

Impact Planning, Evaluation & Audience Research

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Front-end Evaluation: *Speed*

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SUMMARY AND RECOMMENDATIONS

This summary of findings presents visitors' perceptions of and curiosities about the SR-71 plane, the topic of speed, and the proposed exhibition content as a way to highlight potential challenges and opportunities inherent in presenting the topic of "speed" in a science museum exhibition. Including the SR-71 plane as the centerpiece of an exhibition about speed, overall, seems to be a viable strategy. Interestingly, speed was not top of mind for many interviewees when they first discussed the plane; however, after being told the title of the exhibition, interviewees readily made connections between the plane and speed, some based on prior knowledge. As the two (plane and exhibition title) will never be separate, visitors' top-of-mind responses may not be an issue. What visitors' responses do suggest, however, is that interpretation of the plane may need to call out its natural connection to the rest of the exhibition. For example, about one-half of interviewees were curious to learn how fast the plane could travel, a fact that is likely already an integral part of the planned interpretation.

PERCEPTIONS OF SPEED AND RELATED EXHIBITION CONTENT

The findings reveal that interviewees primarily associate the concept of "speed" with something that moves quickly. For example, after seeing the exhibition model and being told the title of the exhibition, about one-half of interviewees expected the rest of the exhibition to present speed in association with vehicles or modes of transportation, such as planes, trains, boats, etc. Likewise, when selecting two exhibit concepts that were most connected to the concept of "speed," most interviewees selected cards depicting objects or ideas they perceived as fast moving (e.g., cheetahs, Olympic sprinters, NASCAR stock cars, etc.). Alternatively, when asked to select two exhibit concepts that were least connected to the concept of "speed," most interviewees selected cards depicting processes they perceived as happening very slowly—over hundreds, thousands, and millions of years (e.g., evolution, continental drift, erosion, etc.). Even after reading the text on the back of each card, many interviewees stayed fixed in their understanding of speed as fast. For example, after reading the text for the exhibit concepts they selected as *least* connected to speed, two-thirds of interviewees said the proposed exhibit *now* connected to speed because visitors would be able to see a slow process, such as evolution, "sped up" (rather than considering the concept of change over time).

Further, interviewees did not associate speed with change over time unprompted. Once prompted to consider a statement relating speed to change over time (see Appendix B), interviewees generally struggled to articulate an understanding of the statement. For example, about two-thirds said they agreed with the statement but provided vague responses about the relationship they saw between speed and change, such as "everything changes," without considering the element of time. However, hearing the statement often prompted interviewees to further articulate how they think about speed. About one-third expanded their definition to include different rates of speed or considered that speed can be relatively fast or slow. And a small portion of interviewees articulated a clear connection between speed and change, explaining that speed is a measure of rate of change over time. Still, after hearing the statement, the exhibit concepts that interviewees associated with change tended to be those depicting slow processes, like evolution and continental drift, concepts they did not associate with speed.

It is not uncommon for people to remain fixed in their understanding of familiar concepts even when presented with new information. Thus, it is not surprising that interviewees stayed fixed in their

perception of speed as fast even when presented with additional information about the exhibit concepts and a statement relating speed to change over time. These findings have implications for exhibition design if a primary goal is to bring visitors to new understandings about speed (i.e., help visitors have “ah-ha” moments about speed). Visitors are not only entering the experience without the concept of “change over time” top of mind; they also are entering the experience without “relatively slow moving things” top of mind. Instead of one potential conceptual hurdle, there are now two. Thus, connections to speed throughout the exhibition will need to be universal and explicit, especially for those exhibit concepts that interviewees perceive as slow and about change. One possible way to achieve this is by emphasizing one key message in all the exhibits. For example, if that message is that all speed can be measured by considering the rate of change over time, then the design of each exhibit should align to communicate this message.

CURIOSITIES ABOUT SPEED AND RELATED EXHIBITION CONTENT

Findings that demonstrate what piques interviewees’ curiosity about speed and related exhibition concepts are encouraging in that they reveal potential hooks that can be used to help visitors enter into the exhibition experience. These hooks also have the potential to be used as a bridge to help visitors come to new understandings about speed, whether the goal is to push visitors to think about speed as more than fast movement or to help them understand the science of speed. Findings suggest that what intrigues interviewees the most is: (1) experiencing something new or unique related to speed; and (2) learning about the *whys* of speed (i.e., the mechanics of speed). In consideration of the first trend, about one-half were intrigued by the experiential aspects of the proposed exhibition concepts, such as feeling different speeds, hearing a sonic boom, or seeing unique artifacts like a moon rock or race car. Likewise, some interviewees were intrigued with the idea of seeing a slow process, like evolution, continental drift, and erosion, sped up or their own movements slowed down so they could witness changes they otherwise would not see. In consideration of the second trend, about one-half of interviewees were interested to discover how people, animals, or man-made technologies achieve such high speeds or create effects like a sonic boom when traveling quickly. About one-third of interviewees also said they were interested in comparing speeds (e.g., why one animal travels faster than another).

First and foremost, acknowledging visitors’ perceptions of speed as fast and addressing visitors’ curiosities about speed creates a comfortable and permissive exhibition atmosphere where visitors are open to new learning. While understanding speed as a measure of the rate of change over time is not top of mind for interviewees, their natural interests about speed might serve as a bridge to this concept. For example, a desire to understand the whys (or mechanics) of speed may be enhanced by helping visitors see speed as a rate of change over time. Likewise, interpretive strategies that prompt visitors to draw comparisons among exhibits and relative rates of speed might elucidate the concept of change over time.

RECOMMENDATIONS

- ◆ Consistently and explicitly present one universal message related to speed in all exhibit text and graphics. Consider a message that: (1) integrates and builds on visitors’ existing knowledge; and (2) visitors can use to frame their experience, e.g., “Speed is relative; it is about more than going fast” or “Everything changes over time; some things change quickly and others change slowly.”
- ◆ Address visitors’ natural curiosities about speed, including a desire to: (1) experience something new or unique related to speed; and (2) learn about the *whys* of speed. Use these curiosities to

create a comfortable learning environment and build new understandings that support the universal exhibition message.

- ◆ The results of the card sort suggest that visitors perceive speed as fast; even slow moving things are not top of mind. Thus, consider an organizing exhibition concept that first addresses visitors' current understandings—speed is about fast moving things; then move visitors beyond this understanding to consider speed as a relative concept that also includes relatively slow moving things; and last, help some visitors to consider the more abstract concept of change.
- ◆ Not surprisingly, findings also suggest that children are inclined to think very concretely about speed as fast, while adults may be open to a more nuanced understanding. Consider integrating interpretive strategies that help adults explain these nuances to children, such as posing and addressing questions in the exhibit titles and text that adults can use as conversation starters.

INTRODUCTION

Roto, an exhibition design and production firm, contracted Randi Korn & Associates, Inc. (RK&A) to conduct a front-end evaluation of *Speed*, an exhibition being developed by The Science Museum of Virginia (SMV) in Richmond, Virginia. RK&A conducted in-depth interviews with museum visitors to explore their thoughts, perceptions, and understandings of exhibition concepts related to speed, defined as change over time. Findings from this evaluation are intended to help Roto and SMV find common ground between visitors' opinions and understandings and the proposed exhibition framework and concepts, including how the exhibition might help visitors connect the concept of speed to the concept of change.

Specifically, the evaluation objectives are to:

- ◆ Identify what a model of the plane compels visitors to think about in the context of an exhibition titled *Speed*;
- ◆ Identify what about the topic of speed piques visitors' interests and what their expectations are for an exhibition about speed;
- ◆ Understand whether and in what ways visitors connect the proposed exhibition materials to the concept of speed; and
- ◆ Determine whether and in what ways visitors connect the concept of speed to the concept of change.

METHODOLOGY

Front-end studies typically employ methods that produce qualitative data, as the goal is to conduct an in-depth exploration of visitors in the context of proposed exhibit content and ideas. For this study, RK&A utilized in-depth interviews as well as a card sort activity to explore visitors' understanding of concepts related to speed and change (see Appendices A to C for the interview guide and associated exhibition content); interviews were audio-recorded with interviewees' permission and transcribed to facilitate analysis. In-depth interviews encourage and motivate interviewees to describe their experiences, express their opinions and thoughts, and share with the interviewer the meaning they construct about ideas, concepts, and experiences. Hence, they are useful for understanding ideas and concepts from the visitors' point of view and produce data rich in information.

Interviewees were intercepted using a random sampling method, such that the interviewer approached the first eligible visitor group to cross an imaginary line near the entrance of the museum. Eligible visitors included English-speaking, adult-only or family groups with at least one child age 8 or older. If a visitor declined to participate in the interview, RK&A logged the visitor's gender, estimated age, and reason for refusal. If the visitor group was eligible and agreed to the interview, the interviewer asked the group to view an exhibition model showing an SR-71 Blackbird plane suspended from the ceiling and to respond to questions about the model and the concept of speed. Interviewees were next provided with a set of 18 cards containing images on the front and text on the back to represent ideas, concepts and/or activities visitors might encounter in the exhibition. Interviewees were asked to sort the cards into two piles: 1) those that connect to an exhibition about speed; and 2) those that do not connect to an exhibition about speed. RK&A also asked interviewees to select two cards from each pile: 1) ones that most connect to an exhibition about speed; and 2) ones that least connect to an exhibition about

speed. In each case they were to discuss why they selected those cards. Interviewees then read the text on the back before responding to a series of questions about the cards' association with speed. Lastly, the interviewer read aloud a statement about speed (see Appendix B) and asked interviewees about their understanding of this statement and its association with the concept of change. Once the interview was completed, the interviewer returned to the designated area and intercepted the next eligible visitor.

DATA ANALYSIS AND REPORTING METHOD

In-depth interviews produce data that are analyzed qualitatively, meaning that the evaluator studies the interview transcriptions for meaningful patterns and, as patterns and trends emerge, groups similar responses. Findings are reported in narrative and verbatim quotations from interviews (edited for clarity) are included to illustrate interviewees' thoughts and ideas as fully as possible. Within the quotations, the interviewer's questions appear in parentheses and remarks made by an adult or child are noted with an "A*" and "C*" respectively.

PRINCIPAL FINDINGS

INTRODUCTION

RK&A conducted in-depth interviews with 41 visitor groups comprised of 57 adults and 31 children; about one-half of groups contained an adult and child(ren), and about one-half were adult-only groups. Interviews were conducted at SMV on one weekday and one weekend at the end of February, 2013.¹

DEMOGRAPHIC AND VISIT CHARACTERISTICS

- ◆ About one-half of adult and child visitors are female, and nearly one-half are male.
- ◆ Adults ranged in age from 18 to 80, with a median age of 41 years.
- ◆ Children ranged in age from 7 to 16, with a median age of 10 years.
- ◆ About two-thirds of interviewees have visited SMV before.
- ◆ All visitors are United States residents, and most are from Virginia (see Appendix E for Zip Codes of U.S. residents).

PART I: PERCEPTIONS OF OVERALL EXHIBITION CONCEPTS AND MODEL

PERCEPTIONS OF THE EXHIBITION MODEL AND PLANE

Interviewees were asked what comes to mind after looking at the scale model of the exhibition that shows an SR-71 Blackbird plane suspended from the ceiling, and their responses varied. About one-third said they associated the plane with war or the military, with a few describing the plane as a spy plane or “designed for stealth;” when talking about these concepts, interviewees often referenced the plane’s design and the “Air Force” inscription on the plane (see the first quotation below). Another one-third associated the plane and its suspension from the ceiling with aviation museums and exhibitions about airplanes (see the second quotation). One-third commented on the immense size of the plane and its scale in comparison to the building and people (see the third quotation). When describing the plane, one-third referred to it by name as an SR-71 or the Blackbird. Several others each said the plane’s sleek design and black color made it look like a fast jet.

A* I thought of the Air Force and maybe a plane that’s used in war, World War I or II. (Why did you think of the Air Force and war planes?) Because it had Air Force written on the plane, and because I’ve seen a plane like that in other museums, the one near the airport. There was a plane that sort of looked like that. It was a war plane. [female 45]

A* It reminded me of Udvar-Hazy, the Smithsonian Museum up at Dulles. It reminded me of that kind of exhibit because we’ve seen the planes hanging all over the place at [the] Air and Space [Museum]. [female 50]

A* It’s bigger than I pictured. (And you said when you walked in that it was big for the building?) For indoor space, yeah. (And why did those things jump out at you?) The SR-71 is

¹ Proportions throughout the findings often total more than 100 percent because interviewees gave more than one response.

kind of a sleek, high-speed spy plane, but it was actually very large. You are used to seeing it outdoors as well, so indoors it seems a lot bigger than you think it is. [male 33]

THOUGHTS ABOUT AN EXHIBITION TITLED *SPEED*

When interviewees were told the exhibition would be called *Speed* and asked their thoughts, many commented on the fast speed of the plane (see the first quotation below). About one-half said the plane looked fast or were curious about just how fast the plane could travel (see the second quotation). About one-third noted that the plane is or was historically the fastest plane (see the third quotation). Several made connections between the speed of the plane and breaking the sound barrier, with some calling the plane “supersonic.” Several each associated the plane with stealth or with the military (as noted in the first section above). Several others discussed speed in relation to other fast things such as other planes, race cars, a speed boat, a cheetah, or a wind tunnel.

A* I think [*Speed* is] an appropriate title of what you’re displaying because you relate speed to that plane. It’s a military plane and they’re fast, and it’s catchy. [male 60]

(The new exhibition is called *Speed*. Knowing that, what thoughts do you now have?) C* How fast can that plane go? (Okay and why does it make you think of that?) Because when you think of a plane you think of how fast and also how high it’s going. [female 9]

A* That [the exhibition title *Speed*] would make a lot of sense; I mean that was the fastest plane of the old technologies. There’s scram jets and stuff that would be faster than that [today], but it got [to] Mach 3. That’s pretty darn fast. [male 36]

CURIOSITY ABOUT THE TOPIC OF SPEED

Interviewees were asked whether anything about the topic of speed piqued their curiosity. About one-third said they were interested in comparing speeds, with a few suggesting that what might be fast for one object could be slow for a different object (see the first quotation below). About one-quarter said they were curious about going fast or man’s continued desire to “go faster” (see the second quotation). Several each were interested in how fast the plane could travel or about fastest speeds in general (see the third quotation). A few were curious about what speed feels like, such as experiencing g-forces like jet pilots, and a few others were interested in the speed of light.

A* What is fast for a car is slow for a plane. What is fast for a plane is slow for a rocket. If it’s fast for a rocket, it’s slow for an intergalactic probe. And it’s interesting to see how all those scales compare. [male 33]

(What, if anything, about the topic of speed piques your curiosity?) A* Oh, how fast can people go? We always want to go faster. (Why is that of interest to you?) Oh my, it’s fun to drive fast and ski fast and fly fast, and it’s just fun, it’s interesting. [female 50]

A* I think about speed on like, the speed on water, speed on land, speed in the air, or I mean the animals, like the fastest animals, those types of things. (And why do those things come to mind?) They are different things that go fast, either that we make or that exist in nature. [male 50]

EXPECTATIONS FOR THE REST OF THE EXHIBITION

When interviewees were asked about their expectations for the rest of the exhibition, about one-half expected it to include other vehicles or modes of transportation, such as other planes, trains, boats, etc. About one-quarter expected to see comparisons of different speeds (see the first quotation below).

Several said they expected it would generally be about things that go fast, such as vehicles or animals (see the second quotation). Several each expected the exhibition would demonstrate what different speeds feel like through simulators or would be about the speed of light or sound. A few expected the exhibition to address the science of flight, and a few others thought it would contain more information about the plane.

A* Probably some kind of interactive thing that shows [you], comparatively speaking, how fast things are, like a bullet coming out of a gun, [is] versus a turtle. [It's] two extremes. A bullet coming out of a gun is pretty fast, right? And a turtle is very slow. So, one speed is very, very, slow and one is very, very, fast, and then [there are] different things in between, things that happen at different speeds in life. [male 47]

A* [I would expect to see] a variety of different things that are fast, that are involved in speed. Maybe race cars [or] other types of airplanes, things like that that can go really fast and you could learn about. (What makes you say that?) I guess I would say to build an exhibit, there would probably be a variety of different types of things that go fast to teach you about different kinds of speed. [female 30]

PART II: RESPONSES TO PROPOSED EXHIBITION CONCEPT CARDS

In the second part of the interview, interviewees were provided with a set of 18 cards containing images on the front and text on the back to represent ideas, concepts and/or activities visitors might encounter in the exhibition. Interviewees were asked to sort the cards into two piles—those that connect to an exhibition about speed and those that do not connect to an exhibition about speed. RK&A also asked interviewees to select two cards from each pile—two that most connected and two that least connected to an exhibition about speed—and discuss why.² After selecting these cards, interviewees read the text on the back and were asked follow-up questions.

EXHIBITON CONCEPTS SELECTED AS MOST CONNECTED TO AN EXHIBITION ABOUT SPEED

When asked to select two cards that were most connected to an exhibition about speed, interviewees' selections varied. The top three cards selected were: *Sonic Boom*, *NASCAR Racing and Technology*, and *Slowing Down Fast Things: Super Slow Motion*. Before being asked what piqued their curiosity about the card, many interviewees began discussing why their selection depicted an idea that interested them in some way. Most cards were selected because they depicted something that goes fast (see the first quotation below). About one-half of interviewees discussed the mechanics of speed such as how professional athletes, race cars, or certain animals can move so quickly (see the second quotation below). About one-quarter discussed perceptions of speed and time, mentioning that we cannot see some things move because they move too quickly, or we perceive time as moving quicker or slower as we age (see the third quotation). Several interviewees discussed how technology, such as computers, cell phones, machines, and communication through these devices, have become faster over time (see the fourth quotation).

A* I think everybody is trying to make things faster, like bullet trains and airplanes. That's what comes to mind for me. (And what makes you say that that's connected to speed, can you tell me a little bit more?) Because everybody is trying to do things as quickly as possible. [female 22]

² See Appendix D for a table listing the cards interviewees selected for each sorting exercise.

C* I guess the fact that a human body can go 100 meters in 9 seconds or whatever the world record is now. A* If you watch the Olympics, some of them run the whole thing and it's fascinating [to think], 'why is someone so fast? Why no matter how hard someone [else] tries, can they not be that fast?' [male 9 and female 50]

A* I like the facial expression thing. I never thought about facial expressions being so fast that we couldn't see the changes. So that would be interesting to see what you could pick up on. [female 42]

(So how do you see this image connecting to an exhibition about speed?) A* [I think about] moving data across a network, how long it takes to load on the computer. I'm thinking what it was like ten, fifteen years ago [how long it took] to get something to download to a machine versus how long it takes now, and the fact that technology changes so quickly. [female 46]

CURIOSITIES ABOUT IMAGES SELECTED AS MOST CONNECTED TO SPEED

After reading the text associated with each card, interviewees discussed whether anything piqued their curiosity. About one-half were intrigued by the experiential aspects of the exhibit concept such as experiencing what different speeds feel like, hearing a sonic boom, or seeing unique artifacts like a moon rock or race car (see the first quotation below). Several of these interviewees were also interested in aspects of choice or control (e.g., controlling variables) described in the text. Another one-half were interested to discover how people, animals, or man-made technologies achieve such high speeds or create effects like a sonic boom when traveling quickly (see the second quotation). Several were intrigued by exhibit concepts they found relevant, including how people perceive time as we age or NASCAR technology that might end up in their car one day (see the third quotation). Several others also were intrigued by concepts that prompted them to think about what is possible to achieve, such as how much smarter can intelligent machines become or whether time travel is possible. Several also were interested to learn new facts about speed, such as the speed of the fastest pitch or how long it takes for a sloth to wake up.

A* It [the *Slowing Down Fast Things: Super Slow Motion* card] makes me wonder if you will actually be able to have access to some sort of slow motion camera or some sort of hands-on thing like that, and I think that would be a lot of fun. (And why would you like that?) It's always fun to get your hands involved and, again, it really helps you connect with what you're looking at instead of if it's just a passive exhibit. [male 33]

A* I think that would be neat to have different objects breaking the sound barrier. It would be kind of cool because you think of the plane doing it, but there are probably different kinds of things that could go that fast. [female 44]

A* Well it's relatable to my own life because it [the *NASCAR Racing and Technology* card] says NASCAR technology that you might find in your own car someday. So that makes an exhibit that I might not really care about that much . . . relate to me, like in my own life. [female 23]

DULL OR BORING ASPECTS OF THE IMAGES SELECTED AS MOST CONNECTED TO SPEED

When interviewees were asked what, if anything, seemed dull or boring about the cards they selected as most connected to speed, about three-quarters said they found nothing dull or boring. About one-third said the exhibit concepts they found to be dull or boring were those not personally relatable; for example, some mentioned their disinterest in learning about the history of NASCAR.³ About one-third

³ No gender differences emerged when analyzing interview responses related to NASCAR (though the sample size ($n = 13$) is too small to draw definitive conclusions).

also perceived exhibits that were less interactive, such as looking at photos or watching a video, as dull or boring (see the quotation below).

A* Usually kids like interactive stuff, and I'm trying to figure out how this [the *Sonic Boom* concept] can be interactive for kids. I mean, they can hear the sonic boom, that's kind of cool, but I don't know. They can hear, but is there something they can use their hands to do as well? [female 33]

EXHIBITON CONCEPTS SELECTED AS LEAST CONNECTED TO AN EXHIBITION ABOUT SPEED

When asked to select two images that were least connected to an exhibition about speed, interviewees' selections varied; however, most cards were selected because they depicted something slow instead of something fast. The top two cards selected were *Evolution: The Power of Time* and *Monumental Erosion*. About two-thirds of interviewees described concepts like evolution, continental drift, population growth, erosion, and the spread of disease as happening over long periods of time—hundreds, thousands, or millions of years—and that speed is something that happens quickly (see the first quotation below). Instead, these concepts prompted interviewees to think about gradual change, the passage of time, and scientific areas of study (e.g., biology, environmental science, etc.)—ideas that many did not connect to speed. Several others selected *Freezing Time* as least connected to speed, as it shows no movement or portrays the “opposite of speed;” visitors who selected this card instead associated it with taking pictures and video stills (see the second quotation). In several instances, adults in the interview group saw a connection to speed and explained to their child(ren) that speed could be about more than just fast things (see the third quotation).

A* When I'm thinking about speed, I'm thinking fast. You know quick, rapid and this [*Monumental Erosion*] is long term. When I think of speed I think of short term, not something that takes years. [male 60]

C* I picked it [*Freezing Time*] because it's not related, because speed is how fast, how slow and this is just pausing something. And if it's pausing something, it's not going fast, it's not going slow, it's just still. [female 10]

C* I don't think it [*Monumental Erosion*] stands out because it takes a really long time for a river to collect all that dirt and stuff. It's not fast. A* You think of speed as being fast, and this looks slow. But speed can be different things, like I was saying, a tortoise is slow, but it still travels at a certain speed. [male 8 and female 42]

CONNECTIONS TO SPEED AFTER READING THE TEXT

When prompted to read the text associated with the exhibit concept, about two-thirds of interviewees started to make connections but stayed fixed in their understanding of speed as fast. For example, interviewees said the description connected concepts such as evolution, population growth, continental drift, and erosion to speed because the visitor would be able to experience a slow process speeding up (see the quotation below). Some were interested in seeing these processes sped up while others were not (see quotations in the next two sections below).

A* You're speeding up the process [of erosion] and so you're taking something that is natural and takes a certain amount of time, a long period of time to happen, and you're going to speed that up to get to the same results. [male 60]

CURIOSITIES ABOUT THE IMAGES SELECTED AS LEAST CONNECTED TO SPEED

After reading the text associated with the exhibit concept, interviewees discussed whether anything piqued their curiosity, and their responses varied. Some were intrigued with the idea of seeing a slow

process, like evolution, continental drift, and erosion, sped up or their own movements slowed down so they could witness changes they otherwise would not see (see the first quotation below). Several others who selected *Is Our Growth Sustainable?* or *Outbreak! A Spreading Plague* were intrigued with the idea of controlling the variables and seeing how this affects the future (see the second quotation).

A* I think it would be cool to be able to watch the erosion play back like that in rapid speed. That would be interesting to check out. (Why is that of interest to you?) Just to see the effects of the [sand] on the object over time. [male 22]

A* The fact that it [the *Outbreak! A Spreading Plague* concept is] interactive. In other words, a visitor can vary, adjust certain variables and see how it changes things. [male 76]

DULL OR BORING ASPECTS OF IMAGES SELECTED AS LEAST CONNECTED TO SPEED

When interviewees were asked whether anything about the descriptions seems dull or boring, about two-thirds said there was nothing dull or boring, with a few commenting that they did not relate the selected concepts to speed. About one-quarter described a card to be dull or boring because it depicted a process that took a long time, such as evolution or erosion (see the first quotation below). About one-quarter described a concept as less interesting than concepts about pure speed, but not specifically dull or boring (see the second quotation). Several others described a concept as dull or boring because they were already familiar with the topic (e.g., issues related to population growth and sustainability), and a few found concepts boring if they were not personally relevant (e.g., the depiction of time dilation in movies).

A* The time span, ten thousand or a hundred thousand years, like whoa that's so many, it's just way outside of what I can appreciate I guess. C* I mean our lives are only so many years. A* This will be our generation's life and I should care about that, but it's [concepts related to *Is Our Growth Sustainable?*] just so far off. [male 16 and female 50]

A* No, it's [the *Life & Time* card] not as exciting as the other ones, but it's not boring. (Why is it less exciting?) It does not have the rush of adrenaline you could get from speed otherwise. [male 50]

PART III: RESPONSES TO THE STATEMENT ABOUT SPEED

In the third part of the interview, interviewees were read a statement about speed and asked about the relationship between speed and change. The statement about speed noted: "The world is constantly changing, everywhere we look. Speed (the concept) is a measure of change over time. Therefore, Speed (the exhibition) provides a way of looking at the world; it is a framework for studying everything that changes."

UNDERSTANDING OF THE STATEMENT

Interviewees generally struggled to articulate their understanding of the statement. About two-thirds said they agreed with the statement but provided vague responses about the relationship they saw between speed and change (see the first quotation below). About one-quarter indicated understanding the statement, but said the definition was too broad or that they thought about speed differently, associating it with movement and fast speeds in particular (see the second quotation). Several interviewees said they agreed with the statement and articulated a specific example of the relationship between speed and change (see the third quotation).

A* I agree; I think everything changes from moment to moment. Our bodies are constantly changing; things around us are changing just at different rates. [male 74]

A* It [the statement] is a broader definition of speed. If I saw something advertised that they were going to have an exhibit about speed, I'm going to think fast robots and fast machines and things like that. But this is a broader range than that, a broader picture. [male 42]

A* I think speed is related to everything. Even this table here, if you left it sitting in the weather, it would actually change and the speed at which it changes would be very slow. If it was outside, it would start breaking down from the elements. But that's related to speed because it's something happening over time, changes happening over time. [male 47]

Hearing the statement about speed read aloud often prompted interviewees to further articulate how they thought about speed. About one-third said there are different rates of speed or that speed can be fast or slow (see the first quotation below). Several suggested that their perception of speed changed from connecting speed to motion to thinking about change over time (see the second quotation). Several others, most of whom said they thought about speed differently from the way it was articulated in the statement, perceived speed as related to motion, particularly fast speeds. A few related speed to the speed of progress (e.g., that processes such as technology and transportation have sped up).

A* When you say the word speed, you think of fast things happening as opposed to just 'look at the change.' Change can be slow or fast, and so evolution or erosion are both things that happen slowly over time, whereas a rocket is something that happens quickly. And I guess just the word 'speed' without any other definition would seem to be more of a fast speed as opposed to any speed. [male 41]

(Does what I read make sense to you when thinking about speed?) A* Yeah, that's a little broader than [what] I would think initially, but yes. (Why does it make sense to you now that you've heard that?) Well, [it] depends on what you mean by speed; that segment [in the statement] talks about speed as a general rate of change of anything as opposed to just [the] rate of changing position, which is a more narrow definition. [male 50]

IMAGES RELATED TO THE IDEA OF CHANGE

When asked which exhibit concepts they thought related to the concept of change, interviewees gave a variety of responses. Most selected cards that depicted processes that are slow or take a long time (see the first quotation below). For example, about one-half selected *Evolution: The Power of Time*, one-third selected *Monumental Erosion*, and several each selected *Is Our Growth Sustainable?* or *Speeding Up Slow Things: See Earth Change*. Several others selected cards that show advancements in technology over time, such as *Communication*, *Future Computers & Artificial Intelligence*, and/or *Fast Machines and Slow Machines* (see the second quotation). A few interviewees said that all the exhibit concepts related to the idea of change.

C* I think erosion is changing, like how the land changes and forms. I think evolution is changing because when you evolve you change your shape, your adaptation, and what you use to survive and change in a new habitat. A* I agree with her that those two are the things that I think of when [I think] of change. When I first walked in [and] you mentioned speed, I'm thinking of NASCAR and you know things that go fast. But after you mention speed as far as changes, then yes, the evolution and erosion fit the best. [female 10 and female 33]

(Tell me why you associate *Communication* and *Fast Machines and Slow Machines* with change?) A* [It's] just because [technology] in the last 100 years, there's been amazing changes. C* It went from the telegraph to the iPhone basically. [male 16 and female 50]

APPENDICES

APPENDIX A

INTERVIEW GUIDE

REMOVED FOR PROPRIETARY PURPOSES

APPENDIX B

STATEMENT ABOUT SPEED

The world is constantly changing, everywhere we look. Speed (the concept) is a measure of change over time. Therefore, Speed (the exhibition) provides a way of looking at the world; it is a framework for studying everything that changes.

APPENDIX C

EXHIBITION CONCEPT CARDS

NASCAR Racing & Technology



NASCAR Racing & Technology

What's special about a winning stock car? How and why have NASCAR speeds changed?

A real vehicle is on display as the centerpiece of a variety of activities, including NASCAR technology that you might find in your own car someday. The science of racing and even some history of NASCAR in Richmond will be included.

Human Wind Tunnel



Human Wind Tunnel

What does it feel like to move really fast?

Visitors enter an air chamber, put on safety glasses and select a speed simulation. Possible choices include an Olympic sprinter, a speeding cheetah, a race car, and a free-fall skydive at terminal velocity! A digital display tracks the increasing speed and a video projection enhances the speed experience. The wind tunnel is large enough to accommodate a group of visitors.

Sonic Boom



Sonic Boom

What does it mean to break the “sound barrier?” What is a “sonic boom?”

Visitors learn about what causes a sonic boom and see photos of different objects breaking the sound barrier. The story of Chuck Yeager (the first human to fly faster than sound) is included here, and overhead a real sonic boom is created by a robotic arm snapping a long leather bullwhip. Cr-ACK!

Asteroids and Meteors



Asteroids and Meteors

What is the speed on impact of a meteorite? What can meteor impacts do to planets and moons?

Visitors learn about asteroids, meteors, and meteoroids by examining real-life stories of major impacts, touching a real meteoroid that crashed into the earth, and making their own craters in fine sand filmed in super slow motion. This display also includes an authentic rock brought back by NASA from the crater-filled Moon itself.

Sports and World Records

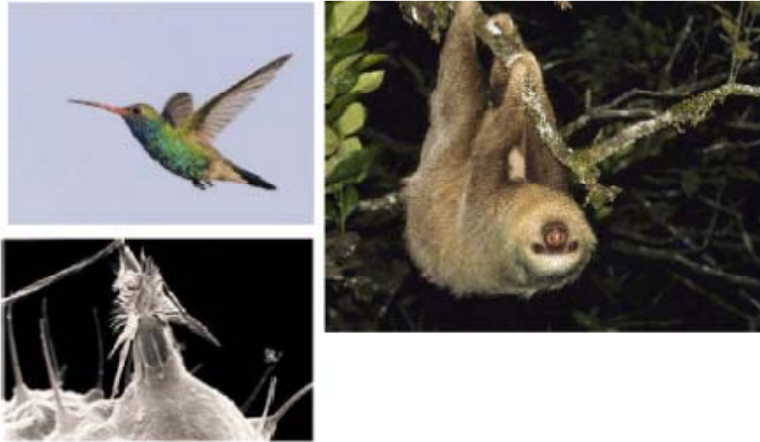


Sports and World Records

What are the most amazing speed feats ever accomplished by humans? How have these records changed over the decades?

This is a collection of amazing artifacts, video and award-winning photographs of Olympic (and other) athletes who comprise the fastest humans on the planet. Who has the fastest tennis serve? What is the fastest pitch ever thrown (and was it a ball or strike)? What is the top speed of a world-class swimmer? You can even see a pair of Usain Bolt's track shoes!

Speeds of Animals and Nature



Speeds of Animals and Nature

**Which are the fastest animals in nature? Which are the slowest?
How do these adaptations help the animals survive?**

This is a collection of amazing artifacts, video and award-winning photographs of mammals, reptiles, fish, birds and insects who comprise the fastest – and slowest – animals on the planet. Which animal has the fastest reflex? Which is the fastest runner on dry land, and the fastest swimmer undersea? Find out how long it takes a sloth just to wake up!

Communication

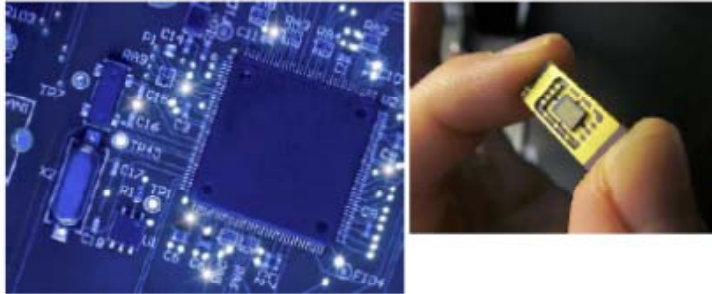


Communication

How has technology changed how fast I can say something? Who is the fastest texter in the building today?

Visitors compete using a keyboard or their mobile phone to type out or text the same message as the Morse code machine in the exhibit. Best times are posted on a scoreboard. How will keypads of the future allow us to communicate even faster?

Future Computers & Artificial Intelligence



Future Computers & Artificial Intelligence

As chips get faster and computers get smarter, how intelligent can machines eventually get? What will this mean for me?

Visitors interact with really fast – and really slow – computing machines to discover more about the amazing pace of technological advancement and where it could lead. What's happening in the labs at IBM that may change the world? What is Google building nationwide that could transform your online experience? Are you ready for a phone that can read your mind?

Slowing Down Fast Things: Super Slow Motion



Slowing Down Fast Things: Super Slow Motion

How can I see something moving really fast?

Visitors use super slow motion video to capture details of events that are too fast to see with the naked eye, from explosions to facial expressions, flying bullets to the muscles in the wings of gnats.

Freezing Time



Freezing Time

What would it be like to freeze time?

Using a special chamber ringed with cameras, visitors examine themselves as if time suddenly stopped. After a brief countdown, the visitor can jump up, juggle, jump rope or hold any other pose, then watch as the exhibit plays a 10-second high-definition video loop where the performer appears to be frozen in time.

Relativity: Time Dilation in the Movies



Relativity: Time Dilation in the Movies

Does time really slow down the faster you travel?

Einstein's famous theory of Relativity has now been experimentally confirmed, and yes, the faster you move, the slower time passes – and, as you approach the speed of light, time actually stops altogether. How have movies and television shows played with this idea to showcase how very strange our universe really is?

Monumental Erosion

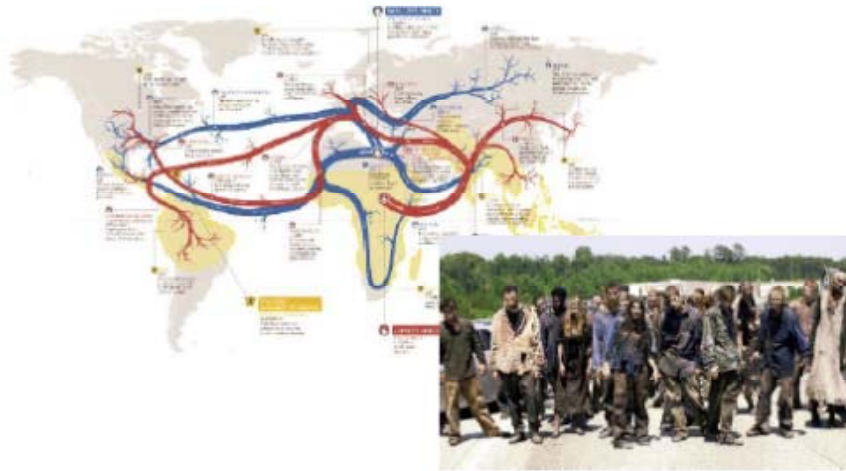


Monumental Erosion

How permanent are human constructions like monuments, buildings and civilizations? What is the speed of their erosion by the forces of time?

Two identical stone statues sit side by side, one of them inside an enclosed glass box filled with flying sand. Visitors control the speed of erosion, and play back a time-lapse video showing the effects of centuries of erosion on objects we think of as "permanent."

Outbreak! A Spreading Plague

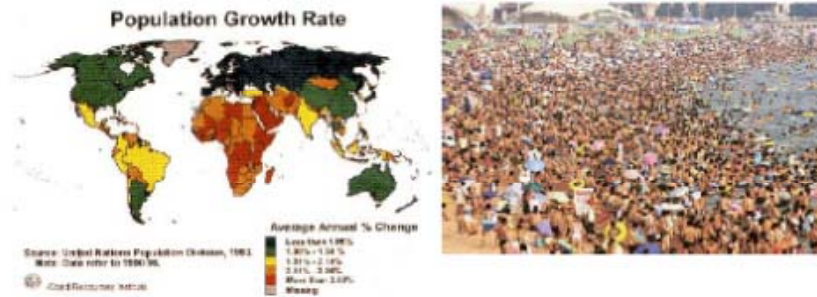


Outbreak! A Spreading Plague

How fast do diseases spread? What makes them spread faster or slower?

Using a high-tech computer simulation, visitors adjust variables like population density, immunity level and type of disease, and then launch a deadly virtual virus into the world population. As the simulation proceeds, visitors watch as the infection spreads across cities, countries, and continents. How many will survive?

Is Our Growth Sustainable?



Is Our Growth Sustainable?

What are the speed and consequences of population growth?

Using a giant machine full of wheels and dials, visitors adjust the rate of reproduction and length of the average lifespan, and then see how the world population changes over the next 10, 100 and 1,000 years. Further variables show the consumption of resources like fresh water and fossil fuels, played out against the population projections, to witness the effects.

Fast Machines & Slow Machines



Fast Machines & Slow Machines

How fast are the world's fastest machines? Why are engineers so excited to build the slowest device ever created?

Visitors explore the extremes of the technology spectrum, from the world's fastest robots and rockets, to the world's slowest man-made mechanical device, including plans for the "Millennium Clock" – a timekeeping device that must run for 10,000 years without stopping.

Life & Time

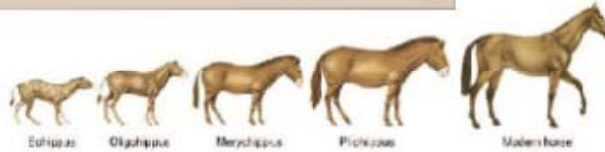


Life & Time

How fast am I aging? Why does time seem to go by faster?

Visitors explore the phenomenon of living through time. Is the speed of life really getting faster? Where will society's quest for speed lead us? Why do we age at all, and can this process ever be reversed? These exhibits will give visitors a glimpse into their own future.

Evolution: The Power of Time



Evolution: The Power of Time

How fast do species evolve? Are humans still evolving?

Visitors sit in a simulator cockpit and “fly” through millions of years to visually explore how the Earth’s living species have radically changed, little by little, through the amazing power of time.

APPENDIX D

CONNECTIONS BETWEEN INDIVIDUAL CONCEPT CARDS AND SPEED

TABLE A
CONCEPTS CONNECTED TO AN EXHIBITION ABOUT SPEED

INTERVIEW GROUPS (<i>n</i> = 41)	IS THE CONCEPT CARD RELATED TO AN EXHIBITION ABOUT SPEED? ¹	
	YES	NO
	%	%
Sonic Boom	97	3
Fast Machines and Slow Machines	96	5
Human Wind Tunnel	96	5
NASCAR Racing & Technology	96	5
Slowing Down Fast Things: Super Slow Motion	88	13
Speeds of Animals and Nature	83	17
Communication	81	19
Sports and World Records	81	19
Asteroids and Meteors	79	21
Relativity: Time Dilation in the Movies	77	23
Future Computer and Artificial Intelligence	66	34
Life & Time	55	46
Freeze Time	49	51
Speeding Up Slow Things: See Earth Change	47	53
Outbreak! A Spreading Plague	32	68
Is Our Growth Sustainable?	27	73
Monumental Erosion	27	73
Evolution: The Power of Time	14	86

¹ Percentages do not total 100 because interview groups sorted all the cards.

TABLE B**CONCEPTS MOST CONNECTED TO AN EXHIBITION ABOUT SPEED**

	WHICH TWO CONCEPTS ARE MOST CONNECTED TO AN EXHIBITION ABOUT SPEED?¹
CONCEPT CARD (n = 41)	%
Sonic Boom	46
NASCAR Racing & Technology	32
Slowing Down Fast Things: Super Slow Motion	22
Speeds of Animals and Nature	18
Sports and World Records	14
Asteroids and Meteors	12
Fast Machines and Slow Machines	12
Future Computer and Artificial Intelligence	10
Human Wind Tunnel	10
Life & Time	8
Relativity: Time Dilation in the Movies	8
Communication	4
Outbreak! A Spreading Plague	4
Evolution: The Power of Time	0
Freeze Time	0
Is Our Growth Sustainable?	0
Monumental Erosion	0
Speeding Up Slow Things: See Earth Change	0

¹ Percentages do not total 100 because each interview group selected two cards.

TABLE C**CONCEPTS LEAST CONNECTED TO AN EXHIBITION ABOUT SPEED**

WHICH TWO CONCEPTS ARE LEAST CONNECTED TO AN EXHIBITION ABOUT SPEED?¹	
CONCEPT CARD (n = 41)	%
Evolution: The Power of Time	42
Monumental Erosion	40
Is Our Growth Sustainable?	22
Speeding Up Slow Things: See Earth Change	22
Freeze Time	20
Outbreak! A Spreading Plague	20
Asteroids and Meteors	12
Future Computer and Artificial Intelligence	8
Relativity: Time Dilation in the Movies	8
Life & Time	2
Slowing Down Fast Things: Super Slow Motion	2
Speeds of Animals and Nature	2
Sports and World Records	2
Communication	0
Fast Machines and Slow Machines	0
Human Wind Tunnel	0
NASCAR Racing & Technology	0
Sonic Boom	0

¹ Percentages do not total 100 because each interview group selected two cards.

APPENDIX E: ZIP CODES AND RESIDENCE BY STATE

TABLE D
ZIP CODES FOR US RESIDENTS (*n* = 86¹)

ZIP CODES	<i>n</i>	ZIP CODES	<i>n</i>
23113	7	22485	2
23831	5	22554	2
23112	4	23002	2
23116	4	23005	2
23220	4	23059	2
23224	4	23875	2
23227	4	39320	2
23236	4	08822	1
23666	4	20194	1
01929	3	22715	1
23106	3	23114	1
23111	3	23235	1
23188	3	23860	1
23221	3	23885	1
23901	3	24477	1
01760	2	28209	1
22406	2	28562	1

¹ Two interviewees provided their state of residency instead of their zip code; one lived in Maryland and the other lived in Virginia.