

AEROMODELLING CLUB

Boomerang Lecture



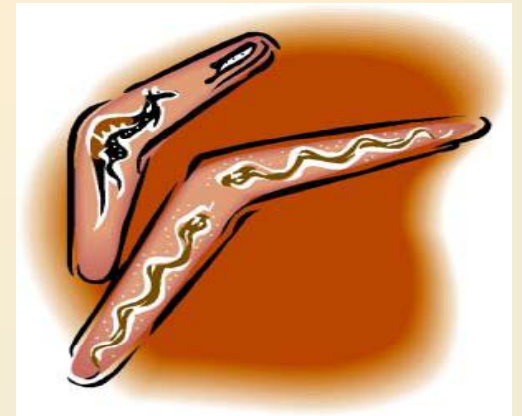
Outline

- What is a boomerang?
- History of boomerangs
- Features and types of a boomerang
- Basic aerodynamics of a boomerang
- Why does a boomerang work?
- Fabrication of a boomerang
- Throwing techniques



What is a boomerang?

- Curved piece of wood etc.
- Heavier than air flying object
- Flies and Returns when thrown properly.
- Smallest - 10cm tip to tip
- Largest – 2m tip to tip

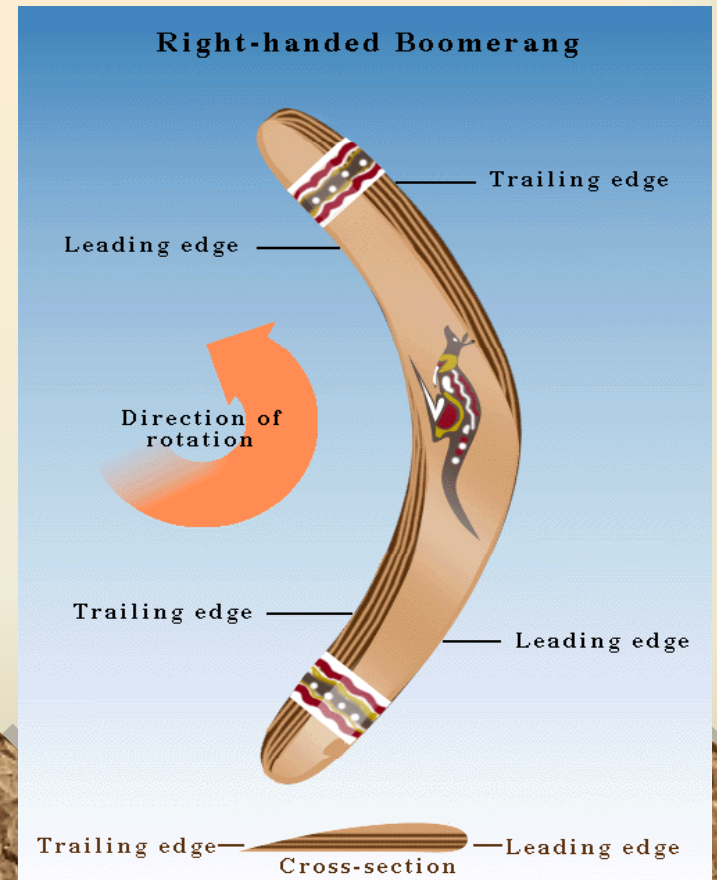


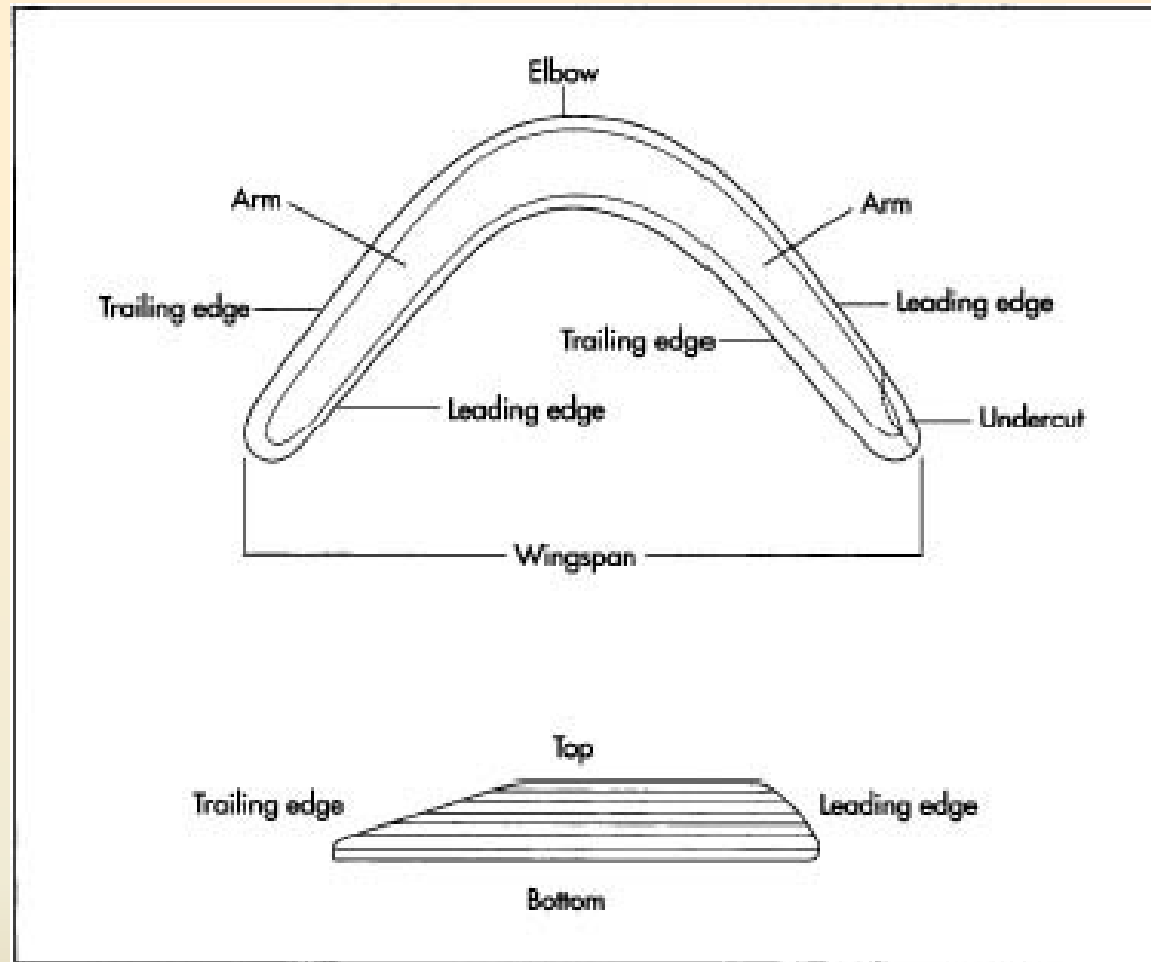
History of boomerangs

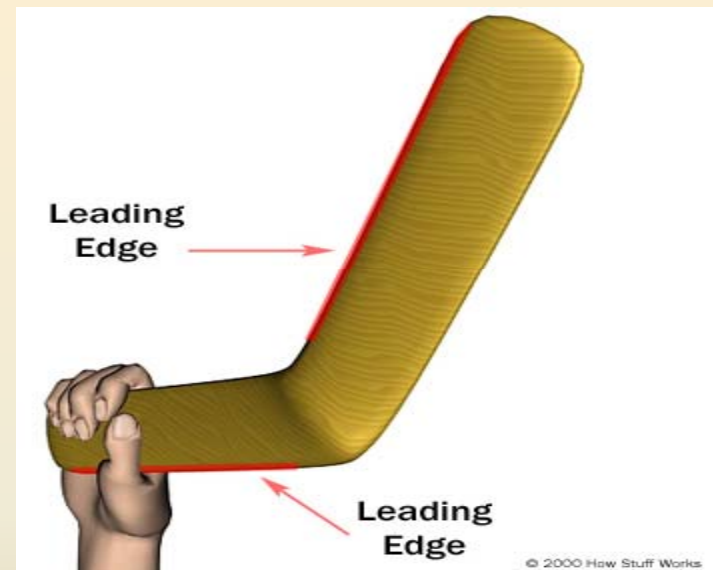
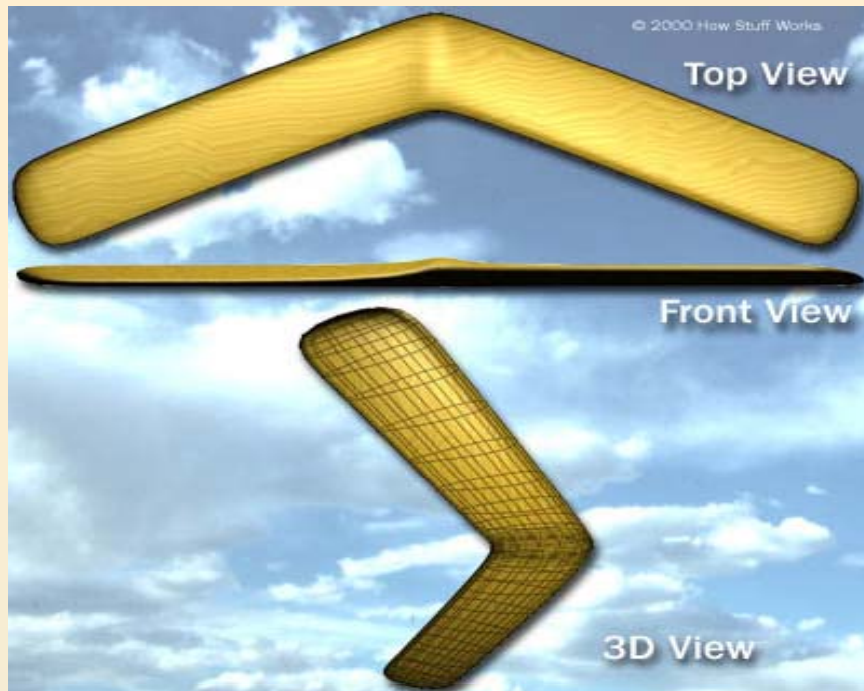
- Believed to be the first 'heavier than air' flying objects
- 30,000 years old boomerang found
- Prominently used by Australian aborigines but evidence of even earlier presence was found
- Were used as hunting sticks (non-return type called **kylies**), which would not return.
- Developments over the year have now given us highly efficient boomerangs

Features and types of a boomerang

- Wide variety of shapes
- Different profiles for right and left handed throws (Video 1)





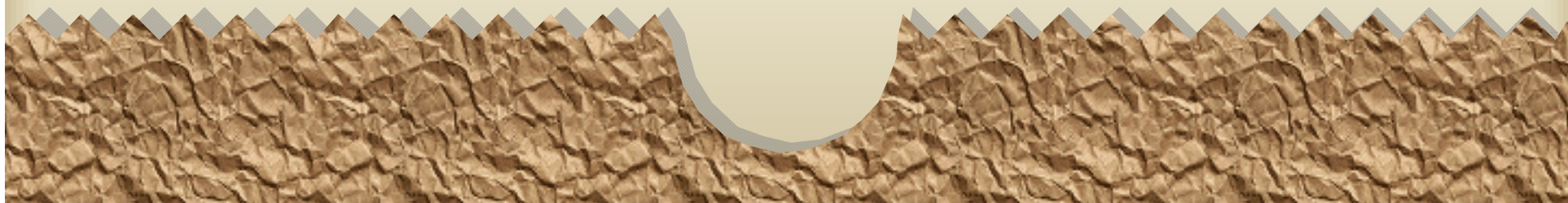
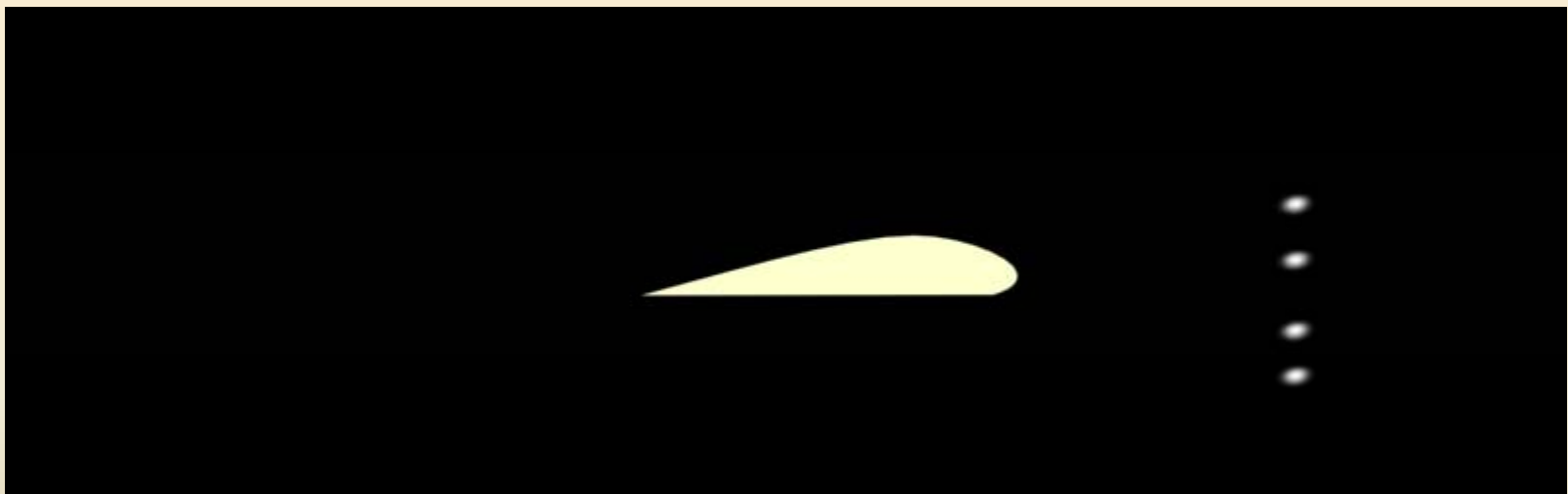
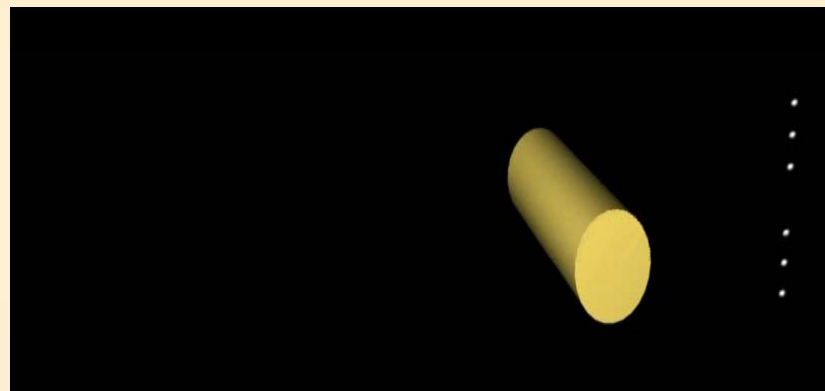
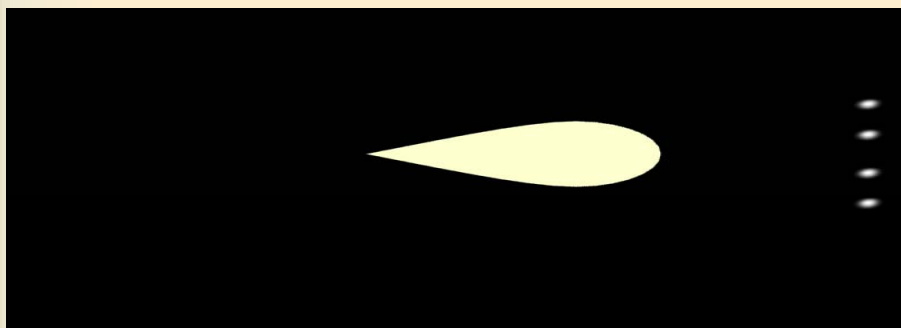


Basic aerodynamics

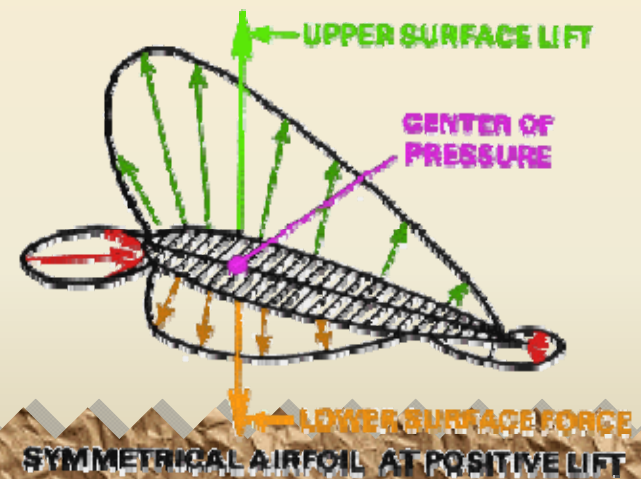
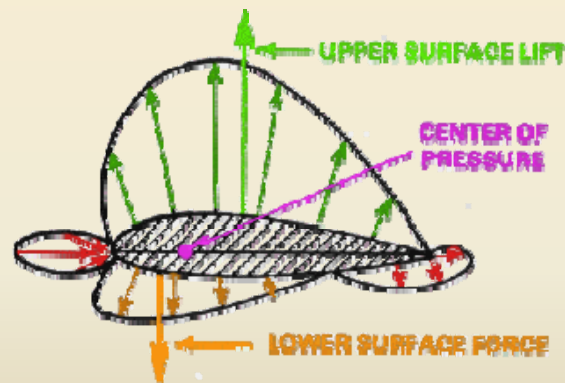
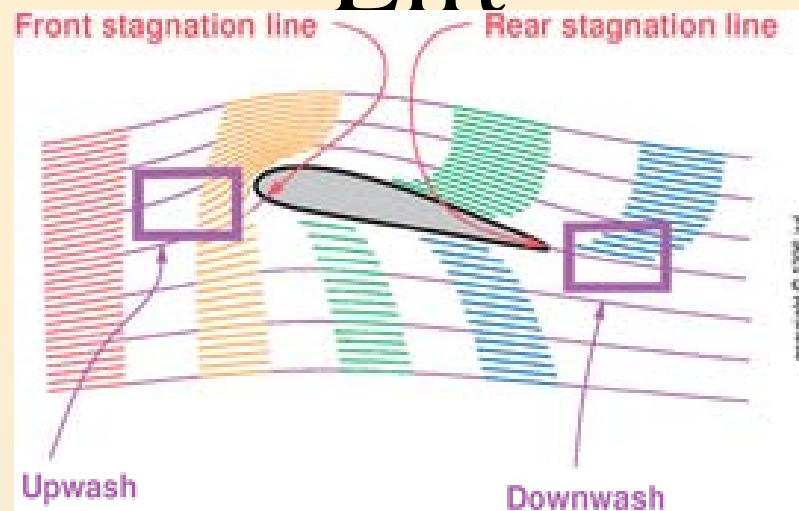
LIFT - Air passing over the curved top of a boomerang's airfoil — at the leading edge of the wing — is forced to go faster than air passing over the relatively flat underside. As described by Bernoulli's principle, this generates less pressure above the wing, creating upward lift. (2,3,4,5)

SPIN - The rate of a boomerang's spin is determined by the length of the wings, the angle at which they're joined, the distribution of material and the amount of force applied by the thrower. Like a gyroscope, a boomerang has greater stability the faster it spins.

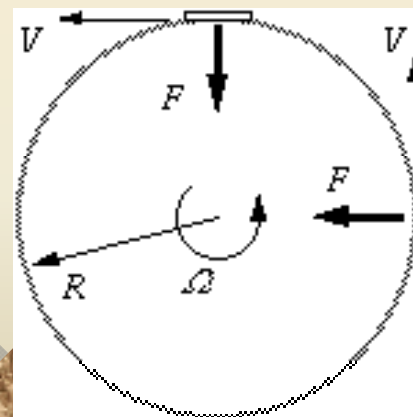
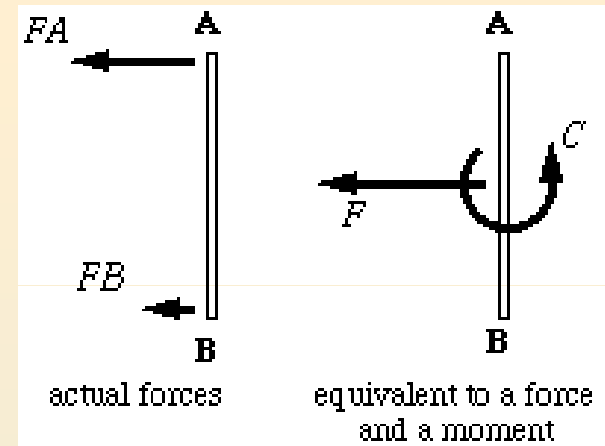
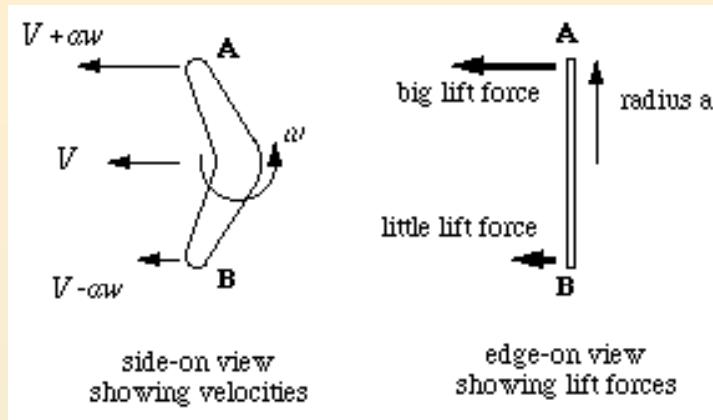




Lift

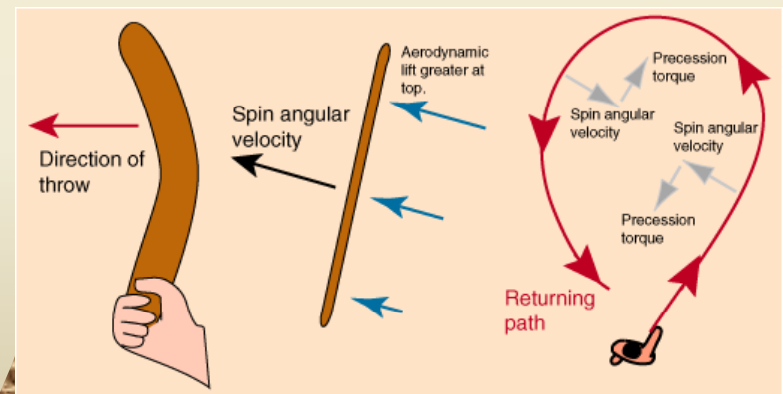
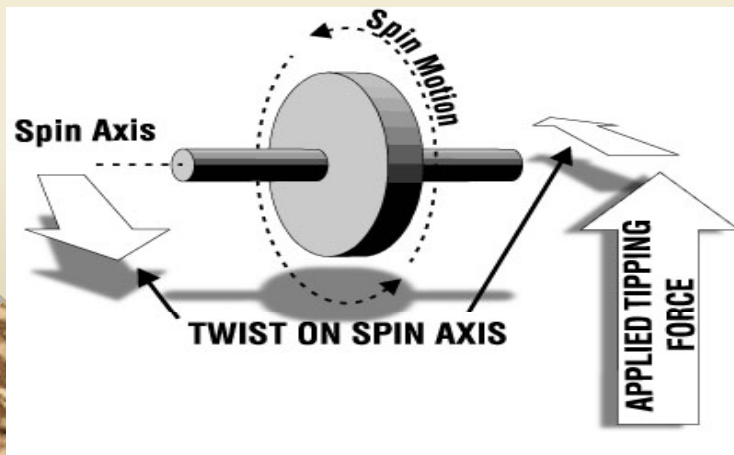


lift



PRECESSION

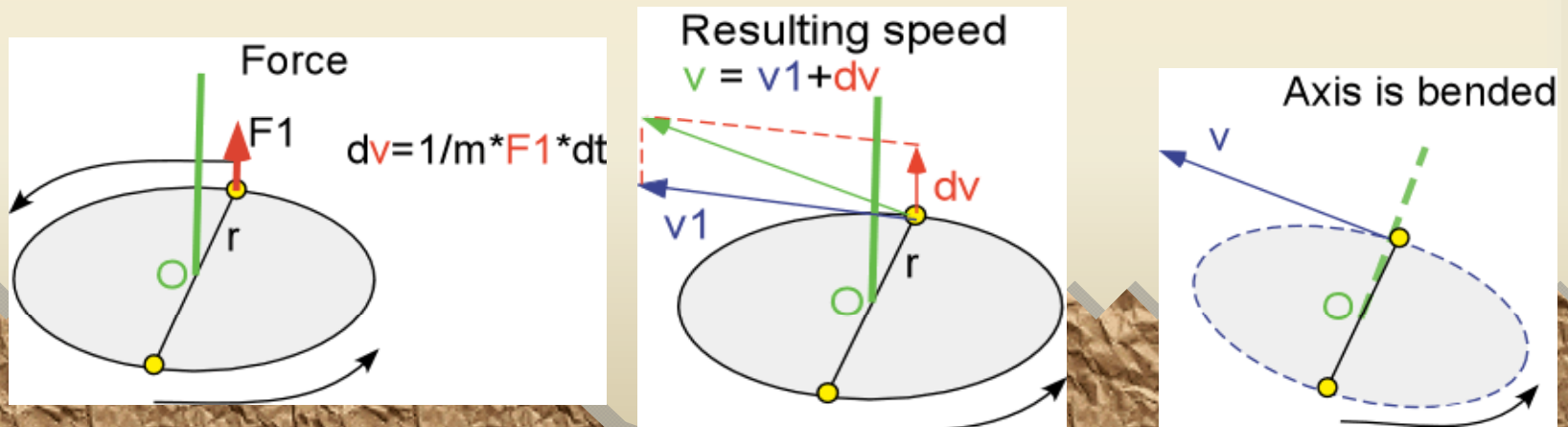
- **PRECESSION** - A boomerang is thrown at a slight outward tilt from vertical. The top wing rotates with the object's forward motion, so it moves faster than the bottom wing, generating more lift. Because the boomerang is spinning, the lift exerts a steady force that is felt 90 degrees later, at the point in each rotation farthest from the thrower. This force nudges the wing laterally and the spin axis shifts. The boomerang turns — eventually curving all the way back to its starting point.





PRECESSION

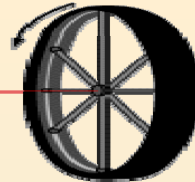
- The device, once spinning, tends to resist changes to its orientation. If external force **F1** is applied to some point which is at radius **r** from rotation axis of gyroscope, the spinning device begins to rotate. The motion "seems to be strange" as it does not follow the applied force direction, but moves in a perpendicular one. This rotation of spinning plane is called precession.
The simplest explanation of the phenomenon is shown below.
- The gyroscopic precession is fundamental phenomenon which explains why boomerang returns.



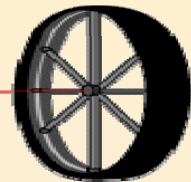
“No Hands” Bicycle Turn

The gyroscope is rotating

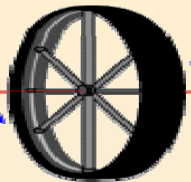
Spin axis



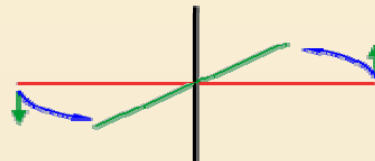
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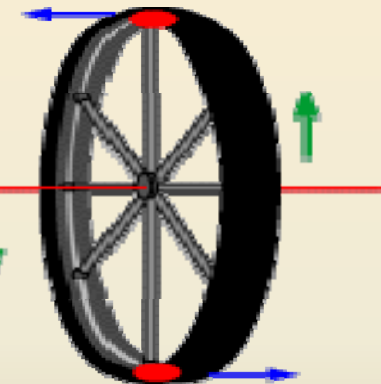
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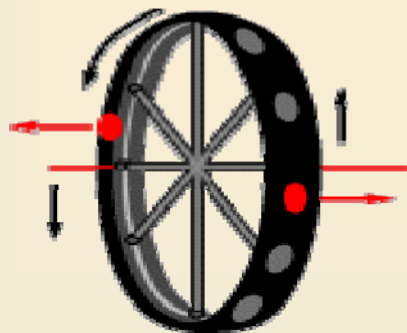
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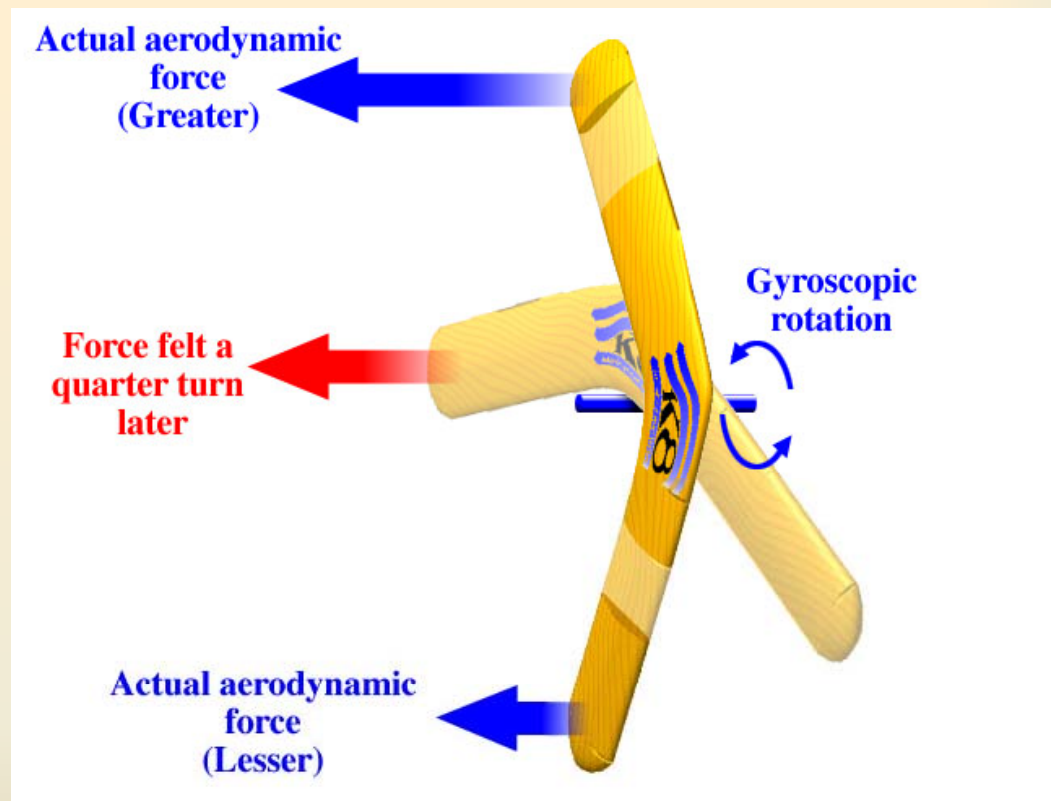
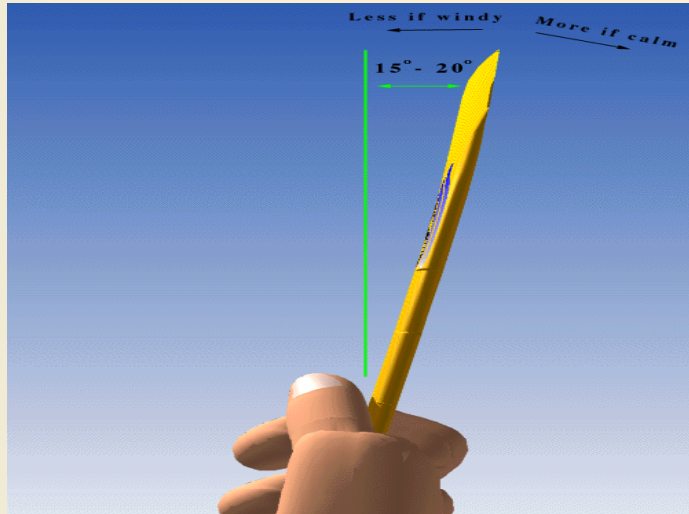


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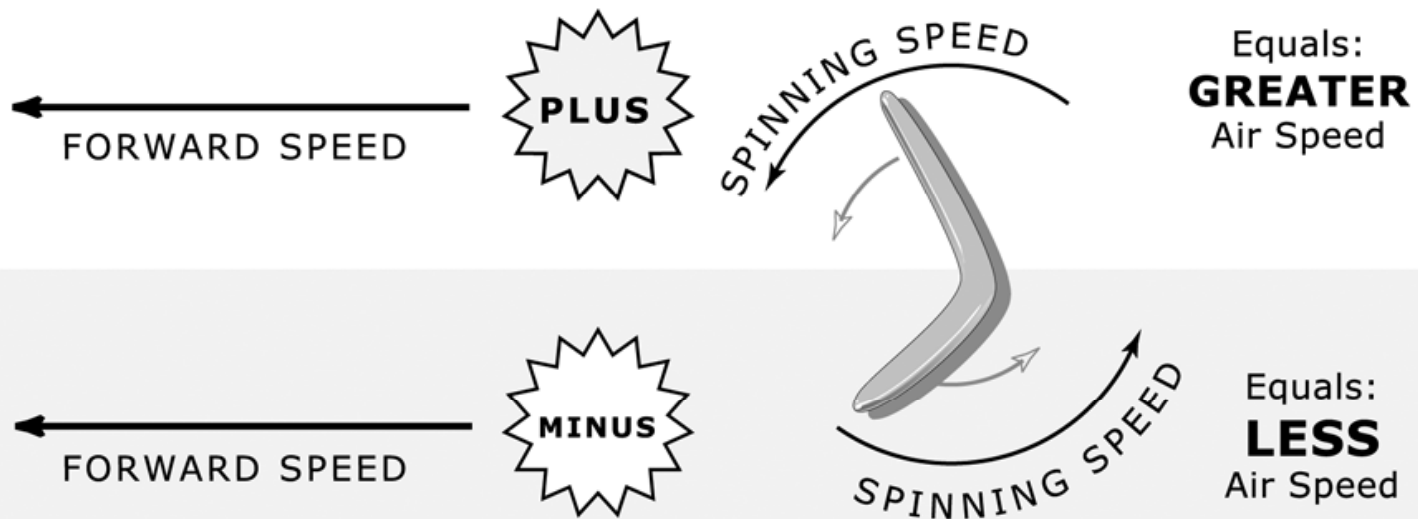


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Why does a boomerang work?



Why does a boomerang work?



Momentum

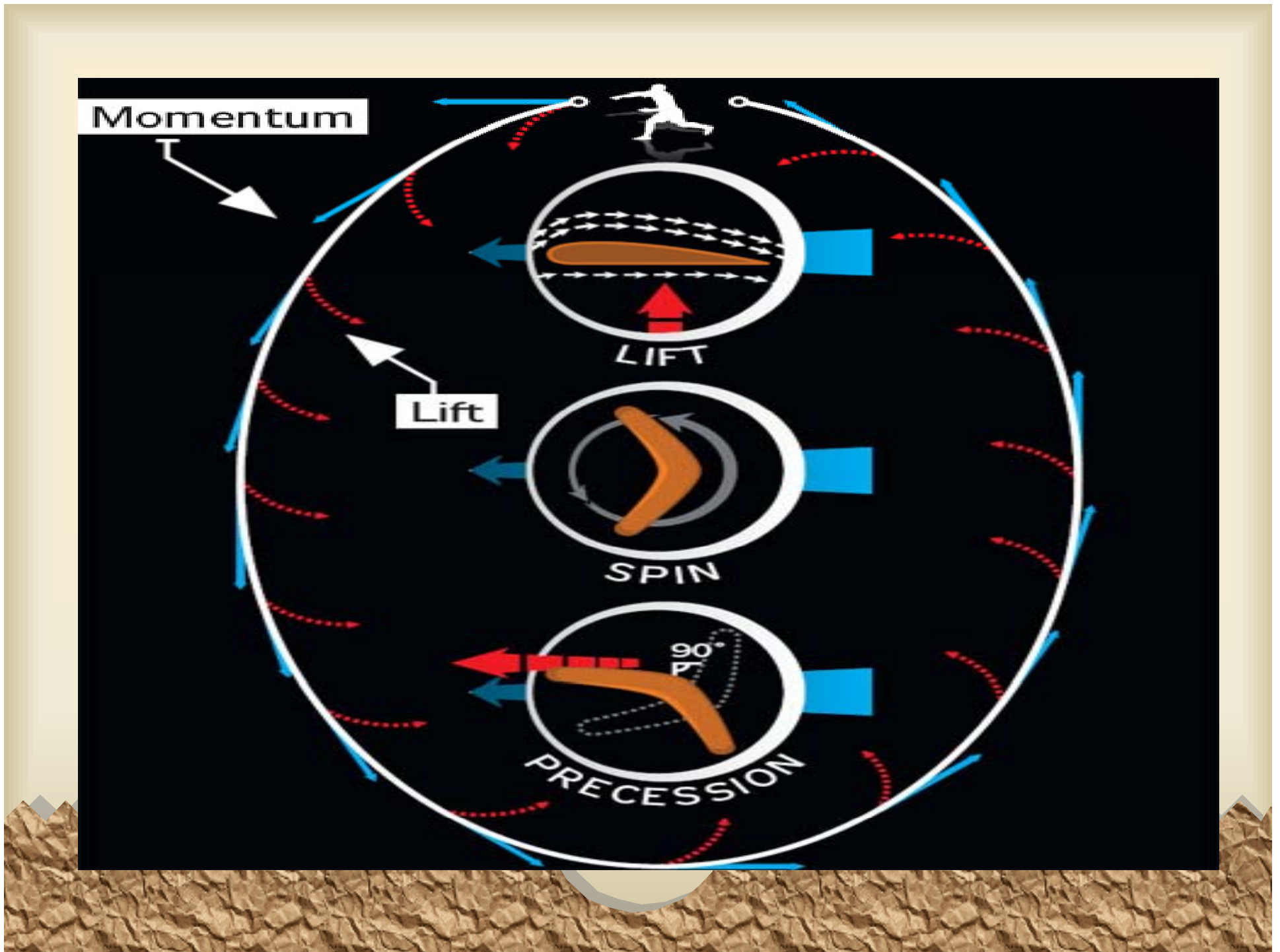
Lift

LIFT

SPIN

PRECESSION

90°



Fabrication of a boomerang

- Fabrication is done using any hardwood
- Birch wood is preferred
- The aerodynamic profile is given using abrasives
- Some boomerangs also employ turbulators to keep the flow attached, and generate more lift

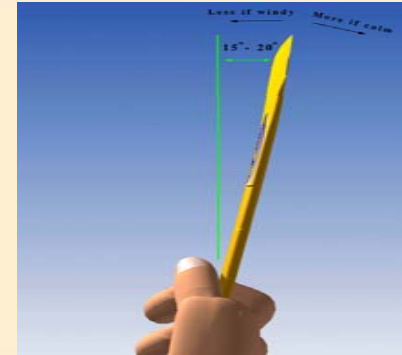


Fabrication of a boomerang

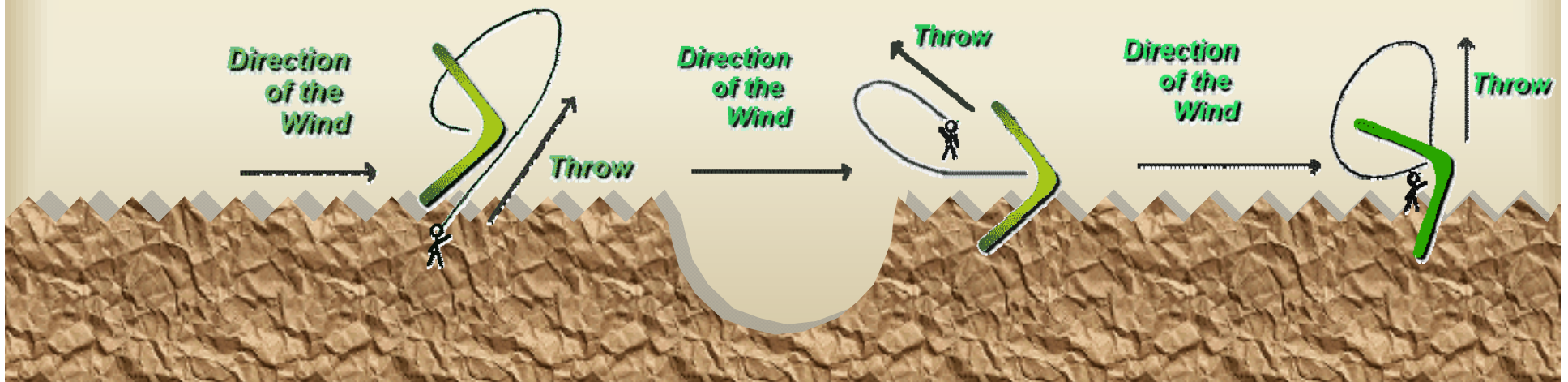
- Roughly 30 in. long, this 19th century rang from Western Australia is made from mulga — a wood so dense “it sinks like a stone in water,” It weighs nearly 2 pounds, so, “You definitely want to stay out of the way when it comes back.”

The unknown maker carved grooves into the top and bottom, shaving off a tiny bit of weight (crucial in a sport where the mass of a paper clip can clinch a record throw). The grooves also form hollows that — like the dimples on a golfball — create a blunt airfoil, which increases lift.

Throwing technique



- More spin to be given than force
- Launch at a slight angle to the vertical
- Wind has to be accounted for- right handed boomerangs are launched to the right of the wind
- Launch has to be perfected by practice



Workshop

- All the above points will be demonstrated in the workshop.
- You will be taught everything from scratch



Summary

- Boomerang is a flying object that comes back when thrown properly
- Supposed to be developed by Aborigines of Australia.
- Boomerang of variety of shapes and sizes are found.
- Lift is perpendicular force experienced due to relative velocity.



Summary

- Lift experienced by boomerang help it to fly.
- Force applied at a point on spinning wheel is felt 90deg. Off. (No hand Bicycle turn).
- The gyroscopic precession phenomenon make boomerang return.
- Boomerang should be thrown with some angle from vertical and good spin.



QUESTIONS ?

THANK YOU