



Teacher's Guide for

Samson's Columns

All activities in this document should be performed with adult supervision. Likewise, common sense and care are essential to the conduct of any and all activities, whether described in this document or otherwise. Parents or guardians should supervise children. Rock-it Science assumes no responsibility for any injuries or damages arising from any activities.

Note: This is the transcript of a lesson that was videotaped during an actual Rock-it Science class with real students, not actors. Filmed April 2012.

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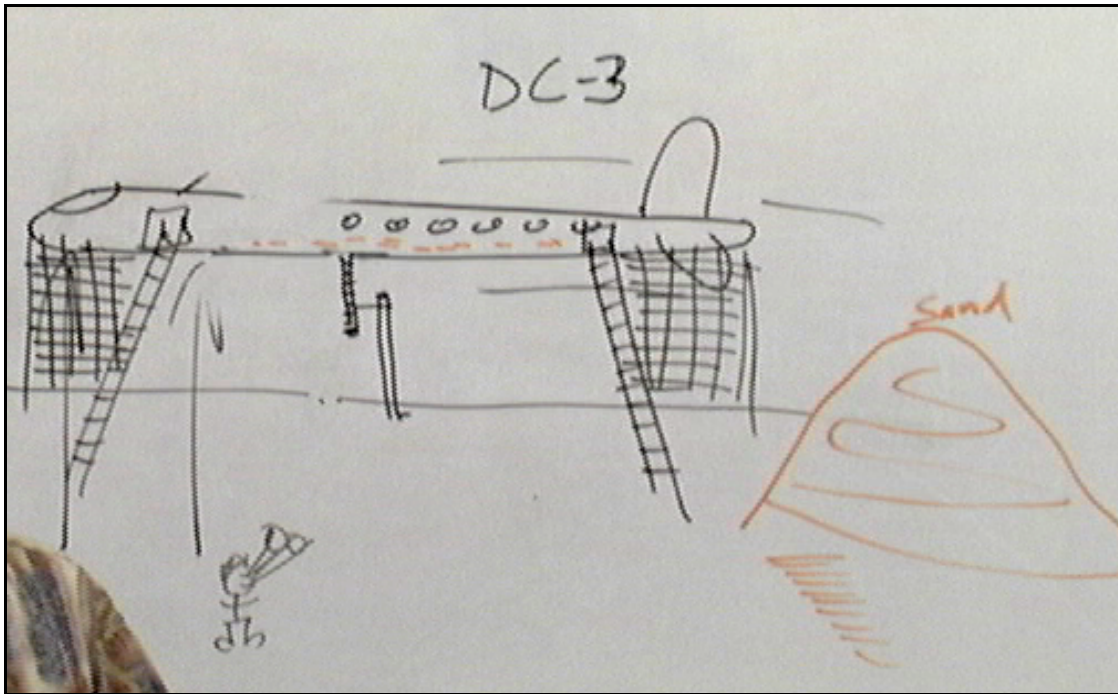
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Rock-it Science

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Intro Quick Recap:



- In the old days, if you wanted to build a plane, you had to draw it and get someone to build it. Then you needed someone to test it to see if it would fly.
- Around 1935, someone built a plane out of metal instead of cloth and sticks. They put the engine on the front, but it was too loud for the passengers. So they put the engines on the wings.
- Then they needed to test it to make sure the body of the metal plane was strong enough not to break if it hit an updraft. But they had to do it without real people in the plane.
- They did a test with just the body, no wings. They set it up on wooden supports at the front and back to hold it off the ground. Then they put openings near the front and back, with ladders going into them.
- They got high school and college kids to fill sandbags, climb one of the ladders, put the sandbags in the passenger seats, and exit down the other ladder.
- They attached a ruler to the bottom of the plane with an indicator so they could tell if the body of the plane was starting to sag.
- After a lot of sandbags were loaded onto the plane, it did start to sag a little bit and make some groaning noises. The guy underneath who was reading the ruler moved further away and continued reading the ruler with binoculars.
- After they continued to load sandbags, the school kids started hearing the “ping” of rivets breaking.
- For their safety, they stopped going inside the plane and started adding sandbags on the roof instead.
- Eventually, the plane started sagging a lot, so the kids cleared out.
- The engineers thought it was great that the plane was so strong. Then all of a sudden, all the rivets started to fail at once, and it sounded like a bunch of machine guns firing.
- The plane crashed to the ground like an earthquake.

Experiment Quick Recap: “Samson's Columns”



- The objective is to use a single piece of paper to hold books off the ground at least as high as a finger width.
- The paper can be cut or folded in any way to support the books.
- Teacher demonstrates some ways of folding paper that won't support a book. Then roll the paper into a tube that will support a book.
- Provide students with tubes and other objects that they can wrap the paper around and tape it to make a shape to test.
- If they want to have multiple legs for the books, they can cut the paper into several pieces. But they can only use one sheet of paper per test.
- Students prepare their paper and continue stacking books on it until the paper collapses.
- Then they take the stack of books and weigh them.
- Then they go to the whiteboard and write their name, how many pounds of books they held, the shape of their paper support, and how many supports they used.
- Students do as many tests as time allows.

Equipment List: “Samson's Columns”

Items needed for Instructor:

- Paper cutter
- Tubes or rods for wrapping paper
- Bathroom scales, two
- Whiteboard and markers

Items needed for Students:

Consumables:

- Paper, 8 ½" x 11", several sheets per student
- Tape, cellophane, a few rolls to share

Non-consumables:

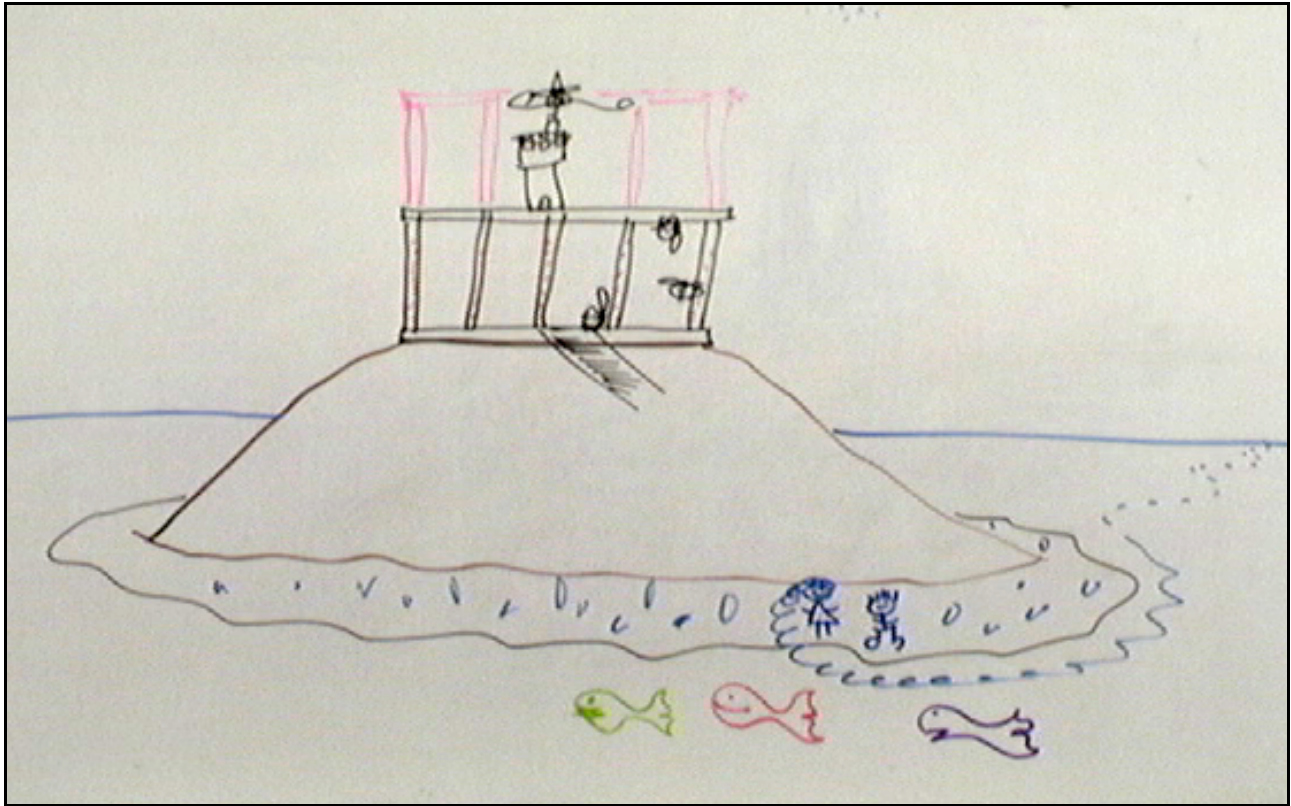
- Books, hardcover, at least 5 per student
- Scissors

Prep Work: NONE



Wrapping paper around rods and tubes.

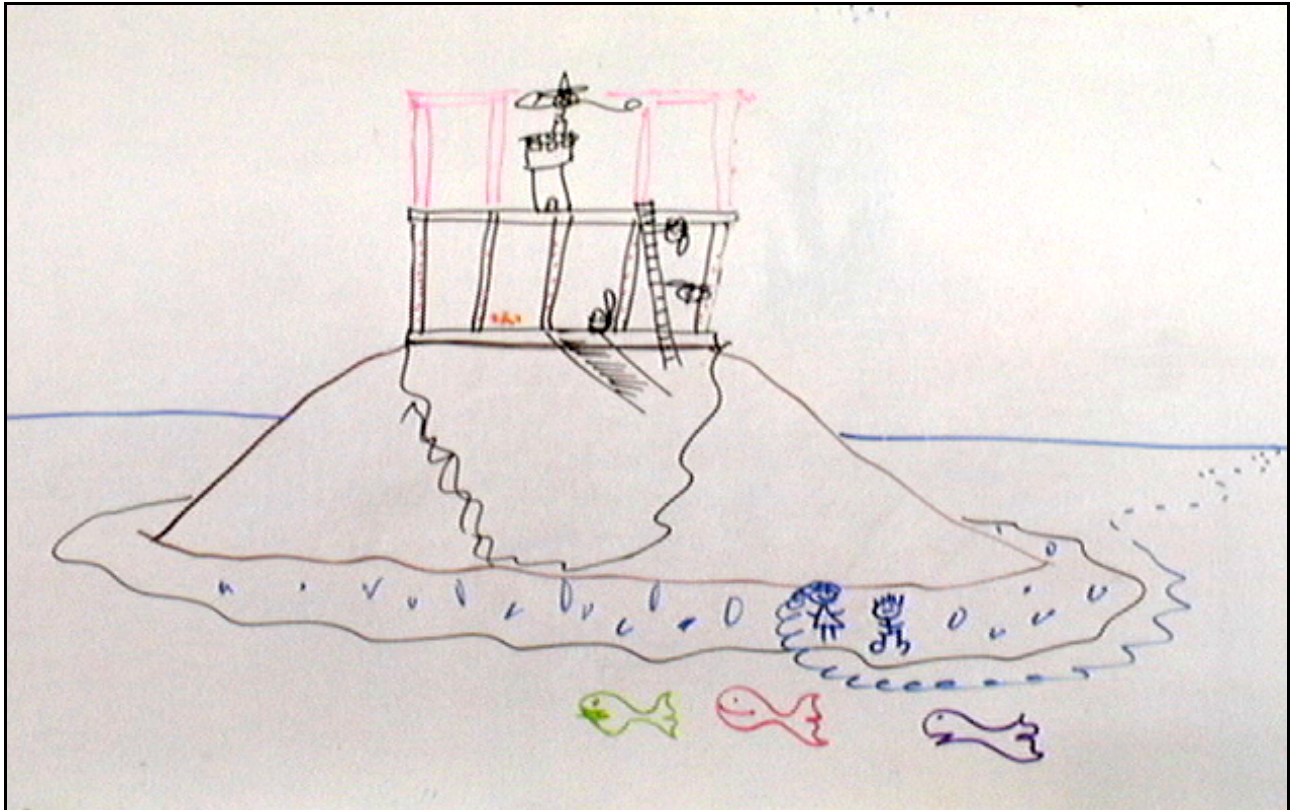
Story Recap, Part 1: “Evil Mister Fred’s Giant Castle”



- Evil Mister Fred was living on an island made of paper. He told his minions to build a big castle with columns.
- So the minions used the paper to build something that looked like the Parthenon and then put Evil Mister Fred's regular castle on top of it. Evil Mister Fred rewarded them with M&Ms.
- Minions also like to chew gum, and they put it on the bottom of their feet so they can climb around on the walls and ceiling.
- Evil Mister Fred hid his supply of M&Ms from the minions by putting them inside the hollow paper columns.
- Evil Mister Fred wanted his new castle to be 100 stories tall, but the minions refused.
- Evil Mister Fred ordered a hundreds of slaves from the Acme Store of Everything. Jack and Jill came along as monitors, to make sure the slaves were treated properly.
- The slaves had to work all day building additional stories onto Evil Mister Fred's castle, and he didn't give them much to eat.
- Jack and Jill discovered that the fish they caught would turn into other kinds of food, such as pepperoni pizza or grape jelly. So they had plenty to eat, and Evil Mister Fred didn't know.
- The minions mistreated the slaves, hitting them on the toe with their baseball bats if they didn't work fast enough.

End of Story Recap: “Evil Mister Fred’s Giant Castle”

****DO NOT* present this part of the lesson until after the experiment!***



- The slaves refused to do any more work, so the minions started chasing them around the island with their baseball bats.
- Meanwhile, one of the minions started smelling the M&Ms hidden in one of the paper columns. He hit it with his baseball bat and it broke open like a piñata, and all the M&Ms spilled out.
- Then the other minions started bashing all the other columns, and the whole structure crashed down and made a huge hole.

Transcript: Intro

In the old days before computers and computer games, if you wanted to make an airplane you had to actually use a pencil and a piece of paper and draw what you wanted your airplane to look like. And then you had to give the drawing to people to build it. And once it was built, you had to find some guy foolish enough to get in it and fly it to see if it flew or not. They ended up with a lot of dead guys doing that sort of thing.

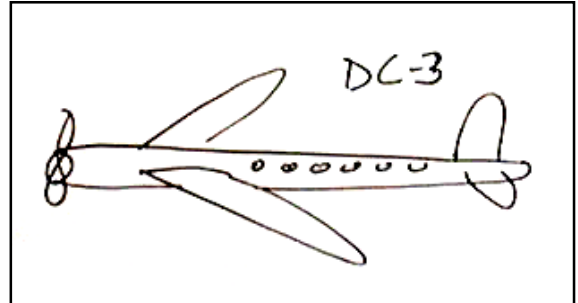
And I knew a guy named Larry once, and this was around 1935. They were making an airplane. Instead of making it all out of cloth and sticks, they made this one out of metal. And they discovered that if you put an engine on the front of a metal tube and put people inside -- it's called a DC-3. It didn't hold very many people. It had seven windows in it, so there were probably twenty-eight people that could fit in there. But it's an all-metal tube, with a noisy engine stuck on the front. You turn the engine on, and it got so noisy inside, people were going crazy just because the noise level was so high.

So they took the engine off the front, put a window there, and they put the engines on the sides. And somebody said, "Well, you know, it's got to pass a bunch of tests. We can't just put a bunch of people in there, fly it around, all made out of metal. It might break.

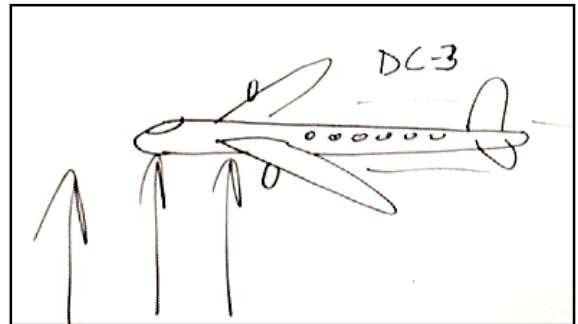
Like, if you're flying along and you come into an updraft, and the front of the airplane goes into the updraft and the backend isn't in the updraft. The body has to be strong enough to not crack in half and spill all the people out. People don't like that. Makes them irritated when they get spilled out.

So somebody had to test the airplane. And you didn't need the wings for the test, so they gave Larry a body of an airplane and said, "Here. Find out how strong it is." He said, "Really? Can I do anything I want?" They said, "Yeah."

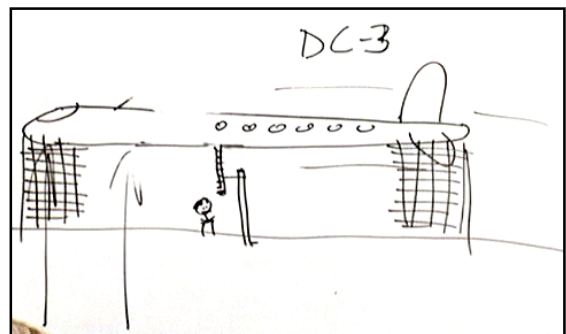
And he had a whole airport where he could play with this. So he piled a bunch of wood in the front (this is like a MythBusters kind of thing), and they piled a whole bunch of wood in the back to hold it up off the ground. Then they glued a ruler to the middle, hanging down, and then they put a stick on the ground with a nail pointing out of it. There's ground level. And they had a guy down there to see if the bottom of the plane bends.



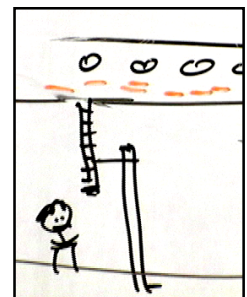
Airplane with engine on front.



Updraft on plane with engines on wings.

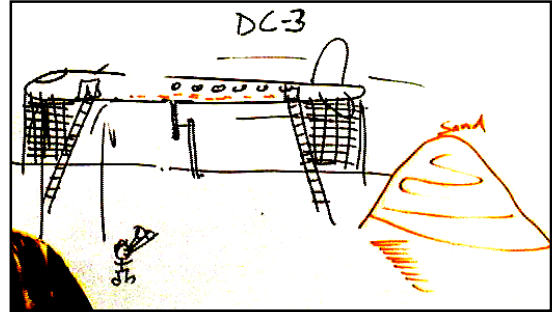


Plane supported on wood, with ruler in middle.



Ruler to measure plane bending.

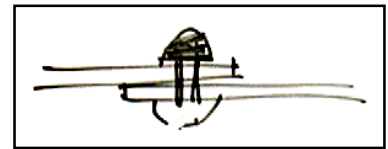
And they made a hole in the back and put a ladder in it. And they made a hole in the front -- I think the hole in the front was already there -- and put a ladder in that. And they called a big truck, and they said, "We need, oh, a couple of hundred tons of sand." So they delivered a bunch of sand and a bunch of sandbags. Then they went to the local high school and local college and they asked for people that were stronger than they were smart. And they got a whole football team's worth of guys.



Ladders and pile of dirt for sandbags.

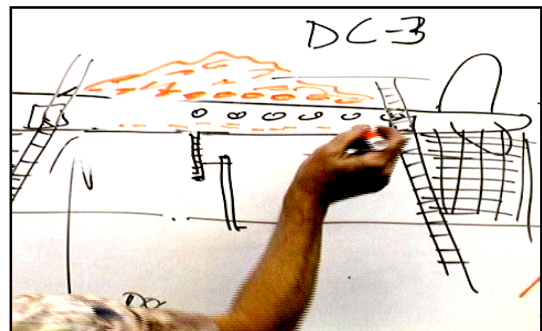
And they said, "All you have to do is fill up the sandbags, put them on your shoulder, climb up the ladder, take them inside, and set them down in the seats. And all these guys said, "Yeah." So they'd fill the sandbags, go up this ladder, put them in the seats, and go out that ladder. And they kept going in and out, in and out, and in and out, and the plane was starting to bend. And the guy down here says, "Well, it's bending. Not broken yet, but it's making all kinds of creaking noises. I don't want to be under here anymore." So he left. He's smart. And he stood off with some binoculars to look at the nail. So he's watching from a long ways away.

And the high school kids were still going inside. And then they started hearing things like "pa-chingggg, boing, boing, boing!" And they said, "What's that sound?" Well, the plane was held together with things called rivets. Now a rivet is like, if there are two plates of aluminum with holes in them, you put this rivet in there. And it's got a head on one side, and it sticks out on the other. And you smash down the other side to make another head, and it holds the two together. Well, if you put too much stress on it, rivets break and they shoot off like little bullets -- pewwww! And these things were starting to shoot off, and the high school kids didn't want to be inside anymore.



Rivet holding sheets of metal

So they said, "Fine. We'll get longer ladders." So they got some longer ladders, and now the high school kids climbed up those ladders and put the sandbags on top of the plane. And now they had a big pile of sandbags on top. Now it was making all kinds of noises, and it was sagging a lot. And pretty soon even the high school kids wouldn't do it anymore. They wouldn't climb up on it.



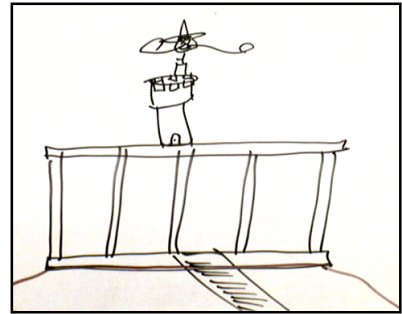
Sand piled on top.

So they stood back and they looked at it and they said, "Wow! That thing's really strong. It'll pass any test. That's great." And just when they were about ready to figure out how to get all those sand bags off, it sounded like five machine guns all firing at once -- brrrrrrrrrr! And all these rivets started to fail, and the thing went ka-boom! -- and crashed to the ground in a big mess. Big cloud of dust, and they said, "Yay!" It shook the ground like an earthquake.

Well, today we're going to be breaking stuff. We're going to be crushing things just to see how strong it is. First, though, we need a crazy story.

Transcript: Story “Evil Mister Fred’s Giant Castle”

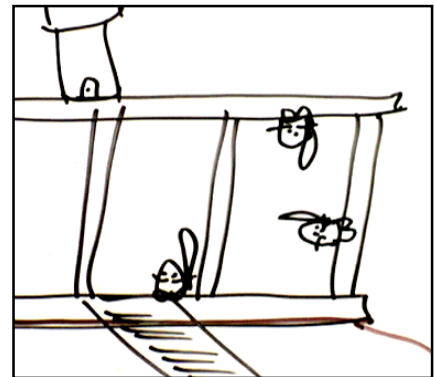
Once upon a time, Evil Mister Fred was living on an island. The entire island was made out of paper. Evil Mister Fred didn't know it, but it's old newspapers, all sitting there moldering away. And when he got there, there was a flat spot on the top. And he told his minions to build him a castle. The minions said, "Aw, boss, look at this. This is terrible stuff. How are we going to make a castle out of this?" And Evil Mister Fred said, "I don't care. Just build one. And this time I want it to be spectacular. No more of those silly straight-up column things." And the minions said, "Okay, boss."



Evil Mister Fred's columns.

So they built him a bunch of columns, like that. And they put a bunch of papers on top, like that. And they made him his own Evil Mister Fred Parthenon. They put some stairs in front of it so you could walk up. And then they built a regular castle so he'd feel at home on the top. So Evil Mister Fred could stand up there and look real sophisticated.

And Evil Mister Fred said, "Now, this is pretty good." And the minions said, "Yeah, but where's our reward? We want some M&Ms." Because that's their favorite food. So Evil Mister Fred had to go in the castle and give them some M&Ms.

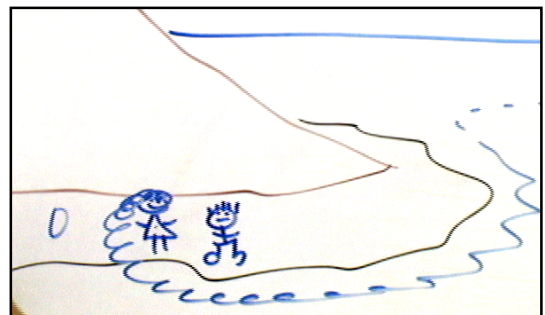


Minions walking on walls.

And the minions also like to chew bubble gum, and they keep getting it on their feet. So it's handy for them. They can walk up sideways with their baseball bats. They can hang from the ceiling. And the minions, of course, were always trying to find Evil Mister Fred's M&Ms. Where he had them hidden, he had to hide them really well. Because if they found them, they'd eat them all, and then they'd get really lazy after eating them.

Now, Evil Mister Fred said, "You know, I would really like this castle to be taller. It's one story tall now, maybe one and a little. I want it to be a hundred stories tall." And the minions said, "Nooooo!" And Evil Mister Fred said, "Arrrrgh, you guys couldn't do it right anyway. I've got to get some quality slaves."

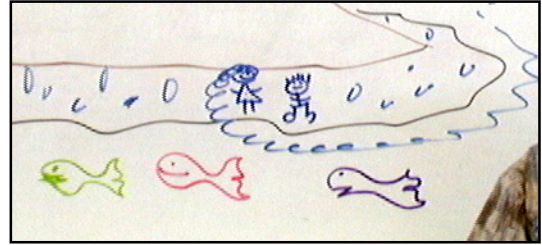
So he called the Acme Store of Everything and he ordered a city's worth of slaves. So they all got delivered, and he had to put them somewhere because he didn't want them up where he was. So there's a black sand beach all around the island, and the slaves had to live down here on the black sand beach. They were smurf kind of slaves. And whenever you order slaves from the Acme Store of Everything, they come with slave monitors. And Jack and Jill were the slave monitors to make sure the slaves were enslaved properly. And then there's hundreds of slaves out there.



Jack and Jill as monitors.

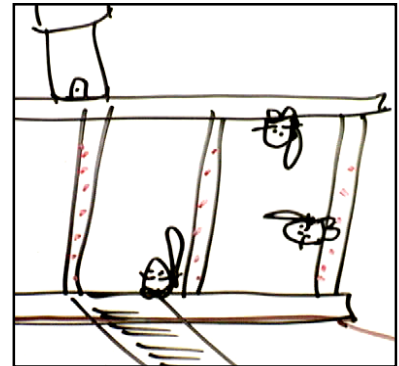
And Jack and Jill said, "All right, Evil Mister Fred, what's going on?" And Evil Mister Fred said, "You're my slaves. You have to do what I tell you. You have to eat what I tell you, and you have to wear what I tell you. I'm in charge and you're not." And Jack and Jill said, "Ohhh, I don't like this job. This is not a fun job. But we have to do what he says."

And they didn't have much to eat. They discovered, though, that the fish in the ocean were weird. If you caught one of the fish, it changed all of a sudden. It didn't just change color and shape. If you caught this kind of a fish, as soon as you grabbed it, it would turn into a pepperoni pizza. If you caught one of the purple fish, which looked exactly like that one except it was purple, it would turn into a jar of grape jelly. And every fish, depending on its color, was a different kind of food.



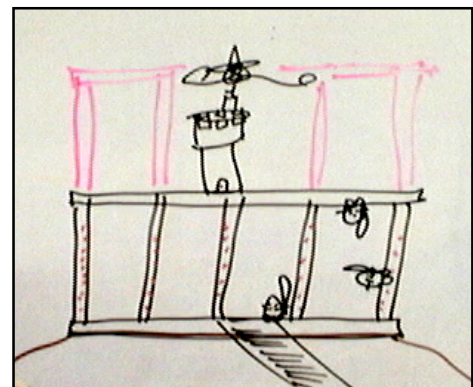
Colored fish become other foods.

Well, Evil Mister Fred was totally unaware of this. And he didn't know that the slaves were eating high on the hog. They were having the best food that ever was. And all he had was whatever the minions made for him. But Jack and Jill didn't tell him. And Evil Mister Fred had to hide their M&Ms. And he discovered that when the minions were off doing something else, the best place to hide the M&Ms was inside the paper columns. So they're all hidden in there. And he could get in from a secret door on the top.



M&Ms inside columns.

Now, the slaves had to get up every day and create more and more floors. And they weren't allowed to leave until they had this thing a hundred stories tall. So they're building and building and building, and Evil Mister Fred is never happy with what they built. If you're Jack and Jill, and you don't want to be enslaved with Evil Mister Fred until you finish a hundred floors of this thing, what would you do?



Second story.

Imagination and Brainstorming Time

[Students make suggestions. THERE ARE NO WRONG ANSWERS! Whatever a student says, you should reply: "That's a good idea," "They might do that," etc., or simply repeat the student's suggestion. After brainstorming, proceed with the experiment, then finish the story.]

We'll leave this "To be Continued . . ."

Transcript: Experiment “Samson’s Columns”

If you notice, there's books all over the floor. And over here there's paper. The objective is to use the paper to hold the books off of the floor. So here's a piece of paper, and if I put a book on it, that holds it off the floor. And you could stack a hundred books on there, and it would hold it perfectly. But it has to hold it off the floor by at least the width of one of your fingers. Now if I took this paper and I folded it, for instance, will that hold a book? *[Students: No!]* Are you sure? *[Places a book on the folded paper.]* Okay, you're right, it doesn't hold it. What if I fold it in fourths? Will that hold it up off the floor? *[Students: No.]* No? No, maybe? I'll put a book on there. *[Places a book on the folded paper, and it collapses.]* Aw, so sad. Doesn't hold it.

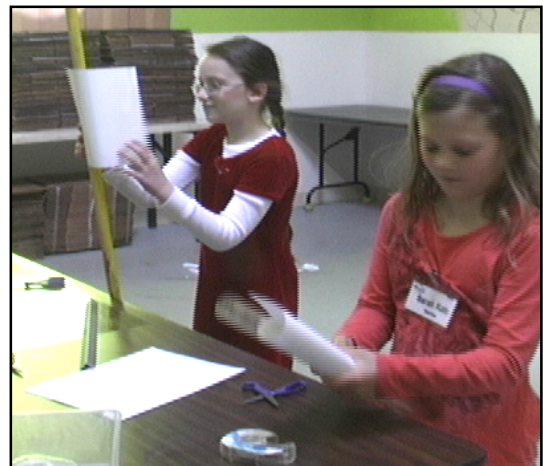
Well, to make it a little bit easier for you, we have some shapes over here. Here are pieces of paper, and here's shapes. If you wanted to, you could wrap a piece of paper around this tube, for instance, and put some tape on it, slide the tube out, and see if that will hold a book. If you wanted to, you could wrap the paper around a square rod and tape it and see if it will hold the book up. You could wrap it around anything you can get your hands on. There are other pieces over there, too. And if you want the paper smaller, for instance, to make more than one leg, you can cut it with scissors *[or have the assistant cut it for you with the paper cutter]*. If you fold it, you'll know where to cut if you want two pieces or more.

So you can work by yourself, you can work with others, and you're going to start stacking books on it. After you stack books, weigh them to see how much they weigh. And write over here your name and how many books it held and what shape you used and the number of shapes or legs you used. We want to see what's the most you can support with one piece of paper. Go. You get one sheet of paper per test. So if you're making legs, you have to divide that one sheet into a bunch of legs.

[Students try out various ways of folding, wrapping, and cutting the paper to see how many books it will hold before the paper collapses. They usually start with a single tube, then divide the paper into multiple smaller



Folded paper collapses under the weight.



Wrapping paper around tubes .

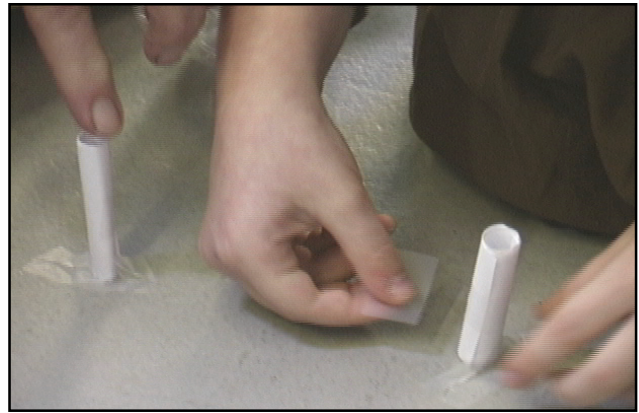


Testing single tubes .

tubes. After each test, they place their stack of books on the scale, read the number, and write their results on the white board. They do as many tests as time allows.]



Testing four tubes .



Narrow tubes might need to be taped to the floor.



Short thick columns will hold a lot.

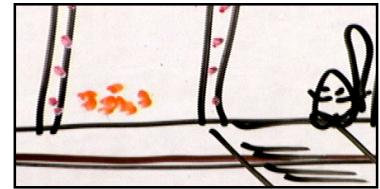
Transcript: End of Story

****DO NOT* present this part of the lesson until after the experiment!***

So Jack and Jill are tired of being slaves, even though they have good food. And they don't want to build a tower a hundred stories tall. And they thought, "Well, what are we going to do?" Every day they had to climb taller and taller ladders to get to the top. And the minions would hit them on the big toe if they didn't work fast enough. Which hurts a lot. You ever been hit on the big toe with a baseball bat? It hurts a lot. And they thought, "What are we going to do?"

And one day they all decided, "We're going to stop working. We're going to rebel. We're not going to do that work any more today." And the minions all came down and said, "Oh, boy! We get to smack a lot of big toes!" And all the slaves and Jack and Jill were running around in circles on the black sand with the minions chasing them, and they're doing the "get out of the minions' way" dance -- "Ooh-ah, ooh-ah," dancing around. And Evil Mister Fred said, "You can't do that. You've got to go to work. You're our slaves." Jack and Jill said, "We'll be right there. Hang on."

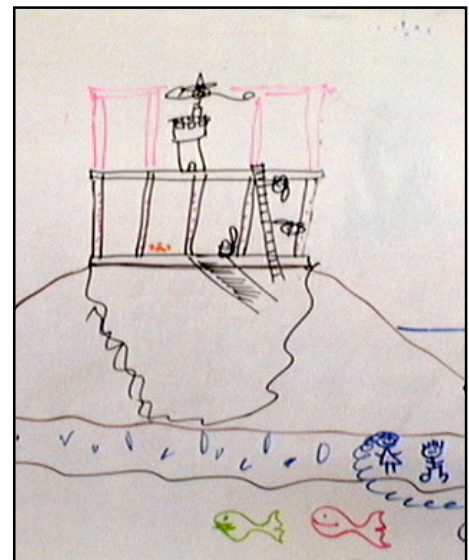
Well, one of the minions was smelling the M&Ms inside the columns. He was going, "(sniff, sniff, sniff) I know there's M&Ms in there. There's got to be M&Ms in here." And he says, "I'm going to find out." And he took his baseball bat and went whack! whack! whack! And he broke open one of the columns like a pinata. And all the M&Ms came spilling out.



M&Ms spilled out.

Evil Mister Fred didn't know about it because he was way up high on the tower. And as soon as he broke it open, all the minions that were chasing the slaves said, "I smell M&Ms! And I hear the sound of M&Ms rattling on the floor!" And they all abandoned the chase and ran up there and found the M&Ms. Then they all started breaking more columns open to get the M&Ms out. And Evil Mister Fred's up on top. And it's starting to [sway back and forth]. He says, "Whoa, what's going on? Whatever you're doing down there, stop it!"

But it was too late. All of a sudden the whole thing went bumm, bumm, bumm, bumm, and pancaked down into the ground. It hit so hard it drove the whole tower deep into the ocean. And they all lived happily ever after, except Evil Mister Fred and a few unaware minions.



The castle collapsed into a big hole.

End of Lesson

If you have questions about this lesson, please ask them through the online [Teacher Support Forum](#) on our web site.