dance

At STREB Action Lab, Dance and Physics Collide

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Choreographer Elizabeth Streb pushes the boundaries of Newtonian physics—with dance. In her show *Forces*, dancers fly, fall, and collide in mid-air. No wonder the "action architect" has her share of scientist fans, among them, big-thinking particle physicist Lisa Randall.

Transcript

IRA FLATOW, HOST:

If you're headed to the ballet this season, chances are to hear something like the "Dance of the Sugar

Plum Fairy" from "The Nutcracker," this season's dance blockbuster as usual. But dance doesn't always sound this sweet. Sometimes it sounds more like this.

(SOUNDBITE OF PLEXIGLAS SLAMMING)

FLATOW: I'm sure you won't recognize that music. That's the sounds of dancers running at top speed and then slamming into a Plexiglas wall. They're members of the STREB Extreme Action Company, a dance company founded by the choreographer and MacArthur Genius Elizabeth Streb. You won't see any tutus here. In Streb's new show "Forces," dancers fall or - actually, they try to fly from 35 feet. They run into walls. They run up walls. They slide down inclined planes face first. They swing a 200-pound steel I-beam and then duck at out the way before it can smash them to bits.

Remember those experiments you did in high school physics class to learn about force? Slide a heavy box down an incline plane, see how far it travels. Cut the weight off a pendulum, see where it flies. Streb dancers are doing these experiments with their bodies, so it shouldn't come as a surprise that the woman behind the moves is a bit of a physics geek. Elizabeth Streb is a choreographer and an action architect and founder of the STREB Extreme Action Company here in New York. Welcome to SCIENCE FRIDAY.

ELIZABETH STREB: Thank you. Thank you. I'm honored to be here.

FLATOW: Let's talk about this idea that your actors or dancers are actually flying through the air and dropping three stories.

STREB: Yes, yes. They're going, probably when they hit, about 35 miles an hour, 32 miles an hour.

FLATOW: And why aren't they hurt when they do this?

STREB: Well, oddly enough, it's a technique that we've formed over the last 30 years gradually, gradually. Only, we leave the residue of many injuries behind us. And if you're perfectly flat like a piece of plywood, you spread out the impact. And actually, it makes you stronger.

FLATOW: And what is the idea behind "Forces" and behind this idea of flying and landing like that?

STREB: Well, you know, in short, Ira, I really believe that humans can fly. So it was a young, very naive idea I had when I watched a fly in a Mason jar turn corners without smacking into something. And so I attempted - I realized that humans wouldn't fly like as brilliantly as birds or as brilliantly as insects, but we could hang in the air for a few seconds. However, my decision to not camouflage gravity, I think, and to take the hit and to experience and to demonstrate the failure of flight, I think, is what perhaps upsets some people in the dance world, which is where my reputation resides still.

FLATOW: I've seen the show. It's terrific.

STREB: Thank you so much.

FLATOW: You are obsessed with gravity, aren't you?

STREB: I am. Although, you know, you I'm aware, in the most naive way, that it's the weakest force. But I think it's the only one I can actually harness myself and my mind and my body's and my company too, and show a few dramatic action.

FLATOW: This is SCIENCE FRIDAY from NPR.

Now let's talk about some of the extreme forces you've dealt with. You've jumped through glass. They don't jump through glass in this presentation, but you actually have - what's the technique there, and what's the reason for that?

STREB: Well, the formal reason like - oddly enough, this all comes from a formal set of questions. But for diving through the glass, which was called breakthrough, simply, I wanted to demonstrate the effect of action on substance because showing force abstractly is very difficult. So I thought if you saw the glass fly into the audience, you'd know how hard I had to punch it to get through it.

FLATOW: But you had to study something about the physics of glass and everything before you did that.

STREB: Well, no, not really. I mean...

(LAUGHTER)

STREB: I hate to say it, but we are trial and error all the way. Like, those equations actually don't necessarily tell you that much.

FLATOW: So you don't really know how something is going to turn out when you first experiment with it.

STREB: Even the show you saw, "Forces," going on right now, I actually sit there with my - pardon my throat - I don't know quite how everything is going to turn out even. I don't think action allows you to know perfectly what will occur.

FLATOW: Mm-hmm. So if you can't predict the effects beforehand, you just try it out; a new move, that sort of thing.

STREB: Yeah, yeah. Well, like, how far can you fall from?

FLATOW: Right.

STREB: You know, we did this piece called "Human Fountain" in the Delacorte in September, and one of my dancers climbed up to 45 feet and fell. And that's higher than we've ever fallen - free fallen.

FLATOW: And survived to tell the story.

STREB: He did. But he did mention that - his name is Felix Hess, and he did mention that his organs hurt. There's a point at which the mat won't depress quickly enough to actually absorb the hit, and our query is, well, how high could we go?

FLATOW: Right. Now, you also have in the show a giant steel I-beam, which must weigh what, a couple hundred pounds, something like that?

STREB: You're right. Yeah, yeah.

FLATOW: The dancers, again, spinning around very quickly in a circle, and then they go up and down and you - it misses them by a micro hair there.

STREB: I'd say we've gotten that close, yeah.

FLATOW: Yes. And the point of that being what?

STREB: Well, for me, again, formerly, I'm trying to excise the drama of action without having to put a love story on top of it. Or "The Nutcracker" on top of it, those types of stories. And so to me, the I-beam is a visceral way to measure time and space exactly, not to fiddle around, to say that's all the time I have. Here, it comes. That's all the space I'm in. I'm out. And I think there's something very profound about seeing the human body out there with an I-beam in terms of temporal issues and spatial issues.

FLATOW: You're dance space is called the Lab, and I heard one of your dancers refer to you as a mad scientist.

(LAUGHTER)

FLATOW: Is that - do you think that's fitting?

STREB: Maybe a little more elegant. It's a more elegant title than - I sort of wonder about things and mix up magic, accidents, even dumb luck, and come up with moments that I find rhythmically moving. To me, the content of action might be in the rhythm.

FLATOW: Mm-hmm. And, of course, you're not a trained scientist.

STREB: Of course not, no. No.

FLATOW: No. But you do the sort of the scientific method of experimentation and then observation to see what...

STREB: Precisely, yeah.

FLATOW: See if what you're talking about is real.

STREB: Yes, precisely. And I force myself on scientists and try and ask some odd questions about quantum physics and particle physics and what would happen if you morphed up those extra six dimensions from superstring theory and put them on the body, what would the body look like? Or - I mean, what does it mean to go in the fifth direction, the sixth direction, the seventh direction.

FLATOW: We have to take a break. And when we come back, more on dance physics and big machinery with choreographer Elizabeth Streb.

(SOUNDBITE OF MUSIC)

FLATOW: This is SCIENCE FRIDAY from NPR.

(SOUNDBITE OF MUSIC)

FLATOW: This is SCIENCE FRIDAY. I'm Ira Flatow.

We're talking this hour about dancing, falling and flying with choreographer Elizabeth Streb. Her new show is called "Forces." A lot of machinery involved onstage there.

STREB: Yeah. Yeah. Very much like an orchestra has instruments, I think.

FLATOW: You have a circular spinning platform that can go in two different directions at once?

I know. Isn't that sad? Only two.

(LAUGHTER)

FLATOW: No, but you...

STREB: I don't know why.

FLATOW: You covered the third with something called the gizmo, right? You have a third thing.

STREB: Yes, I did. I have a third. I have a third.

FLATOW: Yeah. And describe - how would you describe that?

STREB: Oh, my gosh. I guess I'd describe it as a giant snow cone where - and it turns, it runs, and it accesses on its circumference.

FLATOW: It's something you'd see in the amusement park, sort of.

STREB: Yeah.

FLATOW: It looks like it's spinning like, you know, a ride that you would get on.

STREB: Sort of, but you probably wouldn't want to get on it if you didn't practice.

FLATOW: We have all these on our website at sciencefriday.com, all these gizmos and stuff and excerpts from the program. I'm going to play a clip from the show that you're telling a story about the Wright Brothers. Let's play that clip, and we'll talk about what's inspiring to you about that story.

(SOUNDBITE OF DANCE PERFORMANCE, "FORCES")

STREB: Look at the Wright Brothers, you know? They were laughed at out of Dayton. They went to Kitty Hawk so they wouldn't be made fun of by their neighbors. Yeah. You know, after their second summer there, they - everything they did to fly this thing didn't work, and they were baffled. So they went back to Dayton for the winter and worked on some of these designs. And one of them came up with the notion that possibly the Smeaton coefficient of air pressure was incorrect, this equation that had been used - this ratio rather that have been used for 150 years. Went back the next summer and they flew.

FLATOW: And what inspiration did you take away from that story? Why do you tell that story in the show?

STREB: Well, I think that the notion that they realized the Wright Brothers isolated the problem as one of equilibrium, and they had done all the math. They were bicycle mechanics in Dayton. And there's no reason it didn't work. And the fact that they would've question an equation - or this was a coefficient - how could they have questioned something that I guess that had been in use for many years, 150 years? They were scientists. They threw out every other thing, factor that could have prevented them from flying. You know, in the end, I just thought you have to be rigorous about your questions and rigorous about what kind of results you are hoping for. And mine, I guess, is theatrical. So it's a little flimsier than manned flight, woman flight.

FLATOW: I want to bring on another guest into the conversation. Lisa Randall who is famous physicist, professor of science at Harvard. She's a theoretical physicist who works exploring the possibilities of extra dimension. Everybody knows her from this program. Her most recent book is "Higgs Discovery." She's also a Streb dance fan, and you know Lisa, right?

STREB: I do know. Hey, Lisa.

LISA RANDALL: Hi. Good to talk to you.

STREB: Yeah. Same here.

FLATOW: Well, Lisa, what - how do you view this, what Elizabeth is doing?

RANDALL: I guess from the point of view of thinking scientifically at some level, I mean, you're pushing boundaries. You're trying to find out what's actually possible. You know, you asked earlier, could she calculate certain things? And some things are just very hard to calculate because it's not just the physics of glass breaking, for example. It's also the effect on the human body. So these are really difficult problems. And the way they're going to find out the answer is by experimenting. I also just have to say I just really like watching it. It's just exciting. It's really great.

(LAUGHTER)

FLATOW: You know, and your work looks at why gravity is such a weak force.

(LAUGHTER)

STREB: Love that.

FLATOW: It doesn't look weak from this dance.

RANDALL: That's right. That's correct, and that is the thing that seems paradoxical. But, of course, you have to keep in mind the entire Earth is acting on these dancers and you and me.

FLATOW: Elizabeth, you've known Lisa. What kinds of questions would you like to ask her? And what - you're sitting all down over a beer. What would you discuss?

STREB: Oh, I'd - I'd always love to. I just trample on her anytime I see her, like stalked her to begin with. I already have her first book and I said, could I just ask you a question? And she was, like, oh, what? And I said, well, if you took the extra dimensions that exist in particle physics and you, you know, scaled them up to just attach to the human body, you know, what would happen to the body? I want to understand which direction I could go in to really shock the minds of my audiences. She said, you don't understand. It's a billionth, a billionth, a billionth, a billionth the size of a human nucleus. Didn't you say that, Lisa?

RANDALL: I think I was saying what the real effect would be, yeah. I think the other thing that was really interesting to discuss was sort of the role of technology and advancing science and advancing what she's doing. I think we had a lot of interesting conversations about that as well.

FLATOW: Explain that a little bit more. What do you mean, the role of technology? Yeah.

RANDALL: You know, I think, especially these days where theoretical physics become so abstract-seeming, we sort of forget about that. I think that's been changed a little bit by hearing about the results from the Large Hadron Collider, the discovery of the Higgs boson, which I'm sure your listeners have heard about. And that was possible because this big collider, you know, 17 kilometers in circumference that's

accelerating protons together to the highest energies possible, was made.

Now, in this particular case, we actually predicted the particle in advance. But the hope is that there will be particles that emerged that we are not predicting. You need tools. I mean, that's not to say you can't make advances by thinking. But you have to really then go ahead and see what works and what are you leaving out and what's happening. And there's a way which, I think, Elizabeth is doing that in a very different setting

I mean, we think at STREB that hardware is a harbinger of the invention of new moves because the biomechanical body is simply not sufficient to express everything that action can express. So how do you add force to a body? You add a few motors. You get some momentum. The bigger my dancers are, the better. There's more mass.

FLATOW: Well, you're doing the same experiment. You're using body-slamming things.

STREB: It's so much grosser though than the way they do.

(LAUGHTER)

STREB: I mean, I want that Hadron Collider.

RANDALL: (Unintelligible) an important consideration here.

STREB: OK. But Lisa, what would happen if I put one of my dancers in the Hadron Collider, would they go that fast?

RANDALL: In the Hadron?

STREB: Hadron.

RANDALL: No.

STREB: Oh, they wouldn't go almost the speed of light? And then would we...

RANDALL: First of all, they'd die from radiation, so we probably wouldn't want to do that.

STREB: OK.

FLATOW: I hate it when that happens, yeah, yeah.

RANDALL: Yeah. So...

FLATOW: But the similarity, I'm saying, is that you're both - you've said, Elizabeth, that what you want to

do is smash into things and see what happens.

STREB: I want to...

FLATOW: But that she's doing - you're doing it in a certain area.

STREB: Yeah. But when those protons...

RANDALL: I think the fair way of saying it is we want to know what's happens at the edge of what we understand.

STREB: Oh, that's so...

RANDALL: One way of getting at that is by slamming things together, but there are other ways you can look at (unintelligible). I'm also interested in what telescopes are finding, what satellites will find. The reason we're smashing together - I mean, it sounds very dramatic, but that is the only way to explore short distances and high energy. That's the only way we know about, using the beauty of E equals MC squared. That energy can be converted to mass. By going to these high energies, you can make particles that you'd never see otherwise.

STREB: That's - I mean, that's like the faster you go, the harder you hit, you know. We keep thinking if we run fast enough and close enough, we can actually go through each other rather than having to go around each other, which is so time-consuming.

RANDALL: That could be a messy process.

STREB: I know. I know. I know. It's probably...

FLATOW: Is that something you think about trying?

STREB: I really do. And on the piece, "Crash" piece, where people are going towards each other, I'm trying to split that difference so it looks like they went through each other, by cheating seconds and cheating space.

RANDALL: But Ira, one thing we should keep in mind, though, is that, you know, we really are operating on extraordinarily different scales, like the scale of subatomic particles. The laws of physics are looking different than they are at the scales that people operate...

STREB: But I'm so jealous about that.

RANDALL: ...and the beauty of physics is that that can all be absorbed, that it's the same physical laws that underlie things. But you can be applying different ways of thinking about things. You're applying more classical physical laws, you're putting them at the limits. But what she's doing is using classical laws,

Newtonian physics.

STREB: Yeah.

RANDALL: But what we're doing is really looking for underlying physical laws that would have negligible effects at her distance of speeds but still underlie what's going on.

FLATOW: Where did you first think you wanted to get into this?

STREB: Well, again, I was late to the field itself. I started training as a dancer when I was 17, when I decided to major in it in college at SUNY Brockport. I did downhill skiing, like curiostically(ph) all by myself, on the slopes from a very young age. And I also bought a motorcycle the second I could. And so I experimented with how fast you had to go...

FLATOW: Forces, you were interested...

STREB: Forces.

FLATOW: ...in forces from day one.

STREB: Day one, impact velocity. And I was also a varsity basketball, baseball player...

FLATOW: Wow.

STREB: ...in Our Lady of Mercy High School in Rochester. So - and I was an artist. So I thought I'd put them all together and here we are.

FLATOW: Interaction of art and the laws of nature...

STREB: Exactly.

FLATOW: Forces.

STREB: Yeah.

FLATOW: Like I said at the beginning, instead of doing those experiments in college where you roll those things down - they're boring, they just like make your hair hurt.

(LAUGHTER)

FLATOW: And I love physics. It made my hair hurt. Yeah.

STREB: It made your hair hurt.

FLATOW: It made my hair - but you do that with your dancers instead.

STREB: I do. I do. I try to do that and say - I ask a question. I ask a question. I observe their solutions, which many of the solutions come from them.

FLATOW: But, Lisa, isn't that what science is about, getting an idea and then trying to collect the data to see if it's correct?

RANDALL: You know, and I said that (unintelligible). In some ways she does approach it like a scientist. In some ways, some of the ideas might be a little bit different. But the idea that, you know, you think about a general phenomena and you tried to think, what could be possible? And some of it is experiment and some of it is theoretical, and that's the way we - what we do as scientists.

But the other really interesting thing, like I said earlier, is come and get it from a different perspective. That's sometimes where the real breakthroughs happen.

FLATOW: And, in fact, you have been on one of Streb company's machines, the gizmo, right?

(LAUGHTER)

RANDALL: I was.

FLATOW: How did you like that ride?

RANDALL: It was fantastic. It's fantastic. And it's fun, too, because it's a little bit counterintuitive, how you have to - I mean, you basically have to do exactly what she tells you to do: go faster at certain points, go slower at certain points, and it works. And it's really exciting to be up there, doing these things that you thought you'd never be doing. I also had the opportunity to use the trapeze briefly. And, you know - and even the trapeze, I mean you were literally taking a leap of faith to catch that trapeze. And it's a really amazing thing to get to try these things.

FLATOW: Mm-hmm. I want to play another short clip from "Forces." Elizabeth, this is one of your voiceovers called if I could invent my own force.

(SOUNDBITE OF VIDEO)

STREB: If I could invent my own force, I would like a force that allowed a body just magically to change direction every third of a second in an absolute accelerated way, not that old-fashion, boring stop, reaccelerate, reach speed, but just like a jagged, like a jagged line, like this. That a body could move like that, like a scribble.

FLATOW: Hasn't been invented yet.

STREB: It hasn't been invented. But I have these fantasy dances that I make, and I put them on paper. And I plan to do them sometimes - I haven't done this one. It's called ricochet. And it's a glass, bullet-proof box, and I'm inside. And there's a gun pointed at a certain angle of incidence to the corners. And the idea would be - it's about philosophy, so I would have to three times move so fast to avoid the bullet. And on the fourth time, if it hit me, it would have lost all its force. It would demonstrate velocity in a way that I want to switch directions and often.

RANDALL: You know, people all want to do that. I mean, that's what people do, you know, when they've owned cars and things like that.

STREB: Avoid a bullet.

RANDALL: Not - but they don't do it - they do it machines. And the idea that you're doing it in a more visceral way, you know, by yourself, is where it gets scary and different.

STREB: Yeah.

FLATOW: I'm Ira Flatow, and this is SCIENCE FRIDAY from NPR.

Elizabeth, is there a move you've always wanted to do, but you just haven't figured out yet how to do it?

STREB: Well, there is one. But again, I try not to say that our moves - when you come to our show, they entice every audience member. It's the anthropology of human action. It's labor. It's circus. It's crazy, freaks trying to do nutty things. It's me. And so I try and excise, like, what move will be profound if witnessed? And so falling completely vertically but upside down, head towards the floor, but stopping an inch from the floor, because you can't land head first. That's the one thing we cannot do. It's not OK. And I haven't figured out a way to even simulate that yet, that you're watching a body fall head first and - but it lands an inch from the floor.

FLATOW: You need an actor or one of your dancers to do that?

STREB: I don't want anyone to ever do it, but I try to figure out if there's a way. There was a stunt guy once who invented a hydraulic cable machine that you could fall from 120 feet, but you land in an airbag. Or it stops you but absorbs the friction the way a mat or an airbag would, this particular thing. But in short distances, I think it would be extremely difficult to calculate. You can't calculate for an inch with a machine like that.

FLATOW: And why would you want to do this?

STREB: I just have a - it's envisioned in my mind, like everything wrong about what happens with humans in the world, wrong because people are afraid of it. I'd like to present that and to take the mystery away, to take the impossibility away, you know, to - I mean, some of our things scare people, but I think it's the

surprise and the unpredictability of the semblance of action and humanness that makes people actually, I think, sometimes be moved by what we do, not always just fearful.

FLATOW: Lisa, I'm sure you're not volunteering for this one, so...

RANDALL: I am not going to volunteer for that one. But you know, it's interesting, though, because some of the things - you can see why the dancer would want to do it, I mean because you are exploring emotions that you wouldn't do otherwise. Some of us are a little more scared.

STREB: Yeah. I don't even think my dancers know about that one. I keep it private.

FLATOW: But they're not afraid to do anything.

STREB: They're not afraid to do anything. They're not afraid - no, they are afraid. They experience an inordinate amount of fear. But we figure out how to unravel that slowly and incrementally so that when the moment comes, they can repeat themselves.

FLATOW: And how long is "Forces" running?

STREB: It'll run until December 22.

FLATOW: And then maybe tour around the country?

STREB: Yeah. Yeah. Then we're going to take all 30 tons, put it in a 53-foot truck and take off to the south and the west, not the edges of the country but mostly the middle.

FLATOW: I hope all of you, if you're listening out there, that you get a chance, if not in New York, to see this on the road. And it's playing in - where's the company?

STREB: The company is at SLAMS, STREB Lab for Action Mechanics. And you can check everything out on www.streb.org.

FLATOW: It's a fun, fantastic show. I enjoyed it, and I hope everybody gets to see it. And if not, catch your act and your acrobats and dancers on the road. Good luck to you. Thank you for coming in.

STREB: So welcome. Thank you.

FLATOW: Elizabeth Streb is a choreographer and founder of the STREB Extreme Action Company. "Forces" will be running through most of December. Lisa Randall, thank you for taking the time.

RANDALL: Thank you. It's always a pleasure to talk to both of you.

FLATOW: You're welcome.

STREB: Thanks, Lisa.

FLATOW: Lisa is a physicist and professor of science at Harvard University, and her latest book is "Higgs' Discovery." And you can see the video - well, we have a lot of the videos. You want to see what Elizabeth has been talking about? We've got - I took these videos myself...

(LAUGHTER)

FLATOW: ...from watching this, front row...

STREB: Great. Cool. Cool.

FLATOW: ...videos myself. And in between - oh, my goodness - reactions.

(LAUGHTER)

FLATOW: That's why the videos are jiggling a little.

STREB: Even better.

FLATOW: Yup. Plus, we also have a gallery of Elizabeth Streb's dance sketches. These are up now at our sciencefriday.com/streb. That's S-T-R-E-B. Thank you both again for taking time to be with us today.

STREB: My pleasure. Thank you, Ira.

RANDALL: Thank you.