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MILK BASED ADHESIVES



Charles F. Willard, Harvard graduate and race car driver, was trained by Glenn H. Curiss and showed his flying skills as a barnstormer at air shows and became chief engineer working for both Glenn H. Curtiss and Glenn L. Martin.

Willard and Robert G. Fowler were named as founders of the LWF Engineering Company in 1915, named for the construction the company developed, the *Laminated Wood Fuselage*. Their Monocoque structural design approach supports loads through an object's external skin, similar to an egg shell.

By 1917, Willard was chief engineer for Aeromarine Plane and Motor Company that was known as the best in the flying-boat industry producing a World War I wartime output of three hundred aircraft.

As new materials and discoveries became known more innovations resulted. Willard would be well informed of the 1876 first U.S. patent (#183,024) issued to the Ross brothers for the production of casein glue. Early construction used wood or steel tubing for the planes structure but the covering of a skin of fabric such as Irish linen or cotton added weight but no structural strength. By 1912 companies were adapting ideas from the boat industry that typically used laminated strips of wood for structure and strength. The history of adhesives comes from many discoveries changing the way we view structures and bonding qualities for special functions. Casein adhesive's still have their place in many applications. Casein adhesives that were slow to dry were used successfully and remained popular for woodworking including aircraft, construction as late as the de Havilland Albatross airliner of 1937 and the WW II de Havilland Mosquito bomber.

The earliest example of a laminated wood fuselage was produced by the LWF Engineering Company. The chief asset of the company was the laminated wood fuselage developed by Charles Willard. A LWF Model V was used by the Czechoslovakian Air Force in 1919 and was placed in the National Technical Museum in Prague, Czech Republic.

Jack Northrop started his aviation career as a draftsman for Lockheed Aircraft Manufacturing in 1916. Northrop would design the Loughhead S-1 (spelling was changed to Lockheed in 1926) betting on a departure from the early wartime aircraft pioneering experience. Northrop designed a streamlined fuselage that was of monocoque construction and with the team of Northrop; Tony Stadlman, Allen and Malcolm Loughhead devised the process of making molded plywood monocoque shells. The Loughhead S-1 required a 21 foot concrete mold were layers of spruce plywood strips were laid into position and well saturated with casein adhesive. The mold was then covered with a rubber bladder and a cover was bolted to the top of the mold. The bladder was inflated and pressure was applied for twenty-four hours. The half shells were produced and could be joined making a smooth clean bullet like fuselage. This same method was employed in the construction of the Albatross and Mosquito.

MILK AND VINEGAR

The use of milk as an adhesive has interesting properties. The process involves heating milk and adding an acid such as vinegar to separate the curds that form from the liquid (whey). The curds are taken out and mixed with baking soda to neutralize the acid that is left in the curds. The liquid that remains is then pressed out using a heavy weight with a resulting white paste-like substance that will become a powerful adhesive when dry.

