

Anatomy of a Boat

by John Lord

This exhibit, I don't know how many of you have _____ in a boat shop, and it really consists of four sections. The first is about water, because, to me, you can't get the boat without water. Water is what determines the whole anatomy of a boat. The first exhibit is under some Plexiglas. There are four of these diagrams and then there are also written things for those verbally inclined and if they don't have that much interest there is a series of cartoons that are along there that have the same message, that we have found in various places. There are three ways to getting out to the visitors. The second section is some samples of material. A section of a log and how it is cut for wood and samples of aluminum, steel, Plexiglas that sort of thing. A few fastenings and pictures of chemicals _____. The third section covers construction and there are some beautiful scale sections that Joel Gleaner made for the vessels that are in the yard here. These things are really powerful pieces of communication on how boats are built, long boats, log bottom, parts and construction. And then there is a fourth section which isn't operational right now because it involves water and possibility of freezing and so forth. And it is sort of an experimental "hands on" thing which is an old wash tub full of water and four different cross sections that look like this, and people can let them float and see what happens. We thought originally that it would last about a week, but it has been up for almost a year and seems to be fairly interesting. Especially to the kids. There is a round one which you put in that has absolutely no ability, it will roll. Then there is a real wide flat one that is real stable. Then there is a square one. Square ones have the characteristic of floating on a diagonal. This surprises people. They put them in square and they pop over on a diagonal. And then there is one with a center of gravity that is ballast and people can _____ all that they want to. That will be set up again as soon as I find time to do a little paint work on it. The section on water is first because it is where boats live and it's the most important single factor in determining the anatomy of a boat. And of course, water, as you all know can be in three states. Solid, liquid or gas. There have been ice boats out there. I don't know how many were here two years ago when there was the International Ice Boat Championship. Then of course steam. A lot of boats in the past have operated with steam on the bay. Many of the steam boats came from here. And of course almost all ferry run vessels operate on steam. As a liquid, which is principally what boats are concerned with,

water has very definite quality. It is almost incompressible. It is fluid, which means the particles move among themselves without almost no friction and that is by the action of gravity, the water seeks lowest point and the top of it is _____ rest for awhile, it is usually level. Always level. Now the density of water is practically constant, and it is 62.4 lbs. per cubic foot for fresh water and 64 for salt. Just to give you a feel, this is a cubic foot. If that were full of water it would weigh depending on what kind of water you put in it. There is another word that seems to describe water. Responsive. People most of the time are on solids and deal with solids and these are to a certain extent unresponsive. It is just as well, because most of us forget all these natural laws that describe things. These natural laws to me are something you have to observe, whether you understand them or not. They are not like to manmade laws that can be ignored at times, but there to me is the whole difference between on land and in a automobile, it doesn't make any difference what side you sit on or anything like that, but in a boat the minute you put anything, the water responds. Maybe I can demonstrate that a little more. There is a solid in a liquid. I can tilt this a little bit and nothing happens with the solid, but the water responds immediately. Nothing will happen until I get far enough so that the center of gravity gets outside of the base and then it takes place all at once. Most solids, wood and things like that, are lighter than water. Then of course you get into concrete and that sort of thing, and they are heavier. If a thing is homogenous, the same material all the way through, the density is lower than 62.4 lbs. per cubic foot, it would sink. If it less than that it will float. Boats are usually hollow structures, and they float whether they are steel, concrete, glass, or wood, anything on hand as long as the volume that they displace in the water is larger than the equivalent replacement. The reason that they do that - Archimedes was the guy that discovered when things displaced their own weight, and I guess they had to wait quite a long time for Newton to explain why. In water, because of its fluidity and density of it, there is pressure, and that pressure can be demonstrated. Here is a presto pan that has the bottom out of it. I put it in the water and nothing happens. Now take one with the bottom in it, you will notice that there will be additional weight on it, there will be force on the bottom of this, and the force will increase as I increase the depth. Non force is the product that the pressure in theory, on the bottom of the pan. That pressure on the hull of the boat is what makes it float. Because you are physically displacing the water and it will go in the hull, but it will resist with whatever pressure there is there, depending on the depth. Anybody have any questions on that? Because that is a real important point. This illustration shows that the pressure, lets say a foot

depth, is just what is necessary to hold up water that is above that, and it keeps increasing as you go down. That pressure acts in any direction, it doesn't matter whether up on the bottom of the boat or down on the bottom of the river or out on the side of the dam, the bank, it has a given depth of a certain magnitude and it will push up or down or sideways or diagonal or any direction.

Question - _____ -

The pressure increases. After three feet deep, you are supporting over one square foot you are supporting three, instead of two here or one there, so it floats up. So in terms of pounds per square inch, which is what the measure is, it is about a half of pound per square inch for a foot of depth. It just keeps going up. That is why some submarines can only go so deep.

Question: You say some boats are made of concrete. Is there any advantage to that?

Well, during World War II they tried to make a lot of the big vessels out of concrete and also ended up in breakwaters. It is not particularly a good material but currently it has been revised with ferrous cement which is a material more dense. I don't know a lot about it.

Once you get into the water, it is the problem of being stable. You almost have to talk about the center of gravity, centers of buoyancy. I am sure some of you are going to say these are a big mystery. They really are not. The center of gravity is just a place in a solid where it will be balanced in any altitude. Gravity is pulling down this direction. And it will always pull in that direction. If we hang this block of wood up, it hangs in a specific altitude and it displaces the matter. Gravity is acting straight down along that line there. If you hang it from another place it hangs from a different altitude, and the line of action and gravity is down that way now. At this particular point, they intercept so if we hang the thing up there, it is stable that way or that way or that way. So it is eight point where you would consider all the mass of thing concentrated and the force of gravity always acts from that point straight down. The shape of the displaced water has a center of gravity, just the way this does. We call it the center of buoyancy, but depending on the shape of the under water body there is a center of buoyancy. If the boat is at rest you will find a buoyant force is pushing up and is right in line with the center of gravity. The center of gravity can be above it or it can be below. But once the boat begins to heel, the underwater body changes shape and the center of buoyancy moved. If she is floating level that would be where the center of buoyancy was. If she heels under the pressure with wind on her sails, that center of buoyancy moves. You see, it moves way off to one side. The vessel itself is essentially solid and except for people in _____ water, everything stays where it is no

matter how the boat works. So here is the center of gravity. Now, I also put these other two centers and once she is floating normally upright...if I can balance it good enough and it is really a balancing act. That's why anything that changes in the boat makes it move. I can't make it balance there, but I assure you it does when it is level. When she is still and the center of buoyancy is moved way over, you see there is a very positive moment in to right the boat and it comes from the change in underwater take. Most of you are probably familiar with deep keel sail boats where the center of gravity is way down below the center of buoyancy and the more it keels, the more powerful the righting movement you get until she is knocked down completely with an enormous righting arm. It is sort of touch a go when she is keeled way down, whether it will come back or not.

(JOHN LORD IS TOO FAR FROM MICROPHONE...CANNOT UNDERSTAND)

.....keep going. Now this is what bilge water does, it destroys that by changing shape of your underwater volume and it runs down into the lower _____ instead of having a lot of displacement down here in the right of the boat it is all full of water and then you just set that rectangular section down there and the center of buoyancy is way back into the center. The same thing is true with people moving around. Every time a person moves it moves the center of gravity. This is why you don't stand up in a boat because you move the center of gravity up so high it makes it unsafe. These are the same conditions as far as a boat is concerned, but here is a guy sitting down with his center of gravity is over here with a positive righting on and a guy stands up, the center of gravity takes over here. Of course sometimes on a wave, a wave will come along and change the under body shape and _____.

Any question on that?

Question: Yes, I like to ask a question. I don't want to appear any more stupid than I am. How the Rosie Parks keel laid?

I think 1955.

Question: How many columns _____ did _____ lay that keel _____.(too far way)

This is an experiment. Most development on the ships. For instance, in ships almost all the development has just been trial and error from way back.

Question: I mean the original Rosie Parks keel. Not the 1900's. I mean how many boat before that were laid without the assistance of professional help?

Probably all of them on the Chesapeake. It is just a matter of experience. When the first guy went out and lost a canoe and it turned over, and he decided to do something about it to stop it. This is the beauty of these natural logs. They don't care who you are or where you come from or anything else. They act and they act immediately and punishment always fits the crime.

Question: You have a picture of the stern of a boat and the bilge water _____, and you said the center of gravity tended to be moved over?

The bilge water changed the center buoyancy, or vice versa.

Question: When the bilge water in the little boat sank, the boat tend to go even more than if there was no bilge water on that side. Therefore, I should think that the center of buoyancy would be more over on the side where the water is.

Yeah, but the water inside the boat isn't helping support it. It is helping sink it.

Right...but I should think that it would tend to sink it on the side where the water is collecting.

It moves in that direction.

Never mind. Go On.

All I am trying to do is to give you people enough familiarity with this, so if you are asked questions about the exhibit, you will be able to answer. As this gentlemen pointed out, this is necessary to build boats, and people have been building boats for thousands of years without anybody putting a finger on an explanation of why it happened. There are natural laws and if we don't obey them.....

Once we get the thing afloat and stay upright, we have to think about how to make it move. Newton's law about how to make a boat float, for every course there is always a reaction that is equal. If you can push on a boat, it will move. As it moves, it has to push aside the water and slide by it. You can push on the bottom, or push with a paddle on the water, or you can have a tow line, oars pushing on the water. Just as a matter of interest, a single oarsman and a good shell for six or seven miles. An eight oar shell, such as in the world series, those boats go a mile and 5/16 in about six minutes, which is 11.3 miles. These forces that are created when you move the boat can develop fairly large magnitude. If you have a boat that is the right shape and you can move it fast enough, the push aside force is enough to support the weight of it. And that is when a boat planes. It is the same thing that is true on water skis. The skis are trying to push the water aside and the force that is required to push it aside has to be fast enough to keep the people up above the water.

Then of course, the wind. The wind develops forces depending on the velocity. You build up about a square of velocity, so that a twenty five mile an hour wind is about two times per square foot of pressure on your sail. At fifty knots, it goes up to seven. So this is why a small change in the wind makes a lot of difference in the way your boat handles.

The next one is about steering. Here again all you are doing is changing the forces that are acting on the boat. The oars and so forth you can push harder on one side than the other to make the boat turn. With an outboard you usually change direction of thrust in the motor, it always looks like the knob is turning, what is happening the stern is giving around into. Try to turn close to the dock and you realize that real quick.

Of course, stern drives also change direction of thrust and with twin screws you can run one engine faster than the other and change thrust on the thing.

Of course the rudder is another way of steering a boat. You just move it to one side and the force of the water pushes the stern over.

Of course there are a lot of new ways steering gears are arranged. In a small boat, you can frequently steer it just by shifting the wake. I have a little aluminum john boat and I set the outboard on and I just sit there, lean this way or that way and steer it without ever touching the motor.

Question: Sculling the boat is the same thing?

Are you talking about a single wore over the stern?

Yeah.

You work up a forward force and how far you go on either side determines which way you go. A little tricky.

About material. The traditional material on the Chesapeake Bay of course is wood. Anything that actually can keep the water out can be used for a boat. Eskimos' used skins and thicker canvas kayaks, of course metal and concrete, plastic and glass all work. Usually the choice of materials and the construction details depend on what is available in the way of material. Fastenings and tools. Log canoes which were around here even before our settlers got here, just need a tree and a fire and a few tools. Then of course if you have a saw pit or a saw mill then you can build up a boat. Then there are a lot of things in between there. The block wood, the frames on the top side.

The other thing that affects the anatomy of a boat of course is what you want to use it for. Work boats usually have to perform specific functions, carry loads and hopefully make a profit.

Pleasure boats, their requirements provide recreation or creature comforts or to buoy pride or establish status, things like that.

Of course, the method of propulsion. If you are going to put a lot of power on the boat, it has to be one form so it will plane, and if you want to get by with a little bit of power it is displacement type. Any questions?

(apparently a question is asked here, but you cannot hear anything)

Well, sounds like it is pretty dense to me.....just one of the _____ hulls out of the water on a very, very narrow edge and you balance. It takes a great deal of skill to keep them going. There have been a number of real serious accidents, when people try to take this type of thing to deep sea, across the Atlantic and so forth. A lot of them have been successful, but they also don't take care of themselves quite as well as an old fashion single hull.

(another question that cannot be understood)

Well, Joe can probably tell you more about tack boats than I can, because he is a nut on them. He has one. They were a work boat in the Cape Cod area and they are very wide and usually the beam is somewhere near half the length so they are very stable. Very shallow craft centerboard type. Do they usually ballast them Joe? Around Cape Cod they were used for fishing originally and then they became pleasure boats. They are great in shallow water. Real nice boat to look at.

Question: You said they are so great in shallow water and yet they have a draft of five feet, which I thought was extraordinary.

With the centerboard down probably.

They didn't say that.

That's the problem with newspaper articles. I hope there are no newspaper people here, but I never have read a newspaper article where I was completely familiar with all the details and the thing that they were describing, and almost be able to recognize it.

I thought five was a lot for a lot bigger boat.

Yes. It is probably when the board hangs straight down. I think it is probably about 20-24".

(someone else talking.....about 2'3", 2'4" for those type boats.....They have to have a deep centerboard....The centerboard is not for ballast. The centerboard is just to give you more lateral resistance.....Where do they ballast? _____ but they don't put that right in the center. If you put it right in the center it makes too much of a snappy boat and you will break the mast out. You have to spread the ballast out over the box

so that it rolls slow.....The centerboard might have a little weight on it to help sink it when it drops down, but.....

(A LOT OF BACKGROUND TALKING AWAY FROM MICROPHONE)

Thank you for being so patient and listening to me.

APPLAUSE

SOMEONE ELSE SPEAKING.....

The Chesapeake Bay region is kind of quite unique in the boats that are around here. Like John said, they are all built for a specific purpose. I am not talking about pleasure boats. I am talking about work boats. What man has to have to make a living. If they didn't produce, why Herb just got rid of his boat and got another one that would give him more of a return on his investment. A lot of things have been developed here on the Bay due to that fact. They found out, for instance, that you can make a better living with a bigger boat dredging for oysters than with a small one. Therefore they increased the size of the boat and used different kind of dredgers and things like that. All dredgers are not the same. According to what kind of bottom you are going over, determines the kind of dredge you use on the boat and the size of it too. A lot of old boats have found other ways of loading up your deck with oysters. The size of the boat has changed too, because it cost you more to pay for your crew. Before you could afford to pay a couple of guys to just sail a boat. Of course, on a big boat you have two crews. One to sail the boat and the other to dredge the oysters, and so forth. So that actually changed and therefore they made a smaller boat. The maker of the boats cost was rising, so therefore they had to come up with a cheaper method of getting the equipment across and being able to get a bigger return on the amount of capital they put into it. Of course, some of the boats down here, the people have the idea that this was the only place that had them. The boat proposition has moved all up and down the coast. Of course back a ways, when the schooners here use to take oysters out to Long Island Sound and New England south, they saw what was going on up there and came down here. A lot of ideas are interchanged and so forth. For instance log canoes, they used them up in New Haven for years and years. There were fellows up there, that is all the did, was trim a lot of canoe. They would go out in the woods and find a big tree on somebody's land and buy it, fell it, chop out a canoe, load it on a wagon and bring it in to sell it to an oysterman. Those fellows up there discovered that the log canoe was easy to clean out

and so forth. I think it is kind of interesting to know where some of these things are and find out about them. Some of the visitors that come around, you would be surprised, if you start asking them questions you might discover a lot of things you didn't know had existed. Of course, we have a very nice little museum over on the Western shore at Soloman that is quite a source of information. They have a very nice library there. The same as our library here. You find out a lot of information there. Of course, we got in on the ground floor on some of this information..... END OF TAPE