Let Tinkerbell Tinker

As the economy's reliance on innovation grows, the offering of toys for girls remains somewhat less than innovative. Fortunately, a few women who are educators, engineers, and entrepreneurs are starting to figure this problem out, by reviving the time-honored principles of tinkering.

By DAVID MUNRO

My daughter hates princesses, and I love her dearly for it. She also loves fairies, and I love her for that, too. The distinction may seem like the caprice of an 8-year-old mind, but it's actually a simple matter of job description. A princess's job is being a princess. Fairies put in *work*. Case in point: the world's most famous fairy is a mechanical engineer.

Last weekend, we watched Disney's "Tinkerbell" for family movie night. The D-word is problematic in our household, given The Mouse's history of tarting up literature's darker, more nuanced works, particularly those featuring female protagonists. But once we got over the leafy lingerie, what we found was a capable, creative, highly resourceful young woman. In one close scrape after another, Tink saved the day with little more than her wits and ingenuity.

That's because, above all, Tinkerbell is a tinkerer. She figures things out.

The Tinkering Studio, and The Exploratorium as a whole, draws 1.1 million children and adults every year. Participants get to work with resident makers and artists to design all manner of mechanisms, both practical and fantastical.

Given the crisis in STEM (science, technology, engineering, math) education for girls, the paucity of women in technical fields, and an innovation economy that needs 1.7 million new engineers and computer scientists in the next decade just to stay competitive, you'd think that some sort of Tinkerbell Tool Belt would be sweeping the nation. And it might be, if it existed. But it doesn't. Instead, when you Google "Tinkerbell toys," you get product descriptions like this one: *Disney's favorite pixie, Tinker Bell, invites you to share in a magical good time with every gal's favorite fashion accessory – shoes!*

In truth, J.M. Barrie's "Tinker Bell" is a blue collar kid, a metalsmith by trade. On behalf of my aspiring architect daughter, I determined to find out how Tinkerbell the engineer became Tinkerbell the mall rat.

The Value of Futzing Around

"Futzing" is what my father called unstructured play. It's Yiddish for farting. And we're not even Jewish. Anytime I was doing something without a clear and stated purpose – say, building a wrist-launcher that shoots heirloom cocktail forks – I was told to stop futzing around and do something useful and constructive.

In a delicious bit of *pater-filius* irony, virtually all of history's most useful and constructive brainstorms weren't driven by stated goals at all, but rather by messing around. Progressive educators now have an updated, more value-positive term for this kind of activity: *tinkering*. It turns out that futzing has been the mother of invention all along.

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Consider: penicillin, X-rays, microwave ovens, Silly Putty, and LSD. Everyday necessities, many of us would argue. Each stumbled upon by accident. None by design.

"If someone's always feeding you the answers, you don't make connections between seemingly unrelated objects," says Rachelle Doorley, the author of *Tinkerlab: A Hands-On Guide for Little Inventors*. "When kids get to tinker – take apart, reassemble, recombine, mix and mashup–that's where the real discoveries take place."

Tinkering also helps develop a skill that is literally prerequisite for visionaries–spatial visualization, or the ability to manipulate three-dimensional objects in your mind. It's a subject of debate how and to what degree girls naturally lag behind boys in this capacity, but there's agreement that the gap is reduced to inconsequence with practice.

Karen Wilkinson, the Tinkering Studio's director, says that without hands-on experience to "solidify abstract concepts," real learning in science cannot take place.

For kids, practice means play, and play means toys. "Kids use toys to try on roles and explore interests," explains Ms. Doorley. "Tinkering is a form of literacy. Toys can either offer or deny the hands-on practice that forms the basis of real learning." The value of real, tactile toys seems to only grow by the day, as people—both children and adults—spend more and more time on digital screens.

The Origins of Tinker Toy Apartheid

Swept up in the fervor of the Second Industrial Revolution, toymakers at the turn of the last century launched building sets for the next generation of Graham Bell's, Edison's, and Brothers Wright. Meccano led the charge in 1901 with its make-anything medley of girders, plates, pulleys and gears, followed closely by Erector Sets, Lincoln Logs, and yes, Tinkertoy.

The toys did as advertised, inspiring a Laureate's list of innovators and innovations. The precursor to the artificial heart was built with an Erector set. Meccano was used to make a differential analyzer that helped pave the way for Alan Turing's civilization-saving Enigma-cracker. The Great Tinkertoy Computer, created by MIT students in the early '80s, has still yet to lose a game of Tic Tac Toe.

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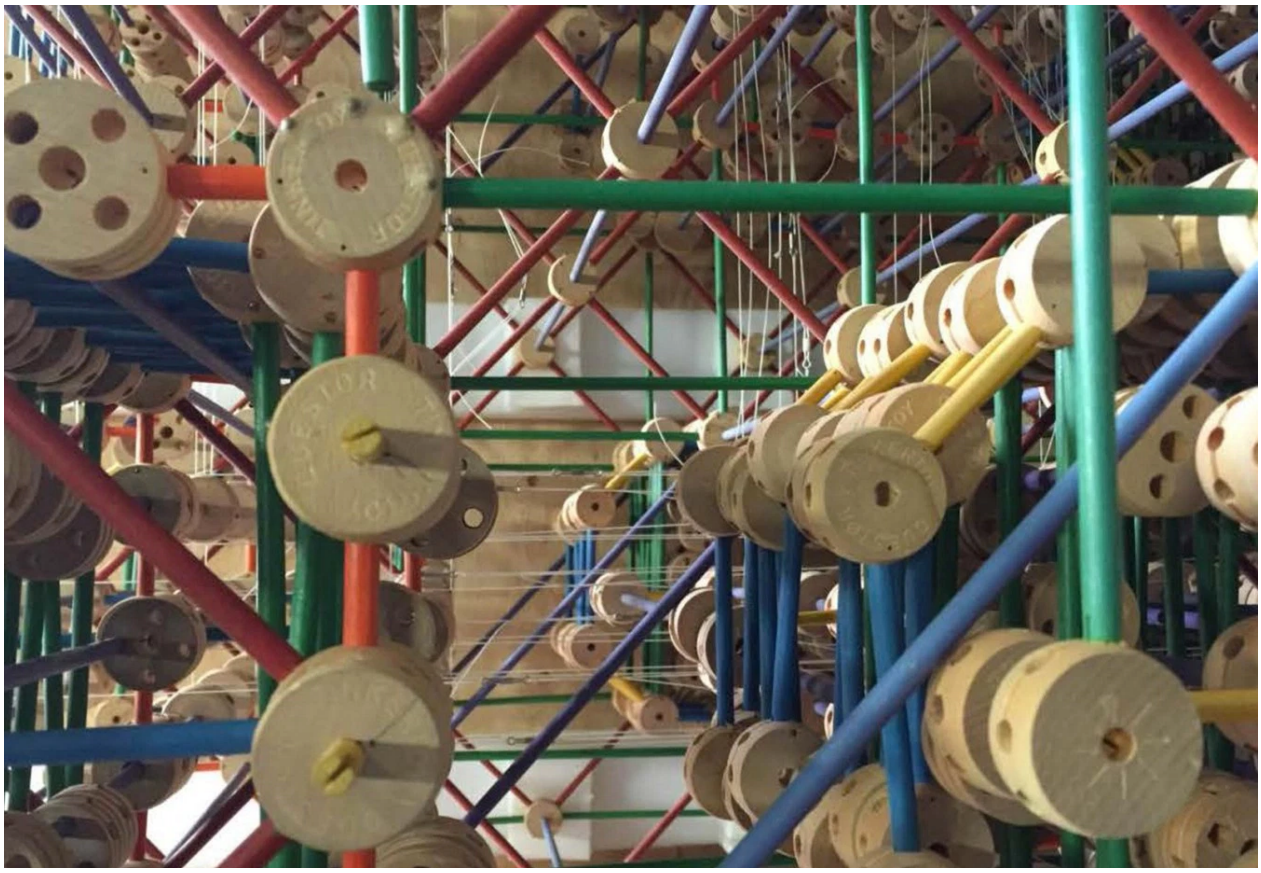
Sadly, the target market was as advertised, too. Meccano boxes spelled out the intended user of its contents with the none-too-subtle descriptor, "Engineering for Boys." "Hello Boys!" was Erector's official advertising slogan. And speaking of subtle, Erector's name was, and is,

"Erector." "Girls go down the paths presented to them," Doorley says, "and for most of the history of building toys, the tinkering path was strictly boys only."

The '70s, that strange and underrated *Free To Be You And Me* spasm of consciousness, gave a short-lived reprieve from separate but equal playtime with a modest injection of gender-neutral toys and marketing. But the '80s came along soon enough to dash any egalitarian pretensions. Before the decade was over, even Sesame Street characters were getting in on the act, joining usual suspects Disney and Barbie in pink-bombing the aisles of new big box toy superstores into color-coded, gender-ghettoed oblivion.



In 1975, a group of MIT students set out to make a computer from wooden spools and sticks. It took several years of "tinkering" to finally make it work. (photo © Computer History Museum, http://www.computerhistory.org)

Suddenly, and like never before, the girls' section was awash with princesses, baby dolls and Care Bears, while the boys' side was stocked with Bob the Builder, Handy Manny, and the new building toy *nonpareil*, Lego. In the face of increasing charges of discrimination, the toy industry responded, but cynically – with girl versions of the same toys.

In Lego's case, that meant soft-hued blocks and "Lego Friends"— a set of distaff Lego characters that – in counterpart to the boys' block-bodied construction workers, astronauts, and EMT professionals – gave girls a shapely posse of shoppers, salon goers, and poolside loungers. "All toys are educational, in that all toys teach," writes Christina Spears Brown, an Associate Professor of Developmental Psychology at the University of Kentucky, in Psychology Today. The question, then, is what are we teaching?

For the toy companies that thought the answer was to set builder-girl hearts aflutter by adding sequins and glitter packets, the market gave an unambiguous rebuttal. "You can't just shrink it and pink it," toy analyst Sean McGowan told the Wall Street Journal about the failure of "pinkwashing." "Those products didn't sell because that's not how girls play."

The education system hasn't figured out how they play either. Since 1987, women have been increasingly outnumbering men in gaining advanced degrees, and in 2016 they will be awarded 53 percent more masters diplomas than men receive. Yet only a fraction of those degrees will be in the so-called "hard" sciences, with just 25 percent in the market-starved, innovation-critical fields of computer science and engineering.

The Story Tinkerers

I vividly remember the hours I spent playing with blocks as a boy. I remember stacking them as high as they could go, until they collapsed on themselves, or more satisfyingly, were demolished by me.

My daughter shares my love of blocks, but not my intent. Her structures, always elaborate, always ambitious, do not end when the building is done. Rather, that is when they begin. She builds things to be inhabited. To form communities for her fairies, dolls, stuffies and creatures. And most of all, to be sites for storytelling.

Alice Brooks spent months observing girl play patterns while developing her wired dollhouse building toy, Roominate. "With the same materials, girls built a wide variety of different things," she says, "but the one constant was story."

Karen Wilkinson, director of San Francisco's Exploratorium Tinkering Studio, goes even further. "Story and community are deeply important to girls," she says. "It's one reason the STEM pipeline makes me nauseous. It's so rigid that it doesn't allow for other avenues of entry. I hated science until I took an art class and learned to pour bronze. Suddenly, I was learning about melt values, and I was hooked."

Karen Wilkinson teams with young makers to build a tower that will support a marshmallow using spaghetti and tape. "Collaboration is something girls do well," she says. "With an atelier model, our education system could look a lot different."

There's documented, footnoted, peer-reviewed research to show that storytelling excites our brains differently than factoids and true or false tests. One study, by Emory University researchers in 2012, showed that metaphors light up our sensory regions in ways that plain speech does not. But really, do we need neuroscientists to tell us that 8th grade biology class sucked? It's entirely possible that, in addition to everything else, girls are simply bored by how science is typically served.

"Girls attack a soldering workshop with the same enthusiasm as boys," Wilkinson says. "But they may not use the same tools in the same way, for the same purpose. There's no doubt girls are equally capable. It's just how we invite them in. And the invitation has to be different. The field has been slanted toward boys for so long, we need to do work beyond the norm to let girls know that they're welcome, too."

Pioneers Get the Arrows

When the 1990s arrived, another technological revolution swept through a region of America's Northern California coast, with a new set of miracles and limitless possibilities in tow. Janese Swanson was a single mom living and working in Silicon Valley at the time. In addition to a day job developing computer games for educational software forerunner, Broderbund (remember CD-ROMs?), Swanson possessed an inventor's itch, an entrepreneur's spirit, and a warrior's willingness to combat injustice at the risk of being shot to shreds.

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In 1989, Swanson began tinkering with a vocal recognition chip she took from a prototype, and the muse struck. She'd earned her PhD with a doctoral thesis on gender issues in product design, so she knew that girls were more verbally adept than boys at an early age. Her first invention was Yak Bak, a hand-held playback

device that started out as a way to hear her daughter's voice at work. After turning it into a toy that could assume different voices, she licensed it to Yes! Entertainment, and all signs pointed up.

That is, until her daughter saw the first Yak Bak commercial on TV and ran to her mother, distressed. "She looked up at me with these sad eyes, and said, 'Mom, why did they make it for boys?'" Swanson recalls. "The commercial was a girl arguing with her brother while he's using the toy to answer her because he's too busy watching TV. That's the moment I knew I had to start my own company."

That company was Girl Tech, founded under the same mission statement she had for raising her own daughter: to promote the adventurous spirit in girls. Swanson soon developed a number of voice recognition products, and coming from the heady, fizzy dream lab of Tech Boom 1.0, she believed anything was possible. She had yet to meet the toy industry.

"The places I worked in the Valley, you came up with an idea in the morning, and you made it happen that afternoon," she says. "So going from that to the toy business was a bit like going from the future to the past. I was straddling two worlds that weren't connected yet."

Among Swanson's war stories was the time at a toy fair, in 1997, when she tried to explain Girl Tech's online strategy to a Toys R Us buyer. "I told him that girls can engage more deeply with the science behind the products on the Internet," she recalls. "I told him that pretty soon, kids will be spending a lot of time there. He rolled his eyes and said, 'Internet, shminternet.' He actually said that."

Big Toy's indifference to girls and technology was just the beginning of Swanson's fire trials. Her adopted home, Silicon Valley, was never much of a girl's club to start with, funding women-fronted companies at a paltry 2.7% of all startups. Then there was the insanely steep cost to market in the days before Office Depot began carrying household 3D printers. Swanson made her prototypes by hand, paying Lucasfilm artists on their off hours to help sculpt her models.

In 1998, Swanson finally got Girl Tech to market, after agreeing to an acquisition deal with an electronic game company named Radica. She was well compensated, but the ordeal was punishing—enough so that Swanson describes her return to teaching as "healing." In her current role as the art and technology teacher at Torrey Hills Elementary School in San Diego, she has the direct, interactive educational platform that the toy industry never gave her.

Radica subsequently sold Girl Tech to Mattel in 2006 – "For zillions," Swanson says with a laugh – and Girl Tech products are still being sold. Among them is Password Journal, a top secret diary that only opens with a voice password that you record. It's a clever update of a beloved staple, though with Janese gone, it lacks the shminternet element that would have taught girls about invisible ink, black light, and digital audio encryption.

Perhaps it goes without saying that Mattel also made it pink.

Re-engineering the Pink Aisle

The thing about revolutions is they're rarely co-signed by the forces you're trying to overthrow. By the mid-oughts, with the advent of DIY prototyping technology like laser cutters and 3D printers, along with membership-model maker spaces like TechShop, women inventors no longer needed the Mattels of the world to underwrite —and pinkify—their ideas. The means of production were now in rebel hands. It was time to come out of the malls and liberate some imaginations.

Roominate's Alice Brooks always loved dollhouses. She built her first one when her robotics professor father gave her a saw for Christmas. "I asked for a Barbie, but he said Santa didn't give dolls," Brooks says. After a childhood spent playing hooky to hang out with her dad's MIT graduate assistants, she followed her love of making to Stanford to pursue a degree in mechanical engineering. She remembers the moment she became radicalized, and it was tinkering that lit the flame.

"The a-ha moment for me was in a class called Manufacturing 2," Brooks says. "The assignment was to make a yo-yo. We split into groups and suddenly we're making molds out of aluminum, testing plastic tolerances, using an injection molding machine. I was blown away by how changing minor variables could make huge differences in outcomes. Most of all, seeing an idea become a finished product was incredibly empowering. That's when I thought, 'I can do this.'"

With her classmate Bettina Chen, and while still students, they started Maykah LLC, and began developing the toy that would become Roominate. "There were no engineering toys on the market for girls," Brooks says. "All our research showed that girls were hungry for a building toy that met them in the way they played."

Roominate is designed to let youngsters build a whole range of creations—with many more possibilities for error, and discovery, than exists with a Lego set. As the Tinkering Studio's Wilkinson notes, "Lego says they're about multiple possibilities, but kids freak out when you take apart Big Ben."

Their first idea was to make a car. It had a motor and gears for mechanical learning, and road trips always make for good stories. But girls were bored by it. This is the moment when a toy industry executive might conclude that girls just aren't into making stuff, and cut bait. But that's not what Brooks and Chen did. Like textbook tinkerers, they started iterating. First, they added decorative elements and a pet pig exterior. Girls liked it a little more, "but only because of the stickers and the pig," Brooks says. "It's a problem when the accessories are more interesting than the toy."

That's when the central lesson of tinkering shone through. As engineers and problem-solvers, Brooks and Chen were trained to fail. "On the outside it may have looked like defeat," Brooks explains. "But for us, failure just meant more data for ways to improve."

A few pieces of popsicle stick furniture later, they took their fully wired dollhouse back for another round of testing. Brooks knew they'd struck gold when a six-year-old looked up at her and said, "I'm going to need more circuits."

Brooks remembered seeing a lot of dollhouses in the rooms of girls who hated their car. So she and Chen took the motor from the car and stuck it in a makeshift dollhouse bedroom as a fan. A few pieces of popsicle stick furniture later, they took their fully wired dollhouse back for another round of testing. Brooks knew they'd struck gold when a six-year-old looked up at her and said, "I'm going to need more circuits."

Toy is a Verb

There's no question that the maker movement, and its once-rarified tools, have given burgeoning inventors unprecedented leverage in bringing ideas to market. But from a strict maker perspective, going to market is kind of against the point. Why buy it when you can make it yourself?

"My meter pegs with some of these girls' building toys," says the Exploratorium's Wilkinson. "There's all this hype, and then you open the box, and it's kind of … nothing. There's a part of me that would rather take that money and go to Home Depot to make something truly cool from scratch."

Ted McGuire, who helped launch the science kit company Thames & Kosmos with his museum director mother, questions the need for gendered STEM toys altogether. "My basic philosophy is, science has no gender," McGuire says. "I understand it's not a perfect world, and you need to start with where people are at, but even our kits with a strong gender preference, like Perfume Science, have no frilly design or girls on the box. It's a self-selecting process, as it should be."

A recent trip to a STEAM carnival with my daughter in San Francisco further exploded any conclusions or assumptions, partly because it introduced another variable – the "A" as in art – to the STEM cocktail. Throughout the day, I watched my daughter beam at moments of pure, art-activated, tinker-rich discovery. Top of lung screams that generated kinetic, aesthetic reactions. Conductive play dough that sparked LED displays. Rolling, iPhone-controlled droids that were creepily capable finger-painting avatars.

So, what is a toy, exactly? Are we back to square one?

Lilah

A friend of my daughter's recently came to school wearing the coolest Halloween costume I've ever seen. She was Athena, goddess of wisdom and battle strategy. She hammered her own shield, after annealing (softening) the copper, under supervision, with a 950-degree acetylene torch. Brad Pitt's pretty boy Achilles wouldn't have stood a chance.

Lilah Dedlow (left) and her twin sister Phoebe use texturing tools to make designs on copper, in their father's garage workshop.

Lilah's dad is Mark Dedlow, an IT manager at Berkeley Labs. His home workshop is not to be believed. And his twin daughters, Lilah and her sister Phoebe, are welcome in it, anytime. Lilah usually starts hammering around 7-ish before school.

Dedlow has no agenda to make Lilah a she-Vulcan (the Greek god of tinkering). He says the main driver is Lilah's relationship to "things." "She likes patterns and organizing objects," Dedlow says. "She'll collect two dozen rocks and wrap them in cloth, then arrange them in a grid on the ground, like Andy Goldsworthy."

Lilah also likes classical mythology, which she was introduced to by *D'Aulaires Book of Greek Myths*. "She read that book every night for months, memorizing whole sections," Dedlow says. When she decided she wanted to be Athena for Halloween,

her father was ready with the materials, tools, and metallurgical lessons that came with it.

Dedlow describes the process of annealing metal in almost meta-physical terms. "The transformative aspect is very palpable to the person engaged in it," Dedlow says. "It connects to physics, but also to mystery. The more you hit copper, the harder it gets. By reorganizing the crystals with heat, you restore it to a malleable state."

Lilah's elementary school Halloween Parade. One reigns supreme.

To a tinker evangelist – particularly one who advocates for girls – the above scenario is perfection. Raw materials. Real-world tools. A creative goal without an IKEA set of instructions. And multiple disciplines: art, technology, story. *Herstory*.

"There are so many pre-packaged products with all the steps laid out," Karen Wilkinson says with a bit of sadness. "Tinkering is an intervention to that. It shows kids that the world is hackable in the most positive sense of the word."

At this point in my conversation with Karen, I am a super-convert, nodding like a Tourette's sufferer and eager to text her photos of me hauling boxes of my daughter's Littlest Pet Shop figurines to the curb, replacing them with scrap wood and hot glue guns.

But then Karen catches herself. "I'm not a purist," she says. "Parents need to give themselves a break. It takes a lot of awareness to go totally DIY, and even paint-by-numbers teaches focus, precision, discipline. Those skills are necessary, too. It's about balance, raising the level of extra-curricular play, and letting kids know they can change the world around them." (For more information on this topic, see our sidebar, "The long trail to becoming a maker girl.")

Epilogue

I ran into Lilah at school today, while waiting to pick up my daughter. I asked what her favorite toy was.

As she thought about it, her mom's friend Sonya, who was on pickup duty, said, "You don't really like toys, do you?" Lilah shrugged. Then I asked what was the favorite thing she's ever built? There was no pause this time.

"A fairy dollhouse," she said, shyly, but proudly. Somewhere, Tinkerbell – the *real* Tinkerbell – was smiling.

David Munro is a writer and filmmaker whose latest project is "Stand Up Planet," a semi-scripted documentary about a new generation of global comedians sparking change through humor. His debut feature film, Full Grown Men, won the Sundance Channel Audience Award.

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