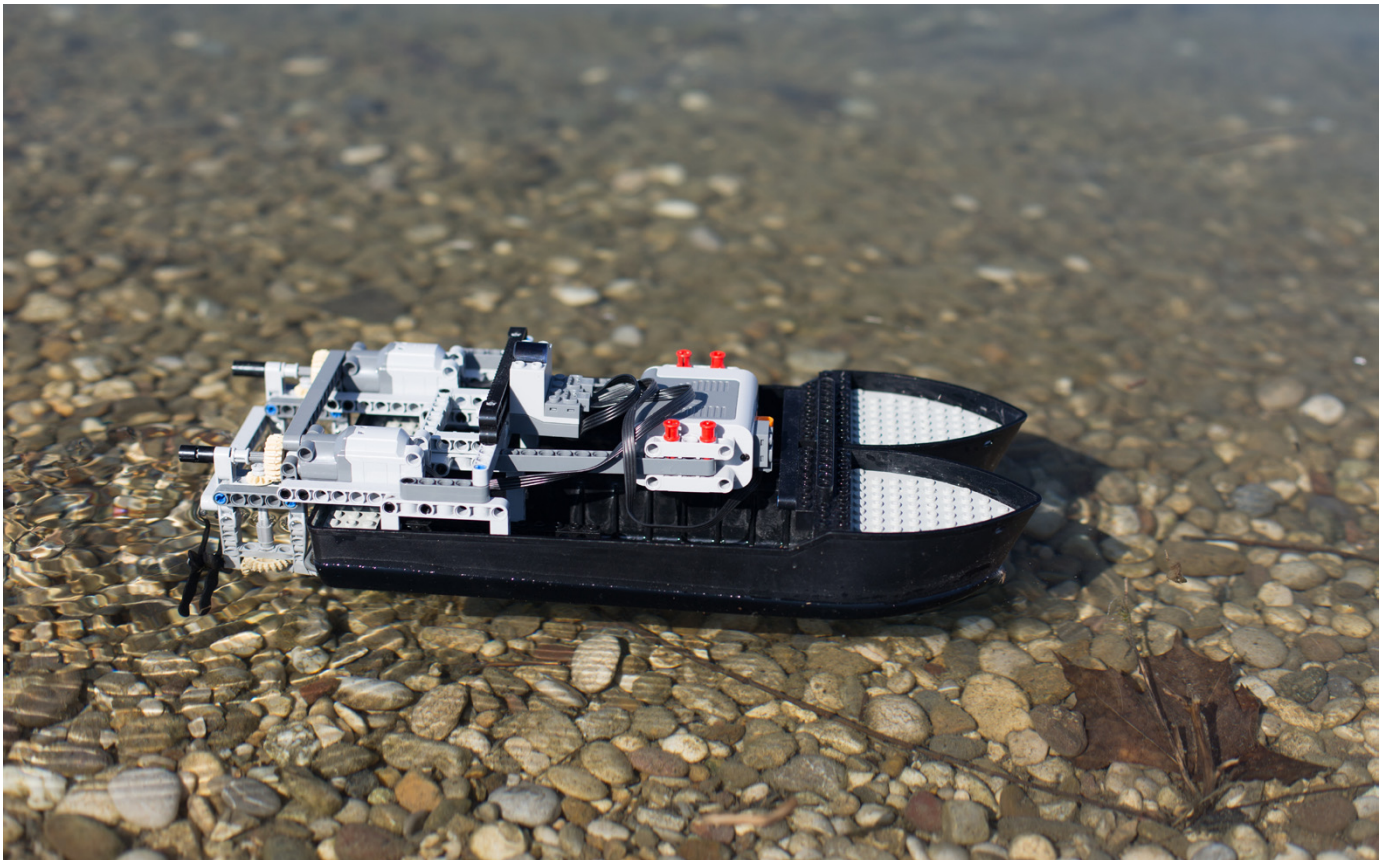
# Handling water with LEGO®

*By Oton Ribic*

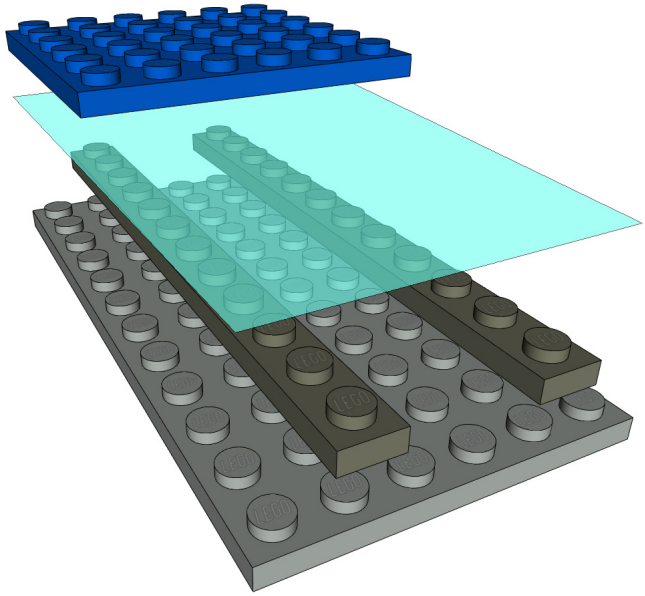
Despite the fact that boats and ships are a fairly common theme since its beginnings, incorporating real water in (or around) LEGO® models is still rarely seen. Reasons for that are quite obvious: narrow gaps between the parts and bricks, necessary for comfortable building, prevent sufficient watertightness to manipulate water — and even if they did, the hard plastic material they are made of would not budge its surfaces enough to stop the water passing in between. Anyone who has attempted to build a LEGO ship or a cup using only regular parts has invariably found it leaking.
One of the simplest solutions, offered by The LEGO Group, is to use the compact ship hulls. As their body is made of a single moulded piece, they float indeed, and yield enough displacement for a decent structure aboard. It is even sufficient to motorize them using Technic, though in that case more than one hull will probably be needed, in some sort of a catamaran layout, and maximum care must be taken to keep the electric parts as far from water as possible.
However simple and available in several sizes, compact hulls are only a limited solution for the cases when dealing with a marine vessel. For other applications of water, different approaches need to be taken.

## Rivers, pools, streams and flumes

A most common requirement is to try to keep water in a specific area, or to let it flow through a desired channel — such as a swimming pool behind a villa, a river or a stream as a part of diorama, an artificial flume of a watermill, etc. Unfortunately, LEGO purists will have to accept there is no universal solution using LEGO parts only (though some specialized parts may sometimes help, such as using the aforementioned ship hulls hidden under the surface), but there is an alternative which will satisfy even most of them — a sandwich technique.
The idea of this technique is to build a pool or a river bed in two LEGO layers, with a carefully prepared piece of watertight plastic foil between them. The outermost, bottom layer serves as a foundation that keeps the structure together, the foil retains water, while the inner, top layer hides the foil for a pure LEGO look. If a foil is flexible enough, studs and connectors will connect easily through it, so there are rarely problems with strength of the construction. Of course, even if a bit of water stays or flows under the top layer, between it and the foil, it does not matter and is barely visible.
Foil used in the kitchen (such as one for keeping ingredients fresh) is ideal for this purpose — it is flexible, durable, thin



Compact LEGO ship hulls are a convenient and a simple way to keep boats afloat, and allow enough weight even for electrical remote power. (Thanks to Sariel for outboard motor design idea). Picture by Marina Zrile

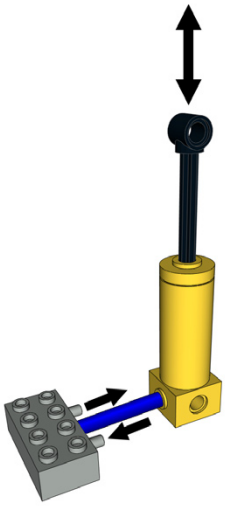


A typical composition of a sandwich watertight layout - the base at the bottom, distancers, flexible foil, and the cover (blue). Distancers help not to “overstretch” the foil.

enough to allow good stud contact through, easily cut and removed, long-lasting and comparatively cheap. Of course, any other type of a foil will serve as well if it is flexible and thin enough.
When employing this technique, make sure to build your water-holding structure entirely first, and then incorporate it into the rest, as it can be difficult to spread the foil if you don’t have easy access to all ends of the bottom layer.

## Water mechanics

Building functioning water pumps is possible, too. The point is to use LEGO® pneumatic parts, which serve quite well when repurposed for handling water. Whether you prefer to submerge the entire pneumatic pump, or employ a standard actuator cylinder connected to a distribution block (an older part, No. 4692) set to draw water from a container and pump it into a desired hose, is up to you — both approaches work. Of course, these pumps can be neatly combined with water containers described above.



A pneumatic cylinder combined with a distribution block can be used as a simple water pump, which is also easily motorized.

Keep in mind, though, that pneumatic actuators are factory-lubricated to reduce piston friction and improve airtightness, but through a prolonged use with water, most of that oil tends to be washed out. Therefore, do not employ this type of pumps for anything related to drinks, and if the pistons move with difficulty once the cylinders are dried out, apply a little silicone oil to restore their smoothness.
For vice versa situation, i.e. obtaining mechanical movement from a moving water mass, various water wheels can be easily constructed using standard LEGO parts, especially Technic. Do not forget that the amount of moving water will usually be very small and such wheels can only have limited efficiency, so try to let the water pass entirely over one side or at least over its quarter (in more precise terms: prefer overshot or breastshot design instead of undershot), and let the wheel perform only very undemanding tasks, requiring minimal torque. Gearing down will not help significantly — there is very little actual power to begin with.

A watermill with flume and waterbed build using sandwich technique and a simple water wheel. The force is sufficient to turn simple millstones in the house through a couple of gears and axles.

## Aqua-friendliness

For those that haven’t yet experimented that far, it is useful to know that, fortunately, LEGO parts show no negative side-effects from a prolonged contact with water, and hold together just as well underwater as they do on a workbench. Also the decorations and decals are of high quality and will not fade underwater — at least not more than they would anyway, in the air. Besides making it easily washable in a washing machine or a dishwasher (at low temperatures), this allows even for some custom aquarium decoration!
The exceptions are, to an extent, chromed parts whose coating sometimes tends to dissolve over time. It does not damage the parts mechanically however, but only their shiny look. And of course, electric parts should never contact water at all.

LEGO bricks have no side effects from prolonged contact with water. A personalized decoration for an aquarium is just one among simpler possibilities.

## Diving deeper

Finally, we can consider a difficult but an undoubtedly attractive idea of a remotely controlled LEGO® submarine. In theory, it may work — a sandwich method mentioned at the beginning may be used upside down, to provide an underwater air bubble where all the Power Functions parts would be contained, with axles and control rods entering the water underneath and leading to the various propellers and control surfaces via various gearboxes and mechanisms.
Needless to be said, such a submarine would be very sensitive to turning sideways, and would need an additional weight in some sort of a keel to counter the lift of the bubble. Finally, its control range would be limited because of water being relatively opaque for infrared light.

On the other hand, if you are ready to introduce more non-LEGO parts, an option is to wrap all the electrical components into a plastic bag, which should make the entire system safer and less demanding for a counterweight. But keep in mind that the motors, although initially functional, can get damaged if submerged, particularly their bearings.
Because of these reasons, unless you are ready and willing to risk lots of expensive parts and endure some frustration, a submarine controlled from above the surface with a couple of handheld pumps and hoses, controlled with submerged pneumatic cylinders, is a vastly more rational idea, where much less can go wrong — in the worst case, the parts will need to dry on a spread towel for a couple of hours.
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**Water handling tips in a nutshell**

- LEGO parts and their decorations have no negative side-effects from a prolonged contact with water. Exceptions are chromed parts which fade, and electrics that should never touch water.

- Watertight structures using only pure LEGO parts are next to impossible, except for some specialized parts such as compact hulls.

- Simple method to build a watertight structure is a sandwich technique: narrowly fitting double layers or hulls with a watertight flexible foil in between. It works both for keeping the water away, such as for ship hulls, and for retaining it, e.g. for river beds and swimming pools. If accurately done, the foil can not be seen without disassembling the model.

- Pumping water is quite easy using LEGO Pneumatic parts, where they are employed the same way as if they were handling air. But do not use it for making drinks, and keep in mind they might need some extra lubrication afterwards if the original one gets washed out.

- Water wheels work, but try to keep water falling over as much of their surface as possible. Even then, do not have high expectations from obtained power.

- For controlling submerged models mechanically, prefer pneumatics controlled by handheld pumps via long hoses.