O'REILLY®

Data, Technology & the Future of Play

Understanding the Smart Toy Landscape

Meghan Athavale

O'REILLY®

Artificial Intelligence

Conference Leadership

Tim O'Reilly
O'Reilly Media, Founder and CEO

Peter Norvig
Director of Research at Google Inc.

Explore opportunities for applied AI

oreillyaicon.com

Data, Technology, and the Future of Play

Understanding the Smart Toy Landscape

Meghan Athavale

Beijing • Boston • Farnham • Sebastopol • Tokyo O'REILLY®

Data, Technology, and the Future of Play
by Meghan Athavale

Printed in the United States of America.

Published by O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.

O'Reilly books may be purchased for educational, business, or sales promotional use. Online editions are also available for most titles (*http://safaribooksonline.com*). For more information, contact our corporate/institutional sales department: 800-998-9938 or *corporate@oreilly.com*.

Editor: Nicole Tache
Production Editor: Nicholas Adams
Copyeditor: Jasmine Kwityn
Interior Designer: David Futato
Cover Designer: Randy Comer
Illustrator: Rebecca Demarest

March 2016: First Edition

Revision History for the First Edition
2016-02-22: First Release

978-1-491-92571-3

[LSI]

Table of Contents

Data, Technology, and the Future of Play 1
The Nature of Play 3
Toy Data: Feedback and Interactivity 11
The Ethics, Risks, and Promise of Smart Toys 13
What's Next? 18
Conclusion 20

Appendix: Companies and Resources 21

Data, Technology, and the Future of Play

Enforced learning will not stay in the mind. So avoid compulsion and let your children's lessons take the form of play.
—Plato, *The Republic*

Through play, many species' young acquire the necessary skills to navigate their world. Play is how they learn, make mistakes, and establish social and cultural norms. According to Thomas Henricks, in his essay "The Nature of Play," "Compared to those moments when people are virtually prisoners of their daily routines, people at play are said to have broken free to conjure new possibilities of being and, even more importantly, to test the implications of those possibilities in protected forms of behavior."

The last half century has seen the evolution of the computer from a monolithic counting machine to a ubiquitous network of small, programmed devices. Processors became cheaper and connectivity became universal. Along the way, toys also got smart. Today's $40 Furby has four times the processing power as the 1960's Apollo Moon Lander. Moore's law explains that an increase in accessibility and decrease in cost leads to an exponential rise in all things electronic year over year. Cheaper, more accessible technologies have filled the so-called need to enhance our productivity and quicken our communication, but technological toys have not actually *proven* themselves to be more educational, more efficient, or more entertaining than "dumb" building blocks, skipping ropes, or even the timeless cardboard box fort.

While the toy industry is worth $85 billion, it's stalled in recent years. Smart toys are the exception, with analyst firm iDATE estimating their global market size growing from €1.3 billion in 2013 to more than €7 billion by 2018. This increase comes just in time, too. One of the growing trends in toys is what is known as the toys-to-life industry, comprised of games that combine smart toys and video games (e.g., *Amiibo*, *Skylanders*, and *Disney Infinity*). The market research company NPD Group states that about 28% of U.S. households own at least one of these games.

So what's driving the increase in smart toys? Production cost and marketing is a big factor. Smart toys cost less to produce than they once did, and many often have flashy elements that are easier to sell. The toy industry has an expression: "Sell the sizzle, not the steak." Technology in toys provides a new kind of sizzle, one that the consumer market finds irresistible despite the lack of evidence that these toys are any better for children.

Another big advantage for toy companies and startups alike is that smart toys require a software ecosystem, and generally some data buy-in from parents and children. This means that unlike traditional toys, which tend to either be outgrown or become boring, there is a digital element in smart toys that has the potential to be updated and customized. Combine that with the personal investment necessary to "teach" your Furby to talk, or create your functioning Little Bits keyboard, and it leads to a much lower abandonment rate; Technobuffalo states that only seven percent of families have lost interest in the toys after picking them up. Clearly, smart toys are the future of play.

What, exactly, "smart toys" are is less clear. Laurent Michaud, Head of Consumer Electronics & Digital Entertainment Practice at iDATE, defines smart toys as "a video game, one or more connected objects, and a distribution platform with a display." One toy executive, who agreed to be interviewed for this report on condition of anonymity, described smart toys as highly connected apps with tons of sensors, but conceded that many toys are not really "smart" at all. Toy and game developer Faran Thomason, with Jungle Cat Productions, calls smart toys "the latest iteration of the 'tech' toy genre." He adds, "They're edutainment-type toys that can be upgraded or connected to the Internet."

Data science is at the core of these smart toys. No longer limited to scripted responses, toys are now employing sophisticated algorithms to enable interactivity. They're connecting to the cloud, sharing data, and getting updates. They're customizable. Smart toys are also a sandbox for new technology initiatives. Special-purpose AI is as likely to emerge from a smart toy as an enterprise application; immersive visualizations may just as easily come from a video game as from DARPA-funded research.

This shift in the type of toy we're manufacturing has important consequences for how we play, and how we learn. There's a huge difference between a toy (unstructured, unconditional) and a game (constrained by rules). We play games with toys. And as toys become connected and imbued with data, the freedom of play can vanish. A smart toy knows how it wants to be played, and so it becomes the playmate. The feedback loops of smart toys, driven by data, are impacting how we learn, and this has important consequences for humans.

Smart toys fundamentally change the nature of play, and how the next generation thinks about interaction—not only with toys, but with one another.

The Nature of Play

While play is a quintessential part of childhood, the word "play" describes a variety of activities enjoyed by people of every age. Play is not a specific activity or outcome; it's more of a subjective *feeling*. Play is fun, while other activities can be tedious, bothersome, or downright unpleasant. We imply, in our division of daily activities, that play is somehow different than "work." Yet many child researchers, including Maria Montessori, describe play as the "work of childhood."

Dimensions of Play

According to Montessori, play includes the following dimensions:

Play is voluntary
: Whether sports, painting, or making music, play is an activity we enjoy and engage in willingly. How many of us, as children, were told to "go play outside" after annoying our parents for a bit too long? Although we do not always seek play, it is some-

thing we pursue with happiness when we find it. This is an important point where technological toys are concerned. For example, a toy like Dash and Dot, which encourages kids to write programming code, turns software development into "play," where writing software code might be considered work in another context.

Play expands skills

Particularly in young children, play tends to draw the player into situations that require the use of existing skills, or the learning of new skills. This is readily apparent in sporting activities, but can also be observed in creative play like visual or performing arts and role-playing. Large and small motor skills, communication, and memory are a just few of the skills we refine over time through play.

Play expands new ideas

We often perform experiments when we play, inventing contraptions, staging complicated interactions, and exploring new places, both physically and figuratively. Role-playing and competitive games allow children to safely explore their roles in society, personal relationships, and expectations of cause and effect. These are some of the complex ideas that children develop while they're young.

Play is social

Obviously, you can play by yourself. But unlike sleep, work, or reading a book, play is a social interaction. Solo play creates a feedback loop that provides a social reward. Whether you paint a picture, fly a kite, or spend an hour on a swing singing to yourself, you are interacting with yourself in a social way, which helps you interact with others. Group play has more conspicuous social benefits.

Play is emotional

If it didn't feel good, we wouldn't do it. With the exception of professional athletes and artists, very few of us are paid to play. We enjoy playing. It's also a survival impulse that can be observed in many young animals. The games and adventures we embark on as children lead us past our fear of the unknown into a greater awareness of the world and its pitfalls. In fact, play often summons a combination of emotions—from fear and disappointment to excitement and happiness. Through games, we

learn to experience, express, and cope with a wide range of feelings.

Constraints and Rules

Another cornerstone of play is constraint. Some forms of play are competitive, and those constraints become rules—a way to determine the winner and loser. Less structured play, such as "playing house," may be collaborative, with the only constraints being the setting and roles. Linda El-Fakir, president of The Big Idea Factory and serial toy entrepreneur, compared the fluctuating constraints of smart toys with the somewhat fixed constraints of traditional toys. "Smart toys use electronics and their programming to guide children in how to play or learn, and some allow growth and change over time with mastery; for example, they can move to a next level of play, select more types of play, or play differently," said Linda. "Traditional toys tend to have set play patterns and can't change over time, but can be played with as intended or differently, and with other toys—for example, blocks and action figures and vehicles together—depending on the child's interest and imagination."

From constraints comes creativity. Constraints provide context, as well as limitations to overcome. In the case of competitive play (e.g., chess or tag), the rules provide the basis for the contest. In creative play, these rules are often emergent, invented as play progresses.

The Nature and Evolution of Toys

"If play is the work of the child, toys are the tools," said Maria Montessori in an article for the Child Development Institute. "Through toys, children learn about their world, themselves, and others."

Per Montessori, toys teach children to:

- Figure out how things work
- Pick up new ideas
- Build muscle control and strength
- Use their imagination
- Solve problems
- Learn to cooperate with others

However, the nature of toys (and play) is in flux. In the last half century, toys stopped being tools for play, and became *agents* of play. All toys offer affordances—a stick might be a weapon, or a mode of transport, or a musical instrument. A stick isn't designed for any of these things, of course, but a child provides the necessary context. One way to look at toys is to consider them in two dimensions: whether the child is a spectator versus a creator, and whether the toy is being used for its intended purpose versus being repurposed (see Figure 1-1).

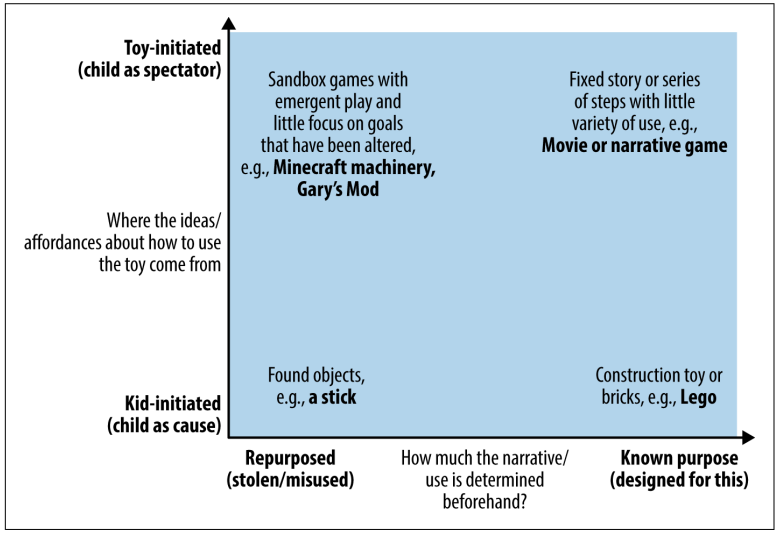

Figure 1-1. Comparison of toys based on provided play narrative

Purpose-built toys have more constraints—ball wants to be thrown, a doll wants to be hugged, and a pen wants to draw. The more complex the toy, think today's smart toys, the more "opinions" it has about how it should be used.

How Toys Became Smart

The brains of today's toys started with arcade video games. Early computer games were the digital equivalent of board games. For example, *Pong* (released in 1972), pitted opponents against one another, without agency on the part of the game. These early games merely enforced the policies and constraints of the game. The next wave of games allowed single-player play, but they weren't adaptive. *Breakout* (released in 1976) had no intelligence beyond a simulation

of physics. The enemy in *Space Invaders* (released in 1978) didn't adapt to player behavior, other than speeding up on more advanced levels. As games became more sophisticated, they began to adjust their play in response to the player's actions. The ghosts in *Pac-Man* (released in 1980) changed their trajectories according to how the player moved.

While difficult to pinpoint, the emergence of "smart toys" likely started in the early 90s, with VTech and LeapFrog. These were the first big toy manufacturers to focus on the smart toy market, and to spread the message that digital toys offer superior educational experiences. The small handheld arcade games and Tamagotchi toys never claimed to make kids smarter, or to be particularly smart themselves. But LeapPad and other products were packaged with the message that they could actually *teach* kids with their built-in technology.

The idea that toys could also learn from kids came later, with toys like Robosapien and Furby. The Tamagotchi's smart companion Furby required care, feeding, and interaction with an owner. This paved the way for even more advanced sidekicks, such as Jimmy the 21st century robot.

In *Alone Together* (Basic Books), author Sherry Turkle writes, "The first computational objects of the playroom provoked a change in children's way of sorting out the question of aliveness. ... Unlike traditional dolls, the robots wouldn't thrive without attention, and they let you know how you were doing. But even the most primitive of these objects—Tamagotchis and Furbies—made children's evaluation of aliveness less about cognition than about an object's seeming potential for mutual affection."

While furry dependents and charming robots were hitting the shelves, ubiquitous computing also became a reality. There are now billions of smartphones in the world, as well as microcontroller kits like Raspberry Pi and Arduino on which to build the brains of a toy. Many modern smart toys rely on ubiquitous broadband for everything from software updates to analytics to tie-ins between physical and virtual elements.

In recent years, games have become even more sophisticated, with storylines that adjust to the player's choices and behaviors, and deeply branched conversations. Games like *Guitar Hero*, which introduced a physical toy linked to a digital game, have blurred this

physical/virtual line. And kid-friendly communities such as Disney's Club Penguin and shared servers for sandbox games like *Arc* and *Minecraft* provide creative interaction.

Powered by software, collecting data, and personalizing their actions based on the user, smart toys not only change how children learn, but also act as surrogates for intimacy and companionship. Play is largely about narrative, and when the toy comes with its own narrator, will it drown out the narrative of the child?

From Opponent to Companion

One of the many ways smart toys differ from traditional toys is that they can control the narrative of play. Their programming is hardly sentient—today it's at the level of a non-player character (NPC) in a video game—but context will soon enable them to react algorithmically, rather than programmatically. This interactivity is compelling. It's why virtual toys are flourishing.

Looking at automated chat programs like Cleverbot, it's clear that this future isn't far off. Figure 1-2 shows an example chat with Cleverbot.

Figure 1-2. Cleverbot chat example

Chat agents like Cleverbot learn from every user, often parroting back what others have said. In this example, nearly 30,000 people are talking with Cleverbot. Its interactivity is a product of a constant feedback loop, just as Google Now learns from the searches its users conduct. And as we'll see, that feedback loop holds both promise and risk for toys.

Apps and the Soul of the Toy

We spend a tremendous amount of time in front of screens. Late 2014 was a tipping point, when, according to Flurry Analytics, the average American spent 168 minutes a day watching TV, but 177 minutes a day on their smartphone.

Behind each of those screens are applications. Much of the time, they're affordable, educational, and better able to teach the new norms of interaction than any other experience. They incorporate increasingly sophisticated software, allowing the apps to learn and

adapt over time. The biggest disadvantage to these apps is that many of them serve up sedentary activities, and are generally not social.

Parents worry about the sedentary behavior that toy apps encourage. But, parents are concerned for the wrong reasons. These toys are in fact becoming less passive, and more interactive. And they're always on.

While toys can't relate to a child as well as humans can, their immediacy is limitless. Children mistake the undivided attention of a toy for intimacy, and as toys get smarter and more contextual, we risk entering an era of "drone parenting," abdicating the raising of our children to a digital nanny. However, we aren't building nannies yet, and we're still very far from artificial intelligence that can do more than one or two things really well. Self-driving cars and delivery drones, for example, require a very specific context (a set of human behaviors and information) to operate well. A great deal more context is required to successfully teach and raise a child to become a responsible adult. If parents lean on technology to satisfy their children's emotional and physical needs, they may be depriving their children of that context.

This is happening before our eyes. Check out MIT's the Huggable, a robotic teddy bear that helps kids cope with the stress of major illnesses. The teddy's brain is a phone. He's an app, with an adorable little body. So is the pre-programmed playmate Ubooly, dubbed "the learning toy that listens." So is the robot Jibo, a family-friendly personal assistant. So is the robotic ball Sphero, and so are the coding robots Dash and Dot.

Is this bad? It's not the first time we've worried about toys. According to London Knowledge Lab's report on Children's Playground Games and Songs in the New Media Age, "Ever since children's games, songs, rhymes, rituals and objects of play were first documented in the mid-19th century, there have been concerns over their vulnerability to a succession of perceived threats. They have regularly featured as symptoms of what adults imagine as the innocence of childhood, and its supposed fragility."

The next generation's imaginary friends will be software-generated, and will change how we learn and think—and maybe that's a good thing.

Toy Data: Feedback and Interactivity

In *The Diamond Age* (Bantam Spectra), novelist Neal Stephenson envisions an interactive book that acts as a guide for the heroine. But *A Young Lady's Illustrated Primer* still had *human* actors behind it, voicing the book and offering advice. Today, we have Siri. Tomorrow's agents will seem vastly more sophisticated.

Three Feedback Loops

Smart toys have three distinct feedback loops: real-time adjustment of toy behavior based on child's reaction, pooled behavior and automated learning, and product roadmaps established by analytics (see Figure 1-3).

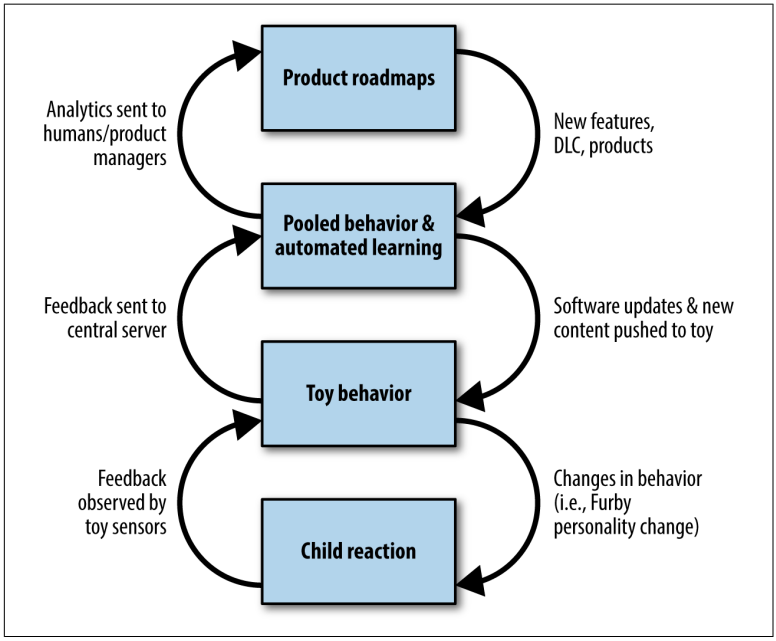

Figure 1-3. Three feedback loops of smart toys

Together, these three loops guide a toy's behavior over its lifetime. Let's look at each loop a bit more closely:

- *Real-time adjustment of toy behavior based on child's reaction* has been around since the Tamagotchi—toys like Furby can change their behavior and personality based on feedback. Some of the

newer toys even try to simulate interactivity, and in many cases are programmable.

- *Pooled behavior and automated learning* is the real promise for smart, connected toys. When the sum of all play leads to feedback and adaptation, toys get smarter. Consider Tesla's recent self-driving car: when it was first launched, drivers complained that it was taking corners too quickly, or edging toward exits when it shouldn't. But within a week, the cars were learning, as each time a problem occurred the driver took the wheel and taught the collective intelligence what to do. When toys benefit from similar automated learning, they'll wise up faster than we expect.
- *Product roadmaps* are informed by customer feedback, but obtaining this feedback was traditionally done in focus groups and by observing sales or product usage. Building analytics into toys gives product teams faster feedback, and it comes from real-world use rather than staged environments. When the toys are smart, new functionality can be pushed out to them quickly, too. Wonder Workshop lets children use their Dash and Dot robots to compete in a robotics league. This league enabled the Workshop to release a new application for visual coding, Wonder, nearly a year after Dash and Dot was launched. With the new app came a variety of new functions and sounds for the robots themselves.

Interactive products like smart toys inherently collect data, but that data can be repurposed and misappropriated. How do we control what's stored, for how long, and how it's used?

Usage of smart toys may even have permanent, long-lasting biological consequences. In a piece she wrote for the UK's *Daily Mail*, Professor Susan Greenfield observes that "electronic devices and pharmaceutical drugs all have an impact on the micro-cellular structure and complex biochemistry of our brains. And that, in turn, affects our personality, our behavior, and our characteristics. In short, the modern world could well be altering our human identity."

The Ethics, Risks, and Promise of Smart Toys

Data-driven play, powered by smart toys, has the potential to help us learn and remember better. But it can also break trust and privacy codes, lead to antisocial or addictive behavior, and even introduce new forms of liability for manufacturers.

Balancing Privacy and Customization

The nature of a child's relationship with their smart toys opens up serious privacy concerns, as Mattel recently learned when it met some resistance in launching Hello Barbie, a Barbie that "listens" to children by recording, recognizing, and processing their every word. The goal behind Hello Barbie is to allow Barbie to have "conversations" with children. ToyTalk, the company that created the Siri-like program that allows Hello Barbie to understand and react to thousands of phrases and words, claims that personalized experiences help children learn and focus. This claim is backed up by research from Georgetown University's Children's Digital Media Center.

The issue with Hello Barbie, though, is that children's voices are recorded, sent to Mattel, and stored. Some might argue that recording and storing children's most intimate moments with their toys is just another kind of focus group, and necessary for further development of the toy's conversational algorithms. But others argue that using data to make a toy more intelligent is pretty terrifying.

Many toy companies, such as Pixel, Tiggly, Toy State, Sphero, and Moppadop, have privacy statements that govern how marketing information is used, or that cover their web content. But few are transparent about the data they're analyzing in real time, or pooling across users, or capturing analytically. And fewer still are thinking about vulnerabilities and hacking. Consider the My Friend Cayla doll. It's a smart toy that can converse, and even comes with a built-in list of bad words and controversial topics. Researchers have learned that the substance of Cayla's responses can be hacked, triggering her to spew vulgar and downright creepy language.

Toy startup CogniToys sells Dino, a small talking dinosaur that connects to the cloud to converse with children—similar to IBM's Watson. The more a child interacts with Dino, the more Dino will learn

the child's vocabulary level, interests, and so on. The child's experience with Dino will then be altered accordingly.

"For smart toys that involve mixing physical and digital experiences, the child's attention is split 80/20 between the digital and the physical," explained one senior toy company executive, who agreed to be interviewed on condition of anonymity. "Skylanders is a good example of this. The promise of cloud-enabled smart toys is that they provide a better and more immersive play experience and can unlock more imagination and creativity through dynamic content. It's hard to say how children will interact with that category of products since there haven't been any big hits with wide distribution—the jury is still out."

The Risk of Social Withdrawal and Addiction

Smart toys present another potential risk—not to children's imaginations, but to their social development. When toys become smart enough to satisfy a child's basic need for approval without human interaction, the child may be less motivated to learn from and interact with other people. This wasn't a concern with television because it wasn't interactive—TV sets didn't give children real-time feedback or try to mimic a living, emotive being. Modern technology creates a completely new kind of relationship between a child and her toy—smart toys blur the line between real and imaginary friends.

Linda El-Fakir, of The Big Idea Factory, is less worried. "Children connect emotionally with their pets and their pets usually appear to 'care' back, especially dogs," she said. "Does this cause Social Connectivity Deficit Disorder? I think not, and in fact we generally promote that kid–pet bond and relationship as reinforcing a whole host of positive behaviors." Linda observes that the manifestation of social disorders is possibly rooted in childhood, not toys. "If a child thought their electronic, battery-driven interactive smart toy was 'real,' and it went on longer than just an 'imaginary friend' phase, and they started withdrawing from the real world, then that would be a cause for parental concern. I'd label that as an individual psychological issue with a child in need of counselling, and not the fault of the toy or the toymaker."

What Happens When the Toy Breaks?

As children come to rely on their toys as companions, they become dependent on them. Toys will become smart agents, lifelong personal assistants. They build up context and knowledge about a child's life, personality, education. Virtual reality experiments using smart toys are currently being carried out on pre-language children to determine their likelihood of having autism or a spectrum of other disorders. Biometric and evaluation data is then shared with parents as a way to inform their child's progress in school, and is also being transmitted over the cloud and stored by the school. No one really knows what happens to this information, or how it may impact children later in life.

Another executive from a major toy manufacturer, speaking on condition of anonymity, expressed real concern about the impact of digital "friends," and went so far as to state, "Creating and imagination are suffering because of smart toys and digital experiences. Ask the average eight-year-old, especially on one of the coasts or in a major metropolitan area, to play pretend and you'll get a puzzled face looking back at you. Digital tools and platforms give kids a different way to express themselves and their imaginations, but on their own, aren't an enhancement or substitute. Your imagination is like a muscle—you need to train it and exercise it regularly, or else it will atrophy."

When the toys and companions on which modern children have come to depend break, or when their functionality is compromised by a software upgrade or system maintenance, how will these children react?

The Ethics of Algorithms

Smart toys operate on feedback and algorithms. The behaviors those algorithms produce could be a source of liability—My Friend Cayla, for example, is programmed to speak on certain sensitive topics such as religion, politics, and sexuality. The toy's manufacturer says exposing children to these topics will "cause Cayla to encourage the child to go and ask a parent or teacher."

But who's liable when these algorithms go awry? Does failure to monitor and adjust a toy's parameters constitute parental neglect? Similarly, would parents *want* toymakers to adjust a toy's behavior in

order to improve a child's grades, or make them less socially awkward?

Consider in Figure 1-4 how Google handles a search for suicide—with both an ad for a help organization, and inline information on suicide prevention. How should a smart toy respond to a similar request? And what about a less obvious one, such as a pattern of depression? Is the manufacturer liable for not detecting such signs?

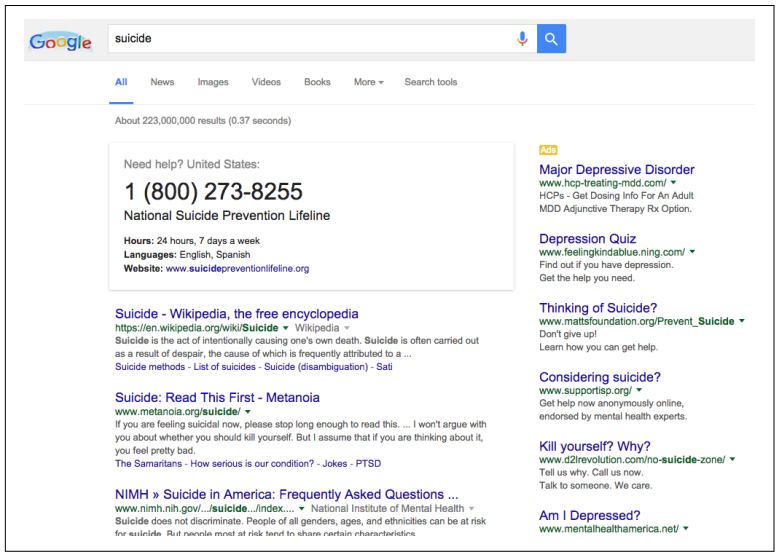

Figure 1-4. Google search results for "suicide"

One toy company expert, speaking on condition of anonymity, cited a double-standard at work in the toy industry. "The regulatory and liability landscape is evolving in this space," he said. "I'd say that smaller companies will be held to looser standards than larger ones, creating an uneven and non-competitive landscape in the near term."

The Benefits of a Smart Companion

There are upsides to smart toys, too. Smart toys that learn from users and provide personalized education are a kind of one-on-one tutoring that was once only available to few children. Smart toys can also creatively inspire users by providing them with compelling scenarios full of novelty, environments that stimulate the user rather than forcing them to battle the ennui of repetition. According to

Google's vice president of research Alfred Spector, in a BBC article, "We have user interfaces that are so exciting that people play video games for hours and hours a day, and they could be educated by them."

What's more, connecting users enables information to be shared socially. Evidence supports the theory that we retain information more effectively when we learn from peers in a social setting, rather than when our training is delivered exclusively through lectures and independent research.

Rob Whent, CEO of startup Thriver, wanted to help his son to learn more effectively. With the help of British pediatric neuropsychologist Jonathan Reed, he identified 44 specific cognitive skills, which Thriver now uses to generate a child's cognitive fingerprint. The website adjusts the library of games offered to a child, based on their unique cognitive profile. The idea is to encourage the best learning environment possible for a child. "Once we have a cognitive profile, the digital world can change to meet our needs," said Whent in an interview with *Parents* magazine. "Technology will adapt to us, and not the other way around."

It's still unclear whether smart toys and interactive games produce *smarter* humans, though. Many of the toy industry experts we interviewed agreed with this assessment. Linda El-Fakir observed that "advantage, privilege, quality of schooling, and basic raw intellect are bigger factors in creating 'smart' kids and making kids 'smarter' than smart toys and interactive devices." She went on to add that, "everything a child experiences in their environment influences development, and the more experiences that they are exposed to, the more they can build and reinforce skills and concepts."

Another toy industry expert, speaking on condition of anonymity, believes that "there will eventually be evidence that kids that interact with technology at a younger age have a deeper intuition about how devices work," in part because of familiarity and in part because it gets kids thinking about how something works.

And still another toy industry expert, speaking on condition of anonymity, stated that content and curriculum, not technology, have the most powerful impact on a child's development. "There are building blocks of larger concepts that kids can learn through playful activities, but I think it's a leap to conclude that kids are learning about the building blocks of physics by playing games with a physics

engine (like *Angry Birds*) or that kids are learning how to code because they can grasp how a conditional statement works." This expert continued to say that free play with smart toys can be transformational, but only for a small portion of kids. "Those kids are the ones that use Legos without instructions or a picture on a box."

What's Next?

Today's toys are on the cusp of becoming truly intelligent. Data collection is still largely informed by decades-old policies from the advertising industry—that is, keep everything, whether you need it or not, and don't give it an expiration date. Vendors are still trying to figure out how to make toys interactive while handling sensitive data properly. They're also trying to determine how to provide analytics around how children learn without stigmatizing them or capturing information that might have legal or ethical consequences.

Here are my four big predictions for how data and technology will change the nature of play and toys in the coming decade:

Play becomes connected

A generation that is growing up connected is playing in new ways. Multiplayer play often involves connecting with others at a distance—from *Club Penguin* and other kid-safe online environments, to *Minecraft*, *Gary's Mod*, and sandbox games where children can extend the game beyond its intended scope to create their own games. We take this connectivity for granted, but it's a fairly recent phenomenon that began with console games and massively multiplayer online games, and is only now finding its way into toys for younger children.

At the same time, a trend toward smaller families and career parents having children later in life suggests that connected play may become a more prevalent form of interaction for children.

Toys go from digital parlor trick to true AI

The Tamagotchi wasn't smart; it simply ran a series of subroutines. Guessing games were simply linked lists. Even supposedly interactive toys, like Teddy Ruxpin and the Furby, were little more than digital parlor tricks.

But if you play a video game, your computer opponent will become smarter. Many modern adventure games advertise adaptive AI, which means that non-player characters change their behavior based on what it has learned from its opponent's

previous actions: members of your squad fight intelligently, seeking cover and attacking opportunistically; a shopkeeper calls the police if they saw you steal earlier in the game; an enemy selects a better weapon to counter your attacks the second time.

This kind of technology is leaking out of video games and into household toys. Children already see Siri as a source of answers; it won't be long before they're playing games with its successors.

To succeed, however, toys need to grow and change with their users, both functionally and physically. Pleo, for example, claimed it would grow and change with a child. "[The Pleo toy had] lots of depth," said one industry insider. "But the execution left much to be desired, as the build-up of its intelligence meant that out of the box, it fell flat. The 'growth' play pattern was not mirrored by a physical evolution, so it was just a slow unlocking of abilities."

More play happens in immersive environments

Today, children often play with toys within screens. Tomorrow, we'll do it within worlds. Virtual reality has been called an empathy machine; indeed, some researchers are using immersive digital environments to change real-world behavior. According to Backchannel writer Sarah C.P. Williams, seeing virtual versions of yourself make good or bad decisions can affect how you act, reducing your desire to overeat or increasing how much money you save when seeing your virtual self grow old. How long until virtual reality and personal avatars become toys?

The volume of data collected from such play is unthinkably large, and systems will use that data to optimize and adjust the experience for the child.

Makers and crowds speed up innovation

Today's innovators have access to a tremendous amount of leading-edge manufacturing products: 3D printers, Arduinos and Raspberry Pis, cheap lighting ordered online. They can also buy customizable kits, from snappable electronics such as Littlebits to full-fledged robots from Meccano. And the Kickstarter model—test an idea, build it if there's demand—has helped launch dozens of smart toy products.

This maker approach to toys is accelerating the pace of innovation in the toy industry. Where larger toy firms are reluctant to

innovate quickly, constrained by concerns about shelf space and channel conflict, smaller toy startups have little to lose. They can distribute through their own crowdfunding or online sales, or even rely on niche distributors like ThinkGeek and Brookstone.

Conclusion

Play is a vital part of how we learn to work with the world around us. It's unstructured, creative, and experimental. But as technology changes toys, it also changes the nature of play. Toys now have opinions, which means games are less open-ended. Toys are now connected, which enables at-a-distance play among groups and software updates. And toys now learn and adapt, using growing amounts of data that is collected and analyzed.

It's still early days for digital toys, but the changes are already widespread. Video games and smartphones have weaned a generation on technology. Lower manufacturing costs and the ability to target early adopters through online channels have spurred innovation. Smart toys are evolving, and they're going to change how children learn and socialize. They're also going to have a permanent impact on our brains, our culture, and ultimately, our species.

Appendix: Companies and Resources

In preparing this report, we looked at the toy companies listed in Table A-1 and Table A-2, and in many cases spoke with them directly.

Table A-1. Large toy companies with notable smart toys

Company	URL	Notable smart toy
Activision	https://www.activision.com/	*Skylanders*, *Guitar Hero*
Disney	http://www.disneystore.com/	Wall-E, *Disney Infinity*
Hasbro	http://www.hasbro.com/	Furby, Furreal Friends
LeapFrog	http://www.leapfrog.com/	LeapFrog/LeapPad
Lego	http://www.lego.com/en-us/mindstorms/	Mindstorms
Mattel	http://www.mattel.com/	Hello Barbie
Nintendo	http://www.nintendo.com/amiibo	Amiibo

Table A-2. Innovators and upstarts

Company	URL	Notable smart toy
Anki	https://anki.com/en-us	Anki Drive
CogniToys	https://cognitoys.com/	Dino
Innvo Labs	http://www.pleoworld.com/pleo_rb/eng/about.php	Pleo
Littlebits	http://littlebits.cc/	Little Bits
Meccano	http://www.meccano.com/	Mecchanoids
Minecraft	https://minecraft.net/	Mojang/Windows
My friend Cayla	http://www.myfriendcayla.com/	My Friend Cayla

Company	URL	Notable smart toy
Osmo	https://playosmo.com/en/	Osmo
Sphero	http://www.sphero.com/	Sphero, Ollie, BB-8
Spinmaster	http://www.spinmaster.com/	Air Hogs
Tech4kids	http://tech4kids.com/	Storytime Projector
Ubooly	http://www.ubooly.com/	Ubooly
V-Tech	http://www.vtechkids.com/	InnoTV, Kidizoom, Baby Amaze
Wonder Workshop	https://www.makewonder.com/	Dot & Dash
Wowwee	http://wowwee.com/	MIP, Robosapien, Dinosapien

About the Author

Meghan Athavale grew up in Northern Canada, in the mining community of Thompson, Manitoba. She spent her childhood running through forests, fishing, swimming, and climbing trees. She launched her first digital media company (PO-MO Inc.) in 2010, and she and her team have since designed thousands of interactive floor and wall displays worldwide.

Today, Meghan is the CEO of Lumo Play, and spends most of her time developing an interactive projector that transforms a child's room into an interactive playground. The toy, called Lumo, is inspired by Meghan's experiences as an interactive digital media producer and single parent with concerns about screen time and childhood development.