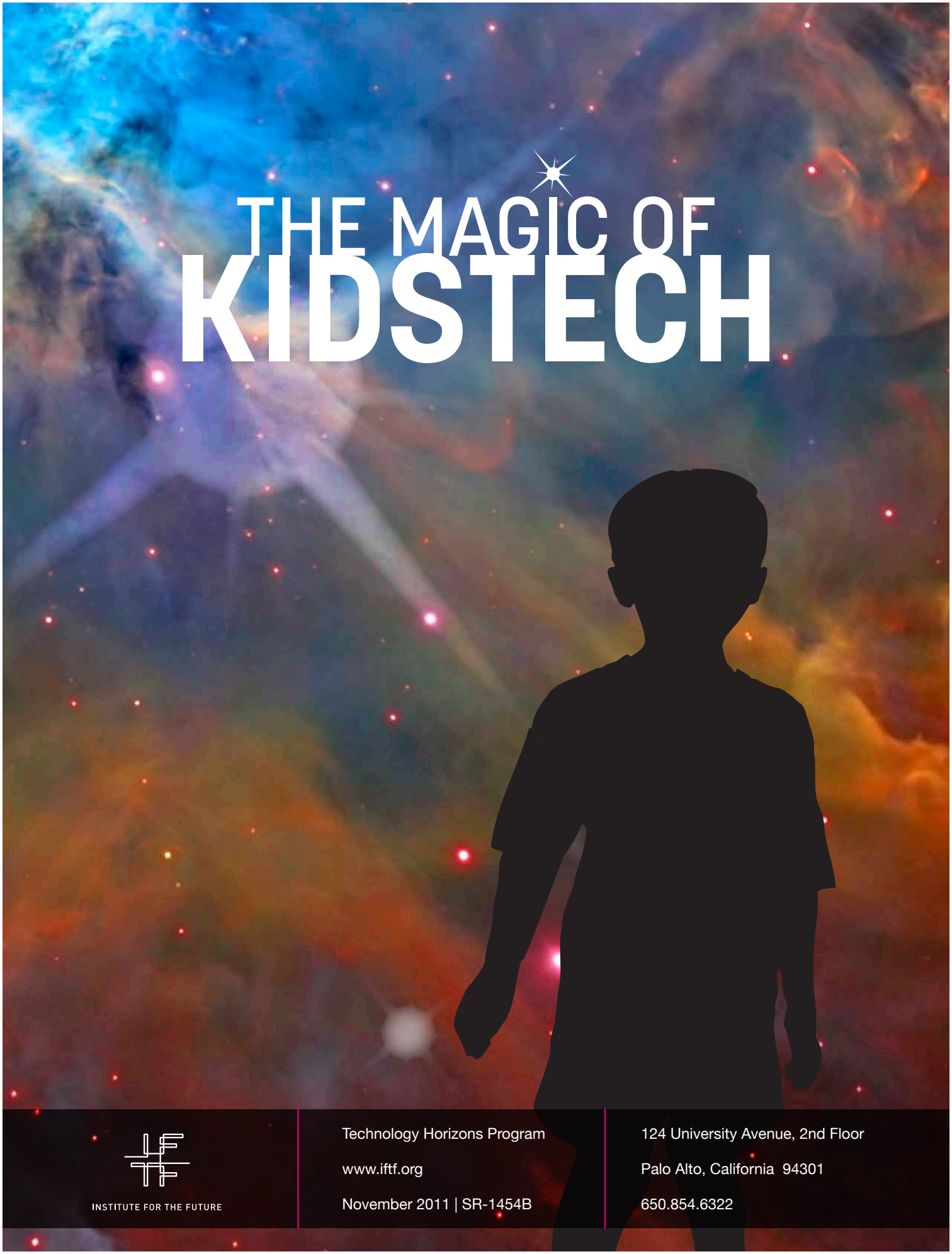

INSTITUTE FOR THE FUTURE

Technology Horizons Program
www.iftf.org
November 2011 | SR-1454B

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about the ...

TECHNOLOGY HORIZONS PROGRAM

The Technology Horizons Program combines a deep understanding of technology and societal forces to identify and evaluate discontinuities and innovations in the next three to ten years. Our approach to technology forecasting is unique—we put people at the center of our forecasts. Understanding humans as consumers, workers, householders, and community members allows IFTF to help companies look beyond technical feasibility to identify the value in new technologies, forecast adoption and diffusion patterns, and discover new market opportunities and threats.

INSTITUTE FOR THE FUTURE

The Institute for the Future is an independent, nonprofit strategic research group with more than 40 years of forecasting experience. The core of our work is identifying emerging trends and discontinuities that will transform global society and the global marketplace. We provide our members with insights into business strategy, design process, innovation, and social dilemmas. Our research spans a broad territory of deeply transformative trends, from health and health care to technology, the workplace, and human identity. The Institute for the Future is located in Palo Alto, California.

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INTRODUCTION:
THE MAGIC OF KIDS TECHNOLOGY

"Any sufficiently advanced technology is indistinguishable from magic."

—Arthur C. Clarke

Magic plays at the edges of human perception—creating a thrilling disjunction between what we know and what we think we know. It thrills because it suggests a bigger world while pointing out the limitations of our senses. Magic holds a special attraction for kids because they are constantly encountering new wonders and the spooky unknown. Childhood itself is a process of navigating the shifting bounds of reality through learning, experience, and physical transformation.

This report explores the enchantments and curses of remarkable technologies that are connecting, empowering, and enveloping kids. "Kids," in this report, refers to those slightly older than toddlers but younger than pre-teens, that is, children from 3 to 10 years old. The core forecasts focus on the social, technological, and cognitive environments for kids in the coming decade. Also included are specialized forecasts within four critical domains of kids' tech: play, health, safety, and learning, and a set of implications for each. At the end of each domain section is an "artifact from the future." Developed with a team of experts and designers at an "artifacturing" workshop held at IFTF in September 2011, these artifacts were imagined and created to address specific challenges that will be faced by kids in 2021. They are meant to embody many of the specific trends and critical tensions raised in the forecasts. They show how these issues will intersect and resonate with technological innovations and new products. The artifacts are not meant to be predictions of actual products in 2021, rather they serve as provocations for readers to think through what a child's technical environment and experience might be in the future.

A child's world in 2021 will be a complex playground of empowering technologies, invisible protections, stimulating connections, and shifting prohibitions. It will be a magical world, but the line between the magician and the audience will be difficult to distinguish. These lines will be drawn, to a large extent, by what resources are available to kids, and how they will use them.

THE GREATEST RESOURCE

Much of the high emotional pitch in discussions around kids has to do with the weight we put on them to perpetuate our values, systems, and even human life itself into the future. Children are our "greatest resource," as the saying goes. But part of kids being our greatest resource is not just based on the idea that they will be responsible for making the future, but also the fact that they already have in their possession, right now, some of our greatest resources.

Time: Although children's time is being structured more than ever, kids still have an amazing amount of free time. They are not encumbered by responsibility for others, a job, or a house or car or other material possessions that require upkeep. Kids can spend hours tinkering with a new toy, taking it apart, or learning all of its functionality by trial and error. Kids can know a device better than almost any adult because they can spend much more time engaged with it. In video games, they can find all the hidden moves and secret "Easter eggs." Being time-wealthy, kids can find these hidden functions, or invent new ones, within the technologies to which they have access.

Flexibility: Kids' brains are supercharged to learn. Most of an infant's metabolic energy goes toward brain development. While the percentage drops off during childhood, a kid's brain is a marvel of knowledge and skills absorption. Kids can learn languages at a much deeper level than adults, they can hear sounds adults cannot hear, they can learn new skills and facts with incredible acuity. Neural plasticity makes the feedback loops between mind and the world very tight, in turn making kids resilient and able to deal with change.

Freedom: There are many kinds and levels of what we call freedom. While a child may not have full legal rights as an individual, kids have a different kind of freedom: the freedom from legacy features of earlier times. Kids have fewer ties to the way life was in the past, and are less weighed down by the habits, cultures, ideologies, or even the scars of history. We tend to "feel" change only when it accelerates: like being thrown back in our seat when a car takes off. Kids are born at that speed, and the sense of acceleration is not as strong. Kids are capable of shifting behaviors, changing their minds, rethinking the world, and responding to the drivers of change in ways that many adults cannot or will not do.

DRIVERS OF CHANGE

Embedded Computation

Low-cost sensors and computing chips are enabling materials, objects, and other artifacts in our world to generate and disseminate data about themselves and the conditions of the environment around them. The ubiquity of sensors, communication networks, and simple processing into everyday objects and environments will unleash an unprecedented torrent of data and create opportunities to use this rich feedback in the design of new systems. The material world will be networked and will communicate virtually. Machines will talk to us, and even more frequently, talk to other machines to coordinate activities at a scale and level of complexity that was heretofore impossible. Embedded computation will make "programming" objects and environments possible, and coding will become a necessary skill and literacy. Kids

coming of age in the programmable world will have a radically different relationship to the objects in their environments and different expectations about intervening in the systems that surround them.

Super-empowerment

An average individual in today's world has enormous powers to impact others at local, regional, or even global scales. Much of the discussion around super-empowered individuals has focused on technologies and weapons of destruction, from nuclear or chemical weapons, to the ability to hack and disrupt global communications networks.[1] However, there are also incredibly beneficial and persuasive powers contained within a highly connected and geographically compressed world. The Internet is one of the most amplifying technologies ever invented, allowing individuals to reach billions around the world. It has also allowed the rapid coordination of individual activities and efforts at large scales. Children today are plugged into a global network, often thinking globally, and have access to a range of technologies that extend the reach of their behaviors.

Precarity

While computation and super-empowerment are enhancing and extending human capacities, we have also created a world of increasing volatility and uncertainty. Economic systems seem to be teetering on the edge of collapse, as unemployment and inequality worsen. The steady march toward long-term climate change will be punctuated by extreme weather events, striking more frequently and fiercely. The fossil-fuel–based energy system we've built our modern industries upon has a shrinking shelf-life, with no cheap and viable options ready to replace the old system. Resource shortages and political unrest will remain with us for decades to come. In the next decade, kids will live in a world of contradictions, with tremendous opportunities for advancement, as well as increasing chances of a "long emergency," or even a civilizational collapse.[2]

Quantification

Many of our behaviors, movements, and even biological processes can now generate useful data. Whether from the intentional tracking of measurements and activities, as practiced by devotees of the quantified-self movement, or the more passive generation of data through location services on our smartphone, or the digital trails we create when using the Internet, many more aspects of our lives are turning into information. And with information comes the ability to generate statistical baselines, norms, outliers, and deviance. Applying these metrics to what were once invisible or unknowable aspects of our lives, such as emotions, pain, or day-to-day decision-making, changes how we relate to those aspects, amplifying our knowledge and suggesting new places for intervention.

Evolving Childhood

Our current notions about childhood as a distinct and special period of life may be the historical exception, not the norm. In early industrial times, children were often seen as "little adults," capable of having careers and positions of high responsibility. More recently, childhood has been an extended period of learning and growing, explicitly separated from the "adult" world. These days, there are fewer canonical responses to

questions such as what a child is, what childhood means, and when it begins or ends. Young children are being tried in courts as adults. Kids are participating fully with adults in social networks of communication and creation. Yet, at the same time, we seem to be erecting more technological and social barriers for kids to cross in order to enter into the adult world. To complicate matters further, trends of early-onset puberty and other shifting biological responses are happening in an age when young adults are extending the “childhood” stage and are returning from college and living at home until their 30s. This mish-mash of cultural, biological, economic, and social trends means expectations and norms for childhood are up for grabs, with few historical precedents to reliably guide us.

THE FUTURE OF KIDS' PLAY: CROSS-DIMENSIONAL PLAYGROUNDS

1

Children at play are the definition of freedom and exuberance. But play also has a serious social function. In modern society, play has been cast as frivolous—at odds with the austere needs of formal education. New technologies, media, and communication forms that attract young people are often initially castigated as degenerate. In late-18th-century England, a new cultural form called "the novel" was said to be sending young women into moral decline. More recently, comic books, television, video games, and the Internet have all been vilified for causing mental decay, creating anti-social behavior, and distracting kids from what adults think they need to be doing.

In play, joy can be derived from nearly anything, from a cardboard box to the latest technical gadget. Kids are drawn to activities, materials and spaces that enable their ongoing experimentation with reality. Over the coming decade, the purpose and structure of play (storytelling, building, role-playing, games) won't change drastically, but the materials, places, and spaces of play will. Smart devices, animated toys, and networked virtual worlds will provide multiple dimensions for fun interaction. The effects of multi-dimensional play on social relationships, creativity, and sensory engagement with the world will follow kids into adulthood, reverberating through our social institutions and relationship structures for decades.

CHANGING CONTEXTS FOR PLAY

Online Play

"Go outside and play" is becoming "Go online and play." The changing context of independent mobility is pushing kids indoors and in front of screens. Children have lost much of their physical independence in the last few decades, due to changing perceptions of danger, new parenting norms, and more car-reliant lifestyles. In the United States the Outdoor Foundation has found a nearly 20% drop in outdoor activities for kids aged 6–12 since 2006. With fewer kids outside, there are fewer chances for multi-age play with large groups of peers. As kids do less exploration and practice of self-control and mastery in physical environments, they are doing more in virtual environments.

Purposeful Play

There is growing parental and teacher uncertainty about future career paths and educational models for their children, especially in a world of increasing divides between the haves and the have-nots. This uncertainty is often addressed by increased pressure on children to be high achievers. Homework for preschoolers is no longer laughable. These pressures are increasing demands for "purposeful play." Purposeful play recognizes the need for play, but attempts to smuggle in additional educational, cognitive, social, or health benefits.

FORECAST: ACTIVATABLE SURFACES

For most adults today, touching a computer screen is still a remarkable experience. The popularity of smartphones, tablet computers, and e-readers has made touchscreen devices, and the apps that run on them, the toys of choice for kids. Even for the very young, direct manipulation through touch is now giving technological devices some of the affordances of traditional play experiences such as a sandbox, a pad of paper, a game-board, or a musical instrument.

Over the next decade, augmented reality and gestural interfaces will expand these affordances to virtual 3D objects, allowing kids to play with a virtual toy the same way they can play with a real one. Displays will also move off of hard, boxy devices and onto flexible surfaces such as the face of a favorite stuffed animal or toy truck. In sum, play will be a more fluid material experience, blending the virtual and the physical. Kids will have many fun options to explore depth, sound, gesture, and images in this blended reality.

SIGNALS

Toca Boca Helicopter Taxi

This "virtual toy" allows kids to look through the screen of an iPhone, iPad, or iPod and play with digital characters transposed onto the background of their own home.

Source: tocaboca.com

Aurasma 3D-I

Aurasma's 3D-I is a visual browser that uses gesture recognition to allow people to reach out in front of their device and interact with virtual content. The image is from "Aurasma Shootout," demoed in September 2011, where players use their finger to keep a soccer ball out of the goal.

Source: aurasma.com

Singing Fingers

This iPad app, based on a tool created at the MIT Media Lab in 2008, turns the screen into a blank page onto which sounds can be captured, animated as color, and played back by tapping and touching.

Source: singingfingers.com

FORECAST: **EMOTIONAL TOYS**

Toys have always been a medium for children to explore social relationships and emotions. Dolls, action figures, and toy animals are the props of imagination. And toymakers have always been amateur child psychologists, finding new ways to make toys more appealing and emotionally engaging. The Bebe Phonographe doll of late-19th-century France, for instance, had a cheap phonograph implanted in its torso that allowed it to cry "Mama"; a century later, the toy Furby, stuffed with sensors and electronics, could giggle and speak phrases in both "Furbish" and English.

Over the next ten years, robotics, contextual computing, and the neuroscience of emotions will give toys more suppleness in their movements, more sensitivity to their immediate surroundings, and more capacity to learn about and respond to their users. MIT professor Sherry Turkle has been studying children's shifting attitudes toward computational and robotic toys for the past 30 years. In her latest book, *Alone Together*, she places us at a "robotic moment" in history. This moment signals our emotional readiness to attach to inanimate objects. These objects will provide friendship and the "comfort of connection without the demands of human intimacy." Sociable robots will draw our children into caring for them, nurturing them, and creating more powerful and effective human-machine partnerships.

SIGNALS

My Keepon

My Keepon is a small yellow robot with soft skin that reacts to touch, detects the beat of music in its environment, and dances in rhythm. Developed to help kids with autism to recognize social cues, it cost $30,000 and lived in a lab in 2007; in the fall of 2011 it was released for less than $50 as a toy.

Source: mykeepon.com

Lets Rock! Elmo

Elmo's latest incarnation can play and distinguish between a range of instruments and a microphone. He also invites kids to play by making music along with him.

Source: hasbro.com

FORECAST: AUTHORING FOR FUN

Drawing pictures, building forts, making up stories, putting on performances for family and friends: self-expression for the sheer joy of it. Today's children have an expanding array of tools and a growing range of environments for sharing their playful creations. In the next decade our technologies will support new forms of expression for kids, including the preliterate and even the preverbal.

Sophisticated but simple authoring tools will make it easier for kids to capture, edit, and share their informal play experiments in sound, color, symbols, and text. More of the "outputs" of play will be digitized, recorded, and tracked.

Children's media will increasingly become a matrix of interaction, where even young kids can upload their own voices and art into a community experience. Children will also be sharing their work with large, even global audiences. Virtual worlds and social networking sites for under-10s are growing quickly—over 400% since 2009, according to UK-based K Zero Worldswide.[3] These sites are often seen as safe training grounds for a future of online communication and collaboration; they encourage children to build customized avatars and personal virtual environments, and to engage with AI characters, friends, and others.

SIGNALS

Toontastic

Toontastic, an iPad app, turns childish storytelling into animated adventures by giving children powerful but simple narrative and animation tools. Since its launch in January 2011, Tooners across the world have made more than 150,000 cartoons. Many are shared on the site ToonTube.

Source: launchpadtoys.com/toontastic/

A Child's First Recording Studio

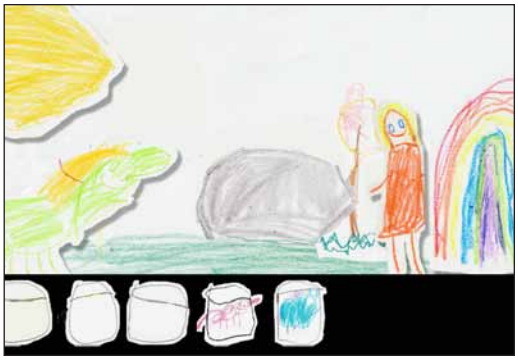
In her first encounter with an iPad, 20-month-old Clementine tries to record herself using the iPhone Studio Mini app and an iPad piano-playing app.

Source: cnetfrance.fr/news/quand-un-bebe-decouvre-l-ipad-39751831.htm

Sissy's Magical Ponycorn Adventure

Created by a 5-year-old and her father during a weekend game-making workshop, this online game has generated quite a bit of attention. New media tools allow ever more inexperienced users, including kids, to produce engaging media and entertainment.

Source: ponycorns.com



IMPLICATIONS

Informal play more visible to third parties: As kids spend more time in digital environments or engaging with toys and surfaces that have computational power, their informal play activities will increasingly be recorded and analyzed by families and third parties. This will create deeper understandings of what children like, and point to opportunities for new services and products. It will also amplify tension between parents and providers around privacy, marketing, and safety.

Earlier and deeper mastery of new media skills through play: Malcolm Gladwell's book Outliers popularized the concept of "the 10,000-Hour Rule," which suggests that spending 20 hours of work a week on something for 10 years is the key to success in any field.[4] In the next decade, many 10-year-olds will be 10K experts at navigating virtual environments; designing and deploying avatars; and multi-modal communication via text, graphics, video, animation, or online games. Expert youth voices and kid-authored content are likely to become more prominent in the public discourse and as products.

New world-interface expectations: By 2021, kids will expect to be able to treat digital objects more like tangible objects, capable of being manipulated via touch and gesture. There will also be a blurring distinction between screens for watching and screens for playing, with less tolerance for dumb screens that can't be activated. Smart toys will be, in essence, sociable robots, and children will expand the kinds of relationships they have with them via touch, voice, and gesture.

New evaluation of face-to-face and remote experience: Face-to-face living is not going away, but there will be a continued growth of social, play, and fun activities that take place in virtual spaces over the next decade. Certain kinds of physical contact, such as playing in the neighborhood after school, are being complemented, or even replaced, by digital contact. Growing up immersed in virtual worlds, social networks, and YouTube videos, children will develop a different set of expectations for evaluating human proximity and presence. Authentic experience will increasingly be measured by its presence across complex, immersive, multi-layered environments.

Child Persona: **NAOMI**

Born: January 2, 2011 (10 years old)
Location: Baton Rouge, LA

Naomi's Story

Naomi was an active and adventurous kid. She loved to play soccer and go horseback riding, and especially loved doing things with her friends—until her accident. Three months ago Naomi broke her C2 vertebra, leaving her paralyzed. She is now confined to a bed or wheelchair. Recent advances in stem cell treatment offer a good chance that she will regain full mobility, but the treatments and rehabilitation will take several years. In the meantime, her parents are looking for ways she can share experiences with her friends in a meaningful way. Her friends still visit, but it is only for a short time, and it is awkward. Naomi just wants to play with her friends, and Naomi's parents don't want her to lose her sense of adventure before her treatments are complete.

Design Challenge

Design a play experience for Naomi and her friends. Invent or re-purpose a technology that connects and enriches her life.

ARTIFACTS FROM THE FUTURE: **HEARTBOOK**

LIVE-STREAMING SHARED PLAY

Friendship is about shared experiences and shared emotions. In a kid's world, where direct physical contact with peers is limited by distance, rules, or the lack of time, the HeartBook is a godsend. Originally developed for paralyzed kids to share outdoor experiences with their friends, it has taken off among all kids, and was the most popular product for 10 years old girls in 2021.

Why HeartBook?

Heartbook works by live-streaming video, audio, and even feelings of kids linked in a social network through a wearable device. No matter where kids are, they can tune in and "feel" the real-time experiences of their friends. It can turn mere friends into telepathic twins, achieving a level of closeness that no distance can diminish.

Always Connected

With HeartBook you can remotely join-in on your friends' real-life experiences.

Always Recording

Records all audio-visual information, and even emotional states, to share with friends.

Custom HeartBook Jewelry

Design your own HeartBook case and print it out with the Heart-O-Matic 3D printer.

THE FUTURE OF KIDS' HEATH: A MATRIX OF WELL-BEING

2

Over the next decade, children's preventive and therapeutic care will improve from advances in connected digital technologies. Innovative participatory epidemiology and other community-based health efforts will reframe preventive public health, leveraging lightweight sensors and visualization tools in order to monitor children constantly, and at a much more granular level. On the treatment side, the integration of smart tablets, mobile technology, and gaming devices will provide new windows on children's intelligence and creativity. At the same time, concerns over excessive exposure to digital technologies and screen time will mount, and overutilization of these new tools will be seen as an avoidable health risk. In the end, parents and professionals will strive to optimize the health benefits that kids' technologies will generate, while keeping a careful eye on the undesirable effects they may produce.

CHANGING CONTEXTS FOR HEALTH

Emerging Health Issues

After peaking in 2003–2004, obesity rates have held steady at 10% for children aged 2–5, and just under 20% for children aged 6–11.[5] Where incidence of disease has not stabilized, however, is in skin allergies and food allergies, and in Attention Deficit Hypertension Disorder (ADHD). These conditions have increased in children over the last decade, with skin allergies and ADHD both affecting around one in every ten children.[6] The prevalence of Autism Spectrum Disorder (ASD) is equally troubling. According to the Centers for Disease Control and Prevention, if four million children are born in the United States every year, approximately 36,500 children of them will eventually be diagnosed with an ASD. Forty percent of those children will not speak.[7]

Trouble Paying for Care

Private health insurance coverage for children under the age of 18 has been on the decline for more than ten years, while Medicaid for this cohort has almost doubled. Although this reshuffling actually resulted in a decrease in the percentage of children who were uninsured, the amount and type of care for which children are covered also declined.[8] More ancillary health services, specifically those related to managing chronic illnesses, are generally only covered in private plans, and not in most state-funded plans. Health reform will likely not change this access to health care. Without financial coverage to help pay for an increased number of medical services, parents will look to novel technology-driven approaches to manage their children's chronic conditions more cost-effectively. These approaches will help parents and empower children with an array of tools to understand and act on potential health risks that surround them.

FORECAST: HEALTH RISKS BECOME VISIBLE

It is no secret that dust, pollen, chemicals in food or in the air, and other environmental risk factors are the triggers for many of the health conditions that impact children and their parents. In addition, researchers are finding that asthma attacks or allergic reactions may be related to strong emotions and stress, which are factors that they have also seen as contributing to behavioral disorders.

As a preventive strategy, pediatricians and allergists commonly advise parents to eliminate outbreak triggers, monitor symptoms and, for asthma, measure peak flow.[9] This advice, while wise, is often very difficult to put into practice and of limited benefit.

Over the next decade, however, a wave of new technologies will enable parents, researchers, and public health officials to perceive the often invisible risks that surround children. Asthma inhalers will be equipped with sensors that will track when and where the inhalers are used. Wearable sensors will be able to track human emotions, perhaps uncovering surprising links between social, built, and natural settings and a child's emotional well-being. Further out, a more refined view of the risks surrounding children will not be limited to external factors. Embeddable sensor devices will allow parents to view their child's biological systems to understand how foods and chemicals are ingested and processed. Beyond the value of the immediacy of this information, the data collected from these devices, when aggregated, analyzed, and visualized, will provide a much broader and richer picture of health triggers and risks for children.

SIGNALS

Asthmapolis Inhalers

At the center of Asthmapolis inhaler caps are small electronic medication sensors that track the time and location that the inhalers are used, and then send that information to a remote server. Maps, charts, and tables of this information can be generated to reveal patterns of location, use, and trends over time.

Source: asthmapolis.com

Q Sensor Curve

The Affectiva Q Sensor is a wearable, wireless biosensor that measures emotional arousal via skin conductance, a form of electrodermal activity that grows higher during states such as excitement, attention or anxiety, and lower during states such as boredom or relaxation.

Source: affectiva.com/q-sensor/

FORECAST: UNLOCKING NEW VOICES

For some families, digital technologies have done more than amplify their children's curiosity and creativity—they have unlocked children's ability to express themselves. Digital interfaces are allowing individuals with disabilities to communicate and express themselves in ways unimaginable before, opening doors for more independence and more engagement. Non-clinical mobile applications, facial recognition software, and gestural and touchscreen interfaces are helping families and caretakers discover more about their non-verbal children's needs, insights, and intellect.

The portability, the sensitivity of the touchscreens, and other built-in features of the newest digital tablets are game changers for people with disabilities, most notably for kids with autism. As journalist Ashley Harrell explains, "Whether they are high- or low-functioning, children with autism tend to be visual learners who gravitate toward technology and screens."[10]

Over the next decade, technology will finally start to catch up with what children with disabilities truly need. Consumer technologies will continue to seep into the medical space, and children with disabilities and their caregivers will repurpose them in order to communicate and express themselves more freely than before.

SIGNALS

Popchilla

At the Autism Center of Pittsburgh, developer Seema Patel is developing an iPad application that will challenge children with autism to identify the emotions of a robot named Popchilla.

Source: autismcenterofpittsburgh.com, mygloss.com /geek/files/2010/08/popchilla-300x210.png

Proloquo2Go

Proloquo2G is a full-featured communication solution for people who have difficulty speaking. It offers natural sounding text-to-speech voices, close to 8000 up-to-date symbols, powerful automatic conjugations, and a large default vocabulary.

Source: proloquo2go.com/About/article/ipad

Affdex

Affectiva's facial expression platform, Affdex, uses web cams to help users recognize facial muscle movements and equate them with human emotions.

Source: affectiva.com

FORECAST: SEGMENTING SCREEN TIME

Concerns that excessive screen time threatens children's behavioral and physical health have caused trusted authorities in children's health and well-being to issue blanket guidelines around kids' media consumption. However, not all interactive screen time activities are the same, and, with the exception of violent video games, little in-depth research has been conducted to understand the potential health benefits and limitations different types of screen time may involve.

Research has demonstrated that "energy expenditure more than doubles when sedentary screen time is converted to active screen time."[11] As a result, interactive digital media is now at the forefront of policy, foundation, and commercial initiatives for childhood obesity prevention and treatment. As exciting as these developments are, other benefits to a child's neurological and cognitive health, yet to be discovered, may also result from interfacing with interactive media.

Over the next decade, a more precise segmentation of media, coupled with a more high-resolution understanding of the biological and neurological functioning of individual children, will help decipher the impact that screen time—sedentary and active—has on different children. Pediatric developmental behavioral health specialist Dr. Martin Stein notes, "[I]ndividual biological risk factors and protective mechanisms are likely influencing adverse psychological, social, and health outcomes associated with excessive media exposure."[12] As a result, media consumption recommendations will be tailored to individual children based on a number of risk factors including the media type and the child's biological profile.

SIGNALS

Exergames Get Kids Off The Couch

Video games that require physical activity, such as Dance Dance Revolution (DDR) and Wii Boxing, help kids burn calories and raise their metabolic equivalent (an approximation of how much oxygen the body uses during an activity). One version of DDR uses the popular Mario character to specifically engage young children.

Source: konami.com

Differentiating Among Computer Users

Alan Kay, a pioneer in computer programming, design, and user-interfaces (UIs), is currently developing an educational UI that will learn what kind of user is trying to use it. The range of human styles and motivations is considerable and taking advantage of them is critical.

Source: news.stanford.edu

IMPLICATIONS

New measurements create new norms: The intention behind tracking children's environmental surroundings and biological systems is to detect potential health risks and curtail future disease outbreaks. Yet growth in the tracking and collection of more precise and continuous data will almost certainly lead to an uncovering of new health ailments and new health threats. And while identifying new diagnoses will likely solve confusion and frustration for some families long struggling from unknown health and behavioral conditions, it will also spur new baselines and new normalities. Determining good physical and mental health will be dependent on yet another set of measurements, resulting in yet another opportunity to medicalize children.

Consumer tech blurs with medical tech: After the truly transformational impact Apple's iPad made on the autism community, the separation between medical and consumer devices is less straightforward. The capabilities, durability, mobility, and—not to be overlooked—the price point of consumer technologies are, in many cases, superior to devices regulated as medical technologies. As more wearable and embedded sensors become important health tracking tools, the distinction will become even more ambiguous. A repurposing of consumer technologies at a large scale may spark investigation from regulators, but it may also open the door for more collaboration and partnership between tech developers and the medical community to create highly efficacious tech-enabled solutions for kids.[13]

Media becomes medicalized: Increasing numbers of young children who cannot tell time on an analog clock, swim independently, or make their own breakfast can use a mouse or a touchscreen, and navigate their parent's smartphone. In recognition of these emerging tech-enabled behaviors, new milestones in a child's development, along with the corresponding checklists and evaluations, will begin to be integrated into routine pediatric care. Also, if pediatricians have a better sense of a patient's "media consumption history," they will have a better chance at intervening before any related negative health outcomes transpire.

Child Persona: **FRANCO**

Born: July 14, 2014 (7 years old)
Location: Emeryville, CA

Franco's Story

Franco lives with his Mom and older brother (Jon, 11) in a small duplex in Emeryville, CA. Franco's Mom works long hours and is rarely home with the boys. Jon often has responsibility for watching Franco. "Watching" consists of playing video games or watching streaming video on their tablet. Last year, Franco's First Grade teacher reported Franco was having extreme emotional outbursts during class, and recommended that he see a child psychologist.

At the advice of the psychologist, Franco's Mom rearranged her schedule to be home during the evenings, and enrolled Franco in special classes offered by the State. These did little to help his condition. Finally, a specialist had Franco tested for a particular allele that geneticists believe cause some children to be hyper-sensitive to video games and other media. The "screen gene" as it was called, made carriers more emotionally reactive and behaviorally unstable than those without the allele, even when consuming the same amount and kinds of media.

Turns out, Franco did have the "screen gene," and his Mom, his doctors, and his teachers are implementing some changes into Franco's lifestyle. This includes limiting television, and prohibiting all video games. Needless to say, Franco is upset about these changes, and feels frustrated and left out from his peers.

Design Challenge

Create a way for Franco to have satisfying media experiences that are appropriate for his emotional reactive levels. Strict prohibition from games and media is difficult, especially in the world of 2021. What services or technologies can you imagine that will help Franco and those like him?

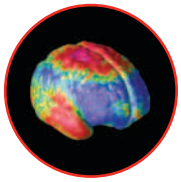
ARTIFACTS FROM THE FUTURE: **DOLL OF DUTY**

A 21ST CENTURY HERO TO KIDS AND PARENTS ALIKE

Doll of Duty is like a traditional G.I Joe toy, but one that also happens to be a physical education instructor, emotional coach, and child psychologist. It is sold as a physical toy, but once it is registered to a child, the Doll of Duty will create a virtual presence in a kid's life, showing up on his social networks, and popping into video games or even into his augmented reality filters.

Why Doll of Duty?

This APA-approved companion toy both monitors kids' media consumption and encourages kids to engage in exciting outdoor adventures with their peers.



Emotional Coaching

As it learns about a child's neurological and behavioral profile, it will curate media and activities to maximize emotional and physical health. Using the patented "goldilox" application, it will feed content and missions that are not overly stimulating, but not too boring.

Personal Biometrics

Doll of Duty measures heart rate, body temperature, stress, and eye movements to create the ideal physical and emotional experience for your child.

THE FUTURE OF KIDS' SAFETY: HIGH-TECH "GUARDIAN ANGELS" 3

In the coming decade, kids will be video-monitored, geo-located, and physically protected more than anytime in history. The content they consume will be automatically filtered and specially designed to maximize learning while minimizing cognitive or emotional harm. Kids' interactions with adults will be closely regulated and allowed only under certain conditions.

A core dilemma for modern parents has been how to protect children without imprisoning them in a protective bubble—how to allow adventure, exploration, and freedom, without undue risk of long-term negative consequences. Adults will have increased capacities to closely monitor and intentionally design experiences for their children. These new capacities will allow parents, teachers, and lawmakers more opportunities to intervene in a child's environment to reduce risks kids are likely to encounter as they grow up.

Surveillance and protective technologies are already beginning to proliferate, but face a backlash against intrusiveness and over-protection. As a result, a system of technologies will emerge in the 2020s that will offer robust monitoring that is mostly invisible to the child. These high-tech "guardian angels" will unobtrusively protect children—letting kids be kids—and will become manifest only when absolutely necessary. Parents, teachers, and others striving for a world of "riskless risk" for kids will use this guardian-angel technology to program or dial-in an acceptable level of risk based on their values and perception of existential dangers in their children's world.

Changing Contexts for Safety and Security

Ubiquitous Monitoring

Social, demographic, economic, and technological trends are driving the push toward high-tech guardian angels. Video surveillance, digital tracking, sensors, and mobile devices have made continuous knowledge of a child's whereabouts and activities possible at a reasonable cost.[14] With these tools available, the social and legal pressure for parents, schools, and other caretakers to use them is strong, and often irresistible. Whereas a decade or so ago, a single phone call to check in served as diligent surveillance, now continuous mobile presence and connection is the norm, even for small children.

Smaller Families

Birth-rates in wealthy, industrialized nations continue to fall, meaning more people are having fewer children.[15] With more riding on the success of these children and less "room for error," each child is likely to receive greater parental attention and supervision. Parents and society will do more to protect these scarcer, and therefore more precious, resources than they would if there were an abundance of children.

Making Risk Illegal

What were once private decisions about an adequate level of protection and surveillance of children are increasingly being made at broader social and policy levels. Many of these are generally accepted as common sense, such as the mandate for use of car seats for infants, or bicycle helmets for children. But now we are also beginning to see greater societal pressure to monitor kids' eating habits and how they communicate on social networks. The socialization of risk, and the sometimes excessive risk aversion of population-wide decision making, will push the development and adoption of more robust, and more invasive, monitoring technologies.

FORECAST: KID-MAPPING

Ubiquitous digital connection and lower-cost biological sampling and metrics have enabled the growth of the kid tracking industry and new government-mandated identification databases.[16] Parents are using digital tracking software to monitor Internet use in the virtual world as well as outfitting their kids with sophisticated mobile devices and expecting frequent phone or text "check-ins" for monitoring in the physical world. In some instances, they are installing passive tracking applications in mobile and wearable devices that constantly relay location and other data about their kids.

In addition to mobile devices, parents and schools are using video surveillance and even radio frequency identification chips in school uniforms to track kids. Continuous location data and behavioral information (for example, which school lunches kids choose) can be gathered by these wearable chips. Privacy advocates have raised concerns about the potential for abuse of data with this level of detail about movement and behavior, but some schools are already experimenting with these tracking programs.

Parents, schools, and law enforcement have also encouraged the collection and storage of DNA samples and other biometric data, such as fingerprinting, for use in cases of missing or kidnapped children. Combined with all-points-bulletins and "Amber Alerts," a growing network of digital and biological data can be utilized to find and identify missing children. While sharing this information is not mainstream now, the appeal of having access to potentially useful data in case of these kind of emergencies is persuading many parents and schools to preemptively gather this data, and to provide privileged access to law enforcement agencies.

SIGNALS

Wearable GPS Tracking Devices

In addition to dozens of mobile device applications that use internal location technologies for peer-to-peer tracking, other stand-alone products are available as well. The Pikavú locator uses a GPS device embedded in a wristwatch worn by the child. A special receiver gives location information to the parent or guardian, and the wristwatch comes with a child-proof lock.

Source: pikavu.com

FBI Child ID iPhone App

The U.S. Federal Bureau of Investigation has developed an iPhone app that stores pictures, identifying characteristics, fingerprints, and even DNA information, which can then be quickly sent to authorities in the event of a kidnapping or missing child.

Source: fbi.gov/news/stories/2011
/august/child_080511/child_080511

RFID Tracking in School Uniforms

Contra Costa County, CA, Schools have initiated a program to monitor the location of students by setting up a network of sensors that can track RFID chips embedded in school uniforms.

Source: thenextweb.com/us/2010/08/26
/california-school-uses-rfid-tags-to-track-location-of-preschoolers/

FORECAST: BACKLASH AGAINST "THE BUBBLE"

Technologies, laws, and parental practices that result in children growing up in over-protective bubbles are not only aesthetically or culturally unappealing, but may also be harmful to a child's overall social, psychological, and cognitive development in the long run.

Psychologist Ellen Sandseter argues that for healthy emotional and cognitive development, "children need to encounter risks and overcome fears on the playground." She notes that a "child who's hurt in a fall before the age of 9 is less likely as a teenager to have a fear of heights." The unknown risk is more terrifying than one that has been experienced. "Our fear of children being harmed by harmless injuries," Sandseter concludes, "may result in more fearful children and increased levels of psychopathology."[17]

As danah boyd, an expert in social media and youth, has observed, "There are serious consequences to imprisoning youth until they grow up."[18] For boyd, overprotection results in a general reduction in creativity and exploration of the unknown by kids. This, by extension, could result in a weakened civilizational capacity to solve our biggest challenges.

In the coming years, we can expect to see a growing backlash against the use of technology to create bubbles of overprotection. However, no parent or guardian wants to leave a child overexposed to risk either. So, the demand for more "invisible" protection systems will grow. The adoption of completely ubiquitous, ambient, but hardly noticeable monitoring and tracking technologies will take hold, allowing parents to more finely modulate the risks to which their children are exposed without having to keep them in protective bubbles.

SIGNALS

Acceptable Risk

A backlash against too much safety in playgrounds is being seen in city planning offices. Henry Stern, New York's Parks Commissioner in the 1990s, led the fight to keep playgrounds from becoming "bowdlerized."

Source: www.nytimes.com /2011/07/19/science/19tierney.html

Antiprotectionism

Finding the right balance between safety and freedom for kids has been, and will continue to be, a struggle for parents and guardians. Technological tethering and protection will be more available than ever, and a concerted effort to keep freedom and risk in kids lives (to "reclaim childhood") will be necessary, as argued in these recent books.

Sources: Tulley, G. *Fifty Dangerous Things (You Should Let Your Children Do)*. Montara, CA: Tinkering Unlimited, 2009; Skenazy, L. *Free Range Kids, How to Raise Safe, Self-Reliant Children (Without Going Nuts with Worry)*. San Francisco: Jossey-Bass, 2010.

FORECAST: BLENDED REALITY–SEPARATE WORLDS

Digital and physical realms are merging. This is what IFTF calls "Blended Reality," the world in which physical objects generate a data shadow, and where information is overlaid onto the material world.[19] With children growing up in this technological blended reality, the traditional barriers to contact between kids and adults, and the systems of surveillance, are falling apart, and in the cracks grow suspicion, paranoia, and fear.

The fear of the comingling of kid and adult worlds, and with it the fear of sexual assault, kidnapping, and emotional harm, has driven the development of software-based content filters. Context and user-aware systems that can determine the age of a user will reduce privacy for all users, and create potentially labyrinthine processes for adult-kid communication and interaction.

In physical space, the mere presence of nonparental adults in a playground or child's area is enough to warrant legal action. This mentality is spilling over into the digital realm as well. New laws and policies attempting to limit direct communication between kids and adults, especially via social media spaces such as Facebook, are being proposed and passed more frequently.

SIGNALS

Unaccompanied Adults?

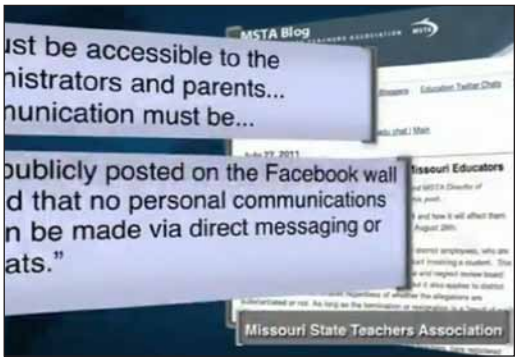
It is a violation in many parks and playgrounds to be an adult unaccompanied by a child. Two women without children were ticketed in Brooklyn for eating doughnuts at a bench in a park. (One is pictured above, accompanied by a child on a later occasion.) Mere copresence of adults and kids is often illegal, and this model of separation is being ported to the digital world as well.

Source: gothamist.com/2011/06/06/ticketed_for_eating_a_doughnut_in_a.php

Missouri "Facebook" Law

The "Amy Hestir Student Protection Act" passed this year in Missouri, prohibits exclusive electronic contact between teachers and students. All communication between teachers and students must be accessible to parents, administrators, or other guardians. Thus, this has been deemed the Facebook Law, because a teacher cannot create a one-to-one closed communication platform.

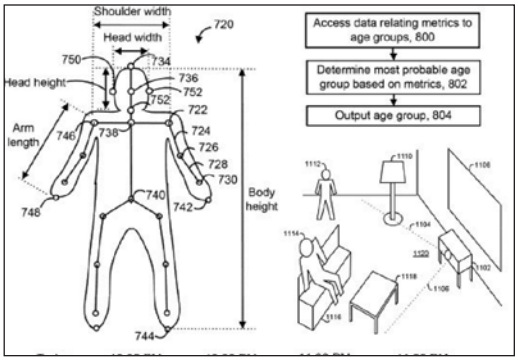
As bill supporter and Virginia Commonwealth University education professor Charol Shakeshaft argues, "In the same way that in a school we would say, 'No, you may not lock yourself into a room with a student,' this law effectively says, 'No you may not lock yourself into a website where only you can get to the student.'"[20]



Kinect Age Scanner and Content Filter

Microsoft has applied for a patent that involves modifying the Kinect to become a surveillance device that can scan bodies in a room to see if kids are present, then filter content according to age-based rules. Thus the Kinect (and devices like it) may become a major parental control technology.

Source: winrumors.com /kinect-may-act-as-a-parental-control-body-scanner-in-future/



IMPLICATIONS

Risk management gets more complex: Managing risk for a child is constant negotiation, with adults often making mercurial choices about when and where to intervene. Evidence, research, and long-term consequence often take a back seat to short-term uneasiness, irrational fear, and peer pressure. With technologies that allow much more parental and adult control over a child's risk environment, wild and unpredictable swings in the application of safety and security protections can be expected. Parents will have the opportunity to try out a host of "child-proofing" tools beyond the confines of home, including technologies to "program" a child's risk environment with much more precision. The fugitive line of acceptable risk will be more blurry than ever, fueling philosophical and ethical debates, and adding the stress of contradictory expectations to parents and caregivers.

Protectionism reveals a paradox: Research has shown that kids have an adrenaline threshold that they attempt to reach by trying risky behaviors. In other words, if a playground has padded concrete surfaces and floors, kids will simply climb higher, try more aggressive stunts, and smash into those padded walls harder. On the other hand, kids tend to play safer when there is more dangerous equipment or conditions around. We may just be "upping the ante" for risky behavior by creating more safety protections.

Adulthood reached by overcoming technical censors: Notions of privacy, transparency, and identity will change dramatically, and kids raised in a world of constant surveillance by adults will come to rely on these tools to navigate their world. Life without monitoring and real-time communication with peers and adults will be scary and confusing for many kids. Technological gatekeepers for information, media, and physical spaces will abound. Kids will bump up against these constraints in their daily lives, and, as kids are want to do, they will test the boundaries of these control mechanisms.

Authentication and permission interfaces will track and limit the free mental and physical movement of kids, forcing them to "hack" their way into the adult world. Kids may come to see their guardian angels not as beneficent protectors, but as prison guards keeping them from reaching their full potential.

Child Persona: **SYD**

Born: February 29, 2015 (6 years old)
Location: Toronto, Canada

Syd's Story

Syd is a 6-year old boy who likes dinosaurs and airplanes. He lives in the suburbs with his parents and newborn baby sister. Syd's parents are reputation councilors and think of themselves as very open-minded, adventurous people. They value freedom and personal exploration, and want to instill those values in their children. However, as Syd grew older, they found themselves becoming more and more protective of him. They installed cameras to monitor the nanny, they made Syd carry a GPS device to pre-school, and they nervously managed Syd's playtime activities. Noticing Syd's increasingly timid behavior, and realizing how over-protective they had become, Syd's parent began to look for ways to give him more freedom and to introduce more challenges into his daily life. These changes have been hard on Syd, who became dependent on his protective bubble. He likes the new things he gets to do, but misses the constant presence of his guardians.

Design Challenge

Create a device or service that encourages exploration of one's environment and helps kids seek new challenges while still maintaining some form of security. Ideally, you should try to design a system that would allow a kid to break his arm, but not his neck. Think about the most effective places to intervene in a kid's world for maximum safety and minimal intrusion.

ARTIFACTS FROM THE FUTURE: **GUARDIAN ANGEL**

PEACE OF MIND FOR PARENTS, UNTETHERED PLAY FOR KIDS

How do you protect your kids, but allow them enough freedom to explore, push boundaries, and take risks? Enter the Guardian Angel. This amazing suite of technologies develops a sixth sense for danger directly into your child.

Why Guardian Angel?

This system provides a balanced approach to safety, allowing a child the freedom to explore their environment, while giving parenvts enough information and control to provide peace of mind.

Biometric Monitoring

Two wearable, networked electrodes, placed on the back of your child's neck monitors location, including stress, blood pressure, hydration levels, blood sugar, and other biofeedback markers vital to creating a real-time, customized risk profile for your child accessible to parents, teachers, or guardians. If a child's blood sugar is low, they shouldn't be climbing the highest monkey bars, and you'll know it.

Feeling Risk

But not only will you know the risk context for your child, our unique "sixth sense" technology will also send a light electric current through the devices on the child's neck, giving them an artificial "hair standing on end" feeling. This clues them in that danger is afoot.

Programming Safety

Parents can program the level of risk acceptable for their child, even including real-time location data from the national sexual predator database, and an accelerometer that indicates if a child is moving in a car.

THE FUTURE OF KIDS' LEARNING: LEARNING TO ADAPT 4

Technologies to augment human learning are as old as language itself. Over time, these augmentations evolved into the giant, complex educational systems we know today. However, the basic institutions that shape learning are now poised for a fundamental reorganization as more advanced technologies come online. A new generation of inexpensive and accessible learning technologies for measuring, personalizing, and augmenting student performance is reaching maturity. Learning technologies are specifically designed to change minds, tightening the feedback loop between user and technology. Marshal McLuhan's famous observation that "we shape our tools and thereafter our tools shape us" resonates more strongly than ever.

As younger generations learn the skills deemed necessary to thrive in the 21st century, the role of education will need to be fundamentally re-examined. This rethink will be the source of provocative, and perhaps inflammatory, debate in the coming decade. To address these emerging education dilemmas, assumptions about the nature of learning, the role of schools and about the nature of childhood itself will be significantly challenged.

Changing Contexts for Learning

Learning About Learning

Our traditional model of education is largely based on a "one size fits all" industrial model. Today however, neuroscientists, psychologists, and educators, are collaborating to gain a more sophisticated understanding of how young brains develop and learn.[21] Learning itself can be defined as a persistent change in neuronal function. A new interdisciplinary field, "neuroeducation," is emerging around the ideal of developing teaching methods and curricula to better match the conditions under which minds learn best. Already, a number of charter schools and specialized programs have begun experimenting with game-based education, new individual performance metrics, and next-generation pedagogical tools that have been informed by the brain sciences. As the insights of these fields are more fully applied, they will pressure education systems to move from a "one size fits all" to a "one neuron at a time" approach.

Learning in the Cloud

Computing capacity continues to increase at the breathtaking trajectory defined by Moore's Law, and is fundamentally changing the technological backdrop of society. As a result, a decade from now kids will have access to about a hundred times the computing power available to today's children—with powerful handheld devices linked to cloud-based supercomputing. With this massive surge of information, and powerful search tools for accessing that information, the old debate about whether we should be educating for information or for character will take on new meanings.

Big Data

Related to pure computational power will be the generation of an almost unfathomable amount of data. Kids today are growing up in a world defined by an exponential growth in data—the era of big data has begun. Ninety percent of the data in the world today has been created in the last two years alone.[22] Cisco forecasts that there will be 50 billion things on the Internet by 2020.[23] All of these "things," all of our devices, and almost all of us on planet Earth will be generating and disseminating data about our location, our condition, what we are doing, and more.

FORECAST: AMPLIFYING THE CLASSROOM

Evaluation of "learning" has traditionally been done through a series of proxies: tests, homework, and performances that let a teacher know that a student "gets it." Now, classroom technologies are poised to provide new feedback loops between students and teachers that will allow for lessons to be more precisely tailored to the actual cognitive styles and learning needs of students.

New measurement tools will allow educators to know, with much more precision, how much information a student is actually retaining, where students are having trouble, and where the gaps in knowledge are that need to be filled. For example, using computer-based testing, they will be able to track what types of problems or assignments take individual students a relatively long time to solve.

Closely connected to these analytics are new approaches to personalization. New ways of connecting teachers and students will ensure that future learners experience an education that is interactive and tailored to their specific needs, level of knowledge, pace of learning, and learning style.

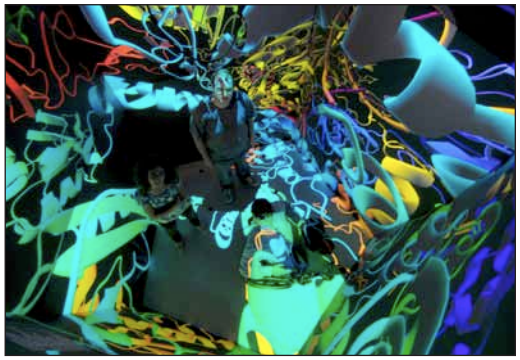
And finally, as the data flows involved in education become more comprehensive and visualization of this data becomes more compelling, learning experiences will become more immersive and "full-bodied." Students will be able to virtually experience natural processes and reenactments of historical events in interactive, 3D environments, instead of just reading about them.

SIGNALS

360˚ Virtual Experiences

The StarCAVE's prototype installation of tiny cellular processes at Calit2 (University of California, San Diego) demonstrates the immersive capabilities of cutting-edge media technologies and their potential use as learning experiences.

Source: whyfiles.org/wp-content/uploads/2009/10/scimaxtheater.jpg



Pedagogical Feedback Loops

Carnegie Mellon's Open Learning Initiative embeds assessment into every instructional activity and uses the resulting data to drive powerful feedback loops for continuous evaluation and improvement of student performance.

Source: oli.web.cmu.edu/openlearning/initiative

FORECAST: DE-OCCUPY THE CLASSROOM

While amplifying traditional classroom functions is critical, education will need to experiment with deeper reinvention if it is to meet the challenges of the coming generation. This reinvention may involve children having more independence, responsibilities, and self-directed learning opportunities. It can be tempting to imagine childhood as a sacrosanct period of innocence and play. But the current conception of childhood has not always been the dominant way of seeing things. People who have grown up in industrialized nations, for example, are sometimes surprised to learn that just a few generations ago the British Navy routinely inducted 10- to 12-year-olds as officers.

If, as Albert Einstein once said, "problems cannot be solved at the same level of thinking that created them," then there will be a premium on learning systems that ensure tomorrow's kids think very differently than today's. New kinds of institutional education mechanisms will emerge to meet this need. Technologies will enable more self-directed learning and more flexible scheduling. Beyond this, promising experiments have suggested that restructuring reward mechanisms away from grades and toward more game-like rewards and challenges may lead to improved engagement and outcomes.

From another perspective, however, tomorrow's adults may themselves need to think more like children. The learning that will be necessary to effectively navigate in a world of such staggering complexity is unprecedented. While it may seem that kids will have to "grow up fast," it may be more beneficial, in fact, to think like a child longer into adulthood. Indeed, the neurological plasticity and learning styles of a child would serve adults well in dealing with a rapidly changing world. The mission of MIT Media Lab's Lifelong Kindergarten Program, for example, is to take inspiration from the ways kids learn and play in kindergarten and apply those principles to other learning opportunities and aspects of life.[24]

SIGNALS

Teaching Digital Kids

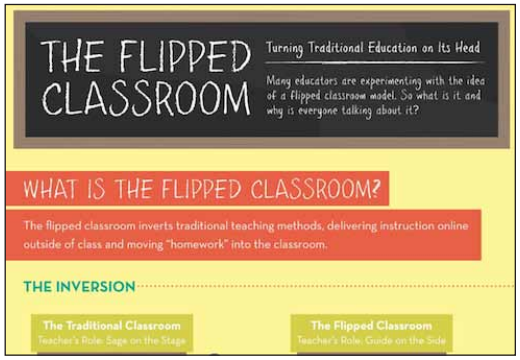
Quest to Learn is a 6-12 grade school in New York City that uses game- and design-inspired methodologies to teach imperative 21st century literacies and skills, such as systemic reasoning and critical thinking.

Source: q2l.org/node/13

The Future of Video in Education

The emerging "Flipped Classroom" educational model uses video in place of direct instruction. Lectures are watched at home and class time is instead spent on individual attention and guidance.

Source: knewton.com/blog/knewton/2011/08/29/flipped-classroom-infographic



Role-playing as Education?

Experiments in learning may open difficult questions, as with Kidzania, a kids' theme park in which children pretend to work in adult occupations. Billed as family edutainment and largely corporate-branded, Kidzania has been franchised in over a dozen countries around the world.

Source: kidzania.com

FORECAST: COMPUTATIONAL THINKING AS NEW MATH

In the next ten years, many domains of life, ranging from politics to the life sciences, will be shaped by the continuous production of massive data sets. As a result, school curricula will need to change to reflect the growing demand for "computational thinking skills." Kid-friendly programming languages, early education in algorithmic thinking and logic, and technologies that teach the fundamentals of programming virtual and physical worlds will enable today's children to meet these challenges of tomorrow.

The institutionalizing of "computer thinking" will provide the foundation for teaching children higher-order skills—problem solving, creative thinking, logical thinking, and systemic experimentation—that will allow them to meaningfully manipulate the data, and the world, around them. As computational thinking becomes embedded in how young people understand their lives and their environments, it will change the way subjects such as the life sciences incorporate emerging disciplines, like synthetic biology.

Computer science education is using online learning platforms to capitalize on the desire to teach computational thinking to younger and younger students. A combination of institutional support for providing access to materials, pervasive high-speed Internet, and functioning community support structures are making it possible for programming education to be at the forefront of true e-learning.

SIGNALS

Scratch Programming Language

Developed by MIT Media Lab's Lifelong Kindergarten Group, Scratch is a programming language that makes it easy for kids to create and share a variety of interactive projects while learning important mathematical and computational ideas, as well as how to think creatively, reason systematically, and work collaboratively.

Source: museum.mit.edu/150/50

Computational Thinking Without Computers

Routing Fruit? Developed by the University of Canterbury and sponsored in part by Carnegie Mellon's Computer Science for High School Teachers program, CS Unplugged uses non-computer methods and materials (such as games, puzzles, crayons, string, and lots of running around) to teach young children computational approaches to the world in a fun and familiar way.

Source: nap.edu/openbook.php?record_id=12840&page=24

IMPLICATIONS

Distributed learning creates a "school" layer on the world: Learning is beginning to look like a very different process than it has been in the past and the combination of the forces discussed above ultimately brings the very idea of "school" into question. Concentrating learning into a single location was in large part a product of information scarcity. Bringing kids together was the best way to efficiently use limited materials and teaching resources. Teachers could not be everywhere at once.

Increasingly however, they can be—or at least teaching systems can be, and the distinction is a critical one. As the complexity of information processing systems begins to rise to the level of basic education, the traditional functions of classrooms will be embedded in the everyday world. In this context, "school" could ultimately take the shape of an embedded learning information layer integrated into the world at large.

Concept of "teachers" evolves: Teaching will undoubtedly still be a critical role, as children will have access to far more information than in the past; access to mentorship in how best to use and process this will be at a premium. However, this points to a fundamental bifurcation that may take place.

In a world of ubiquitous access to information, employing people to simply pass this information en masse on to groups of students is an awfully conspicuous waste of resources. More than ever, people will be needed to help learners address the question of how best to relate to the material that they are learning. Deep information can, after all, be overwhelming and "paralysis by analysis" was already recognized as a problem even in the comparatively meager information environment of the mid-20th century. And, if we consider learning as a process of changing neurons, a teacher's role may be less about imparting information, and more about counseling children how to live with their continually changing brains.

Ubiquitous access to information reshapes definition of knowledge: This gets at perhaps the most fundamental question looming over learning technologies. In a world where nearly any piece of information is available at any time, what types of knowledge are actually worth absorbing? The question is more than academic in multiple senses. After all, learning technologies are on some level neural prosthetics and qualitatively shape users' learning patterns in addition to amplifying them. To the degree that education is about information, it will be directly in the path of this process.

Child Persona: **DIEGA**

Born: August 23, 2013 (8 years old)
Location: London, England

Diega's Story

Baby Diega, as she's known around the office, began programming for INSCO at age 4, when aptitude tests qualified her for INSCO's pre-k coding curriculum. INSCO's program was one of the most respected and innovative in the UK, incorporating game mechanics and neurolearning design into the education experience. Diega advanced quickly, and by grade 2 she was the youngest girl ever accepted into INSCO's prestigious internship program. In the program she received advanced programming training, a small staff of assistants for special client projects, and a trust fund she could access when she turns 16 (if she stays on with INSCO). Diega loves to play, like many of her adult colleagues, who treat her as a fellow, albeit smaller, adult. INSCO's campus offers cutting-edge gaming and sports facilities, and even an award-winning chef preparing meals. She rarely misses home.

Design Challenge

Kids enjoy playing adult roles and mission-based learning. In the future, they will be interacting with adults and participating in occupational activities more frequently.

Design a tool to help kids learn the necessary life skills they'll need in this world. Help kids socialize, learn, and grow in a healthy and productive way.

ARTIFACTS FROM THE FUTURE: **ADAPTAPAL**

A FRIEND THAT GROWS WITH YOU

With network access, new technologies, and more opportunities to share their creations with a global audience, kids are integrating more fully into the adult world. But they may not be ready for the dog-eat-dog world of the Internet, or even a corporate office. AdaptaPal is a friend and guide for kids as they navigate the complex and morally confusing waters of a globalized, adult world.

Why AdaptaPal?

AdaptaPal's learning algorithms can help provide kids with a moral foundation that is in line with their parents', community, or company's mission. It can instantiate itself as a physical or virtual being, and learns along with its user, giving critical feedback and decision-support where appropriate.

Grows With You

AdaptaPal can take many forms as a child grows: from a fuzzy baby toy to a comic book superhero to a teen idol. It can manifest itself in physical form using programmable matter, or even as a holographic projection.

CONCLUSION: SIX BIG STORIES 5

This report has explored the "magical" world of kids' technology. It has explored the shifts these technologies are generating, with more specific examination of changes occurring in four domains: health, learning, security, and play. With these forecasts in mind, we can draw out some of the big stories—the broader social impacts and critical tensions that will be emerging over the coming decade, and imagine the kinds of worlds that are possible for those who will be shaped by the technical and cognitive environments on the horizon.

The technological, social, and cognitive environments that kids consider normal and natural will be radically different than those of their parents, and maybe even their older siblings. The technological wizardry of the next decade will enchant kids throughout their lives. As this cohort moves into young adulthood and into positions of responsibility in society, they will carry certain expectations of control, interaction, feedback, and relationships that they are learning now. What are the habits, expectations, affordances, and relationships that kids will carry forward with them into adulthood?

MAGIC WANDS ACCELERATE GRATIFICATION

Technologies are designed to reduce the time and effort needed to accomplish a goal. They work by reducing the gap between desire and outcome. An axe allows a person to fell a tree; a gas-powered chainsaw fells it even faster, reducing the time to desired outcome. As this gap between desire and action is reduced further and further, the things we want will begin to almost magically appear. New technologies, especially touch and gestural interfaces, are shrinking this gap. President of the Parents' Choice Foundation Claire Greene observes that with touchscreens a child's *"finger becomes a magic wand."*[25]

What kinds of behaviors will emerge when delayed gratification is no longer a product of lack of access or physical barriers? Will delays and barriers be purposely designed into technologies and systems in order to create feelings of achievement? How will reducing the barriers between thought and action affect the way people exert their will, and how will these intuitive interfaces change our relationship to machines?

Kids are growing up in a world of instant consumption, ambient assistance, and constant persuasion. They do not have to wait until Saturday morning to watch their favorite cartoons, or until their parents go to the bookstore to get a storybook. Streaming digital content, downloadable apps for tablet computers, and 3D printing machines point to a future in which kids are able to access vast media repositories and even make custom toys with incredible ease. Future sandboxes will be filled with claytronic magic dust.[26] Coloring books, storybooks, and other content will be delivered through digital apps, and a simple touch will turn a red digital crayon blue. Gestures, touchscreens, and computational applications will make a kid's world a dance of desire, with digital sleight of hand transforming materials before our eyes. Kids today are already learning simple programming languages and are even learning the gray art of computer hacking.[27] In a decade, many kids will be adept at "coding" their digital and physical spaces for executable outcomes.

Designing high-quality engagement is often predicated on the successful tuning of the feedback loop—providing a well-timed and appropriate connection between a decision or action and the impact of that action. Games have been lauded as providing a very effective type of feedback. In games, a player always knows, or can figure out quickly, how certain actions will move the player closer to or further away from a given goal. Many of our new technologies, especially education and health technologies for kids, provide rich data and real-time feedback on activities. So much so, in fact, that most kids will be accustomed to receiving constant affirmation or acknowledgment of progress.

TOTAL KID AWARENESS: A DILEMMA

The default expectations for both parenting and childhood in general are changing. Traditional barriers and habituated responses will appear anachronistic in the near future. For example, the amount of parental monitoring of a child has been determined by the boundaries of physical space, the limited availability of communication technologies, or the cost of tracking tools. Even if parents wanted to keep an eye on their child all the time, the "natural" barriers to this would prevent it. However, with the implementation of a massive social surveillance infrastructure (including CCTV and RFID tags), the ubiquity and low cost of smartphones, and the penetration of social media into our daily lives (which allows one to track location information and other "digital trails"), the possibility of continuous copresence and "total kid awareness" becomes real for millions around the world. With these tracking tools in place, what will the default monitoring setting be for parents and caregivers? How will people deal with the social pressure to keep a constant eye on their kids? What happens if they don't?

These kinds of pressures and changing defaults lead to uncertain and inconsistent responses. When our norms and our technical capacities are out of sync, passionate social debates, new laws, and shifting political partnerships arise. Practices also emerge that try to rectify logical inconsistencies between our values and our actual behaviors.

For example, in regards to the surveillance issue, many parents feel the need to watch and protect their children as much as they possibly can. Yet they also know, and research is confirming, that overprotection can lead to psychological and cognitive harm to their child, and they want their children to have the freedom to explore and try new (and sometimes risky) things. It is part of growing up. These conflicting urges are leading to attempts to create what might be called "riskless risk." Parents, teachers, and others will be designing toys, playgrounds, and experiences that give the appearance of freedom, but that have invisible safety nets that won't allow a kid to go *too* far.

Another example is the increasing dilemma between structured and unstructured playtime. Many kids today have their daily schedules and activities planned out extensively, with playtime included as a line item. Free recesses are being cut at schools, and many kids go straight from school to organized activities such as music or sports, instead of the totally open playtime between the end of school and dinner at home that kids from previous generations experienced. But again, the perceived benefits of this open play are not lost on most parents, who are trying to find ways to structure unstructured time into their kids' routines.

Over the coming decade, what new "magic tricks" will be attempted to rectify the conflicting value sets and logical inconsistencies of parenting? How will riskless risk, structured unstructured time, and many other seeming contradictions be confronted and rectified, or not?

JUVENOIA: THE COMING KIDULARITY?

In some ways, society's anxieties about kids mirror those we have about technologies. We continue to try and improve, advance, and integrate them into our lives, but we also fear giving them too much power. We project our deepest fears onto technology and onto children. We design technologies and socialize children in ways that reflect our current values, beliefs, and expectations about what they are supposed to be. We want them to have some autonomy and independence, but still "know their place."

As social change continues to accelerate, due in large part to rapid technological innovation, how will adults and kids deal with these empowerment/enslavement reactions as they increase in frequency and amplitude? Where will balanced responses come from?

We, as adults, fear the control they might have over us, that we might be helpless against them. The narrative arcs of *The Terminator* or *The Matrix* look very much like *Children of the Corn*. Or, take another powerful image of the future these days, the "Singularity." The Singularity is one popular name to describe a world in which greater-than-human machine intelligence brings about massive technological and civilizational change. This acceleration happens so fast that change itself changes, and we cannot even fathom it within our limited human mindset. According to many proponents of this idea, we will merge with, or be surpassed by machines, and life as we have known it will be left in the dustbin of history.

So, taking the kid/tech analogy a step further, one (only slightly tongue-in-cheek) way to describe the super-empowerment that new technologies are bringing to children might be called the "Kidularity." The Kidularity would be the point at which children have more proficiency and control over the technical infrastructure than adults. Kids will then exert their superior will over systems and institutions, radically altering social power dynamics.

This Kidularity, however, might simply be a contemporary bottle for very old wine. Consider this statement,

> The children now have luxury; they have bad manners, contempt for authority, they show disrespect for their elders, and love chatter in the place of exercise. *Children are now tyrants, not the servants of their households.*[28]

That quote is by Socrates in the 5th century B.C.E.! This fear of the tyrannical control that children could have over adults seems to have cycled through history and into modern times. And the manner and pace of social change have only amplified this tendency. Paranoia about youth and paranoia about technology can resonate strongly, creating a vicious cycle of overreaction and irrational prohibitions. David Finkelhor, Director of the Crimes Against Children Research Center, describes the "exaggerated fear about the influence of social change on children" as "juvenoia."[29]

PROGRAMMABLE WORLD–PROGRAMMABLE KIDS

When computation and sensing technologies are embedded into the hardware of our built environment, the material world (and even parts of the natural world) become mutable, programmable machines. Kids will expect the world to be programmable. One no longer needs to be an engineer or an architect to build a new building, if instead all the skills that are needed involve coding programs to tell materials to form into certain shapes. These skills will be accessible to people at younger and younger ages. Rapid prototyping, 3D printing, synthetic biology, claytronics and other innovations that bridge the gap between information and objects are blurring the distinctions between tangible materials and computational codes.

When thinking about the overall ecology of perception, the programmable world has another, potentially darker side. With universal content filters, algorithmic recommendation engines, persuasive technology, neuromarketing, and embedded governance built into our devices and the environments we occupy, the idea of a free, individual, and autonomous decision-maker might be strange to kids of 2021. People are offloading and automating more and more of day-to-day decisions and increasingly need filtering tools and behavioral algorithms to help navigate a very complex world.

How will the human relationship to materiality change when matter and the built environment are programmable? Given the increasing reliance on algorithms, might our choices and life paths be "programmed" into us from a young age by the design decisions of platform coders and device manufacturers today? Or, perhaps, have we always been "programmed" by the cultural institutions and technological infrastructure we grow up with? Will the intentionality of this programming make it easier or harder to resist?

THE "GLOBAL" CHILD

How will having a global audience affect a child's development and identity? How will this trail of transparency follow a child into adulthood?

A child's perception of space, time, and distance is much more constrained and intimate than that of an adult. A child's mental world is usually limited to the immediate spaces and people who surround them. This more limited horizon is being changed by network technologies that connect people, including kids, with others all around the world. Rather than experience defined by rooms and immediate surroundings, kids have an awareness of global connectivity, dimension, and distance. This not only changes a child's perception of distance, but also radically expands conceptions about spheres of influence, and allows a child to conceive of a "global" audience from a young age. Kids now live much of their lives on the Internet. Billions of people have access to the images, creations, and performances of children. Experiences are shared with huge numbers of people, and a child's growth and development can be tracked by friends, family, and others. This global transparency and public performance of childhood is unprecedented in history.

ENCHANTED KIDS

The questions and tensions that emerge from the forecasts included in this report will be critical to address as we impart (or impose) the world we've built onto our children. Adults often perceive that social change will be amplified for the next generation, and fear that the negative changes will be carried forward forever by these kids. However, kids are in some ways made to deal with change, and may have more to say and more power to influence the world than at any other time in history. That new empowerment will be the real magic kids bring to the world, and it may be the magic that saves the world from adults.

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