But Why: A Podcast for Curious Kids

How do water slides work?

March 10, 2023

Jane 00:21
This is But Why: A Podcast for Curious Kids, from Vermont Public. I'm Jane Lindholm. On this show, we take questions from curious kids just like you all over the world and we find answers. It's still cold and wintry here in Vermont, so we wanted to head somewhere warm and tropical-feeling (and really fun) for today's episode. But we also didn't want to have to go too far. So we drove up to northern Vermont, right up near the Canadian border, to an indoor waterpark to research answers to your questions about waterslides. At Jay Peak Pump House Waterpark, we met up with Leland.

Leland 00:59
I'm from Saranac Lake area.

Jane 01:01
And how old are you?

Leland 01:03
10.

Jane 01:03
How do you feel about waterslides?

Leland 01:05
I don't really like them that much. I just like the smaller ones.

Jane 01:09
How do you think people make waterslides?

Leland 01:12
Well, I actually do know the answer to that. And it's like, it takes a lot of pieces. It's like a gigantic puzzle. It takes a lot of pieces.

Jane 01:22
You're totally right. And you know the other thing that's kind of amazing about them is they have to fit somebody who's your size and somebody who's my size, and we are totally different sizes, right?

Leland 01:31
Yeah.

Jane 01:32
How do you think they do that?

01:34
I don't know. They just have to keep measuring and measuring about different angles and how, what materials they're made out of.

Jane 01:43
So are you going to do one of these water slides today or stick to the lazy river?

Leland 01:49
I don't know. I'm thinking maybe tomorrow.

Jane 01:52
We had a lot of questions about water slides, too. My first attempt at research was to try going down one. I did that a few times. And while I learned a lot about how and why water slides are so much fun, and sometimes a little bit scary, I didn't get very far in learning how these things are made. So I dried off and called up some engineers whose hold jobs are designing and building waterslides. And sometimes roller coasters, too. Songyi Moon works at a company called WhiteWater West.

Songyi Moon 02:23
I'm development engineer from WhiteWater.

Kelly Sall 02:27
My name is Kelly Sall, and I am the product manager for water rides at WhiteWater West.

Jane 02:33
What's so hard about making a waterside? You just, you know, you put like a piece of slippery plastic down and make it go in a downward direction, put a little water on it, you've got a water slide. But there's clearly more to it. I mean, we wouldn't be talking with engineers if it was that simple. So Songyi, what goes into making a waterslide?

Songyi Moon 02:56
There is a lot of math and physics going on behind the waterslide. When you design the waterslide, you have to think about how fast it goes. And then how much energy you have, and so on. So there are lots of math and physics you have to think about, in addition to just water and plastic to make a slide. Also the slide material and how much water flows on the water slide; that makes a big difference. And also weight of people and the type of rafts, that makes a big difference for the speed.

Songyi Moon 03:30
Kelly, I as a, you know, water slide rider don't want to have to think about math and physics when I'm riding on a water slide. But maybe you, as somebody who's developing water slides and other kinds of

rides, that's key! So everybody who's studying math right now in school, this is the kind of thing that you might be able to use all of that math knowledge for in the future.

Kelly Sall 03:40
Yeah. The big secret is that the math is actually not that difficult. It's about a high school level of math that we use to design the basics of the waterslide. You know, it's it's gravity and it's it's friction. Songyi was was right, like, it's, it's more difficult than you might think in the range of operating conditions that we have to recognize, you know. We have to make the sure that the slide is fun and safe for itty bitty people and big people as well, make sure it's fun and safe on a rainy day as well as a hot sunny day.

Jane 04:22
Hmm. So what kinds of things go into that kind of thinking as you're designing it, all of the different ways it has to be safe and all the different kinds of people who might be riding it under different conditions? And even to the point of, like, what kind of swimsuit are they wearing and how does that affect the friction or how fast they're going to go on the slide?

Kelly Sall 04:43
Yeah, swimsuits is interesting because all around the world people wear different kinds of swimsuits. And there's parts of the world where swimsuits aren't allowed and you have to wear something else. So we have to make sure, again, that our our slides and rides are fun and safe for a whole bunch of different kinds of people around the world.

Jane 05:01
Just to be clear: in the places where swimsuits aren't allowed, people are still covered up. They're just wearing clothes that cover their arms and legs. There is one specific thing that makes water slides work and that is friction, or really the lack of it.

Songyi Moon 05:18
Friction is the resistance of motion when one object rubs against another, anytime two objects rub against each other, they cause friction, even when you wash your hands in water or cleanse your hands with a soap. So water park is wet and water has interesting characteristics when it contacts different materials. So there are different materials used on the waterpark depending on the application as well. So when people walk on a deck, we don't want people fall down. So people use higher friction material. But when people slides down through the slide, we don't--we want low friction so people can slide fast and they have fun. So for the water slide water, water between your skin and fiberglass creates low friction and make your body skid down fast through the slides. Also, some water slides use rafts.

Jane 06:19
The water slide I went down at Jay Peak required rafts. It's really just a floaty tube with a hole in the center of it. So I grabbed one at the bottom and then I had to walk up and up and up and up several flights of stairs to get to the top of the slide. The water was pumping out of the top of the water slide and rushing through the tube. So when the lifeguard told me it was safe for me to go down, I plopped onto my raft, and I let the flowing water carry me from the flat top of the slide down into the tunnel as it

started to head downward and twist and turn. As Songyi said, the important forces here are friction and gravity. On my walk up the stairs, the people who made the waterpark made sure I didn't fall by having the walkways and stairs be not slippery. There was a lot of friction between the surface of my feet and the surface of the stairs. But when I got on the slide, they wanted there to be less friction, less resistance between my body and the surface of the slide so I could slip downward. They did that by making sure the tube itself, the waterslide, is a really smooth, slippery material. And then they added water, which makes it even more slippy, and then the raft, so I can kind of float on top of the flowing water. Since the slide started at the top and basically pointed downward, gravity helped pull me toward the bottom of the slide. And the fact that there was little resistance, little friction, meant I could go pretty fast. Now, when someone is designing a waterslide, sometimes they're not designing one that just goes straight down like the slide on a playground. You might be twisting and turning and sometimes even going upside down while you're riding a waterslide. Designers have to calculate how much energy you need to get over those bumps and around any curves. The taller and steeper the slide, the faster you can go. But it also depends on you, too.

Songyi Moon 08:23
So it's all about energy.

Jane 08:25
The potential energy you create by going high up to the tippy top of the slide, and then the kinetic energy--the energy of motion--created when you start moving down through the slide. If you have enough energy, you can even do a loop where you go upside down for a second or two without sliding backwards. At the end of the slide it usually flattens before spitting you out into the pool. That's to slow you down. While we were riding the rides at Jay Peak, we talked with six year old twins Tiago and Juliana, who shared both a birthday and a question.

Tiago 08:57
How do you get all the water for it?

Juliana 09:00
How do you get all the water in the water slides?

Jane 09:03
Tiago and Juliana weren't the only ones wondering that.

Roxy 09:07
Hi, my name is Roxy. I'm seven and a half. And I'm wondering where does all that water come from?

Jane 09:14
Water parks use a lot of water. Like one water park might take 900,000 gallons of water just to run the slides and pools! That is such a big number, it's kind of hard to even imagine. But let's just say it's a lot of water. But luckily water parks don't have to pump in that much water every day. The water park industry says that most water parks, once they're filled, are really reusing the same water over and over again. That sounds kind of gross, but water parks also have filtration and cleaning systems to make

sure the water stays good. And there are lots of chemicals like chlorine in the water that kill germs. So definitely don't drink the water in a water park. Water parks do lose some water in the cleaning process and from water splashing out of the pools. And at outdoor water parks, a lot of water can evaporate in the hot sun and need to get replenished. But how does the water that flows down the slide and into the pool at the bottom get back up to the top of the slide? Well, water parks use pumps to carry water from the bottom back up to the top. The pumps create pressure by using a motor with a propeller that moves water particles up a narrow pipe. And water can be moved through many different parts of the park before it goes back up to the top of a slide again. If a water park is in a cold environment, it will be heated by water heaters so you're not shivering through your fun afternoon. The people who design rides want them to be fun and fast and a little bit scary. Coming up how do engineers and designers balance thrills with safety? And why do they sometimes say you're too small to ride?

BREAK 10:55
BREAK

Jane 10:55
This is But Why: a Podcast for Curious Kids. I'm Jane Lindholm. Today we're learning about how waterslides work. We're talking with Songyi Moon and Kelly Sall of WhiteWater West. That's a company that makes water slides and water parks. When you're going fast on a slippery slide, and there's water rushing all around, you want it to be exciting, maybe even just a little bit scary. But how do engineers design slides that make you feel a little nervous, but in actuality, are really safe? And not just safe for you, but safe for your little sibling and your big adult chaperones, too. Here's Songyi Moon.

Songyi Moon 11:33
There is the safety regulation. We follow the guides to design the water slides. So all the slides are safe. And then we test enough. We even build a prototype at work, and then test with either in a smaller scale or actually size. And we test it and then go through a few iterations. And then we change if anything necessary. So it we test it, and then prove it's safe enough to go to the public. And then even when we build in an actual water park, we go through lots of testings to make sure it's safe to open. And then people or kids, parents, grandparents, everybody can join and have fun at water park.

Neomi 12:26
My name is Neomi. I'm seven years old. I live in Everett, Washington. And my question is: do you have to be a certain age to go to a water park?

Songyi Moon 12:36
Oh, yeah, that happened to my daughter too, when she was too young.

Jane 12:41
Sometimes water parks want to make sure you're big enough to ride the rides safely. Your height can be important, and also your weight. Because how much you weigh helps determine how fast you're going to go. If you're not moving fast enough, you might actually slide backwards when the water slide goes uphill or around a loop. So each water slide has a height and weight limit. But engineer Kelly Saul

says it's also about how old you are and how well your brain and body will respond to the ride. And sometimes a height requirement has more to do with your age than actually how tall you are.

Kelly Sall 13:15
When it comes to kids, the height limit is an important factor for us. And it's not actually, in in the rides that I work on, it's not actually the height itself. It's more the height is an indicator of how old a child is. And we find that there comes a certain age where kids are able to intuitively hold on to things and brace against forces. And below that age, then the rides can be quite dangerous for them. They won't know how to anticipate a turn or be able to hold on tight through a certain section. So height is usually an indicator of of age and maturity. The problem these days, though, is kids are getting bigger younger. And what was an acceptable height limit 20 years ago may not be an acceptable height limit today. And that's something that we struggle with.

Jane 14:11
Is there are a top speed that someone can go on a water slide?

Songyi Moon 14:16
It's a tricky question.

Kelly Sall 14:17
Do you want to handle this?

Songyi Moon 14:19
Because we don't go with the speed, it's more like acceleration. So we have a standard that governs those acceleration limits. And then it depending on...also that standard is governed by different countries as well. So we can't really say this is the top speed. And then also depending on the weight of the people and then the water condition, that produces different speeds so we can't really tell you what's the top speed.

Kelly Sall 14:55
We do have a slide that starts with you standing in a little capsule and you're standing on a glass floor, looking straight down into a slide, almost straight down. And then there's a countdown and somewhere between two and one, that door opens and you drop into the slide. So for that brief moment, you feel like you're going pretty fast.

Jane 15:18
Kelly has also worked on designing roller coasters. And he says roller coasters are actually kind of more simple to make than waterslides.

Kelly Sall 15:27
Because you've got this big train, and it's sitting on a track. And you always know where the train is, because it's on the track. With a water slide. You don't have a train, you have people. And as we mentioned before, people come in all shapes and sizes. So we don't always know where people are going to be. So we have to make sure that the ride is built in a way that you can still have fun and be

safe, even though we don't know exactly where you're going to be. And that's why you can write a water slide over and over again and have a different experience. If you're on a raft, you might be pointing backwards, sometimes you might be looking somewhere else. So that's the main difference between water slides and roller coasters. They're both fun, but our challenges in designing water slides are, I would say, are a little bit more.

Jane 16:13
When it comes to all these rides, I can sometimes get up the courage to ride a roller coaster or slide down a water slide. But I have to really work on my bravery. I'm envious of those of you who have no fear and just enjoy the thrill. But you know, if floating down the lazy river is more your style, that's cool, too. What I liked about putting together this episode was learning from Songyi Moon and Kelly Sall, of Whitewater West, all the different elements engineers have to think about when they're designing rides. Thanks very much to them for helping us understand that. Engineers and designers are using math and physics. And then they also think about ways to make rides feel thrilling, like sending you into a tunnel so you're plunged into darkness and can't tell that the ride is about to get really steep. Or making the ride look cool from the ground so you really want to ride it. Amusement parks even think about what to call a ride to make you want to ride it and whether you should be able to see part of it from the highway or parking lot, so you get your excitement up before you've even entered the park. Now that you've listened to this episode, see if you can design your ultimate roller coaster or waterslide. Draw a picture of what you would create if you were a ride designer. Then have your adult take a picture of it and email us or tag us on social media. We want to see your monster rides. You can email your designs to questions@butwhykids.org, which is also the email address to send us your questions. Have your adult record you telling us your first name, where you live, how old you are and what you're curious about. We take questions about anything and everything. We can't answer all of them. But we love knowing what's on your mind all the time. But Why is produced by Melody Bodette and me, Jane Lindholm, at Vermont Public. Our team also includes Kaylee Mumford and Kianna Haskin. Our theme music is by Luke Reynolds. We'll be back in two weeks with an all new episode. Until then, stay curious!