Build a Milk Carton Boat for the Valleyfair Milk Carton Boat Race is divided into two boat categories. A boat can be used for only one category. A boat may compete in either a) four or less students in a boat or b) five or more students in a boat. A school is not limited to the number of boats entered (a student may be a crewmember for only one boat).

CREATE YOUR DESIGN

The following size milk cartons may be used:

One Quart
Half Gallon
One Gallon

A minimum of 50 half-gallon cartons or the equivalent is required for each entry. A school may have only one team in a category (four or less students in a boat, five or more students in a boat). An entry must complete the defined racecourse.

Flotation must rely solely on milk cartons. Speedboats usually feature minimal structure above the waterline. They tend to be long and narrow. Style boats can be any shape desired by the builder. Builders of style devote most of their attention to the above water structure since they are competing for the best look.

Take time to draw a plan of your boat on paper. Work out the dimensions of the boat and try to estimate its completed weight, with the weight of students included. The size and complexity of your boat should reflect your available resource: money, labor, and time. In addition, you must consider how you will transport the boat to the park.

Determine how many crewmembers your boat will carry and who those people will be. Crewmembers usually represent the greatest weight aboard your boat (a one gallon jug will float 8 lbs). For example, if the weight of your boat hull, superstructure and crew equals 600 lbs, you will need 75 one-gallon jugs or 150 half-gallon cartons.
Your boat’s stability is another important consideration. A boat that is too narrow for the weight it must carry may capsize. Most people propel their boat by sitting on their boat and paddling with an oar.

Most milk carton boats do not need a rudder for steering. Most crewmembers can turn their boat by steering with their paddles.

**REMEMBER: Safety is the number one priority. ALL CREW MEMBERS MUST WEAR AN APPROVED LIFE JACKET WHILE OPERATING ON THE WATER.** Valleyfair will supply life jackets for all participants prior to their scheduled race time.

**MATERIALS**

Hull structure can be built of wood, plastic, or steel. The above water structures can be built of cloth, plastic, wood, Styrofoam, paper-Mache, etc. Use screws, glue (wood glue, hot glue, etc), wire, tapes (fiberglass, plastic, duct) and other fasteners to join the parts of your boat together. Decorate it with paint, carpet, linoleum and craft supplies.

Finding an adequate supply of milk cartons is usually the biggest challenge facing the boat builder. Experienced boaters collect cartons all year round. Ask friends, relatives, and neighbors to collect for you.

**CONSTRUCTION**

Hulls should be joined together securely with screws. Steel tie-downs and brackets provide added strength. A strong secure hull frame will prevent your boat from breaking up during transport or operation.

If you are using a plywood deck on which people will sit or stand, brace the deck underneath. Use wooden 2” X 4”s for the areas on which boaters will be placing weight, and smaller cuts (1” X 2”s, 2” X 2”s, thin plywood sheeting) for areas that will not bear heavy weight.

Hot glue your milk cartons shut and reinforce the seal by taping the closed mouth (do not fill the cartons with foam as it will make them less buoyant). Than hot glue the sealed cartons together into bundles or blocks of four-to-eight cartons. Wrap the blocks with duct tape to reinforce at the top and bottom of the carton. Use screws to fasten to the hull; you can also hot glue them in place. You may wrap the bottom of your boat with plastic mesh or chicken wire to prevent cartons from breaking free in the water and floating away. **DO NOT PERMANENTLY ENCLOSE THE CARTONS WITHIN THE HULLS WITH WOOD, PLASTIC, OR FABRIC. NOR SHOULD THE CARTONS BE SCREENED FROM VIEW. THESE MEASURES WILL RESULT IN DISQUALIFICATION.** For specific rules or questions contact Steve Ethen at 952-607-6074 or via e-mail at sethen@umn.edu.

You can build you boat as a single unit or in parts that can be assembled at the park. If you choose the later, its best to build the hull as one part and the above water structure in component parts. Remember to bring necessary construction supplies to the park and allow sufficient time for assembly.
TEST RUN

Most milk carton boat builders neglect to test for buoyancy, stability, and structural integrity with a trial run (this applies to virtually all builders whose boats end up sinking on race day). Allow time in your building schedule to conduct a trial run. When you remove the boat from the water, examine it for breaks, cracks, separated frame pieces, loosened milk cartons and other surprises. In particular, watch for evidence of flooding through punctured milk cartons. Reconstruct or reinforce weakened or damaged components as needed.

REGISTRATION, INSPECTION AND OPERATION

Beginning May 1 you can visit our website at www.valleyfair.com/physics to register. Check in (all crewmembers with signed waivers as one team) at the Boat Registration table in the park as soon as you arrive (before 10:30 AM). An inspector will examine your boat to see that it complies with all the rules and regulations (study these closely to avoid the disappointment of being disqualified). You will be provided with a registration number that must be affixed to your boat.

Note the Schedule of Events be posted online at www.valleyfair.com/physics. It will also be posted at the Wave Pool on each of the event dates.

It is the responsibility of each school to remove their boat/parts once the competition is completed.

HAVE FUN!
MILK CARTON RAFT

The rectangle raft is a simple platform that floats on milk cartons. The number of milk cartons determines the weight that can be carried by the boat. This raft, which is made from a 4 X 8 sheet of plywood with a 2 X 4 frame, is floated by 132 cartons (11 rows with 12 cartons each). The approximate boat capacity equals the total carton displacement minus the boat weight and the difference divided by 1.5 (minimum). For this boat the approximate flotation capacity equals 528 lbs. (132 X 4 lbs per 1/2 gallon = 528 lbs) – 77 lbs (wood weight) = 451 divided by 1.5 = 300 lbs. We recommend that you test the boat to determine how the crew weight affects stability and handling.

Materials:
3 – 2 X 4 X 8 studs (weight 9 lbs each)
1 – sheet 4 X 8 plywood 1/2” thick (weight of OSB sheet = 50 lbs each)
½ lbs. - 3” screws to secure 2 X 4’s
1 lbs. - 1 ¼” screws to secure plywood to frame
132 - ½-gallon cartons
30 - hot glue sticks to seal cartons and to secure cartons to underside of raft
6 rolls - clear packaging tape to band cartons
MILK CARTON RAFT OPTIONS

Build a raft with a bow
Cut a point on a 4 X 8 sheet of plywood that runs from the center out to each side. Frame the bow with 2 X 4’s as shown in the diagram. Secure the plywood to the frame with screws. Add cartons to fill the bow area. Cartons may need to be deformed to make them fit into voids. Materials are the same as the raft, except add 1 more 2 X 4 (total 4 – 2 X 4 X 8’s) This boat will have 9 rows that are 12 cartons wide (108 cartons plus 10 – 12 cartons in the bow. The approximate capacity of this boat = 4772 lbs (118 X 4 lbs per ½-gallon = 472 lbs total displacement) – 77 lbs (wood) = 395 divided by 1.5 = 263 lbs

Build a smaller boat
Build a narrower boat that is 10 cartons wide. Cut the 4 x 8 plywood to 41” wide by 96” long. Add a point and build a frame as shown above. This boat will have 9 rows that are 10 cartons wide (90 cartons) plus 6 – 8 cartons in the bow (total carton displacement = 384 lbs) Materials are same as raft with bow. The approximate capacity of this boat = 384 lbs. (96 X 4 lbs. per ½-gallon = 384 lbs total displacement) – 77 lbs. (wood) = 307 divided by 1.5 = 204 lbs.