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WHY KITES FLY

Teacher Background For DSO For DoDDS Japan

Day With Kites

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WHY KITES FLY

by

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INTRODUCTION

Each school year, usually in the spring, a Japanese kite maker conducts kite making and flying classes in the Japan School District Elementary Schools of the Department of Defense Dependents Schools (DoDDS) Pacific Region. The program is conducted, in part, as a cultural program so that American students may learn a little about the long standing Japanese hobby of kite flying. Of course we know that American children have long flown kites each year in the spring, especially when the March winds blow. Many DoDDS students, however, spend the majority of their early school years overseas, thus missing the Saturday afternoon and Sunday morning kite flying sessions their stateside counterparts have with friends and family. In a sense, while probably not mentioned by their teachers, DoDDS students also learn something about a hobby of their own country while enjoying the activity with their Japanese guest teacher.

PRESENTATION

Man has, for many thousands of years, been fascinated by flight. Long before the Wright brothers historic flight in Kitty Hawk, North Carolina, individuals, entranced by the flight of birds, tried themselves to fly. Trips to the Air and Space Museum at Smithsonian Institute in Washington, DC, or the Experimental Aviation Association Museum in Oshkosh, Wisconsin, not only provide opportunities to examine early flying vehicles, but to also watch movies of

Mans' early attempts at flying. There were many (laughable now but ingenious) schemes designed which were intended to allow Man to soar to new heights. All were doomed to failure! Why! The answer, of course, is that early would be aviators did not understand some simple physical principles of flight even though experienced scientists like Benjamin Franklin had long used kites to study environmental phenomena.

Physical Principles: There are many physical principles engineers must understand and with which they must deal as they design and produce modern airplanes. Some examples are friction, center of mass, center of gravity and more. Two important principles effecting the flying ability of both kites and airplanes are one of Newton's laws and Bernoulli's Principle.

1. Newton's Law. The law states that forces exist in pairs, equal in force and opposite in magnitude. Thus, for each physical action we observe there is an equal and opposite reaction. Applied to kites and airplane wings, if a mass of air traveling at a sufficient velocity encounters a flat or curvilinear surface, the air pushes on the surface and the surface pushes on the air. Since the surfaces, in which we are interested (kites and wings), have slight angles from the horizontal, the push on the air results in air being deflected toward the ground (see Figure 1).

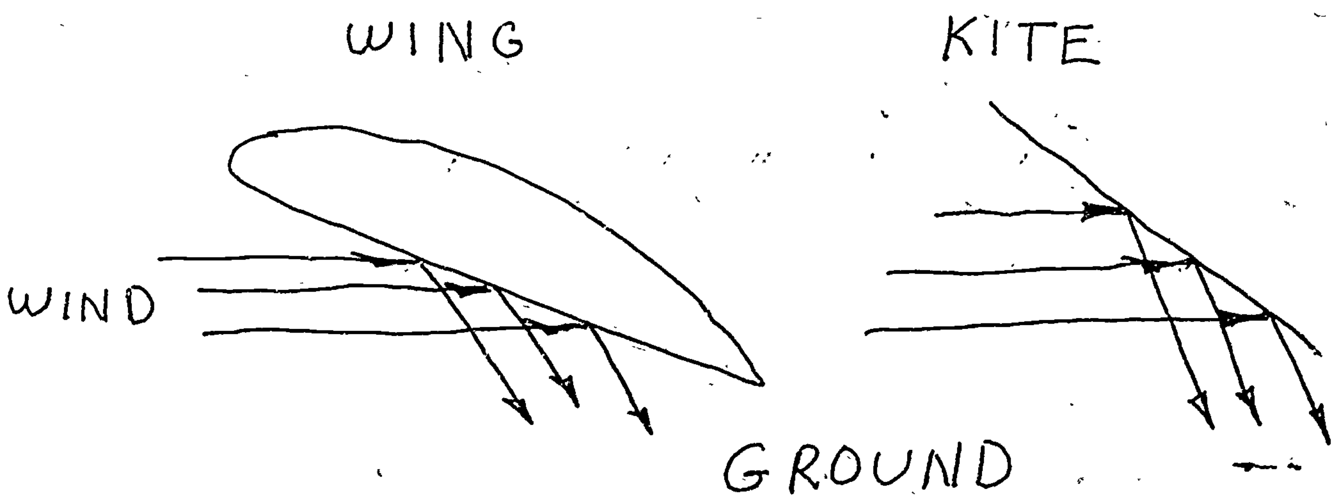

FIGURE 1. Wind Patterns with Wings and Kites

Because neither the airplane wing nor the kite enjoy a fixed location, the net result of the action is to lift the surface (wing or kite) relative to the ground. The kite flies! This, however, is not the only reason why kites fly. Recall that the kite has a string attached to it and the other end of the string is held by the flyer. The result of the flyer not paying out string, is to cause the kite to gain altitude, a direct application of Newton's Law. If the flyer is paying out string in comparison, the kite also lifts off the ground but tends to increase in altitude more slowly.

2. Bernoulli's Theorem. Bernoulli postulated that when a volume of moving fluid, enters a constricted area, its velocity increases (see Figure 2). The velocity increases because the unit volume of fluid (like a cubic centimeter) entering the constricted area at point "A" during each unit of time (for example, one minute) must exit the area at point "B" in the same amount of time.

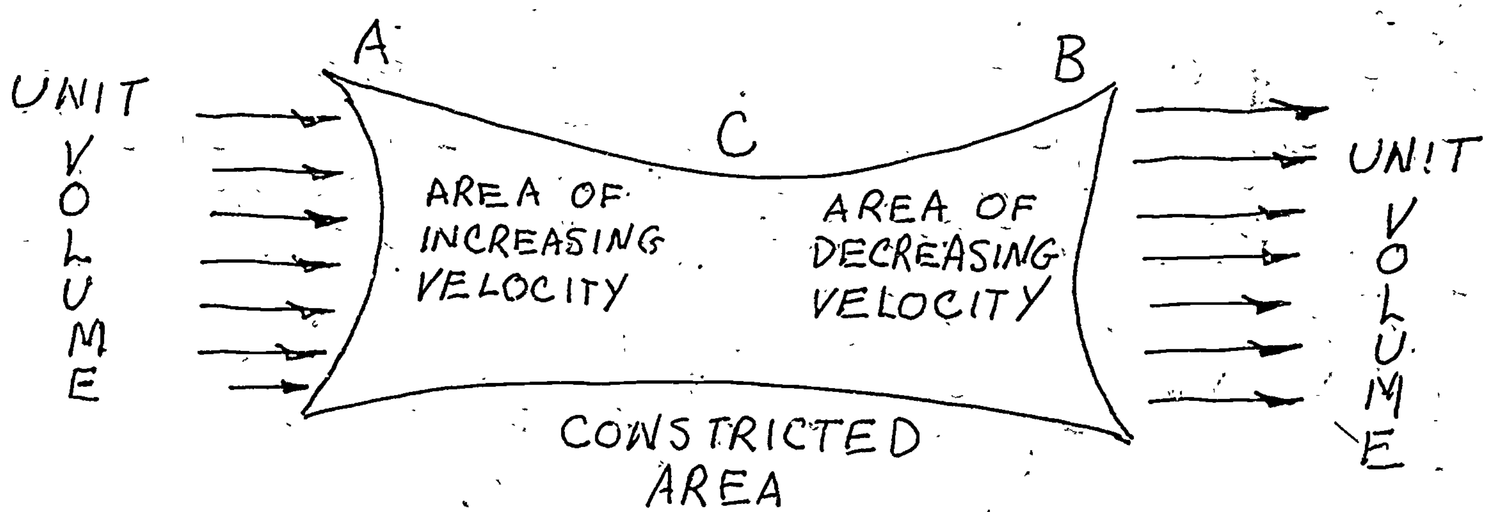

FIGURE 2. Fluid Velocity Relationships in Constricted Areas

The fluid, therefore, must speed up at point "C," moving faster there than it will be moving at Points "A" and "B." The increase in fluid velocity as the fluid approaches point "C" from point "A" results in a decrease in pressure being applied by the fluid on the sides of the constricted area. The converse is true as the fluid moves from point "C" to point "B". Figure 3 shows an example of the pressure differential. In the Figure the relative lengths of the arrows indicate relative amounts of pressure.

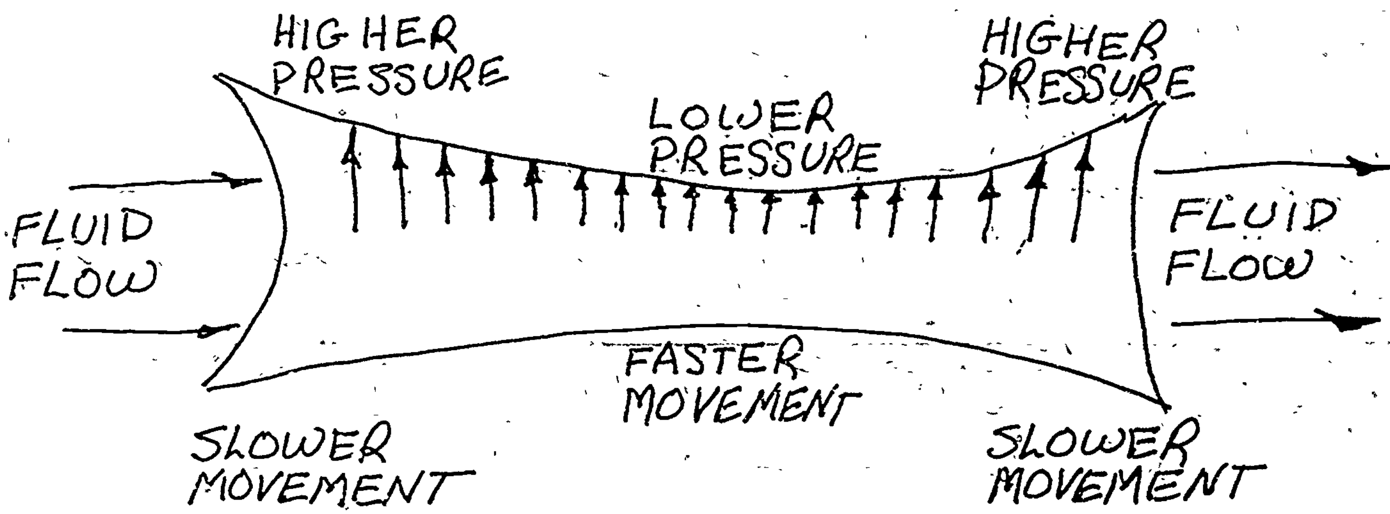

FIGURE 3. Arrow Vectors Showing Differential Pressure Exerted On the Sides Of A Constricted Area By A Fluid.

When a fluid moves over an object having two curved surfaces, one with a greater radius than the other or an object with one flat and one curved surface, the amount of pressure applied to opposite sides of the object by the fluid differs (see Figure 4).

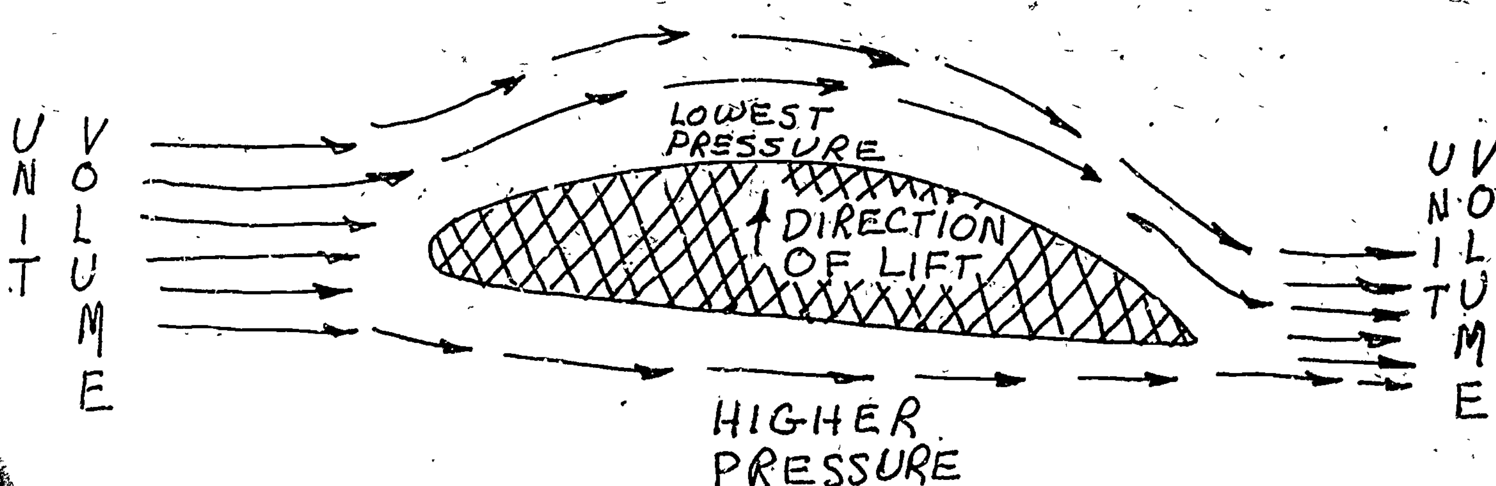

FIGURE 4. A Fluid Passing Over An Object With One Surface Having A Greater Curve Than The Other

The result is a lower pressure being applied to the upper surface (or the surface with the smallest radius) of the object by the fluid than the fluid applies to the lower surface of the object. Because there is a difference in pressure applied to opposite sides of the object (airplane or kite) the object tends to move (or be lifted) in the direction of the lower pressure or toward pressure equalization. Since air is a fluid, it acts the same as water and lift is developed. Thus, the passage of air, at sufficient velocity, in sufficient volume, over the wings and horizontal stabilizer of an airplane causes it to lift off the ground. The same is true of kites which if examined closely will be found to have curved surfaces. Kites are lifted in the direction of the low pressure.

The height to which the kite will rise depends upon the mass of the kite, the air density and wind velocity, the curvature of the kite covering and so on. Discussion of a kite ceiling (maximum altitude attainable by a kite) is beyond the scope of this paper.

SUMMARY

From our discussion, we see that two factors critical to understanding why kites fly are a basic understanding of Newton's Law and Bernoulli's Principle. While other factors like the friction between the air particles moving over the flying surface and the material of which the flying surface is composed are important, these two physical principles explain the major components of lift and therefore the major reasons why kites fly.

Appendix 16

END

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