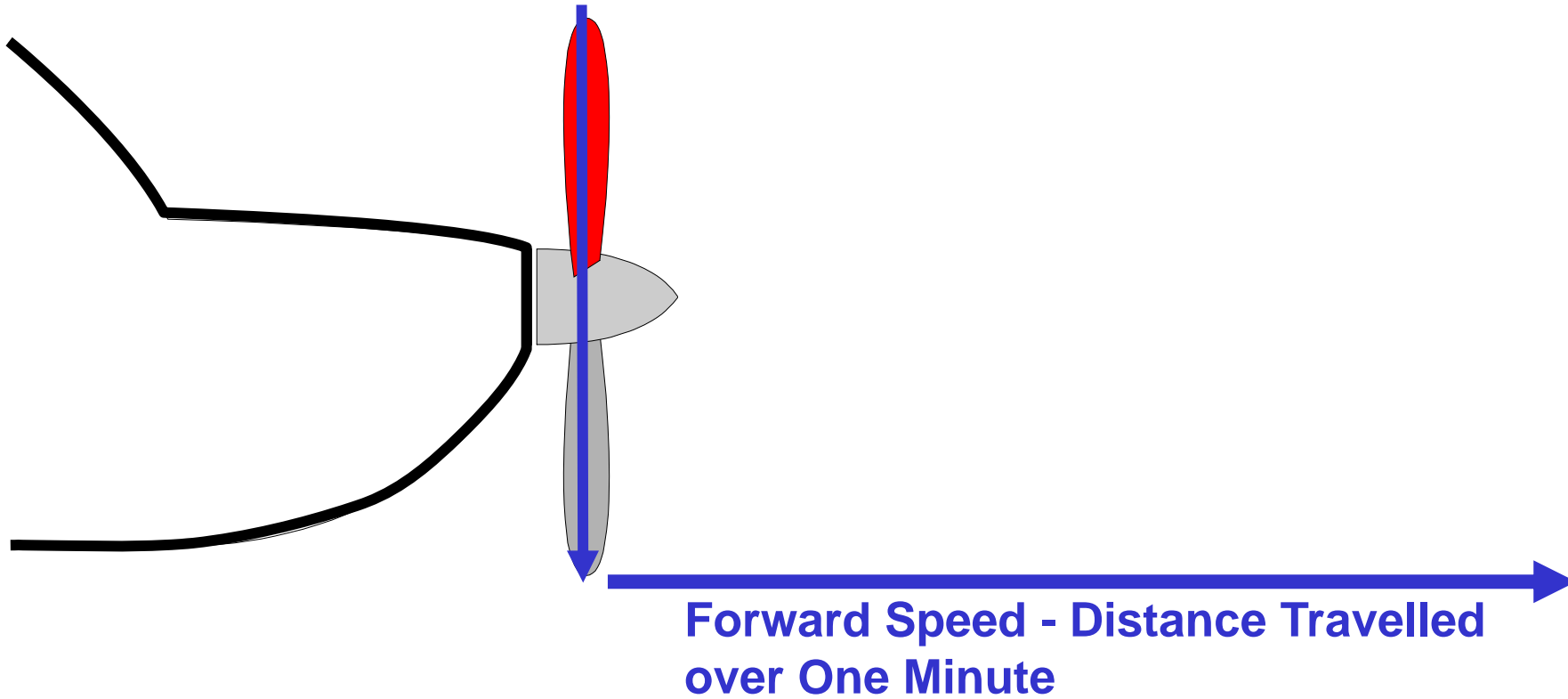
**PROPELLER SYSTEM**



How the blade tip travel produces the **HELIX ANGLE**

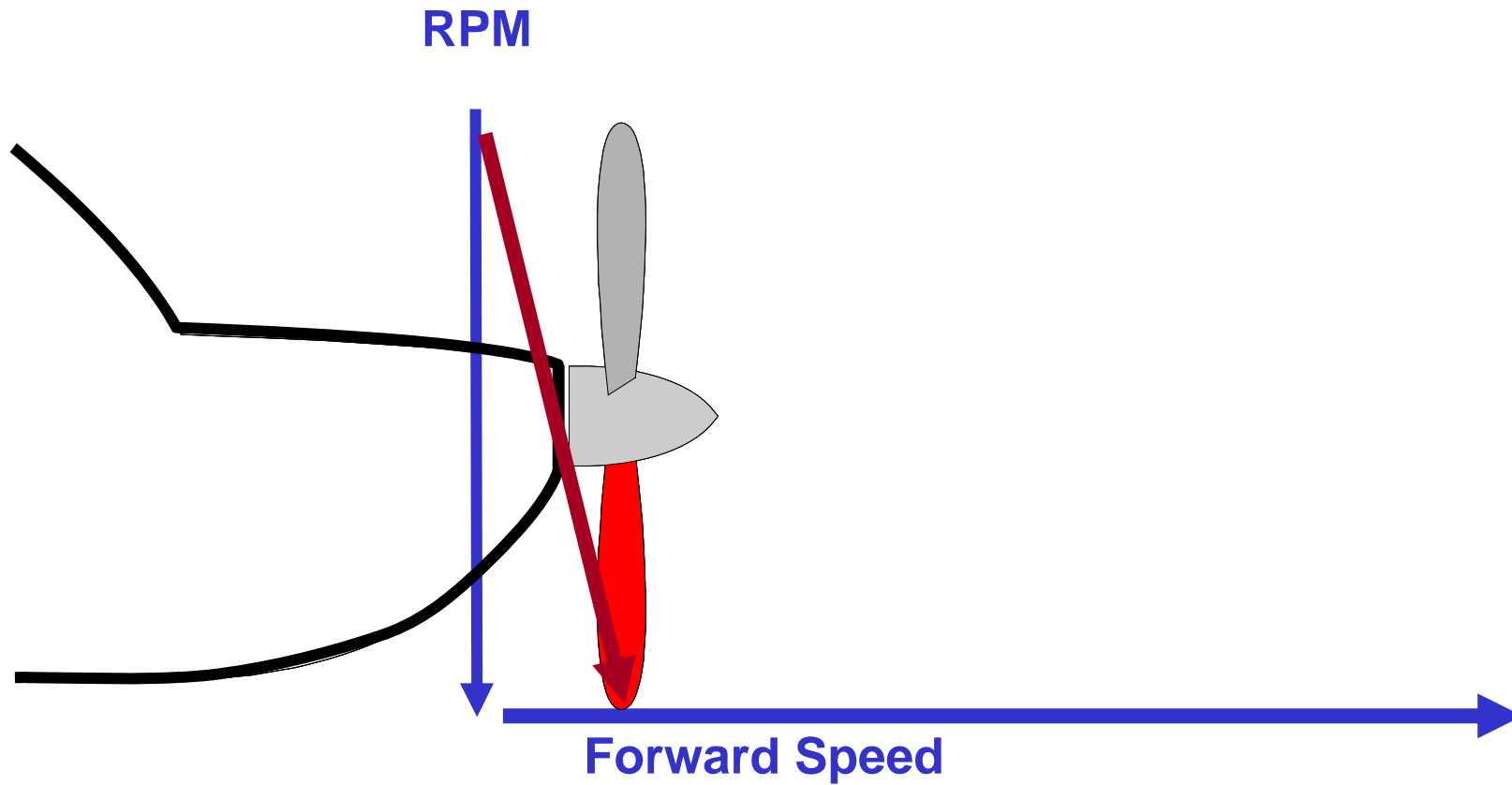
**PROPELLER SYSTEM**

Rotation -  
Number of  
Rotations  
per Minute

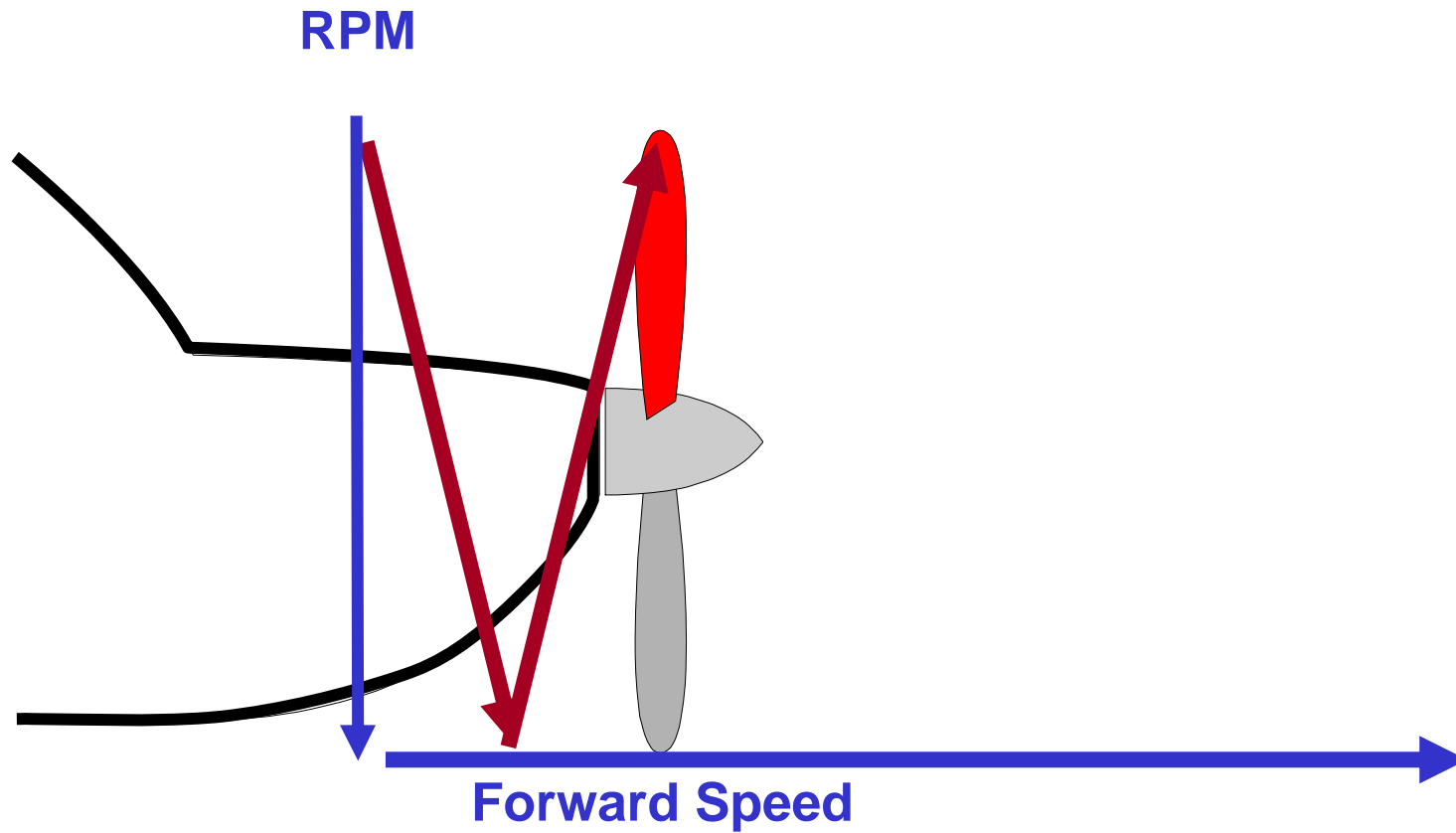


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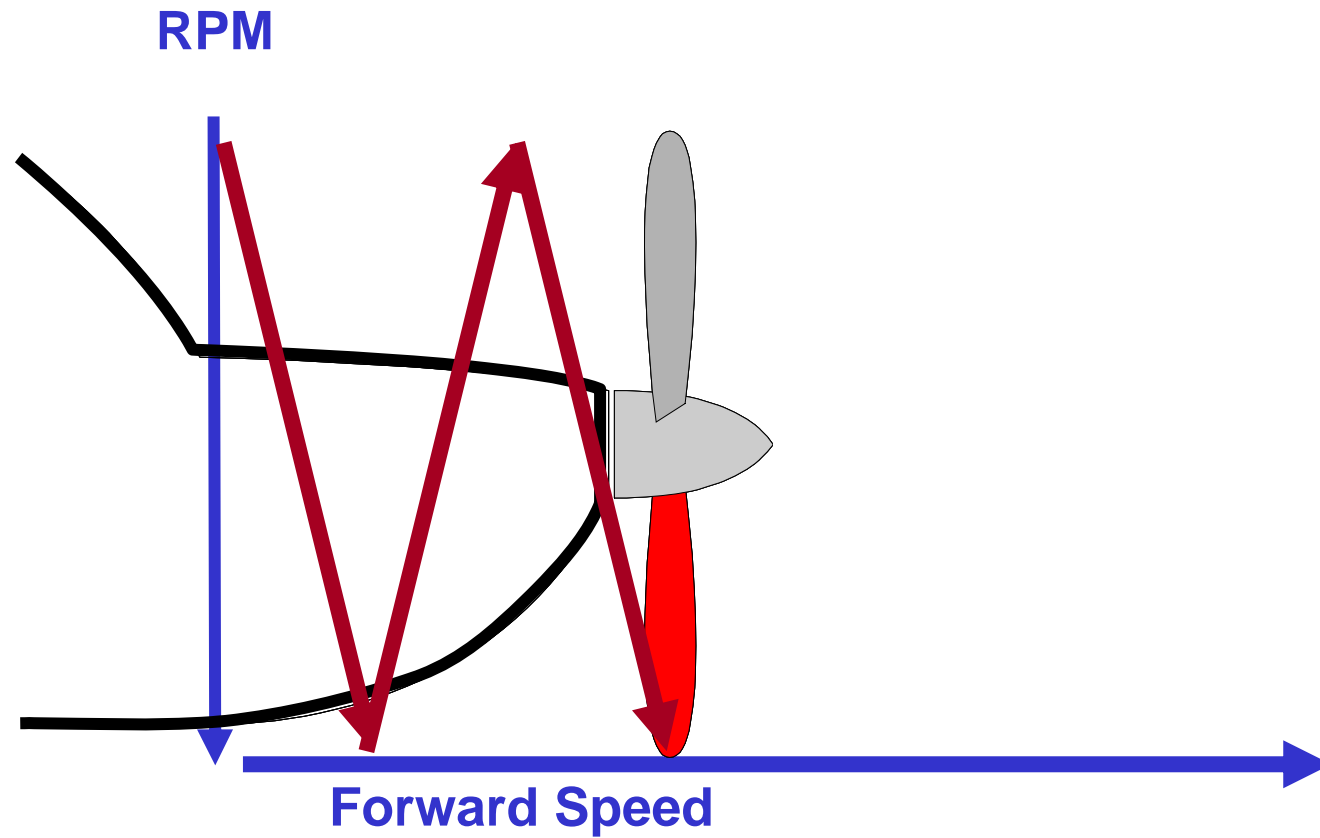
**PROPELLER SYSTEM**



How the blade tip travel produces the **HELIX ANGLE**  
**PROPELLER SYSTEM**

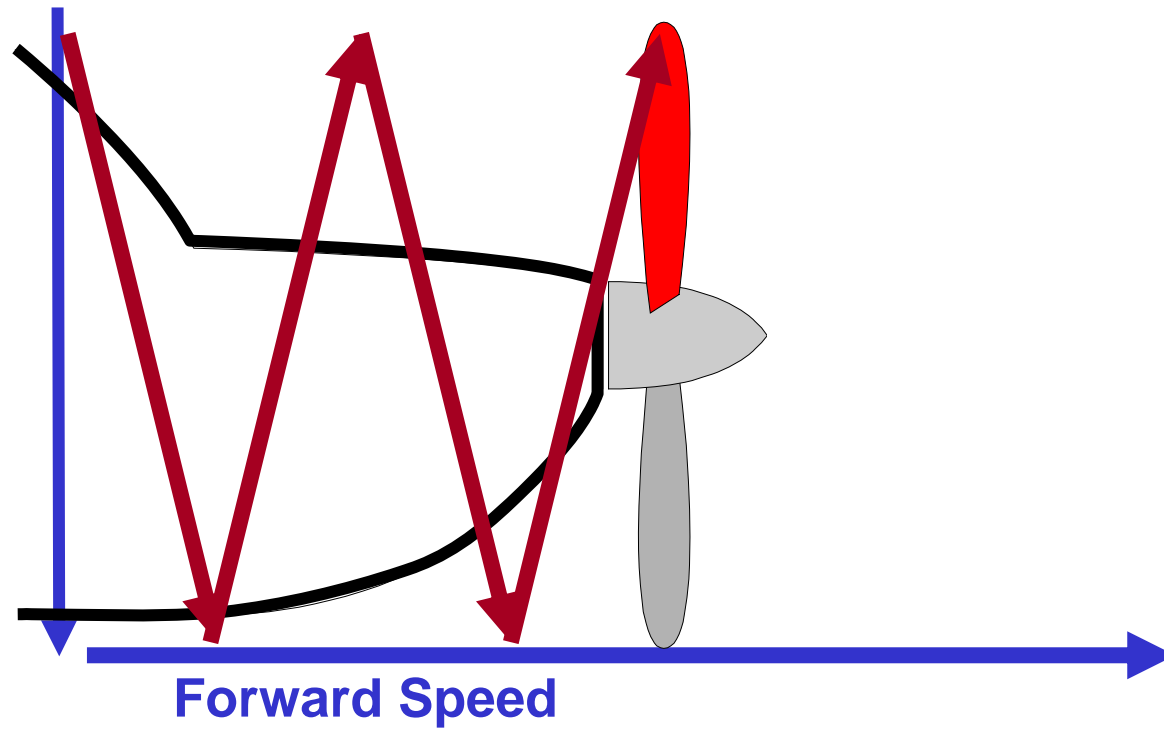


How the blade tip travel produces the **HELIX ANGLE**  
**PROPELLER SYSTEM**



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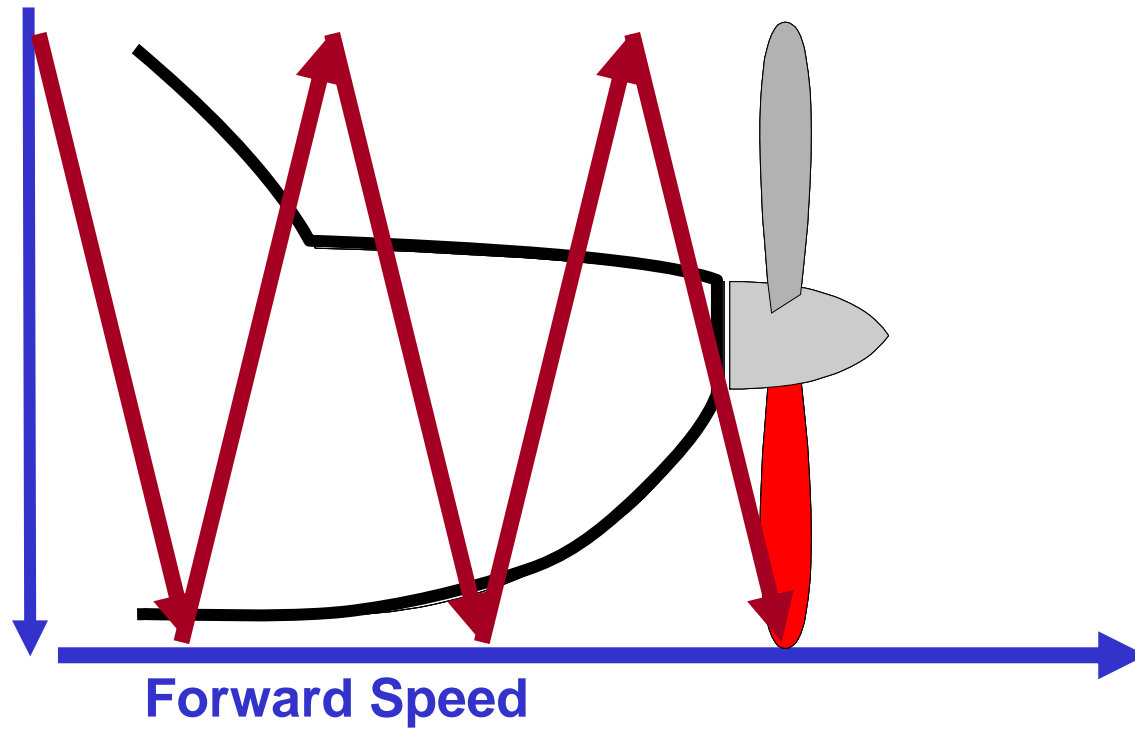
RPM



How the blade tip travel produces the **HELIX ANGLE**  
**PROPELLER SYSTEM**

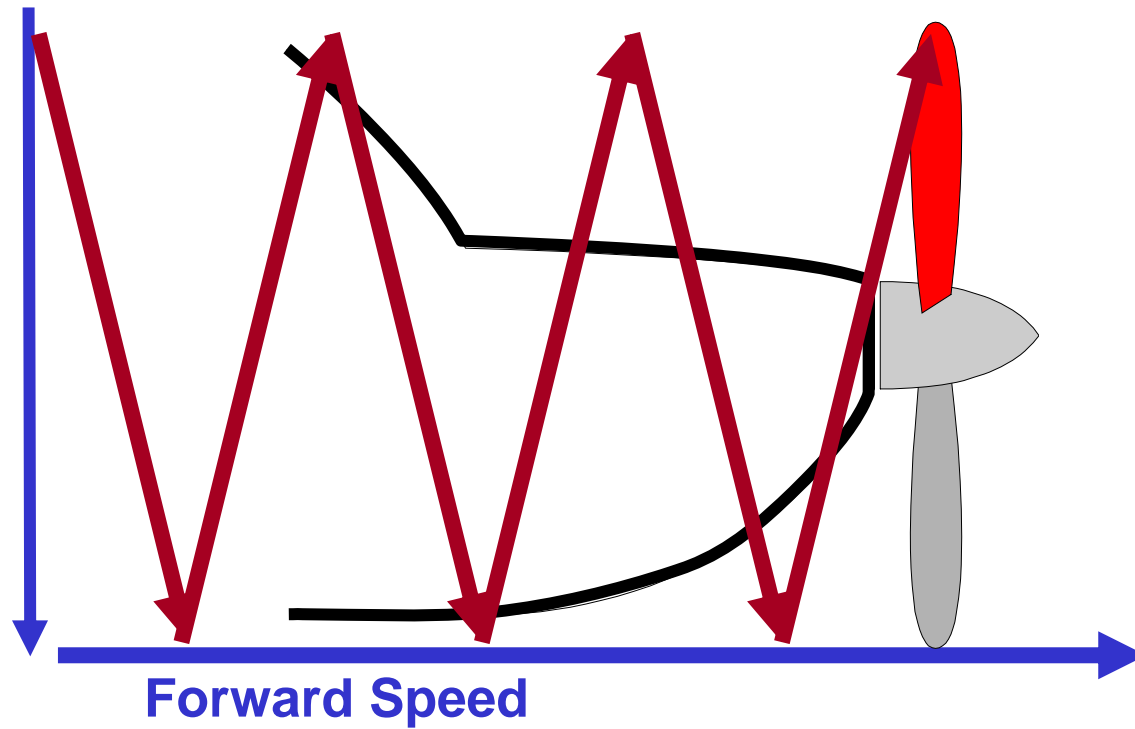


RPM



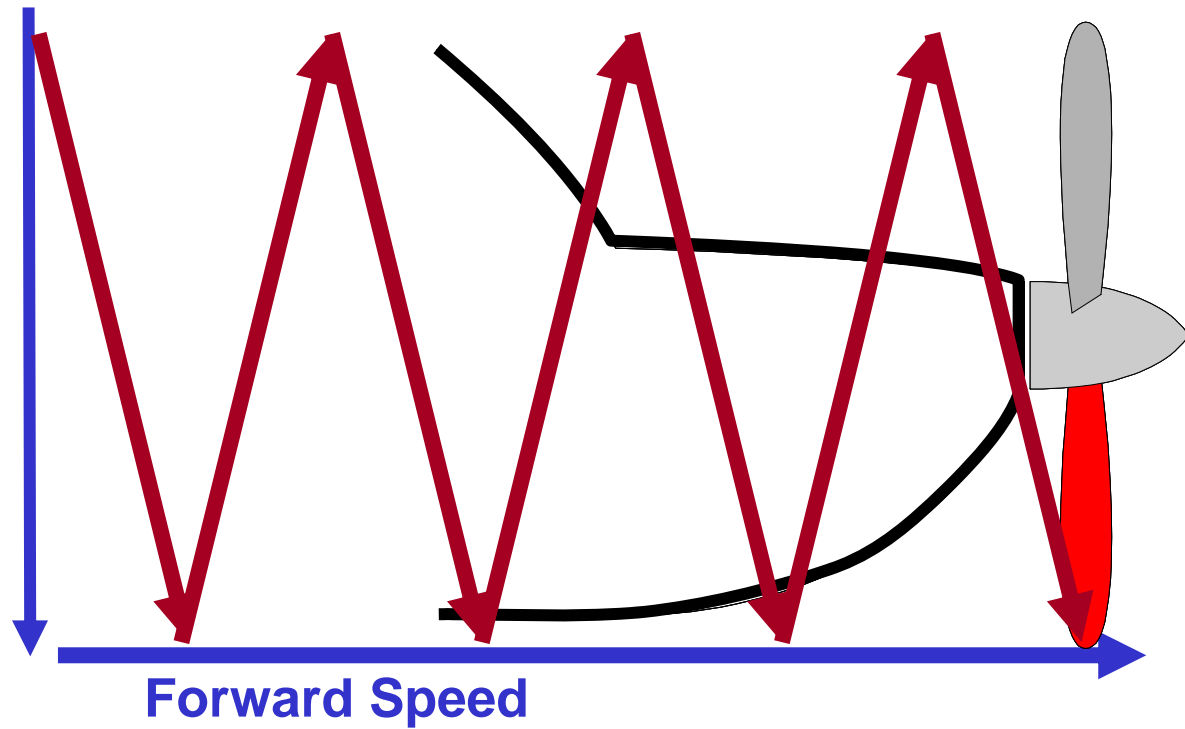
How the blade tip travel produces the **HELIX ANGLE**  
**PROPELLER SYSTEM**

RPM



How the blade tip travel produces the **HELIX ANGLE**  
**PROPELLER SYSTEM**

RPM

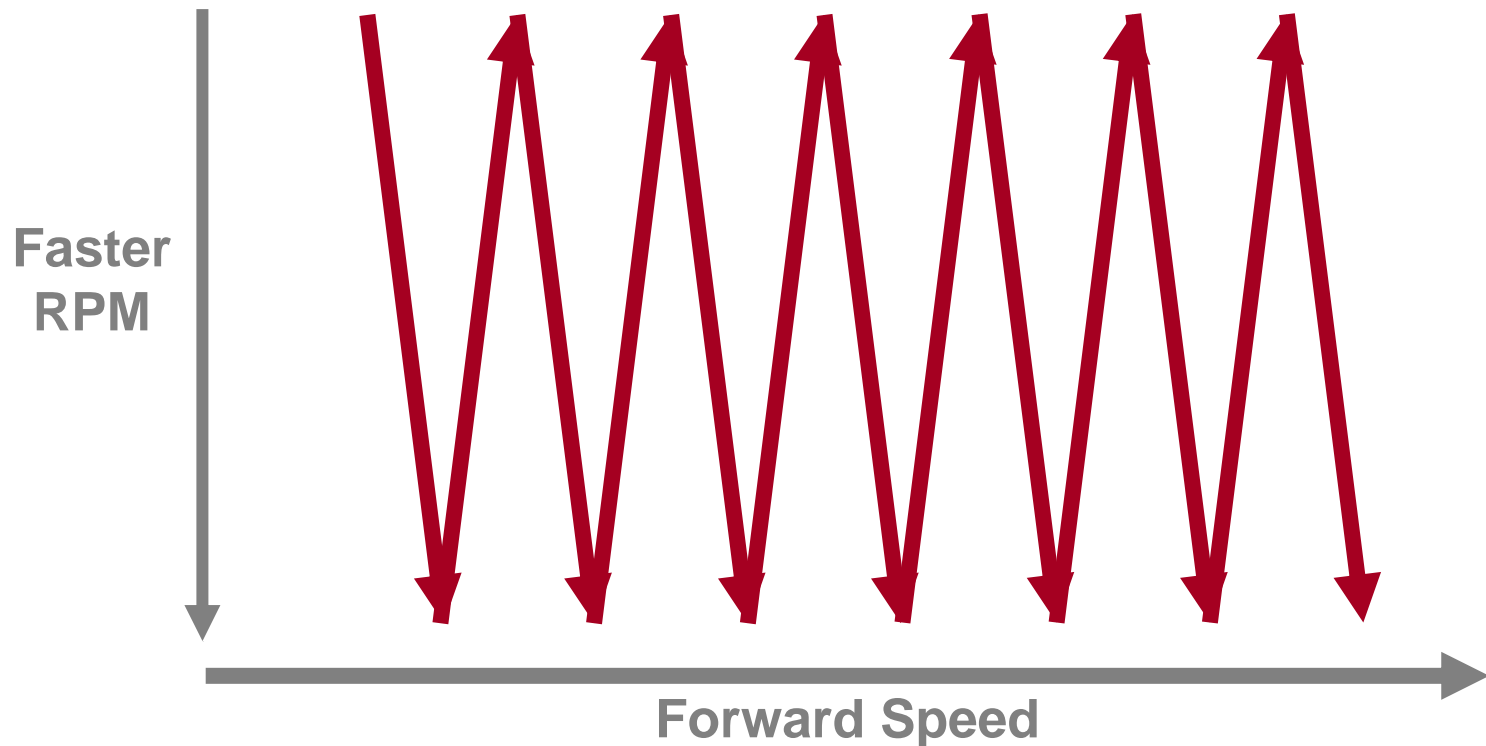


How the blade tip travel produces the **HELIX ANGLE**  
**PROPELLER SYSTEM**

How the **HELIX ANGLE** is changed by engine rpm and forward speed

**Changes in FORWARD SPEED and RPM will change the Helix Angle**

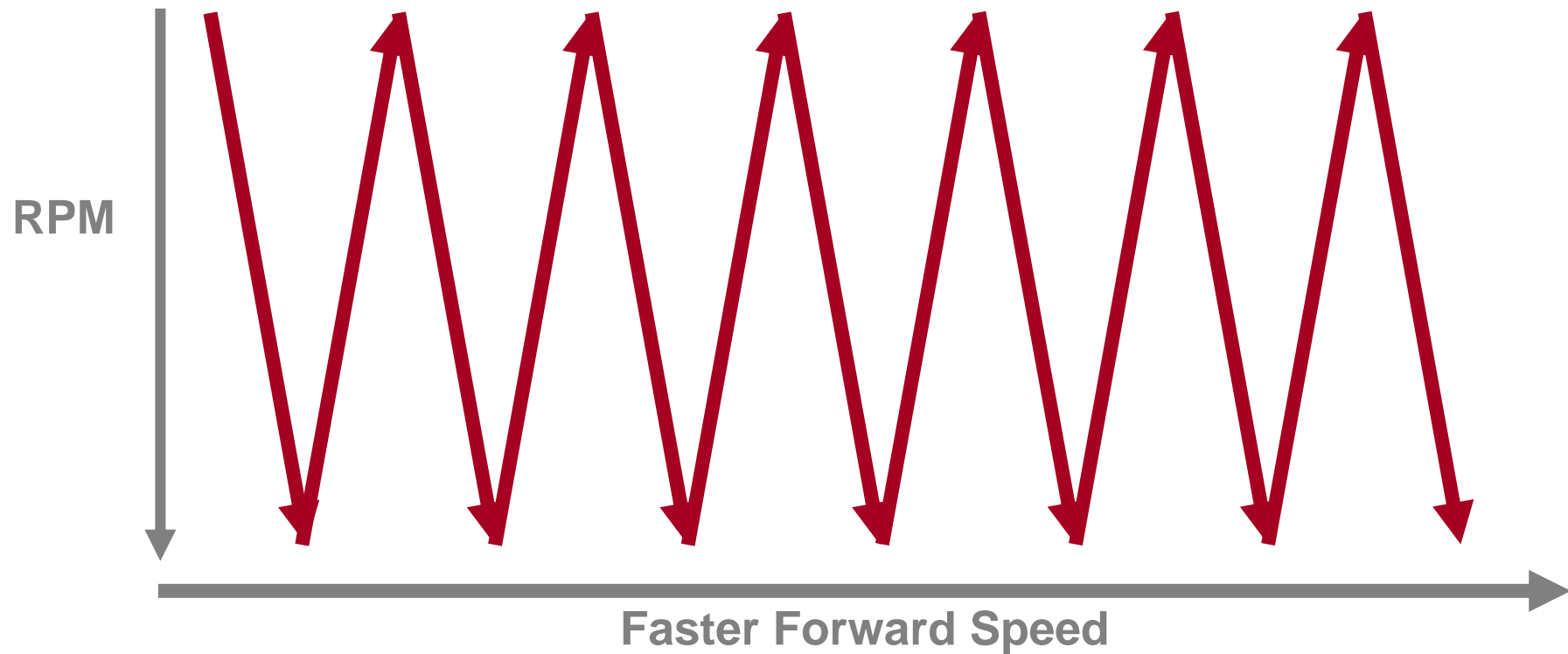
**How an increase in RPM changes the Helix Angle**



**How the blade tip travel produces the HELIX ANGLE**

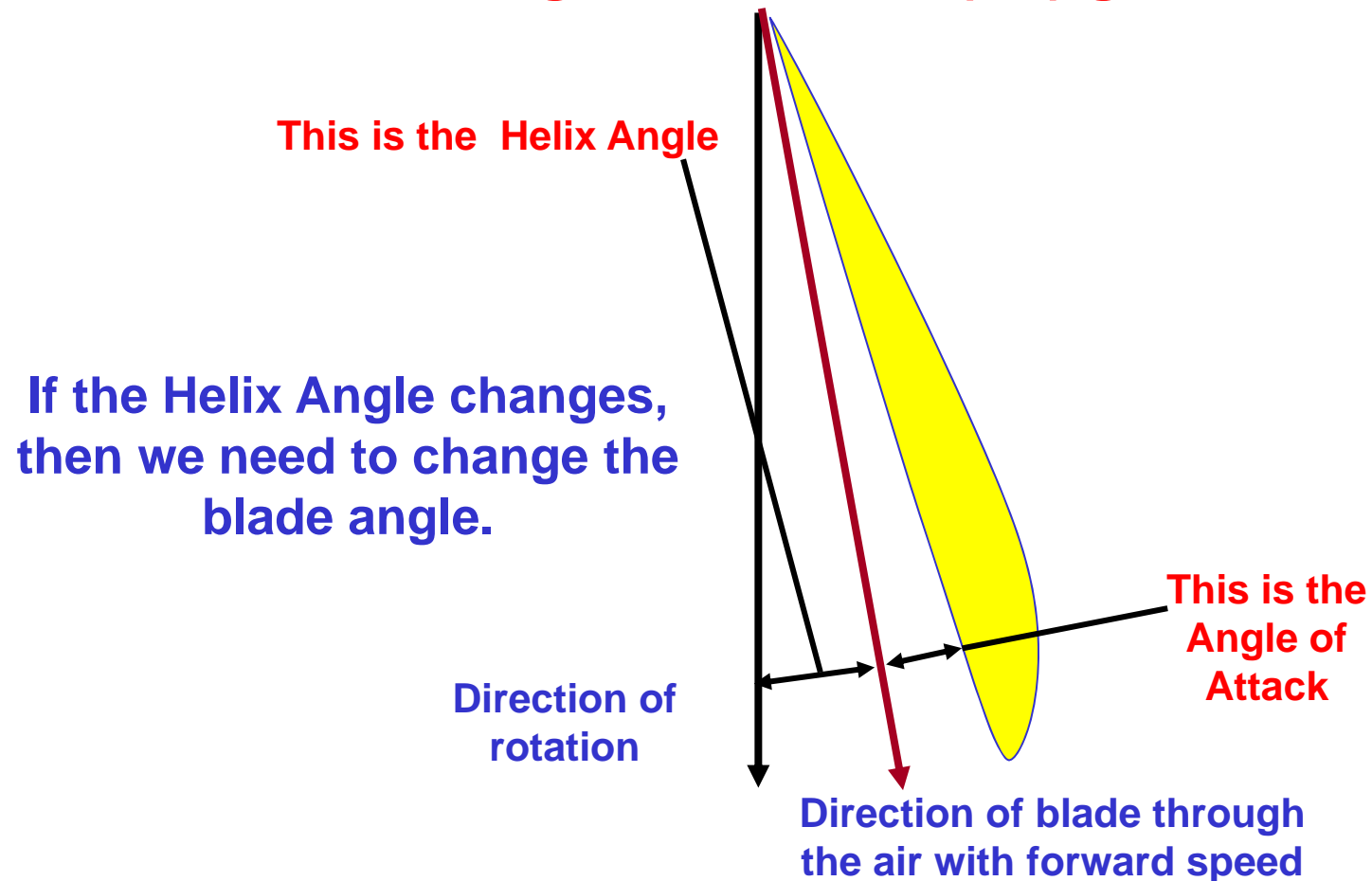
**PROPELLER SYSTEM**

**Changes in FORWARD SPEED and RPM will change the Helix Angle**



**How an increase in FORWARD SPEED changes the HELIX ANGLE  
PROPELLER SYSTEM**

## Let's take a closer look at the blade aerofoil and the Helix Angle and thrust (lift) generation

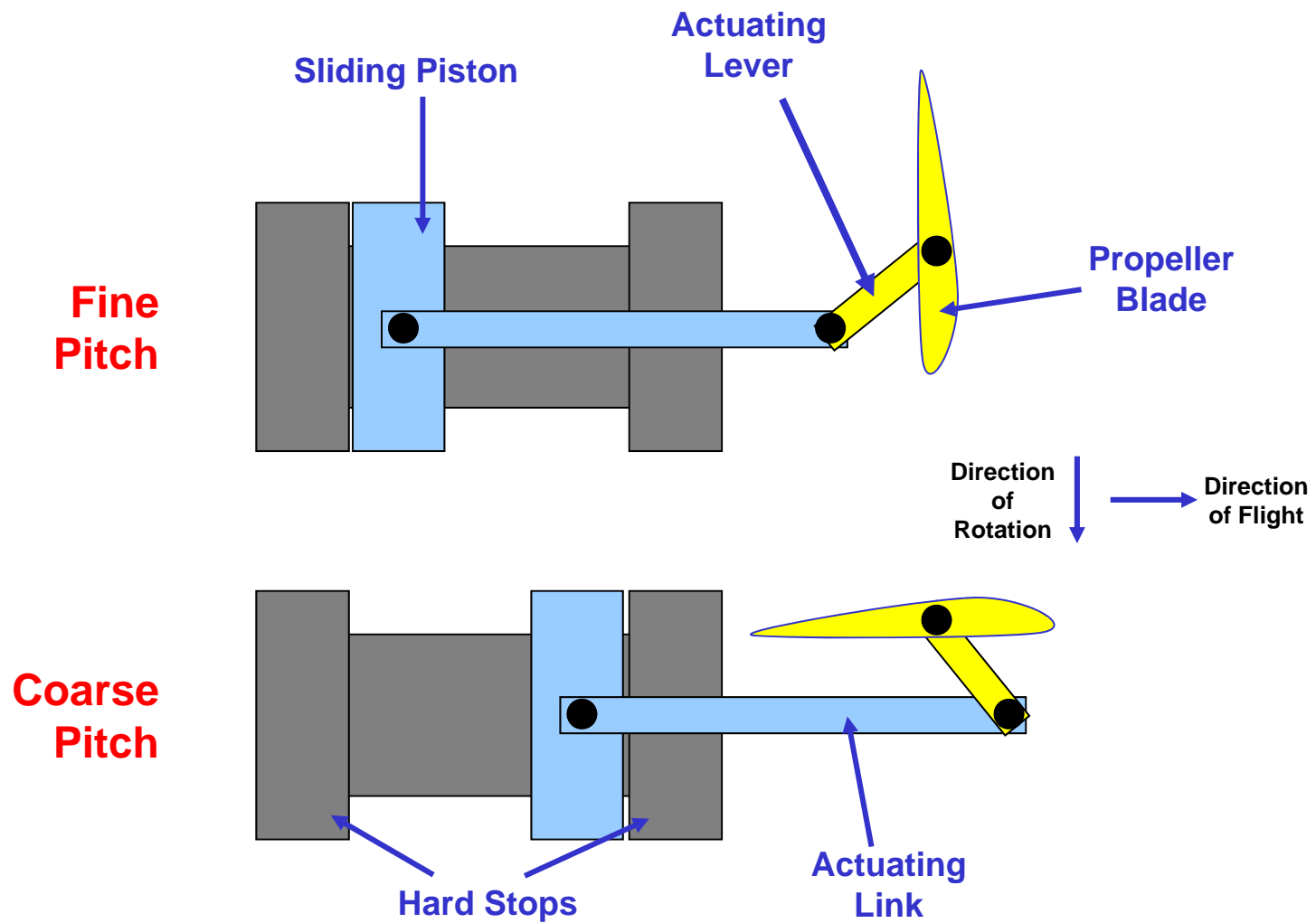


Remember (from the comparison with the aircraft wing), the optimum Angle of Attack is required to maintain most efficient thrust generation.

## PROPELLER SYSTEM

## **Mechanical STOPS and blade angles**





All propeller blades are actuated by the same mechanical linkage

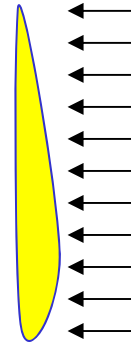
# PROPELLER SYSTEM

# The blade angle changes through 90deg with piston travel

Direction  
Of  
Rotation



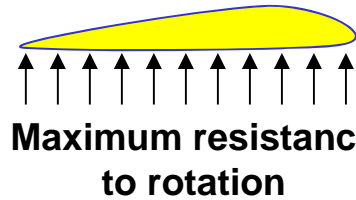
Fine pitch



Maximum  
resistance  
to forward  
speed

Minimum  
resistance to  
rotation

Coarse pitch  
Or  
'Feathered'



Minimum  
resistance to  
forward  
speed

Maximum resistance  
to rotation

Piston travels between 'hard' stops

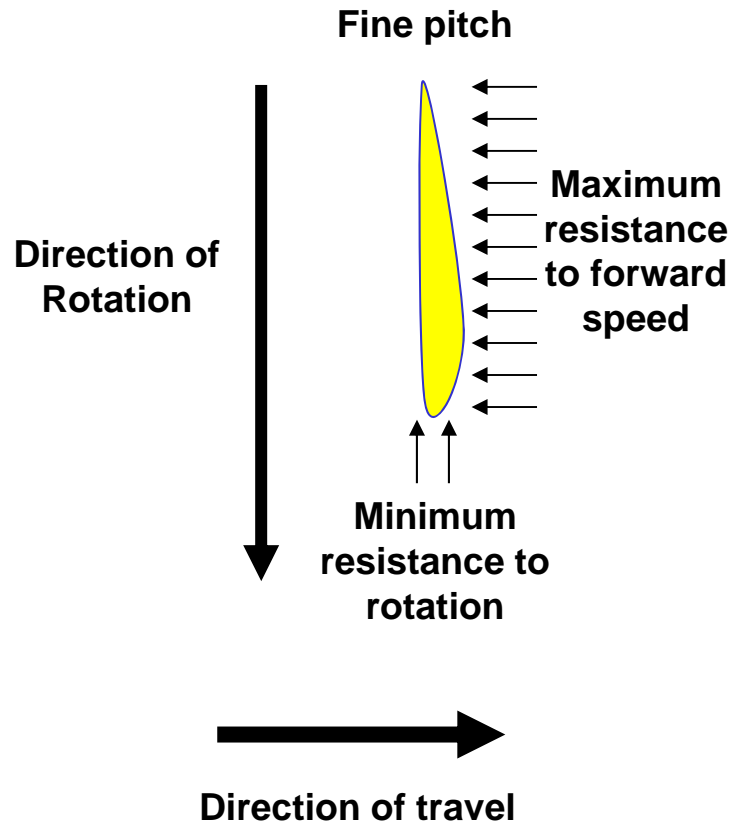
At this hard stop  
the blade is in  
this position

At this hard stop  
the blade is in  
this position

Note: - blade angle is relative to piston travel

## PROPELLER SYSTEM

# Zero pitch – or Ground Fine Pitch



## Good for:-

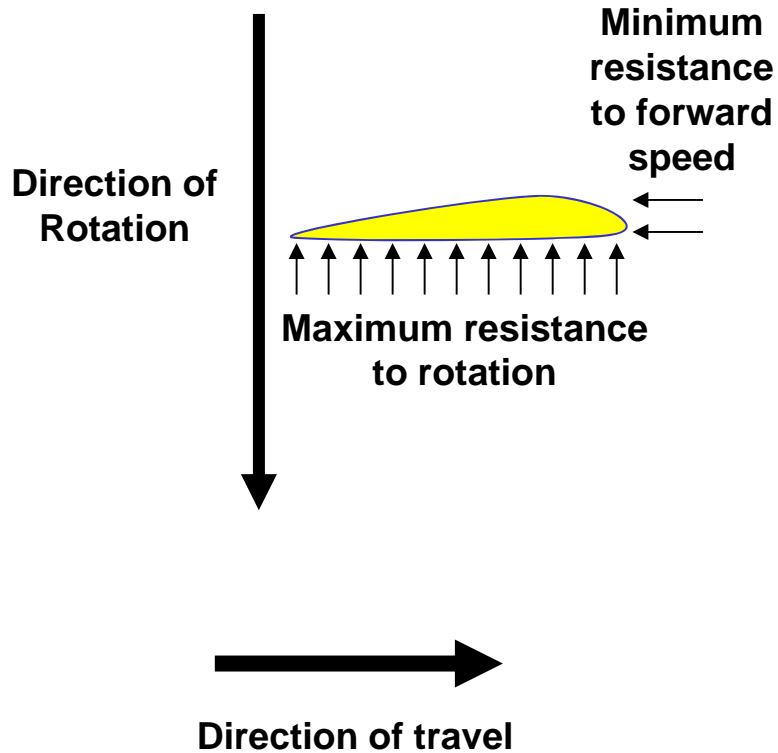
- Easier Starting of engine
- Running engine with no/minimal thrust
- High drag – braking effect on ground

## Bad for:-

- In-flight – loss of control
- In-flight engine failure – loss of control and engine disintegration

Importance of set blade angle  
**PROPELLER SYSTEM**

# Maximum pitch – or Feathered



## Bad for:-

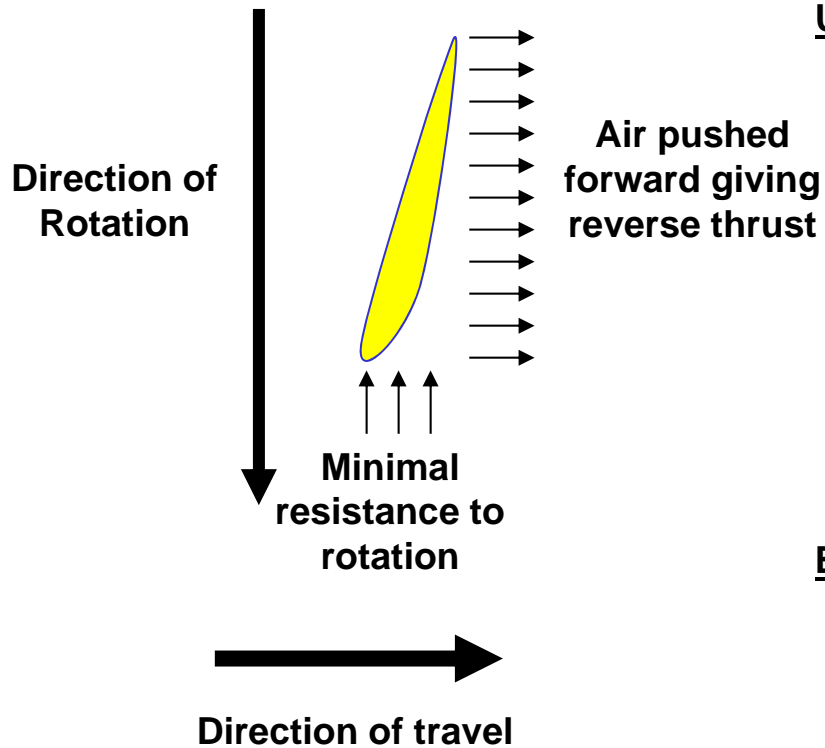
- Starting of engine
- Could cause engine burn-out if running
- Low drag – NO braking effect on ground

## Good for:-

- In-flight – loss of control
- In-flight engine failure – control maintained and engine stops rotating minimizing damage

Importance of set blade angle  
**PROPELLER SYSTEM**

# Reverse Pitch



## Used for:-

High drag – high braking effect on ground

**Usually for military aircraft only**

## Bad for:-

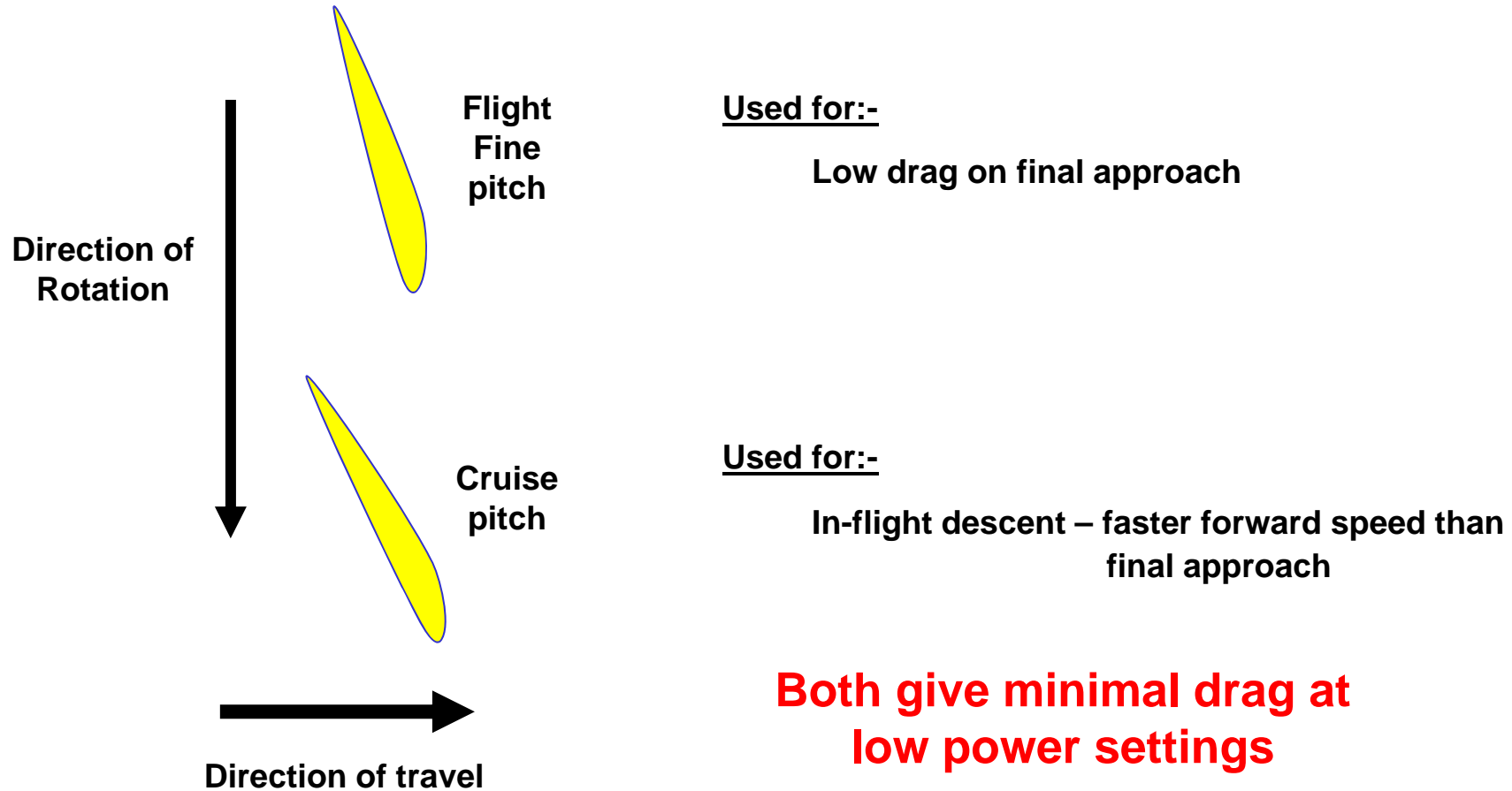
In-flight – loss of forward speed, aircraft stalls

In-flight engine failure – loss of control and reverse rotation increasing engine disintegration

Importance of set blade angle

## PROPELLER SYSTEM

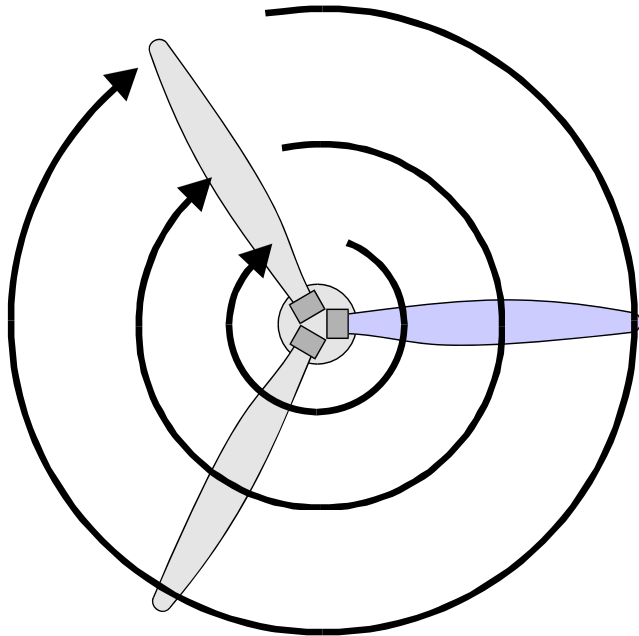
# Flight Fine and Cruise Pitch



Importance of set blade angle  
**PROPELLER SYSTEM**

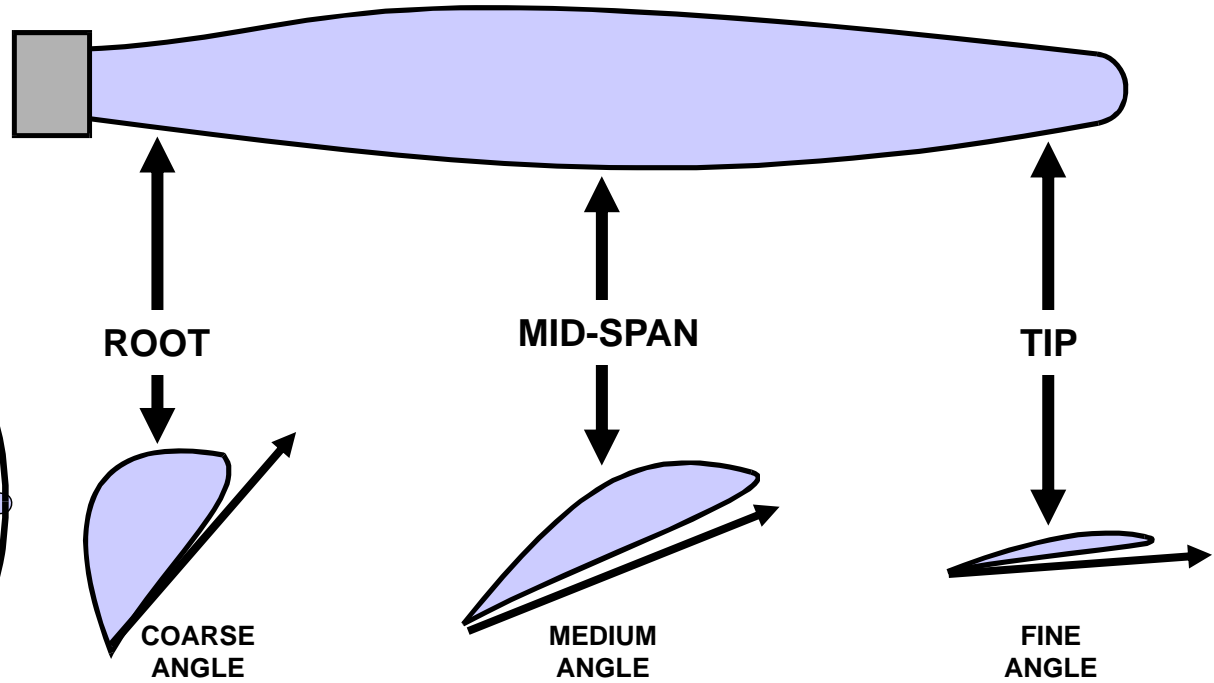
**Blade Twist**

### Typical 3 Blade Prop



DISTANCE TRAVELLED BY  
ROOT, MID-SPAN AND TIP

### Typical Blade



BLADE ANGLE RELATIVE TO DISTANCE (AND THEREFORE SPEED)  
TRAVELLED BY ROOT, MID-SPAN AND TIP

THICK FOR  
STRENGTH

THINNER FOR  
STRENGTH AND  
THRUST

THIN FOR  
THRUST

### Blade Twist

# PROPELLER SYSTEM