

the
**Henry
Ford**

MAGAZINE
MARCH-MAY 2017

®

Gain perspective.
Get inspired.
Make history.

THE MATH ISSUE

PAGE 48

**What if a museum of history
added a mathematical exhibit
to the experience equation?**

**WRITING CODE THAT
CREATES MUSIC
HOW MATH SLIPS INTO
THE MAINSTREAM
MODERN-DAY MAKEOVER
OF A MATH BOOK**

SOMETIMES, OUR HIGHEST HEIGHTS HAPPEN
**LONG BEFORE
TAKEOFF.**

Official Airline of The Henry Ford.



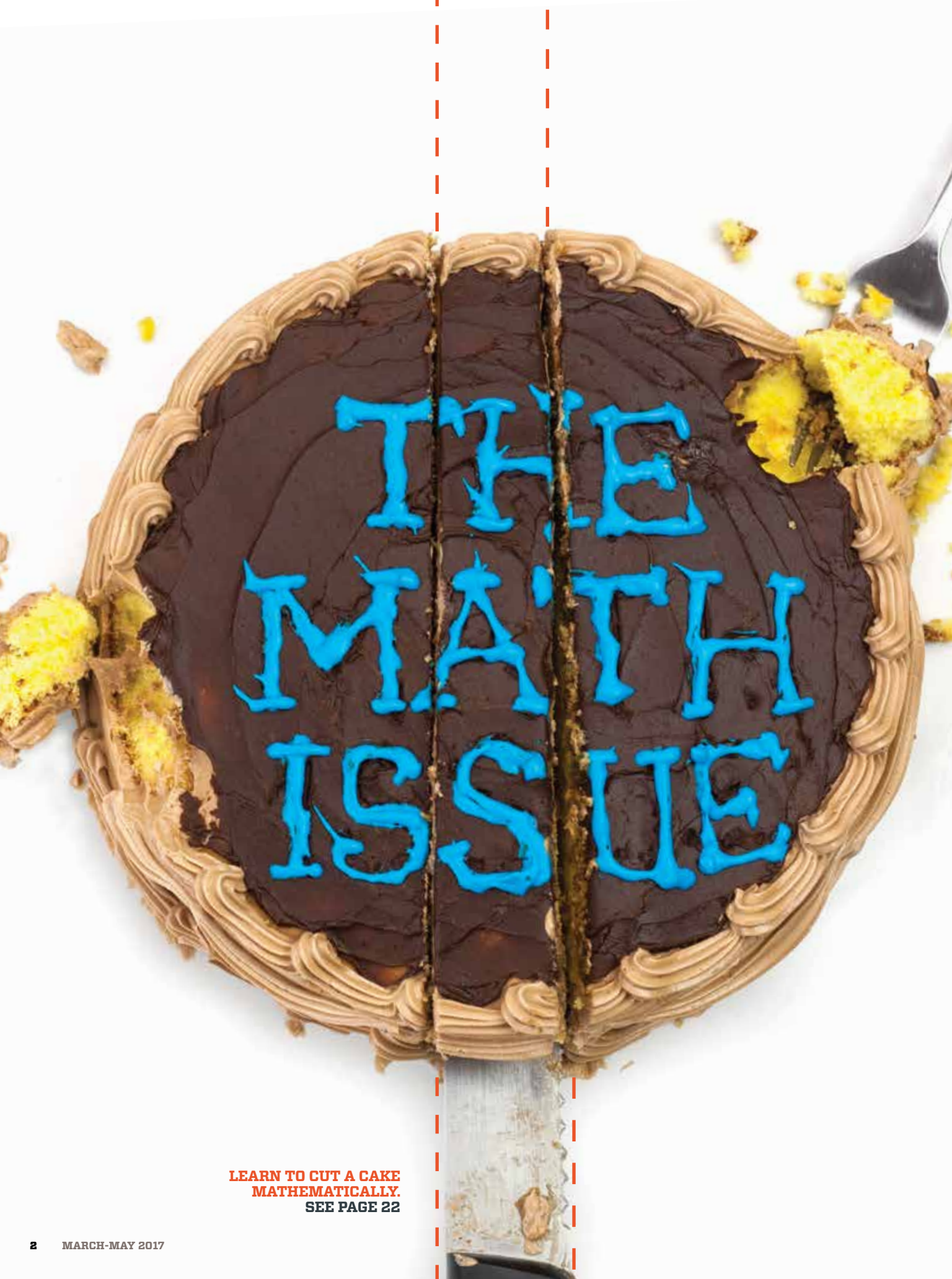
KEEP CLIMBING



There's a difference between being in a community and being part of it.

Citizens Bank is pleased to support The Henry Ford and its mission to inspire people to learn from America's traditions of ingenuity, resourcefulness and innovation to help shape a better future.





**LEARN TO CUT A CAKE
MATHEMATICALLY.
SEE PAGE 22**

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**MATH BOOK
REIMAGINED**
Iconic text loved by mathematicians for more than a century gets a designer reboot

STAY, EXPLORE + SAVOR 61

ON THE COVER

With an eye to the peephole of the Conic Sections interactive, a world of surfaces and curves formed by tightly stretched strings comes into startling view. Charles and Ray Eames' groundbreaking *Mathematica* exhibition opens in Henry Ford Museum of American Innovation this fall.

PHOTO BY BILL BOWEN

Gain perspective. Get inspired. Make history.

THE HENRY FORD: A NATIONAL TREASURE AND CULTURAL RESOURCE

The Henry Ford in Dearborn, Michigan, is an internationally recognized cultural destination that brings the past forward by immersing visitors in the stories of ingenuity, resourcefulness and innovation that helped shape America.

A National Historic Landmark with an unparalleled collection of artifacts from 300 years of American history, The Henry Ford is a force for sparking curiosity and inspiring tomorrow's innovators. More than 1.7 million visitors annually experience its four venues: Henry Ford Museum of American Innovation, Greenfield Village, Ford Rouge Factory Tour and the Benson Ford Research Center. A continually expanding array of content available online provides anytime, anywhere access to The Henry Ford Archive of American Innovation. The Henry Ford is also home to Henry Ford Academy, a public charter high school that educates 485 students a year on the institution's campus.

In 2014, The Henry Ford premiered its first-ever national television series, *The Henry Ford's Innovation Nation*, showcasing present-day change makers and The Henry Ford's artifacts and unique guest experiences. Hosted by news correspondent and humorist Mo Rocca, this weekly half-hour show won Emmy Awards its first two seasons on the air. It airs Saturday mornings on CBS.

For more information, please visit thehenryford.org.

Help us inspire future change makers

The Henry Ford inspires dreamers, doers, movers and makers with stories of the greatest breakthroughs and inventions throughout history. Your support goes a long way toward unleashing The Henry Ford Archive of American Innovation and making our collections available to the world.

The Henry Ford is an independent nonprofit organization. We depend on ticket purchases, income from our stores and restaurants, and tax-deductible contributions and memberships for support. To learn how your generosity can help take it forward, visit thehenryford.org/support.



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WHAT IS YOUR FAVORITE NUMBER?

Our contributors tell us.



JING WEI

8. It's the luckiest number in Chinese culture. I'm a bit superstitious, so I'm always looking for 8's in my life (dates, hotel rooms, passcodes, etc.). Aside from that, it's just a very pleasing and satisfying number to look at!

Jing Wei is a Chinese-born, California-raised illustrator who enjoys doing a lot of things at the same time. She regularly freelances for clients such as Target, Herman Miller, MailChimp, Adobe and *The New York Times*. When she's not in the studio, she works as the illustration director for Etsy, where she helps develop the brand voice and vision. And when she's not doing either of those things, she's teaching publications at Pratt Institute. In her spare time, she is a fan of swimming, traveling and having people pronounce her name correctly.

Ask + Answer, Page 9



ALLEN SALKIN

6. Birth year is '66. Birthday is April 2: $4+2 = 6$. Mother's birthday is 4/2/42 (yes, same day, different year) — again, $4+2$ and $4+2$ is how I see it. I always bet on sixes. Mark of the beast? Whatever.

Allen Salkin is a world-renowned trend writer, author, filmmaker and journalist.

Math Gone Viral, Page 18

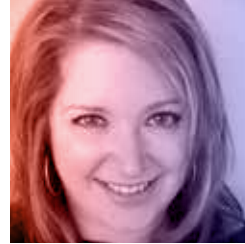


ENISAURUS

∅. When someone asks me what my favorite number is, I always think the same thing: why was my attention never caught for any particular number? Maybe it's because I was always totally awful with math at school, a complete disaster, and that bad relationship built a barrier between us. But if I had to choose one, it would be 8, the infinity number.

Enisaurus (Santiago Usano) is a full-time freelance commercial illustrator with a background in graphic design living and working in London. His work is a mashup of geometry, textures, bold strokes and intense colors. He develops commercial, advertising and editorial illustration projects for clients such as *Seattle Met* magazine, TEDx and BMW.

Math Gone Viral, Page 18

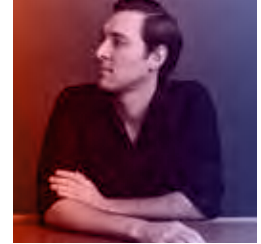


SARAH JONES

12. The great Quincy Jones once told me, "You know, there are only 12 notes!" That perfectly encapsulates the foundation — and limitless potential — of Western music.

Musician and journalist Sarah Jones has chronicled the creative and technical forces shaping the music industry for the past 20 years. She's the editor of *Electronic Musician*, a magazine for musicians.

Math, Music + *The Matrix*, Page 28



JASON KEHE

17. When I was a kid, I thought liking the number 17 made me different. Turns out it's pretty significant, mathematically and culturally. And that's now how I view myself.

Jason Kehe is an associate editor at *Wired*, where he covers books, art and robots. He reads science fiction and fantasy almost exclusively.

Math Book Reimagined, Page 38

You may have heard that we changed the name of Henry Ford Museum to **Henry Ford Museum of American Innovation**.

While the name of the overall destination remains The Henry Ford, extending Henry Ford Museum's name to include the word "innovation" better serves our visitors not only in this community but across the country and around the globe, as it effectively conveys the core idea that threads through the museum's key collections — innovation. The museum has always been about ideas and innovations that changed the world. Its name now directly reflects its focus.

Innovation comes in many forms, whether it is a technological idea, a social movement or a new way of thinking. The unparalleled collections on the floor of Henry Ford Museum of American Innovation are there for the inspiration and education of our visitors. Whether you are walking through Buckminster Fuller's Dymaxion House or sitting on the actual bus in which Rosa Parks refused to give up her seat, the museum's core promise has always been to activate people's imaginations and ignite that spark that is in each and every one of us to make a difference.

This year, our excitement surrounding the museum also goes far beyond its enhanced moniker. The actual museum floor will also be abuzz with exciting activity, and maybe even a few real sparks, as our new *Mathematica* exhibition is permanently installed. Created by designers Charles and Ray Eames in the 1960s, *Mathematica* is a visionary accomplishment in interactivity that will introduce museum visitors — in a very hands-on way — to fundamental mathematical concepts that align with the science, technology, engineering and mathematics (STEM) teachings used in schools today (see Page 48). Already, I am awestruck at, but not surprised by, the careful attention, expertise and hard work of our curators and conservation and technical staff to protect the historical integrity of *Mathematica* while preparing

it for its new permanent spot in the museum. When finished this fall, the exhibition will activate people's imaginations and engage them in the potential playfulness of math.

With *Mathematica* taking up residence at The Henry Ford, it seemed like an obvious choice to dedicate this issue of *The Henry Ford Magazine* to stories with mathematical undertones. Read about one man's passionate journey to reprint, with extra craft and care, a 130-year-old book loved by mathematicians for decades. Explore the unexpected ways math concepts and theories seep into everyday tasks and forms of entertainment, or how sound, math and computer code can create music. Also in this issue: a closer look at the unexpected connection between the working Jacquard loom in Greenfield Village and modern-day computer programming.

The Henry Ford has created many breakthrough moments in its 88 years of existence. With your help, we will continue to inspire the next generation of thinkers and doers, workers and entrepreneurs with additions such as *Mathematica* and a number of other new experiences, national partnerships and exhibitions coming soon to Henry Ford Museum of American Innovation.

Thank you for your continued support and friendship.

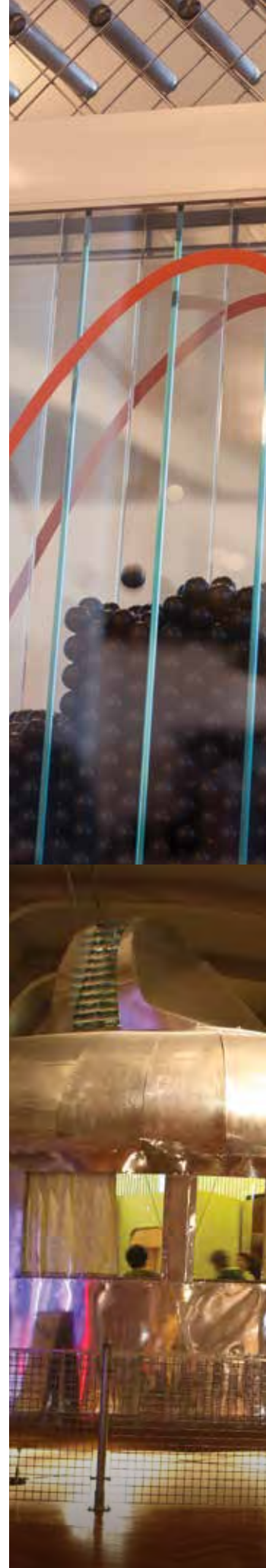


Patricia

**PATRICIA E. MOORADIAN,
PRESIDENT**

PHOTO BY KRISTINA SIKORA/
KMS PHOTOGRAPHY

MATHEMATICA AND
DYMAXION HOUSE BY
BILL BOWEN; ROSA PARKS
BUS BY KRISTINE HASS;
QUADRICYCLE BY
EMILY BERGER





HENRY FORD
**MUSEUM OF
AMERICAN
INNOVATION™**

“The museum has always been about ideas and innovations that changed the world. Its name now directly reflects its focus.”

— Patricia E. Mooradian,
president of **The Henry Ford**





FROM THE HENRY FORD ARCHIVE OF AMERICAN INNOVATION

10,000

Number of glass artifacts in The Henry Ford Archive of American Innovation

PAGE 54

60

Number of Ford F-150s rolling off the line every hour at the Ford Rouge Complex

PAGE 52

6,000

Number of 22-millimeter-in-diameter polypropylene balls that drop, travel down through 309 pegs and make a bell curve in Henry Ford Museum of American Innovation's new *Mathematica* exhibition's Probability Machine (opening fall 2017)

PAGE 48

130

Age (in years) of the cult-classic math book *Flatland*, reprinted in 2016 by design and publishing studio Epilogue

PAGE 38

DYMAXION HOUSE

Dynamic + Maximum + Tension = Dymaxion

Architect R. Buckminster Fuller had an unorthodox way of looking at mathematics. He was sure that geometry, for example, held the key to understanding nature's coordinate system. And he designed his own formulas of geometry to capture motion, looking for something more than straight two-dimensional lines and curves. It was from his revolutionary notions about triangles, circles, tetrahedrons and the like that he developed tension-based dome designs such as his Dymaxion House.

1: the number of masts that support the house

12: the number of cable tie-downs anchoring the house to the ground, set into 12 small concrete foundations

30: the maximum weight (in pounds) of a Dymaxion House structural part

10: the number of laborers needed to build a Dymaxion House in two days (according to Fuller!)

1,017: the square footage of the house

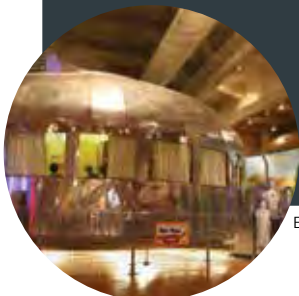
3: the number of revolving closets in the house

96: the number of aluminum floor beams

300: the number of square feet of window area in the house

18: the distance in inches from bottom of floor beam to museum floor

1: the number of Dymaxion House prototypes left in the world; see it in Henry Ford Museum of American Innovation



BILL BOWEN



JAMES HAN



ILLUSTRATION BY JING WEI

ASK: Can math be fun?

ANSWER: Ever heard someone say, “I’m not good at math,” “I hate math” or “I wasn’t born with the math gene”? As a math teacher, I hear this all the time. Unfortunately, math has such a negative stigma that rarely do I find students as passionate about math as I am. Somewhere during the building of foundational math, students are losing the joy of solving problems. By high school, their minds are made up that they don’t like math nor will they need it later in life. And so, the stage has been set, the gauntlet has been thrown and my challenge begins.

Lucky for me, there is a drive toward STEM/STEAM education. STEAM stands for science, technology, engineering, arts and math. Instead of having students solve multiple abstract problems from a book, they are tasked to do hands-on activities

to solve real problems. Recently, I asked my math students to design a functional speaker stand that could work in multiple classrooms without being permanently mounted. We also designed and hand-sewed tangram pillows.

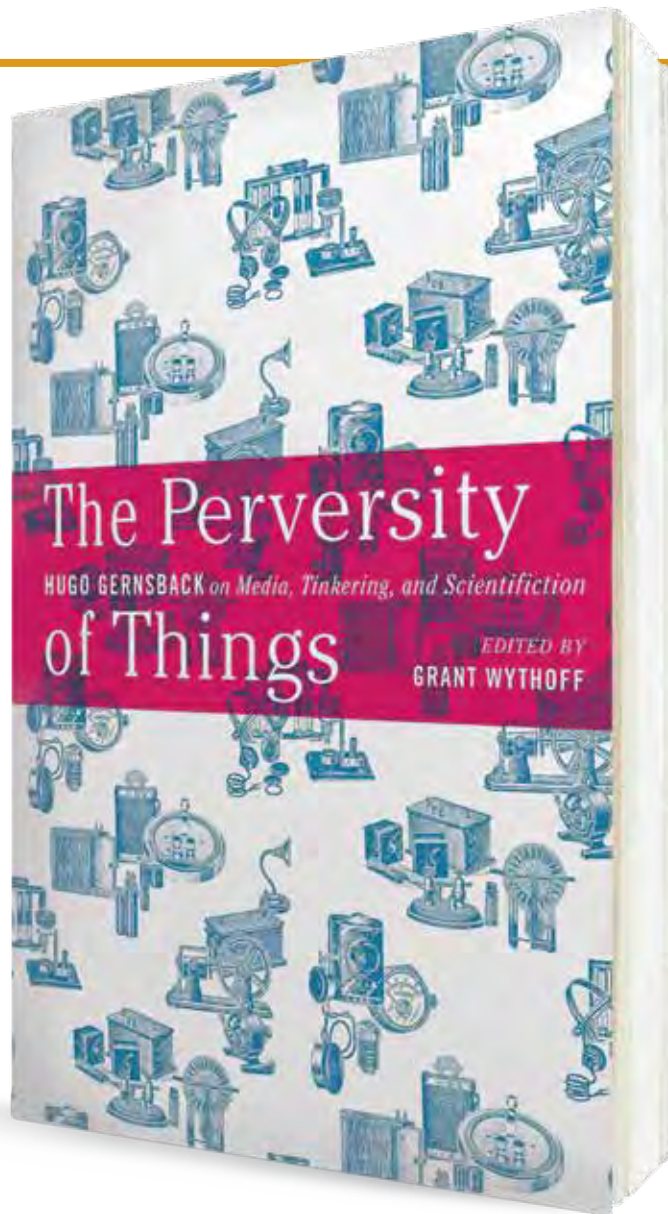
Math isn’t some specific item with only one solution and one way to solve it. Math is problem solving, failure and perseverance. It’s OK to make a mistake. Try again. When students learn this way, they develop reasoning and understanding.

That’s why I can’t wait for my students to experience The Henry Ford’s interactive *Mathematica* exhibition (see Page 48). It’s another opportunity to see math through a different lens.

A place where math is about “doing,” not just “listening.” And besides, it’s always more fun to be an active participant than a passive bystander.

JENNIFER KUHOWSKI

is a math teacher and CyberPatriot coach at Henry Ford Academy in Dearborn. The CyberPatriot program inspires students toward careers in STEM disciplines critical to our nation’s future (uscypatriot.org).



The Perversity of Things: Hugo Gernsback on Media, Tinkering, and Scientifiction

KRISTEN GALLERNEAUX, THE HENRY FORD'S CURATOR OF COMMUNICATIONS AND INFORMATION TECHNOLOGY, REVIEWS EDITOR AND LITERARY SCHOLAR GRANT WYTHOFF'S CAREFUL COMPILATION OF ESSAYS, FICTION AND TEXTS FROM HUGO GERNSBACK, THE INVENTOR AND WRITER KNOWN FOR LAUNCHING SCIENCE FICTION AS A GENRE.

Hugo Gernsback became “the father of science fiction” when he published *Amazing Stories* in 1926 — the first pulp magazine dedicated to the genre. Here, editor Grant Wythoff proves that the pathways to imaginative speculation formed decades earlier in Gernsback’s hobbyist magazines *Modern Electrics*, *The Electrical Experimenter* and *Radio News*.

Essays from 1905–1932 that originally appeared in these publications are thematically arranged into areas such as tinkering, radio, television, sound and fiction. Wythoff’s annotations provide each text with modern context; this book is as useful to media historians as it is to makers.

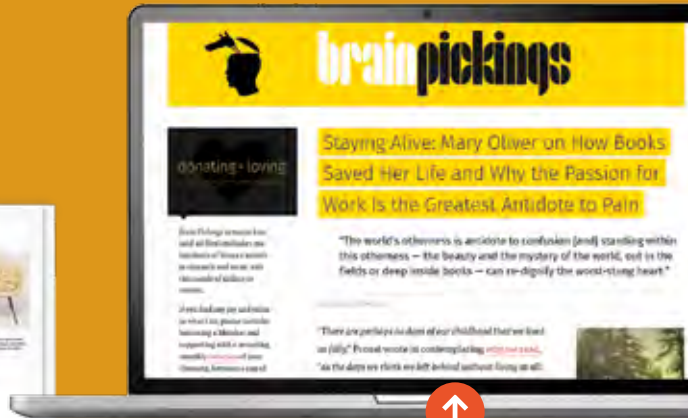
In a 1916 article, Gernsback described “the perversity of things” — the frustrating resistance of inanimate things during an unproductive day at the workbench. But these “misbehaviors” are usually the result of impatience, lack of proper tools or knowledge. Gernsback’s brand of self-empowerment through technology believed in helping people to understand the science and behaviors of their devices and materials.

As Wythoff notes: “Wireless [radio] was magical to Gernsback’s readers not because they didn’t understand how the trick worked but because they did. That elemental, raw materials could produce such effects was absolutely fantastic and provided an endless source of fascination.”

“This book is as useful to media historians as it is to makers.”

— **Kristen Gallerneaux, The Henry Ford’s curator of communications and information technology**

What are we reading + watching?



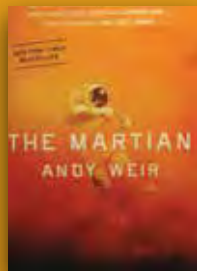
Katherine White
ASSOCIATE CURATOR OF
DIGITAL CONTENT
The Henry Ford

Eameses

by Gloria Koenig

While much has been written about mid-century modern design icons Charles and Ray Eames, Gloria Koenig's text provides a concise, yet still thorough, primer on the lives and work of the famed duo. While the Eameses were often remembered solely for their furniture, the book reminds the reader that Charles and Ray were true creative polymaths — that their work spanned film, industrial design, exhibition design, architecture, photography and more — without delving into a comprehensive review of their lifetime's work.

Plentiful archival documents and photographs make this a quick, informative read while still conveying a sense of the Eameses' penchant for "serious fun."



Jake Hildebrandt
HISTORIC OPERATING
MACHINERY SPECIALIST
The Henry Ford

The Martian

by Andy Weir

This 2011 debut novel from Andy Weir follows a NASA astronaut engineering his own survival while marooned alone on Mars in the near future. It is hard science fiction in its most enjoyable form: a thrilling human adventure based around science and technology straight out of today's textbooks.

Refreshingly, technology is not the villain in *The Martian's* story, and science shares the role of hero with the human spirit.



Charles Sable
CURATOR OF
DECORATIVE ARTS
The Henry Ford

Chihuly Garden Installations

by Dale Chihuly

This lavishly illustrated book documents Dale Chihuly's outdoor installations, from his seminal exhibit at Garfield Park in Chicago through his more recent displays at the Frederik Meijer Gardens & Sculpture Park in Grand Rapids, Michigan.

Chihuly is the superstar of studio glass, and this book documents his most ambitious efforts.

For anyone with an interest in studio glass, it is a must-have.



Lish Dorset
SOCIAL MEDIA
MANAGER
The Henry Ford

brainpickings.org

The right side of my brain drives most of my activity throughout the day, so free-time reading online is usually dedicated to photo-heavy Instagram. Luckily for me, there's Brain Pickings, a site created by Maria Popova showcasing her thoughts on what she thinks you need to know about the world right now. From reviewing Susan Sontag biographies to making sure you know about the African-American mathematicians who powered early space exploration at NASA, Popova's posts keep you informed of the fascinating news you might have missed.

MATH MUSINGS

The Benson Ford Research Center shares its short list of books, films and oral histories for those who wish to further meditate about math and the masterminds behind The Henry Ford's new permanent exhibition, *Mathematica*. For help, write to research.center@thehenryford.org.

BOOKS

An Eames Anthology: Articles, Film Scripts, Interviews, Letters, Notes, Speeches by Charles Eames, Ray Eames and Daniel Ostroff

The World of Charles and Ray Eames by Catherine Ince and Lotte Johnson

Synergetics: Explorations in the Geometry of Thinking by R. Buckminster Fuller and Arthur L. Loeb

Iwoz, Computer Geek to Cult Icon: How I Invented the Personal Computer, Co-Founded Apple, and Had Fun Doing It by Steve Wozniak

EARLY MATH TEXTBOOKS/ READY RECKONERS

The Improved Ready Reckoner, Form and Log Book (1881)

Pocket-size volume containing calculation tables for merchants and farmers.

Marmaduke Multiply (1839)

Multiplication tables in nursery rhyme form with hand-colored illustrations.

A New and Complete System of Arithmetic: Composed for the Use of the Citizens of the United States by Nicolas Pike (1797)

VIDEOS

Powers of Ten: A Film Dealing with the Relative Size of Things in the Universe and the Effect of Adding Another Zero (1989)

Oral History Interview with Steve Wozniak (Collecting Innovation Today Oral History Project, The Henry Ford, 2008)

#AskACurator 2016

There are many events to look forward to at The Henry Ford. One of our curators' annual favorites — #AskACurator Day — takes place on Twitter each September. Read below, and you'll soon see that it's a day full of questions and comments about anything and everything.

— Lish Dorset, social media manager, The Henry Ford

Katherine White, associate curator of digital content, treats The Henry Ford's design followers to a few facts about new exhibition, *Mathematica*, and communicating with Mars.

@TheHenryFord:

A goal of the @EamesOffice was to "bring the most of the best to the greatest number of people for the least." This goal led to their innovative use of plywood in furniture. #AskACurator

@TheHenryFord:

Lesser known than their furniture, the @EamesOffice also created exhibitions, like "Mathematica: A World of Numbers and Beyond" #AskACurator

@TheHenryFord:

The Henry Ford purchased an original "Mathematica" exhibit in Summer 2015. Our conservators have been busy working on it. #AskACurator

@TheHenryFord:

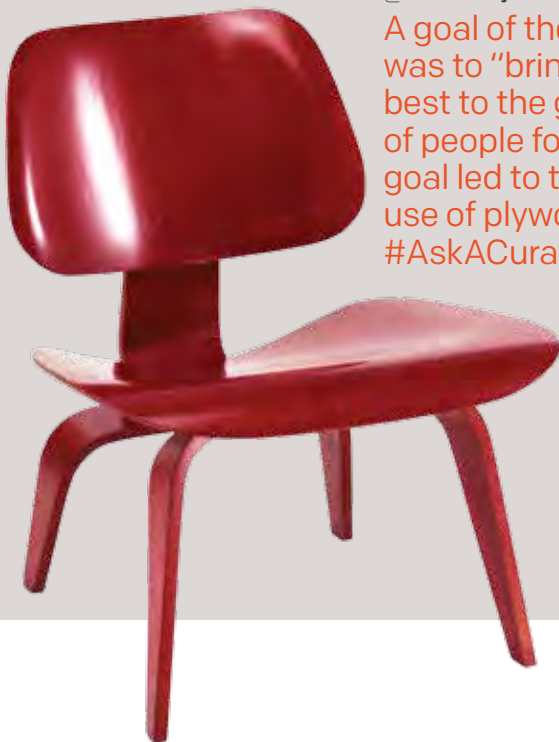
"Mathematica" will open in Fall 2017 as a permanent exhibition on the museum floor.

@SpaceRaiders_KP:

#AskACurator Any curators of extraterrestrial artifacts lingering on Twitter?

@TheHenryFord:

I don't know about extraterrestrial artifacts, but check out our recent blog post about Mars! thehenryford.org/explore/blog/reaching-for-mars



EAMES MOLDED PLYWOOD CHAIR, 1946-1949;
GEOMETRY INFORMATION SIGN FROM *MATHEMATICA*;
RADIO RECEIVER ALL FROM THE HENRY FORD
ARCHIVE OF AMERICAN INNOVATION

ONLINE Join the discussion on Twitter
#AskACurator ►

STAY CONNECTED WITH THE HENRY FORD. ►



visit thehenryford.org



INNOVATION NATION

An Emmy Award-winning TV show that airs Saturday mornings on CBS presents inspiring stories that showcase present-day change makers and the possibilities for future progress. Each episode of *The Henry Ford's Innovation Nation* shares dramatic accounts of the world's greatest inventions — and the perseverance, passion and price required to bring them to life.

Spider Catcher **14**
Ideas in Action **16**

SEASON 3 EPISODE 58

CATCH & RELEASE

A dedicated dad finds a more humane way to rid your residence of arachnids

Whether it's how fast they scurry across your kitchen floor or the element of surprise they inspire when lowering from the ceiling, spiders bring out the beast in many people. A common impulse is to smush first and ask questions later. With his new invention, the Spider Catcher, Tony Allen is one of the few friends a spider has got.

The Ireland-born innovator's initial focus was to help his arachnophobic son conquer his fear of spiders without harming the unwanted houseguest. After years of trying to capture creatures in a jar, Allen's aha moment happened where many great ideas are born — the bathroom. The bristles on his toothbrush

sparked a search for the right fiber that could help him turn fear into fun.

Using his building trades background, Allen fashioned his first prototype using two rubber rings embedded with long, soft bristles that open at the touch of a trigger handle and close around an unsuspecting intruder. He added a 4-foot-long shaft to ensure the captured crawler stays at arm's length, allowing humans the opportunity to release it outside or into a specimen jar from a safe distance.

The Henry Ford Magazine caught up with the inventor and Bugco Web CEO after he appeared on *The Henry Ford's Innovation Nation* to bend his ear about bristles and bugs.

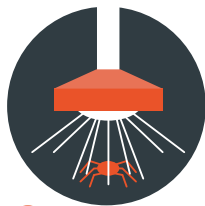
DID YOU KNOW? / Spiders are not insects. Spiders belong to the class Arachnida, while insects belong to the class Insecta.

DID YOU KNOW? / Some silk made by orb weaver spiders rivals the tensile strength of steel.



HOW IT WORKS

Even the most squeamish spider-phobes can surround scary arachnids using this clean, green, catch-and-release spider machine.



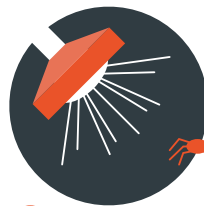
1

Stifle your need to scream. Squeeze the Spider Catcher trigger, then encircle the spider with the bristles. Aim for the center of the bristles.



2

Release the Spider Catcher's trigger to close the bristles around the spider.



3

March confidently to the nearest exit, and squeeze the trigger while holding the bristles close to the ground. Watch caught arachnid run free.



SPIDERS BY GETTY IMAGES/ALASDAIRJAMES; GETTY IMAGES/PHILIPPE INTRALIGI/EYEEM

THF Magazine ▶
Were you a
“buggy” kid?

Allen ▶ When I was a kid, I was interested in watching bugs move around our garden. At wintertime, I would build bug homes from old matchboxes and anything else I could get my hands on. One corner of the garden looked like a mini New York with matchboxes piled high on top of each other. Instead of killing insects, I would catch them and put them in my bug hotel. I never saw the point in killing them.

THF Magazine ▶
What was the
inspiration for your
invention?

Allen ▶ Every night, we would search my son Robert’s room in case there was a spider hiding. If he spotted the smallest spider, I would get a call to his room and have to climb over furniture. And I did not like killing them, so I would chase them with a tumbler. Then I had a lightbulb moment, thinking here is an opportunity to find a solution that will allow me — or even better, Robert — to be able to pick up a spider, hold it gently and place it outside without harm. People invent products to solve a problem, and spiders were my big problem.

THF Magazine ▶
What materials did
you use, and where
did you find them?

Allen ▶ At first, I tried balled up tissue, cotton, wool and bits of foam, and so on. Then one night, I was brushing my teeth, and I said there’s the answer. I set about cutting chunks off every bristle I could find in the house. I tried my wife’s sweeping brush and the yard brush. Every brush in our house was bald for a couple of weeks. I also had the idea of building a circle to try and surround the spider.

THF Magazine ▶
Any other uses for
your invention?

Allen ▶ We’ve just developed a nature-day kit for children. The idea is that they can go out to the garden, or on the beach or near the pool, and collect all kinds of insects. We supply them with a child-size holder, and we give them a study book where they can list the date and the place they caught their bug, and they have to sign for a release date as well. I gave samples to local schools, and the kids had a great time collecting all kinds of insects, studying them and then setting them free during a big release day.

BY THE NUMBERS

11

The width, in inches, of the goliath bird-eater, the largest spider in the world

2

The number of feet a wolf spider can run per second

100

The number of spider species that live in a single home

40,000

The number of known spider species

2,000

The number of insects a spider eats in a year

WATCH See the full episode thehenryford.org/explore/innovation-nation/episodes/spider-catcher ▶

ONLINE In the U.S., the Spider Catcher is now branded and sold as My Critter Catcher. Learn more about Tony Allen’s inspiration and invention mycrittercatcher.com ▶

PHOTO COURTESY OF MY CRITTER CATCHER

IDEAS IN ACTION

A sampling of cool inventions and crazy notions



COURTESY OF KINGII

PROBLEM:

Fido's four-legged gait has failed.

SOLUTION:

Give the wheel a whirl.

GOING A LA CART

When Buddha, Ed and Leslie Grinnell's beloved dog, lost the use of her rear legs in the '80s, the family faced a big dilemma. In their eyes, their pup still had a lot of living to do. So Ed, a mechanical engineer, started pondering four-legged mobility, using a couple of his daughter's red wagon's wheels to design his first custom dog cart. A wheelchair of sorts that let his canine pal tramp around the trees again. Because of Buddha's bum backside, the Grinnells have now put thousands of dogs, cats, rabbits, pigs and even an alpaca on their wonder wheels. Giving creatures living with a disability a leg up on their mobility.

eddieswheels.com

WATCH

thehenryford.org/explore/innovation-nation/episodes/pet-wheelchairs ▶
(Season 3)



COURTESY OF GLOBAL CROP DIVERSITY TRUST

PROBLEM:

Agriculture might not always adapt to the environment.

SOLUTION:

Start safekeeping seeds.

NATIONS ENSURING VEGETATION

In a place where no grains, no gardens and no greenery can grow, an idea to save our seeds has grown to epic proportions. The Svalbard Seed Vault is on an island about 1,300 kilometers from the North Pole. The remoteness, plus the constant negative temps, equate to the perfect spot for preserving the tapestry and genetic history of agriculture as we know it. An icy mountain scooped out and chock-full of 850,000 different seed samples from the world's crop collections. It's the global backup of our agri-system. Biodiversity's ultimate insurance policy.

croptrust.org/what-we-do/svalbard-global-seed-vault

WATCH

thehenryford.org/explore/innovation-nation/episodes/drone-racing ▶
(Season 3)

PROBLEM:

Getting caught in a current can kill.

SOLUTION:

Keep your head above water.

IT'S ALL IN THE WRIST

After Tom Agapiades lost a dear friend to drowning, he decided to do something about it. The Kingii is his call to action. This small inflatable is worn around the wrist, and if swimming gives you a cramp or you're caught in a current, all you've got to do is pull the lever to inflate the flotation. Not a replacement for a life vest, mind you. Instead, an ideal wearable in case of a water emergency.

kingii.com

WATCH

thehenryford.org/explore/innovation-nation/episodes/3d-statuettes ▶
(Season 3)

PROBLEM:

It gets cold out there.

SOLUTION:

Fight the freeze by wearing hair from the prairie.

BUNDLE UP WITH B100

Throughout American history, people have fought many a fight, those nature-made and those brought on by human nature. Conquering the cold has always been a battle hard-won. While many makers are leaning on high-tech materials for their cold-weather gear, United By Blue is harkening back to the heat factor of the bison hide. B100 is its favored filler fiber for its fashions. Made from the hollow hairs of the monstrous mammal. Naturally antimicrobial and heat-regulated.

unitedbyblue.com

WATCH

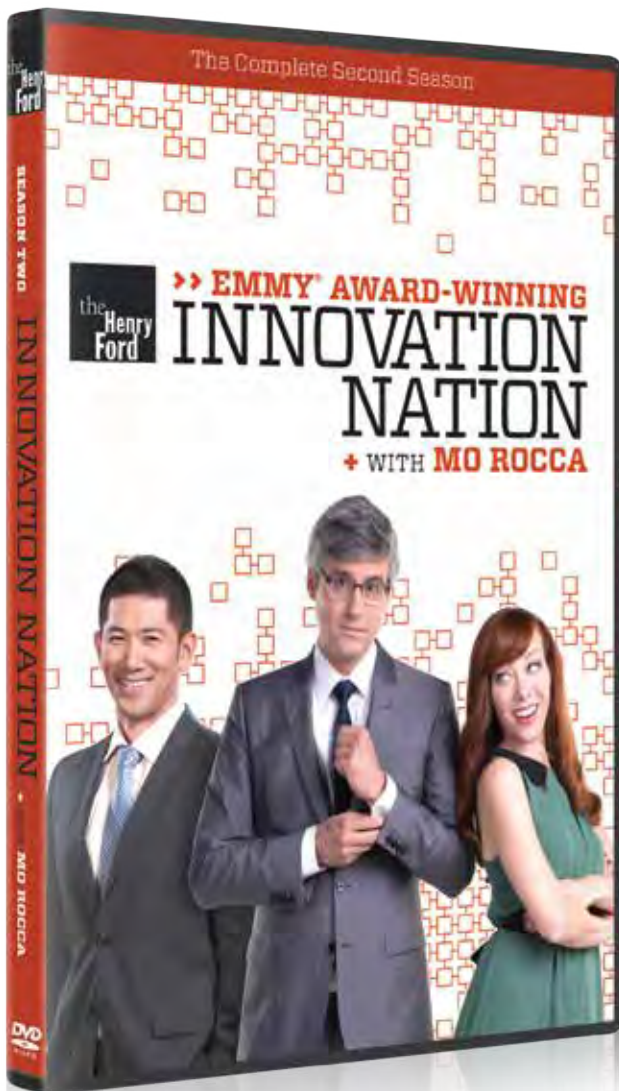
thehenryford.org/explore/innovation-nation/episodes/3d-printed-body-parts ▶
(Season 3)

Learn about these great ideas in action and much more on *The Henry Ford's Innovation Nation* with Mo Rocca on Saturday mornings during CBS Network's block of educational programming called CBS Dream Team...It's Epic. Check your local listings.

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Math Gone Viral

Why numbers, shapes, equations, graphs, probabilities and Pythagorean problems are having a pop culture moment

By Allen Salkin

Additional reporting by Julie Rehmeyer

Illustration by Enisaurus



It

is tempting to credit YouTube for making Vi Hart famous. But that's not the whole story.

The 28-year-old's fast-talking, brightly illustrated, hypnotically compelling videos on odd math topics such as hexaflexagons and why pineapples have swirly skins have attracted millions — I mean, millions — of views and earned her numerous money-making opportunities. And yes, her rise certainly fits a classic internet rags-to-riches arc.

Starting in 2010 when Hart, then a recent graduate of Stony Brook University in New York with a degree in music, was living with her grandmother and her props consisted of a notebook and a pen, her homemade videos began to attract attention. They are gems of video pop art that reveal the secrets of math with a tone that manages to be friendly, approachable and authoritative all at

once. Within a couple of years, she was using flowers, fruits and, in a rant on the physical impossibility of SpongeBob SquarePants' house, a live snail.

Counted among Hart's admirers now are luminaries such as Cindy Lawrence, executive director of the National Museum of Mathematics (MoMath) in Manhattan, who gushed, "I love Vi Hart. She epitomizes the coolness of mathematics."

MATH AS ART

True, before YouTube, there was no ready-made way to reach an audience that might be interested in doodles of "infinity elephants," part of a video in which Hart draws circles inside circles and says in a voice that is both matter-of-fact and youthfully disarming, "This is called an Apollonian gasket." ▶

READ

Goodnight Numbers!, a children's book with a math spin, by Danica McKellar, an actress from *The Wonder Years* ▶

RESEARCH

The Lady Gaga of Math, Cédric Villani ▶

ONLINE

Learn more about mathematician Vi Hart, and scroll the giant list of her posted math-centric videos vihart.com ▶



GETTY IMAGES/BANAR FIL ARDHI/EYEEM

Math in the Mainstream

In the world of entertainment, math has been making quite regular star appearances lately. Consider these more recent mainstream films, stage plays and television shows that all feature elements of mathematics as major or minor parts of their story lines.



- Good Will Hunting*
- Infinity*
- A Beautiful Mind*
- Stand and Deliver*
- Breaking the Code*
- Proof*
- NUMB3RS*
- Moneyball*
- Lost*
- Pi*
- 21*
- Imitation Game*
- Breaking the Code*
- Bletchley Circle*
- Hidden Figures*



THE JOE COOL OF MATH

Vi Hart personifies today's pop mathematician. The star of a series of somewhat wacky yet mind-boggling videos explaining math theories in modern, artful ways, Hart's hipster persona and approach to dissecting a problem make it an easy segue to calling her the Joe Cool of math.

PHOTO BY AYSIA STIEB

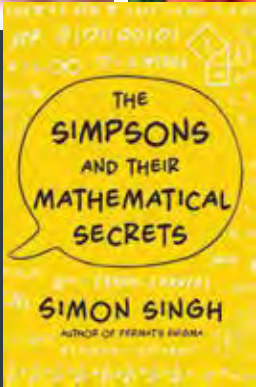


MORE THAN DOODLES AND DIAGRAMS
 Many of recreational mathematician Vi Hart's videos are of her doodling in a notebook about anything and everything "mathy," from binary trees and infinity elephants to origami (as proof of the Pythagorean theorem) and fractal patterns. The idea is to explain math as art. One of Hart's biggest demographics watching her videos — teenage girls.

COURTESY OF YOUTUBE.COM/USER/VIHART

4 Watch the segment Homer³, part of *Treehouse of Horror VI* (1995). Pay attention to the reference to an unsolved problem concerning the relationship between hard problems (NP-type) and easy problems (P-type). One scene in the segment shows the equation $P=N.P$.

5 Take note of the apparently random series of numbers and letters — 46 72 69 6E 6B 20 72 75 6C 65 73 21 — in the Homer³ segment of *Treehouse of Horror VI*. The letters are actually hexadecimal (or base 16) numbers. Together, each pair of hexadecimal digits represents a character in ASCII (American Standard Code for Information Interchange), a protocol for converting letters and punctuation into numbers.



DID YOU KNOW? / *The Simpsons'* executive producer, Al Jean, went to Harvard at age 16 and earned a math degree. Writer David X. Cohen studied physics at Harvard and computer science at the University of California, Berkeley. Writer Jeff Westbrook taught computer science at Yale University before coming to the show.

READ *The Simpsons and Their Mathematical Secrets* by Simon Singh, and then check out his suggested list of math books worth reading simonsingh.net/books/recommended-books/mathematics-books ▶

doodle that I'd been thinking about," she said. "Instead of making a blog post, I thought it would lend itself to video. It was surprisingly successful. I realized that there was a hunger for that, beyond that small community."

But how deep is the hunger? For generations, math was considered boring and even somewhat un-American because of its emphasis on rote answering of questions with precise answers, what you might call its lack of freedom, said Dave Anderegg, author of *Nerds: How Dorks, Dweebs, Techie and Trekkies Can Save America*.

"Adults in America teach that precision is painful and hard, and it's not free," he said during a phone interview from his home in western Massachusetts. "Math is precision."

In some European countries where students are required to learn advanced math, precision is considered beautiful. In those cultures, "adults do not believe they are torturing children to do math," Anderegg said.

The idea that some people are just good at math and others aren't has been disproven by the research of Stanford professor Carol Dweck. She has proven math is not like a talent. Math is like a muscle. If you use it, you get better at it.

And yet this evidence, along with the promised earning power of students educated in math and science, has not yet been enough to change the widely held idea that these are pursuits only for "nerds." Children in upper-middle-class schools proudly proclaiming themselves nerds is not enough, Anderegg argues.

"Among working-class people, the negative nerd/geek stereotypes still hold sway," he said. "They believe that math and science make you unsexy."

BUILDING A BRIDGE

Can the ascendance of Hart and her cohort really change all this? She hopes so.

"YouTube makes a big difference in being able to show people's honest love of math, the life and thought process of an individual who loves math," she said. "And people respond to that."

Her proud dad, whose website MakingMathVisible.com shows classroom teachers how to build "beautiful mathematical objects" their students can ponder, hopes so, too. Precision is OK by him. "Mathematics is the celebration of rationality, of logic, pattern and structure," he said. "It's a way of thinking that helps you understand the reason behind something instead of making vacuous claims."

A more modest success on the front lines of building a bridge between pop culture and math is Elana Reiser, a math teacher at St. Joseph's College on Long Island, New York. She digs up old episodes of television shows that have math moments and shows them to students as part of a lesson plan.

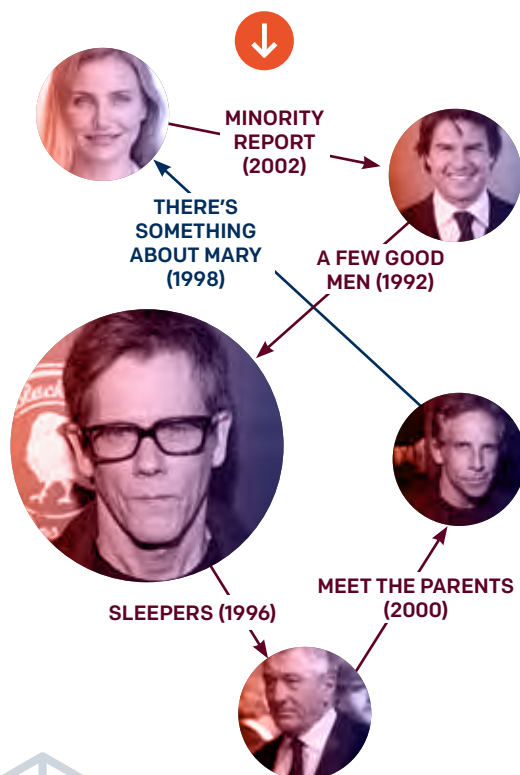
In an episode of *The Office*, for instance, a character who plays a manager is told to kneel as part of a job promotion ceremony in which he is, comedically, hired as an assistant to himself. He is then told that as a manager he "kneels to no one." "It's an example of a logic riddle," Reiser said. "Should he kneel or should he not?"

Her method with movie clips is working. And she is now sharing her proof of concept through her book *Teaching Mathematics Using Popular Culture: Strategies for Common Core Instruction from Film and Television*, in the hopes of helping thousands of other teachers add a little extra pop to their math lessons. •

SIX DEGREES OF SEPARATION KEVIN BACON

Kevin Bacon. You've probably heard of him. He's an actor. The guy who danced his way to fame in the film *Footloose* (1984). The bumbling dad-to-be in *She's Having a Baby*. The opposing counsel in the armed forces drama *A Few Good Men*. He's also the guy at the center of the game called Six Degrees of Kevin Bacon. It's a piggyback on the theory of six degrees of separation, first proposed by Hungarian writer Frigyes Karinthy in 1929 in a short story called *Chains*.

Karinthy's theory is that anyone on the planet can be connected to any other person on the planet through a chain of acquaintances that has no more than five intermediaries. The game, of course, rests on the assumption that anyone involved in the Hollywood film industry can be linked through their film roles to Bacon within six steps or fewer. The game of finding the shortest path between actors and Bacon is a traditional graph problem: that of finding a path between two vertices.



READ *Mathematics in Popular Culture: Essays on Appearances in Film, Fiction, Games, Television and Other Media* edited by Jessica K. Sklar and Elizabeth S. Sklar, with foreword by Keith Devlin ▶

RESEARCH Oulipo, a French method of combining math and poetry ▶

ONLINE Check out Matt Lane's musings on math in pop culture mathgoespop.com ▶

CAMERON DIAZ BY GETTY IMAGES/JB LACROIX; KEVIN BACON BY GETTY IMAGES/ROB KIM/STRINGER; ROBERT DE NIRO BY GETTY IMAGES/TRISTAN FEWINGS/STRINGER; BEN STILLER BY GETTY IMAGES/BRUCE GLIKAS; TOM CRUISE BY GETTY IMAGES/SAMIR HUSSEIN



MO' MATH, PLEASE

There really is such a place as a National Museum of Mathematics (MoMath). It opened in Manhattan on the north side of Herald Square on 12-12-2012. Since then, there have been more than 560,000 visitors. One of the most popular exhibits allows visitors to ride bicycles with square wooden tires (at right). It works because the bikes are on a course with rounded depressions spaced at the length of each side of the square tires. Riding the bikes is fairly smooth because the edges of the tires sink into the depressions and keep on “rolling.”

At another exhibit, Hank Guss, an interpreter at MoMath, helps explain how you can ride a plexiglass boat over a sea of roly Reuleaux triangles (above). Guss' passion is generative art, a field he said he was drawn to as a math and computer science major at Oberlin College. One of his recent art pieces is a computer program he wrote to take a colored polygon and split it into two arbitrarily sided polygons, which then take a slight modification of the original color. His computer program repeats this action on the new polygons until a kind of visual splatter of colors fills a screen. The artwork is both the computer program he created and the always unique and colorful results.

Downstairs at the museum, Guss explains a room-sized maze puzzle projected onto the floor for visitors to navigate by walking. It's designed to demonstrate problem solving. If you test every branch in a certain direction off the main path and all of those branches lead to dead ends, you can then eliminate that entire set of pathways, check it off and move forward to test another branch as a possible exit.

This explanation will quickly shoot you back to sophomore geometry when you were taught proofs. Step into the maze, however, and follow a path until you bump into a light wall, and you'll quickly get a sense for the fun you can find in problem solving.

One of the museum's most successful events is a giant group demonstration that the nearby Flatiron Building is actually a right triangle — which means that one edge is a 90-degree angle (at bottom). If you stand at the famous front edge of the building and look at it, it seems like an isosceles, not a right angle. But, using families, tourists and curious onlookers, each holding a glow stick as a measuring device, the museum staff demonstrates that when it comes to the Flatiron Building, $a^2 + b^2 = c^2$. “Once we proved it,” said MoMath executive director and CEO Cindy Lawrence of their 2013 discovery, “thousands of people were standing around the Flatiron Building yelling, ‘Proof! Proof! Proof!’”

— Allen Salkin



PHOTOS COURTESY OF THE NATIONAL MUSEUM OF MATHEMATICS

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A membership at The Henry Ford comes with outstanding benefits like unlimited admission to Henry Ford Museum of American Innovation, Greenfield Village and our Giant Screen Experience, plus free parking, food and retail discounts. However, the greatest perk of becoming a member might be your ability to help the next generation of innovators find their path. To help support our mission to provide a uniquely inspiring experience for the makers of the future, join a community centered on progress. Renew your membership or join today.



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FROM LEFT: GWEN PHILLIPS; EMILY LITYNSKI/EMILY MARCHETTI PHOTOGRAPHY; MARY MARSHALL



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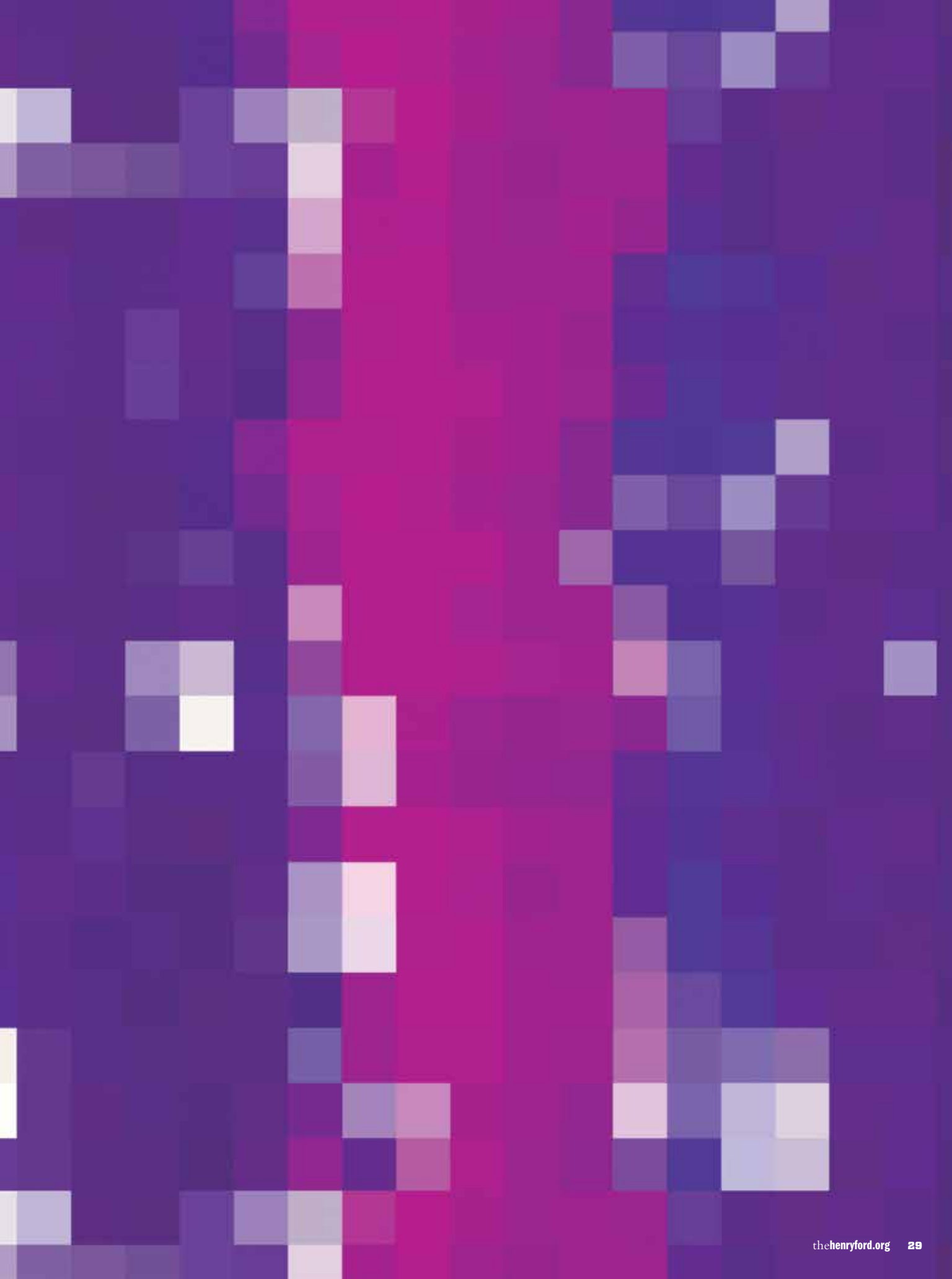
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“But to do for the world more than the world does for you-that is Success.” - Henry Ford

MATH, MUSIC+ *The Matrix*

LIVE CODERS ARE
IN TUNE WITH THE
MATHEMATICAL
MAKEUP OF SONG

By Sarah Jones



Y

ou're in a nightclub. The cavernous space is packed with bodies moving in time to the pulsing, morphing rhythms of electronic music. On a small stage, a shadowy figure hunches over a laptop, typing furiously. Projected computer code scrolls down a wall, *The Matrix*-style, a digital flurry of numbers, words and brackets as synth sounds build and music loops modulate.

This scene could almost be a slick DJ club set, but there are no knobs, decks or instruments in sight. Yet the code is real, and it's all live.

This is the world of live-coding music, an art form in which performers create music by programming computers on the fly, in front of an audience, writing and revising instructions that trigger and manipulate sounds, rhythms and effects in real time.

THE MATH OF MUSIC

When it comes to expressing musical ideas, computer programming might seem an unlikely outlet. But computer science is grounded in math, and music, with all of its messy, imprecise human expression, is largely built on mathematical relationships — harmonic structure, rhythmic patterns, and at its most fundamental, the unique combinations of sine waves that make up the sounds all around you, from birdsong to the roar of a jet engine.

We've been exploring parallels between music and math since the days of Pythagoras. Today, musicians and composers are able to use computers as tools to interpret and express these values and relationships.

"It's clearer through coding that music can be expressed as essentially patterns of numbers that are processed and transformed in various ways — and that we can add expressivity by changing the sounds we are using and shaping the structure of our sounds," said Shelly Knotts, a composer, experimental artist and live coder in the United Kingdom.

As a live coder learns to anticipate these mathematical relationships, his or her ears learn to "hear" the relationships, much like in traditional music theory training. Live coders often write code that they can hear in their heads — which, at a fundamental level, relates to Beethoven's ability to continue composing even after he had completely lost his hearing. ▶

SYNTH, SOFTWARE & SCHOOLING

Live coder Sam Aaron performs at Moogfest 2016 using Sonic Pi, a software program he created to help teach people how to manipulate sound. Aaron is of the mindset that music wraps "math concepts and computer science concepts into something that has direct meaning to kids."

DID YOU KNOW? /
Moogfest — an annual, multiday music, art and technology festival — will take place May 18-21, 2017, in Durham, North Carolina.





PHOTO BY IAN CLONTZ

BREAKING DOWN BARRIERS

Live-coding languages and styles vary. Most performers create music entirely on the fly, constructing ideas from scratch; a few mix in precoded elements, DJ-style. But they all embrace the movement's overarching philosophy that live coding should be inclusive and accessible to everyone.

For most live coders, exposing their code is part of the performance and serves to demystify their process, forging a connection with the artist through his or her "instrument," explained Sam Aaron, a British researcher, software architect, educator and live coder. "Why is it important for a guitarist to let you see his or her guitar? People have all held guitars; most of us are not very good at it, so when you see someone who's good at it, you can appreciate the virtuosity."

There's no denying that projecting computer code adds a compelling visual element to a performance, but if you're not paying attention to the language itself, you're missing the point. "It's like saying Jimi Hendrix made amazing music, but he had a fabulous wooden necklace," added Aaron.

Live coding challenges preconceived ideas about the programmer's experience by bringing a traditionally solitary process into a participatory realm. "It's like writing, really; you don't generally write in a social way," said British musician and researcher Alex McLean, member of the live-coding band Slub and cofounder of TOPLAP, an organization formed in 2004 to bring live-coding communities together. "I think live coding is not necessarily showing programmers as something different, but rather a different way of interacting with the computer; it's very different, working alone on a piece of text and having people in front of you, listening intently," added McLean, who is also credited with co-inventing the algorave, a rave-like club event based around live coding.

Since its inception about 15 years ago, live-coding culture has been rooted largely in Europe and the U.K., but the movement is slowly building international interest through festivals and other live events, long-distance collaborations over video and social media, and creative partnerships with more mainstream artists. But the most powerful force for longevity is education, and right now, it's Aaron holding the key. ▶

IN LIVING CODE

For most live coders, including Shelly Knotts (left) and Alex McLean, exposing their code is an important element of their performances.



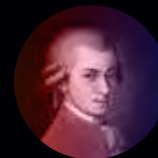
MUSIC MADE IN THE MOMENT

Live coder and visual artist Dan Hett (below) performs a recent algorave session at the Blue Dot Festival in northwest England (at right). Hett is a prominent member of the algorave movement, an ongoing series of electronica events where all music and visuals are created entirely with live code, which is shared with the audience as part of the experience.





PHOTO COURTESY OF ALEX MCLEAN



THE MOZART EFFECT

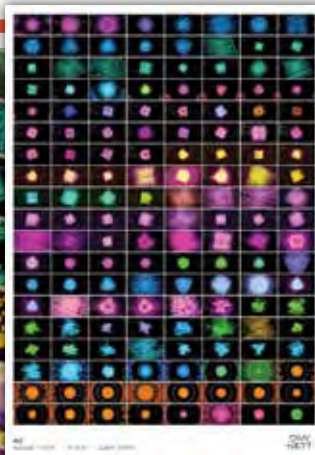
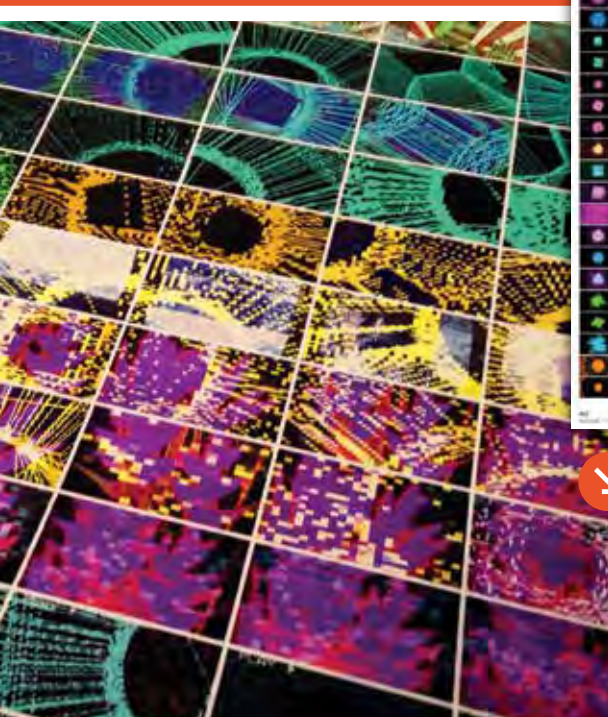
CAN LISTENING TO MUSIC MAKE YOU SMARTER?

Given the parallels between music and math, it's a natural progression to explore the relationship between musical exposure, experience and ability, and enhanced cognitive abilities. And while some research suggests a connection, studies don't take enough variables into consideration, explained Dr. Robert Slevc, assistant professor in the Department of Psychology and the Program in Neuroscience and Cognitive Science and director of the Language and Music Cognition Lab at the University of Maryland.

"For example, imagine I find some relationship between children's musical and mathematical abilities — say, that the more musical kids learn algebra faster than the less musical kids. That might result from some shared processes underlying both music and math," he explained. "But it might actually reflect some third factor — for example, perhaps the kids who are smarter overall do better at both music and math. Or the more motivated kids pay more attention in music and in math class, so end up being better at both."

For this reason, said Slevc, the Mozart effect — the idea that listening to Mozart makes people better at cognitive tasks — has been largely debunked in the science community. "Specifically, there's good reason to think that listening to Mozart does make people do better at some kinds of cognitive tasks, but it doesn't seem to be because Mozart makes you smart.

"Instead, listening to Mozart makes people a bit more calm and happy, and calm and happy people tend to do better at a bunch of different things," he added. "It's a bit like why you might listen to music when you exercise: Music can have pretty strong effects on mood, emotion and motivation, which might then lead you to have a better run. But it'd be misleading to say that there's a, say, Daft Punk effect where listening to Daft Punk makes you faster."



DID YOU KNOW? / During live improvised performances, particularly algoraves, live coder Dan Hett captures a stream of his performance footage as image sequences. He then takes this visual data set and creates a series of print responses to it — each print representing precisely five minutes of a live improvised performance that's unique. "Once a set has finished, the code no longer exists," he said. "I wanted to really try and capture that in some way."

PHOTOS BY DAN HETT

```
    p = play  
    slide: 4, cutoff  
    rrand(0, 0.2), p  
    rrand(4, 8)  
    control  
    rrand(80, 120),  
    end
```

note = chord([:b1,
choose, :minor).c

start_note, rel
: 30, cutoff_sli
pan: rrand(-1, 0)



“May not music be described as the mathematics of the sense, mathematics as music of the reason? The musician feels mathematics, the mathematician thinks music: music the dream, mathematics the working life.”

— mathematician James Joseph Sylvester, 1864

CRACKING THE CODE

"I want to make sure the leap from code to music is as small as possible and as clear and simple to as many people as possible," said Aaron, a passionate advocate for unearthing the creative potential of programming languages. He spends his days as a researcher at the University of Cambridge in England and his nights performing live coding.

In 2012, Aaron created Sonic Pi, a simple yet powerful open-source programming environment designed to enable users at any level to learn programming by creating music and vice versa. Sonic Pi is used all over the world; it runs on any computer platform including Raspberry Pi, the \$40 credit card-sized computer designed for DIY projects and for promoting computer science in schools and developing countries.

"Music really helps by wrapping the math concepts and computer science concepts into something that has direct meaning to kids, which is making

music," Aaron said. "And making the kind of music, hopefully, that they listen to on the radio or stream."

The case for building these new learning paths to computer science is strong. Understanding basic programming improves logical thinking and provides a fundamental understanding of technology we use every day.

"Teaching people what coding is — how precise a language has to be for a computer to understand it — gives people an appreciation of an execution of semantics in a program, affordances of a system, interaction with a system," said Aaron. "People are telling kids to learn how to program because they can become professional programmers. It's like saying we should all do sports in school so we can become professional athletes. You don't teach math because you're training the future mathematicians. There's a level of math that's useful to all of our lives." •

WATCH Sam Aaron live code a DJ set with Sonic Pi youtube.com/watch?v=KJPdbp1An2s ▶

ONLINE Overtone is an open-source audio environment designed to explore new musical ideas, from synthesis and sampling to instrument building, live-coding and collaborative jamming overtone.github.io ▶

RESEARCH Smule, a mobile app developer, specializes in developing social music-making applications smule.com ▶

READ Curator Kristen Gallerneaux's blog post about her experience at Moogfest 2016 thehenryford.org/explore/blog/tag/moog ▶



PHOTO BY IAN CLONTZ

DID YOU KNOW? / The Stanford Laptop Orchestra is a unique computer-mediated ensemble of 20 laptops, human performers, controllers and custom multichannel speakers performing boundary-free music together.

DID YOU KNOW? / The International Conference on New Interfaces for Musical Expression gathers researchers and musicians from all over the world to share their knowledge and late-breaking work on new musical interface design.

◀ Sam Aaron is looking to educate the masses about programming by creating music and vice versa.

SAVE THE DATE

Kimberly Bryant of Black Girls CODE will be in Henry Ford Museum of American Innovation on March 18. Bryant founded Black Girls CODE to introduce girls of color to programming and encourage them to become the next generation of coders. For event details, visit thehenryford.org/innovatorspeaker



WIKIMEDIA CREATIVE COMMONS/
EVAN-AMOS

LIVE-CODING TOOLS

If mixing math, music and computer programming is your personal thing, or you're an educator, parent or mentor looking for ways to leverage music to make math more digestible for young minds, there are a number of free educational resources that can help.

PICADEMY: Offers a range of free Raspberry Pi teacher-training tools from the Raspberry Pi Foundation, from two-hour classes to a two-day course. raspberrypi.org/picademy

TOPLAP: The official community organization for the live-coding movement, TOPLAP hosts videos, blogs, event listings, software links, discussion forums and other resources for live coders and fans. toplap.org

SCRATCHJR: A free app for iPads and Android tablets that lets young children (ages 5-7) program their own games. A Spanish version is available. scratchjr.org

LIVECODING.TV: Broadcasts live and archived screen-share streams in focus areas ranging from music to video games to website design, searchable by programming language and ability level. liveedu.tv

THE SONIC PI LIVE & CODING PROJECT: Are you an educator? This research and development project offers a free toolkit that includes software, lesson plans and a collection of inspirational works. sonic-pi.net sonicpiliveandcoding.com

The Raspberry Pi (top) is a credit card-sized computer designed for simple DIY school projects that promote computer science and programming. Students at the Sonic Pi: Live & Coding Summer School (above right) explore their potential and the potential of the Sonic Pi software. ▲



PHOTO BY CLARE HAIGH



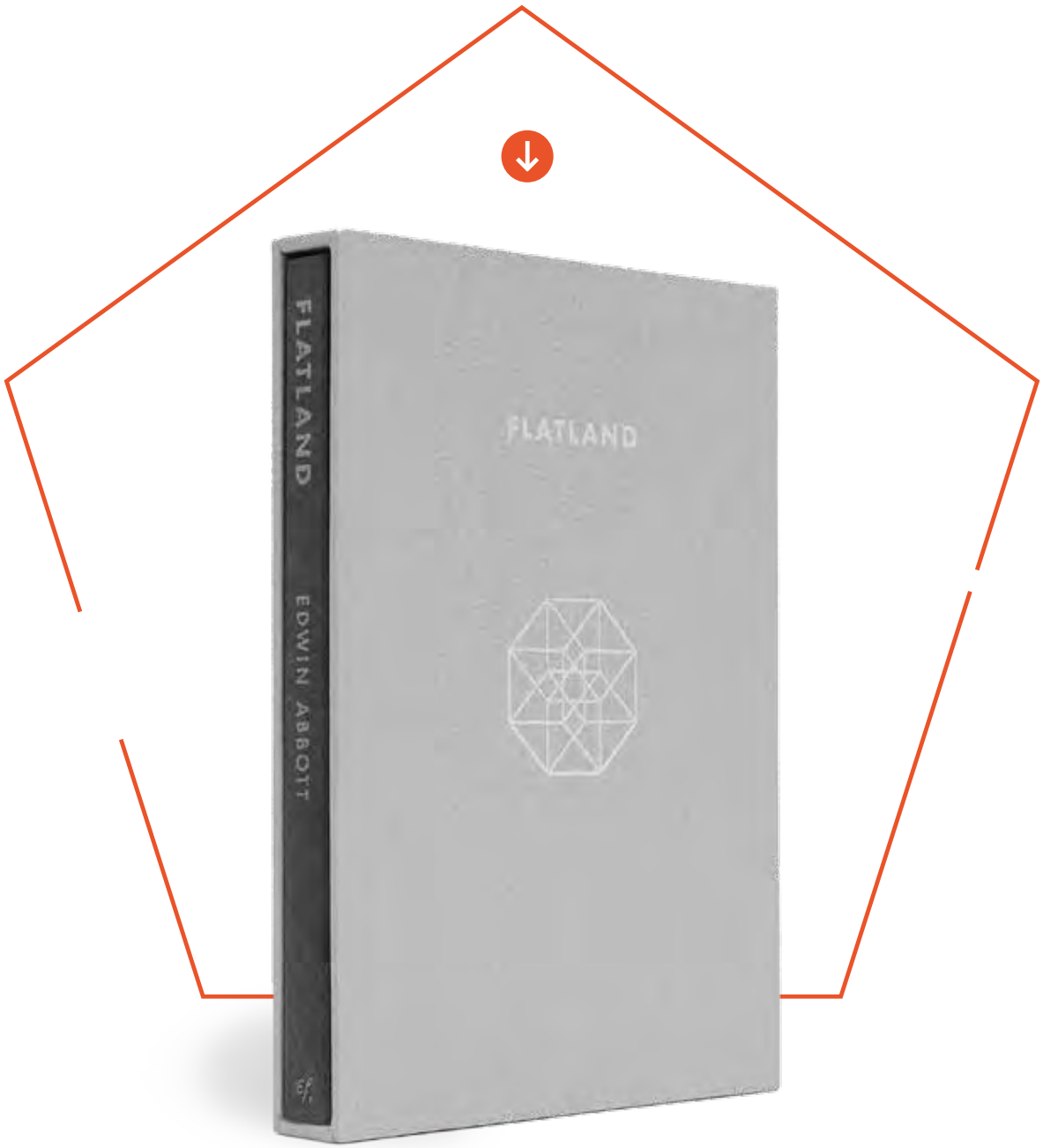
MATH

BOOK

REIMAGINED

Iconic text loved by mathematicians for more than a century gets a designer reboot

By Jason Kehe
All *Flatland* book and related images by James Han



W

hen Chris Lauritzen quit his job at YouTube in October 2014 to start a book design and publishing studio called Epilogue, he expected to have a working version of his first title — a reissue of Edwin A. Abbott's cult classic *Flatland* — ready by the holidays. So much for expectations: The launch party was held in April 2016.

Not that Lauritzen was slacking off in the intervening year and a half. Independently publishing a print book these days, especially one conceived as a beautiful art object, takes a serious, long-term commitment. Lauritzen didn't just have to design *Flatland* — to conceptualize it, typeset it, illustrate it and prototype it. He also had to crowdfund it and then look all over the country (plus Canada) for those few remaining specialty shops that would suit his various printing, binding and shipping needs. All of which raises the obvious question: Why? Who would want a meticulously crafted print edition of a 130-year-old public-domain text in 2016? Especially when print is, if not dead, then certainly struggling?

Lauritzen's answer is to question the question: He believes it's a glorious, singular time for the print medium.

SMALL BOOK, BIG IMPACT

At one time, everything was printed on paper: ads, fliers, brochures, pamphlets, notes. Or, as Lauritzen characterizes that stuff: "Junk. Ephemeral noise." But over the years, much of that material has gone digital, clearing the printed world of clutter.

"By choosing to do something in print, you're saying this thing is worth a damn," Lauritzen said. "Print is starting to become its own quality filter."

A NEW DIMENSION

Epilogue's *Flatland* includes a 50-page visual appendix that offers readers new diagrams and illustrations that help further explain the rules and concepts brought to life by author Edwin A. Abbott.

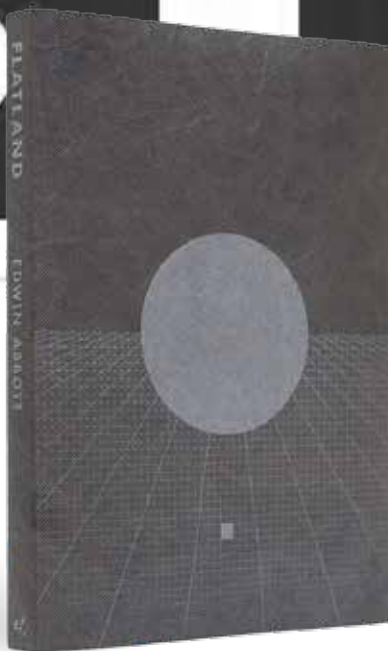
Lauritzen knew he wanted to apply that filter to something in the public domain, a vast collection of works that anyone can use, print and distribute without permission. But he wasn't aware of *Flatland* until a friend suggested he check it out.

Written in 1884 by the English scholar Edwin A. Abbott, *Flatland* is a small book about a big subject: multiple dimensions (see sidebar, Page 43). The narrator, a square named (fittingly) A. Square, lives on a flat 2-D plane, but he's forced to consider what the 3-D world of Spaceland might look like when a sphere from there pays him a visit.

Ian Stewart, an emeritus professor of mathematics at the University of Warwick in England who published an annotated version of *Flatland* in 2002, considers Abbott's book one of the earliest works of popular science. "There's really nothing else like it," Stewart said. "It was completely original and unusual."

The book wasn't just about having fun in multiple dimensions, though. Abbott used geometry to challenge Victorian norms about the role of women in society — math as a tool for social progress. Some didn't get it; many did. The first edition sold out quickly, and it has been in print ever since, a favorite among a wide range of readers who wonder about their place in the world. ▶

WATCH The making of Epilogue's *Flatland*
creativeapplications.net/news/ep1-flatland-by-epilogue ▶



ONLINE

See the Copybook of Mary S. Lewis, "Her Book," 1800, in The Henry Ford's Digital Collections for arithmetic rules and examples of a student practicing numeration (place value), addition, subtraction, multiplication, division and conversions more than 200 years ago [thehenryford.org/artifact/377379](https://www.thehenryford.org/artifact/377379) ▶



FROM THE HENRY FORD ARCHIVE OF AMERICAN INNOVATION

DID YOU KNOW? / Edwin A. Abbott was a theologian and schoolmaster, not a mathematician. *Flatland*, his only math-centered published work, was one of more than 45 books he authored during his 50-year writing career.

DID YOU KNOW? / *Flatland* predates, by many years, Albert Einstein's four-dimensional world of relativity.

Lauritzen was an immediate convert — it was exactly what he was looking for. Given its largely two-dimensional setting, he felt it would play nicely with his skill set as a graphic designer. But more than that, *Flatland* had a following, not huge but passionate, that was rather unhappy with the editions of the book currently available.

NOT JUST FOR SHOW

Because works in the public domain can be accessed for free, there's not much financial incentive for a publisher to put out nice editions. *Flatland* is no exception. It exists in a variety of terrible formats, from websites and PDFs to cheesy print runs that feel more like pamphlets than books. "It's really unsatisfying," Lauritzen said.

So, when he launched a Kickstarter in April 2015, that was his selling point: the chance for a beloved classic to get the makeover it deserved. The goal was \$24,000; he raised well over three times that (\$81,777, to be exact).

Then the real challenge — making the book — began. Even though Lauritzen intended the reissue to be something of a collector's item, he didn't want a finished product that was destined for a coffee table, untouched and unread.

"It shouldn't be a fetishized object," he said. "The sooner you throw it on the ground, the better."

To that end, he chose to make it softcover, with thick paper and

extra-wide margins for writing in. The floating spine means you can bend the pages back as much as you want and the binding won't crack. Lauritzen also appended a visual guide, full of exquisite black-and-white illustrations that illuminate various concepts in the text. He's now working on a supplementary online library of shapes — "an education/art experience for students of geometry," he said. Finally, to add heft, he designed an elegant gray slipcase, stamped with a silver tesseract.

This wasn't a solo production, of course. At last year's launch party, held in a small shop in San Francisco, Lauritzen thanked all of the people who helped him along the way — friends, family, the workers in Vancouver and Phoenix and Oakland who printed and bound and shipped the books. Of the 2,000 copies Lauritzen printed, roughly half were sent to Kickstarter backers, and the remainder are now available for \$65 each, a price Lauritzen hopes will decrease in subsequent print runs.

You can tell Lauritzen is proud of the result. He flips through it lovingly — though he's not afraid to bend a corner or mark up a page. The whole point is to get people to read it.

"Time was spent writing this thing, time was spent designing this thing, time was spent producing it, time was spent getting it into your hands," he said. "That's contagious. That's something you can sense. It gives you permission to take time with it, to sit down and really delve in." •

WATCH

Tom Banchoff, research mathematician and scholar, share his thoughts on *Flatland* author Edwin A. Abbott and the fourth dimension [youtube.com/watch?v=1hP9tbhIJrg](https://www.youtube.com/watch?v=1hP9tbhIJrg) ▶

ONLINE

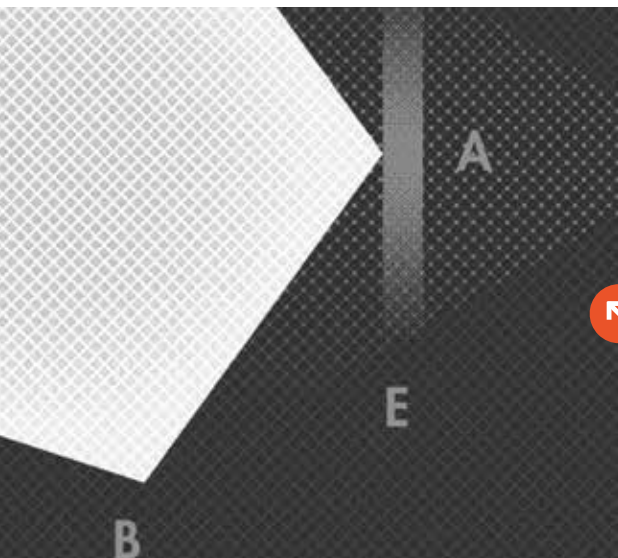
See the *IBM World of Numbers* book from 1958 in The Henry Ford's Digital Collections [thehenryford.org/collections-and-research/digital-collections/artifact/406994](https://www.thehenryford.org/collections-and-research/digital-collections/artifact/406994) ▶

WATCH

Flatland, The Movie, an animated film starring Martin Sheen, Kristen Bell and Michael York flatlandthemovie.com ▶

ONLINE

Find out more about Epilogue, the design and publishing studio that recently reprinted *Flatland* epilogue.press ▶



DID YOU KNOW? / Each illustration of Epilogue's *Flatland* is carefully designed using a layered grid system based on the 13-pt. baseline used to typeset the book.



DID YOU KNOW? / Publisher Chris Lauritzen is now looking to create an open-source digital library of shapes and dimensions. When finished, the free library will allow users to browse and interact with geometric shapes. libraryofshapes.com ▶

In a two-dimensional world where everyone is a flat geometric shape, how would you distinguish men from women or one shape from another shape?



Flatland Works Your Brain

WHY THE HENRY FORD'S DIGITAL COLLECTIONS & CONTENT MANAGER SUGGESTS YOU READ THIS SCI-FI, MATH-CENTRIC BOOK

A Victorian novel about mathematics involving the adventures of a geometric shape in various dimensional worlds? It might not sound like a winner, but there's a reason *Flatland* by Edwin A. Abbott remains in print more than 130 years after its first publication in 1884.

The subject matter — how life might work in one-dimensional (Lineland), two-dimensional (Flatland) and three-dimensional (Spaceland) worlds — is complex, and reading *Flatland* will work your brain. But the author is also a good explainer, and the concepts are clear.

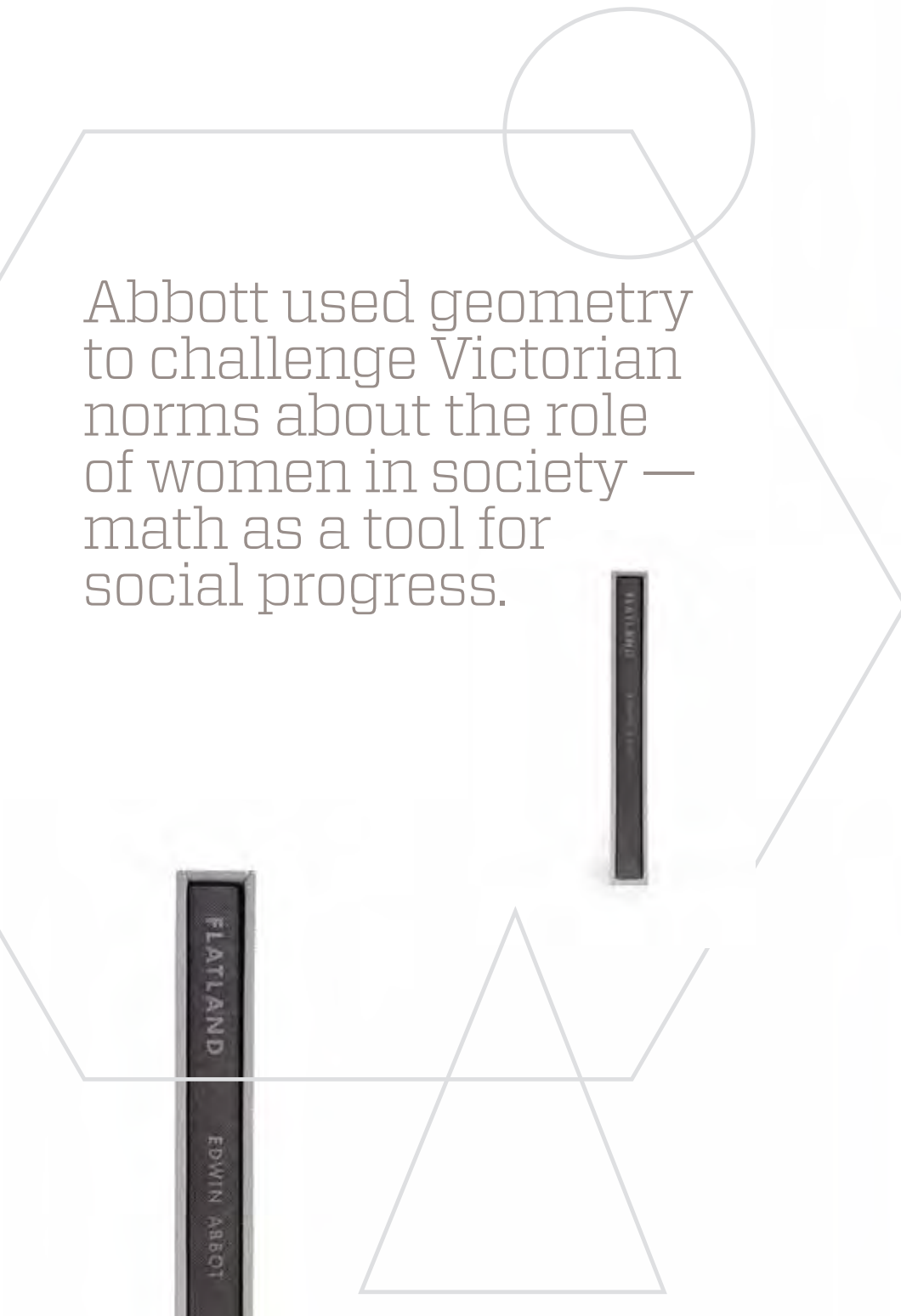
In a surprisingly disarming way, many intriguing questions are raised: In a two-dimensional world where everyone is a flat geometric shape, how would you distinguish men from women or one shape from another shape? How would houses be arranged? How would a denizen of Spaceland explain the third dimension to someone from Flatland, or someone from Lineland explain two dimensions to a resident of Lineland?

In addition to mind-bending mathematical and philosophical questions, *Flatland* also raises questions around ideas of gender and class. Both are key themes of the novel, and both are represented from a Victorian perspective, with women ranking somewhere between second-class citizens and completely insignificant, and class being the defining characteristic in *Flatland's* society. However, Abbott takes both of these concepts to ridiculous satirical extremes in *Flatland*, resulting in a presentation that may take modern readers by surprise.

If you are interested in issues of gender and class, have always wanted to understand math better, or just enjoy a good philosophical mind-bender, *Flatland* is the book that satisfies.

— Ellice Engdahl, Digital Collections & Content Manager, The Henry Ford

READ Other books inspired by *Flatland*, including *Sphereland: A Fantasy About Curved Spaces* and *An Expanding Universe* by Dionys Burger and *The Dot and the Line: A Romance in Lower Mathematics* by Norton Juster ►



Abbott used geometry to challenge Victorian norms about the role of women in society — math as a tool for social progress.

EDWIN ABBOT

FLATLAND

EDWIN ABBOT

FLATLAND

EDWIN ABBOT

RESEARCH

Turkish photographer Aydin Büyüktas, who has created a series of mind-boggling images inspired by *Flatland*, using a combination of 3-D modeling and photography aydinbuyuktas.com ▶

READ

The Colossal Book of Mathematics by Martin Gardner ▶



What Inspired Edwin A. Abbott to Write *Flatland*?

Flatland's fans include many mathematicians, who find the story especially engaging because of its underlying dimensional analogy. When Edwin A. Abbott wrote about the trials and tribulations of a two-dimensional creature attempting to understand the third dimension, his real message was to three-dimensional Victorians trying to understand the fourth dimension. That topic was in vogue because of a heady mix of science, spiritualism and theology. Abbott added social commentary, especially on the class system and the low status of women.

He was born in London in 1838. His middle name, also Abbott, reflects his father's marriage to a cousin. It might just explain the pseudonym he chose for *Flatland's* author: A. Square. In mathematics, a^2 is a squared. Abbott's life revolved around the City of London School, where he was a pupil from 1850, becoming an unusually youthful headmaster in 1865. He took a keen interest in Shakespeare, writing several books about his plays, and also wrote extensively on theology.

Flatland was totally different. Precisely what led Abbott to write it is not known, because most of his papers were lost. But it surely must have involved Charles Howard Hinton, a talented mathematician and a flamboyant rogue. Hinton had a passion for the mathematical logic of George Boole and, later, for Boole's daughter Mary, whom he married. He was fascinated by the fourth dimension, writing somewhat mystical pamphlets about its relation to science, ghosts and the afterlife.

In the 1880s, Abbott was heavily involved in improving women's education, bringing him into contact with Dorothea Beale, headmistress of Cheltenham Ladies' College. Hinton taught in Cheltenham, and was also a colleague of Abbott's great friend Howard Candler at Uppingham School. So, although there is no recorded evidence that Abbott and Hinton met, they surely must have.

And that's probably what inspired a theologian and Shakespearean scholar to create the much-loved satirical mathematical fantasy that is *Flatland*.

— Ian Stewart, emeritus professor of mathematics, Mathematics Institute, University of Warwick and author of *Flatterland*

CHRIS LAURITZEN'S KICKSTARTER GOAL TO REPRINT *FLATLAND* WAS

\$24,000

HE RAISED WELL OVER THREE TIMES THAT:

\$81,777



Now showing at The
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thehenryford.org

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EDITED BY STEPHEN JUDSON AND JASON PAUL PRODUCED BY SHAUN MACGILLIVRAY DIRECTED BY GREG MACGILLIVRAY



INSIDE THE HENRY FORD

The Henry Ford is 250 acres of innovation, 300 years of history and 26 million artifacts. Flip through the following pages to find out what's happening inside this mind-blowing cultural institution during the winter and spring.

Henry Ford Museum of American Innovation	48
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Connect 3	60

PLAYING WITH MATH

New *Mathematica* exhibition introduces complex math concepts in a designer yet highly digestible fashion

Making

math fun. Making math participatory. Making math an experience. When visionary designers Charles and Ray Eames created *Mathematica* in the early 1960s, their ideas were at the

forefront of what makes an exhibit a hands-on tool for learning. They wanted to convey mathematics through interactivity, to make it digestible for everyone, whether a numbers novice or prodigy.

More than 50 years later, *Mathematica's* fundamental principles still ring true. And now, the thousands of guests who visit The Henry Ford daily can experience this visionary approach to mathematical concepts that support the modern-day STEAM (science, technology, engineering, arts and mathematics) platform used in schools today.

Acquired from the Eames Office in 2015, *Mathematica* goes on permanent exhibition in Henry Ford Museum of American Innovation this fall. "Acquiring *Mathematica* is just one more example of our commitment to present the legacy of the Eames Office, from both a design and a communications angle," said Kristen Gallerneaux, curator of communications and information technology at The Henry Ford. "We recognized it as a playful — yet rigorous — learning tool for STEAM education."

Mathematica is a very early example of an interactive exhibit. While preparing it for

exhibition, The Henry Ford's curatorial and conservation staff were prudent and committed completely to maintaining its original intent and integrity. "When we acquired *Mathematica*, some of the elements were operational, others were not," said Gallerneaux. "We have worked throughout the process of reviving it to stay true to every detail of its prior history."

As a result, The Henry Ford made several careful decisions about internal mechanical upgrades and the addition of new logic boards and circuitry for several of the interactive models and kinetic installations.

For visitors, all of this research and careful reconstruction equates to *Mathematica* becoming another learning environment at The Henry Ford: a place where visitors can come to an understanding of mathematical models and theories through direct demonstration in action. Plus, it's just a sensory funfest, full of flashing lights, buttons to press and classic Eames-style graphics to appreciate.

"*Mathematica* is representative of extreme innovation, robust in the sense that it hosts guests and encompasses this participatory quality," said Marc Greuther, chief curator and senior director of historical resources at The Henry Ford. "Classic Eames in its design, graphics, fonts and layout, it side-steps boundaries between education, play, art and science."

ONLINE For more information, hours and pricing, visit thehenryford.org/museum ▶

ONLINE **WANT TO INSPIRE STUDENTS?** Subscribe to THF OnLearning at thehenryford.org/enews ▶

DID YOU KNOW? / *Mathematica* will be on permanent exhibition on the floor of Henry Ford Museum of American Innovation this fall, near the *Fully Furnished* exhibition.



BY THE NUMBERS

30

The number of seconds of silence before 6,000 22-millimeter-in-diameter polypropylene balls drop once again in the Probability Machine

6

The number of wire wands in the Minimal Surfaces device that dip in soapy waters to make bubble forms



SAVE THE DATE
 DrinksXDesign will be hosted in Henry Ford Museum of American Innovation on November 9 to celebrate the opening of *Mathematica*. Visit thehenryford.org for more details.



◀ Charles and Ray Eames created three versions of *Mathematica*, one of which is currently on permanent exhibition at the New York Hall of Science in New York (shown here). When Henry Ford Museum of American Innovation debuts its *Mathematica* this fall, all three versions of the interactive experience will once again be on display. The third belongs to the Museum of Science, Boston.

PHOTO BY JILLIAN NORTHRUP



MATHEMATICA'S INTERACTIVES DECONSTRUCTED

The heart of *Mathematica* is populated by a group of large mechanical interactives, many of them hands-on in nature. Here's a sampling of the exhibition's major players, where looking — and sometimes touching — are highly encouraged.

MINIMAL SURFACES

This device contains six specially formed wire wands. Watch as they dip in and out of a soapy bath to create delicate cubic, tetrahedral and other atypical bubble forms.

CELESTIAL MECHANICS

Press a button on the Celestial Mechanics device, and metal ball bearings are released and cycle around and down a vortex funnel, demonstrating the orbital relationship between heavenly bodies. Gravity finally ends their slow waltz downward as they disappear into a hole at the bottom.

PROBABILITY MACHINE

This device carries the clockwork clink of thousands of plastic balls dropping along a grid of pegs, which settle into a perfect bell curve.

ONE, TWO PUNCH

How the programmable Jacquard loom changed the weaving industry and influenced modern computing

Imagine

a kitchen drawer full of pot-holders. Each one handmade by children who carefully wove colored fabric through the “shed” opening of pre-strung strands of fabric, beating the fabric down tightly and

then joyfully repeating using different colored fabric to create their own design.

Who knew, as these children created their 4-by-4 functional squares of love, that they were also taking a step toward computer programming.

Historically, weavers would not only change the shuttle thread color (the weft) but also shift between sheds of pre-strung thread (warp) often hundreds of times to create increasingly intricate patterns, designs and even pictures. Knowing which warp and weft colors should appear required skill, vision and, most likely, a ton of patience. It also took a lot of time, and errors were regularly made.

When Joseph Marie Jacquard came shuttling along, he did something that changed not only the way people thought about weaving but the way people think about machines and even work itself.

Jacquard, the son of a master weaver, developed a series of cards for a new kind of loom. In each card, holes were punched. The holes represented one row of the design on the finished fabric. A series of these punched

cards were strung together, each card’s holes (or lack of holes) representing a change in the design. (Consider the comparison: A series of cards with holes representing a “yes” or “no” function for the loom like a series of punched cards with the information of “0” or “1” for binary code.)

Jacquard had created the first practical programmable loom and a language to go with it. A weaver would be able to create an endless variety of “programs” on punched cards, resulting in an endless variety of designs.

Jacquard’s loom was patented in 1805 by Emperor Napoleon. While understandably hated by weavers, Jacquard’s invention was loved by the industry as a whole, and within a few years, more than 10,000 of his looms were in operation across France.

More important, Jacquard had made an inventive leap forward that would eventually impact everyone. His punched cards created inspiration for the father of the computer, Charles Babbage, and a basis for early digital compilers for IBM (see sidebar).

In Greenfield Village’s Weaving Shop, you will find a working Jacquard loom, a seemingly unwieldy machine with its Jacquard attachment jutting through the ceiling of the shop’s second floor. Demonstrated regularly, it’s a sight that truly must be seen to be fully appreciated.

WATCH

The Jacquard loom is featured in The Henry Ford Connect 3 video titled *Interwoven Influence on Personal Computing* thehenryford.org/interwoveninfluence ▶

ONLINE

For more information, hours and pricing, visit thehenryford.org/village ▶

DID YOU KNOW? /

Coverlets made on Jacquard looms are displayed and rotated regularly (to limit damaging light exposure) in Henry Ford Museum of American Innovation. The display case is located on the museum floor across from the Rosa Parks Bus.

▶ Volunteer Christine Jeryan regularly does demos of the Jacquard loom in Greenfield Village.

PHOTO BY MICHELLE & CHRIS GERARD



CALCULATIONS + CARDS + COMPUTERS

Long before computers, calculators and even adding machines, engineers, scientists and navigators flipped through books of tables containing the answers to sometimes mind-numbing mathematical calculations. Dating back to the time of Ptolemy and Menelaus, these tables were created and published by human beings. Mathematician and engineer Charles Babbage knew all too well that these human-made tables were prone to human-made errors. Errors that could not only be costly but even catastrophic for the user, depending on the tables' accuracy.

In 1812, Babbage realized that a machine could compute all of these tabular functions with consistent accuracy. Babbage actually took a page from the budding world of mass production — the idea that even the most complex process could be broken down into simple, manageable stages. He also realized the same held true for math. His steam-powered mechanical computing devices, in fact, had much in common with modern computers: separate data and program memory, an instruction-based operation and more.

Recognized as one of the first mechanical computers, Babbage's Analytical Engine was partially inspired by none other than Joseph Marie Jacquard. Babbage actually modeled his device after the Jacquard loom and its ability to process complex data using punch cards.



FROM THE HENRY FORD ARCHIVE OF AMERICAN INNOVATION

BY THE NUMBERS

622

The number of punch cards in a continuous loop used to produce pictorial textile designs on the Jacquard loom in Greenfield Village

1934

The year Sidney Holloway, then textile director at The Henry Ford, built the Jacquard loom in Greenfield Village

2008

The year the Jacquard loom was reintroduced as a working exhibit in Greenfield Village

4

The number of operating mechanical Jacquard looms in existence in North American museums, including The Henry Ford's.

SINGLE TRUCK, EVERY MINUTE



Just-in-time parts delivery at Ford Rouge Complex ensures a built-right F-150 comes off the line every 60 seconds

Today,

STEAM is the buzz acronym that stands for science, technology, engineering, arts and math, and it has become a priority for educators. Students young and old will find plenty of STEAM

brought to life at the Ford Rouge Complex.

First, a little history. In 1915, Henry Ford purchased 2,000 acres along the Rouge River. At the time, Ford was reveling in his successful attempt at mass production at his Highland Park plant. Building Model T's at a rate of one every 93 minutes, he was far outproducing his Piquette Plant. However, the Highland Park site, like Piquette, was landlocked and not conducive for receiving parts and materials.

Ford's new land along the Rouge River didn't have that problem, sealing its destiny to become the largest single industrial complex in the world.

With better supply access and more space at the Rouge site, Ford further reimagined auto production. Raw materials such as iron ore could be brought up the river or along rail lines and roadways, eliminating wasted time and costs associated with supplier delays. This new way of building cars became known as vertical integration. At its peak, the Ford Rouge Complex had an estimated 93

buildings, 100 miles of railroad track, 15 miles of paved roads and nearly 100,000 people dedicated to turning out a vehicle at a rate of one every minute or so.

Today, the award-winning Ford F-150 is still produced at that same rate. How is that possible considering the complexity of modern automobiles? Part of the answer lies in going "lean," said Cynthia Jones, general manager of the Ford Rouge Factory Tour and Henry Ford Museum of American Innovation. "American manufacturing is alive and well, and you can see it and learn about it at the Rouge. And it has gotten lean."


Lean manufacturing relies on just-in-time delivery of the truck's more than 3,000 parts and assembling them in a way that eliminates waste created by unevenness in workloads in the production process. "The key to staying lean is having great logistics, just the right amount of parts on hand and perfected processes. Plus, great workers," said Jones.

Visitors taking the Ford Rouge Factory Tour witness the final assembly of the F-150. While being wowed by the story of the Rouge, they can also contemplate the ecological science, engineering, good design and old-fashioned math that goes into building a truck — soon discovering it takes a heck of a lot of STEAM.

ONLINE For more information, hours and pricing for the Ford Rouge Factory Tour, visit thehenryford.org/rouge ▶

ONLINE INTO HOW CARS ARE MADE? Subscribe to **THF OnWheels** at thehenryford.org/enews ▶

PHOTOS BY GTB



◀ At the Ford Rouge Complex, there are only six production hours worth of materials on hand at any given time. A kitting system on the door line and signaling system in tooling that notifies an off-site parts staging area help ensure a smooth manufacturing flow.

FOR THE BIRDS

In 1915, when Henry Ford purchased the 2,000 acres where the Ford Rouge Complex now sits, he considered making it a bird sanctuary. Serendipitously, the Ford Rouge Complex is not only woven into logistical networks today but tied into ecological networks as well. Porous concrete, natural light, recycled rainwater and one of the world's largest living roofs (more than 10 acres) spanning the final assembly building are among the energy-efficient green innovations at the complex. And on that green roof, nestled among the tiny sedum plants that carpet the surface, are the nests of geese, killdeer and ducks. Part of Ford's bird sanctuary idea has been realized in a way that he could have never expected.



BY THE NUMBERS

10,000

The approximate number of parts needed to build a 1909 Model T

3,000+

The number of parts needed to build a 2017 F-150

400

The number of semitrucks per day that go in and out of the Ford Rouge Complex to deliver parts and take away finished trucks

4

The number of access options within the Ford Rouge Complex: road, rail water and air

GLASS GALLERY x2

Acquisition of significant studio glass collection helps mold pair of new experiences at The Henry Ford

The

Davidson-Gerson Modern Glass Gallery is in Henry Ford Museum of American Innovation. It opened in October 2016. The Davidson-Gerson Gallery of Glass is in Greenfield Village's Liberty

Craftworks District. Its grand opening is April 15, 2017, when the village opens for the season.

Both galleries provide an in-depth look at the American glass story. The museum gallery focuses specifically on the studio glass movement of the 1960s, while the village gallery surveys the history of American glass, ranging from 18th-century colonial glass through 20th-century mainstream glass as well as studio glass.

Charles Sable, curator of decorative arts, was tasked with updating and reinterpreting The Henry Ford's American glass collection. He envisioned creating an all-new gallery adjacent to the museum's Glass Shop in the Liberty Craftworks District of Greenfield Village — a place to exhibit portions of the institution's 10,000 glass artifacts currently in storage. His vision intersected with that of collectors Bruce and Ann Bachmann, who were seeking to donate their 300-piece studio glass collection.

According to Sable, the studio glass movement, which began in the early 1960s, is recognized as a turning point in the history of glass, as artists explored the qualities of the medium in a studio environment. Their goal was to create fine art. Evolving over a 20-year period, the movement matured in the 1980s with artists producing a myriad of unique works.

While other museums were interested in the Bachmann collection, it was The Henry Ford that garnered the collectors' full attention and eventually their generous donation. "The Bachmanns had very specific criteria for their collection," said Sable. "They were looking for an institution that was in an urban area, preferably in the Midwest where they live, had a large visitation, and was capable of exhibiting and maintaining the collection.

"As Bruce told me, it was a good marriage. He felt his collection would live here in perpetuity," added Sable.

The story of the studio glass movement is now on permanent exhibition in the Davidson-Gerson Modern Glass Gallery, which is located in the museum space that once showcased The Henry Ford's silver and pewter collections. "Our exhibit is a deep dive into how studio glass unfolded," said Sable. "It's the story of the combination of science and art that created a new and innovative chapter in the history of glass."

The exhibition also looks at the impact of studio glass on everyday life and includes a section on mass-produced glass influenced by studio glass and sold today by retailers such as Crate and Barrel, Pier 1 Imports and others.

Once the new Davidson-Gerson Gallery of Glass in Greenfield Village opens this spring, thousands of visitors will have an added opportunity to see larger-scale studio glass pieces from the Bachmann collection as well as the evolution of American glass.

ONLINE For more information about the collections of The Henry Ford, visit thehenryford.org/collections ▶

ONLINE INTO GOOD DESIGN?
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thehenryford.org/enews ▶

PHOTO BY BILL BOWEN



◀ Artist Richard Royal's *Untitled* glass sculpture from his Relationship Series is the lead piece that welcomes visitors to entering the new Davidson-Gerson Modern Glass Gallery in Henry Ford Museum of American Innovation.

DID YOU KNOW? /

The all-new Davidson-Gerson Gallery of Glass in Greenfield Village is a careful redesign of the McDonald & Sons Machine Shop in the Liberty Craftworks District.

DID YOU KNOW? /

The Bachmann studio glass collection includes representation of every artist of importance in the movement, including Harvey Littleton, Dominick Labino, Dale Chihuly, Lino Tagliapietra, Laura Donefer and Toots Zynsky.

BY THE NUMBERS

180

The number of glass artifacts on display in Henry Ford Museum of American Innovation's Davidson-Gerson Modern Glass Gallery

155

The number of artists represented in the Bachmann studio glass collection

300

The number of studio glass pieces in the Bachmann collection

2017 Events

Celebrate.
Play.
Imagine.



MAKE SOMETHING: SATURDAYS

EVERY SATURDAY, SEPTEMBER-MAY
10 a.m.-3 p.m.

Henry Ford Museum of American Innovation

Inspired by the stories of past and present-day change makers, this weekly program in Henry Ford Museum of American Innovation motivates kids to be the next great innovators and entrepreneurs. This is the place where you can explore the innovations, big and small, that have made the world what it is today and step into the stories of the real-life rule breakers and boundary pushers who created them.

Join the innovation nation movement during Saturday hands-on, minds-on activities targeted for youth ages 8-12 that will engage them in learning-by-doing experiences that bring practical problem-solving to life, and so they can consider how they, too, can have a stake in shaping the future.

Be inspired with monthly innovator demos and talks by entrepreneurs who share how they turned their ideas into action, and learn side by

side with engineers and inventors who are changing our world — all while surrounded by and connected to the stories and achievements of innovators over time.

Young tinkerers and hackers can also expect to build design thinking skills through animation fun with Pixar, circuit board building and skitterbot animating. Plus, they can see demos and visit with inventors who have appeared on The Henry Ford's Emmy Award-winning TV series, *Innovation Nation*, or get hands-on with a bot project that's sure to create a passion for learning and show them what's possible if they start now. Pop-up talks in the galleries and live Skype sessions at Giant Screen Experience will also help immerse future leaders in this rich heritage of learning by doing.

Let's make something together.

DID YOU KNOW? /
National Engineers Week is February 18-25. Children attending Make Something: Saturdays this year will meet Dash (above). A real robot, Dash can dance, sing and respond to voice commands.

COURTESY OF
WONDER WORKSHOP

ONLINE visit thehenryford.org/makesomethingsaturdays ▶

NEW AND NOTABLE

Kimberly Bryant, founder of Black Girls CODE, will speak at Henry Ford Museum of American Innovation at 1 p.m. March 18. Bryant is dedicated to introducing girls of color to programming and encouraging them to become the next generation of coders. To learn more about Bryant and Black Girls CODE, visit blackgirlscode.com. For event details, visit thehenryford.org/innovatorspeaker



COURTESY OF BLACK GIRLS CODE

2017 Events

YEAR-ROUND

Throwback Thursday Nights*

Most Thursdays,
7 p.m. (Giant Screen Experience

Make Something: Saturdays

September-May,
10 a.m.-3 p.m.
Museum

Tinkering for Tots Preschool Program

Second Monday of each month, 10 a.m.-noon
October-April - Museum
May-September - Village

MARCH

American Style and Spirit: 130 Years of Fashions and Lives of an Entrepreneurial Family

Running through
April 2
Museum

Innovator Speakers Series: Kimberly Bryant, Founder Black Girls CODE

March 18, 1 p.m.
Museum

Sensory-Friendly Saturday

March 25
Museum

APRIL

American Style and Spirit: 130 Years of Fashions and Lives of an Entrepreneurial Family

Running through
April 2
Museum

Sensory-Friendly Saturday

April 29
Village

Day Out With Thomas™*

April 29-30
Village
Locally Presented by Meijer

Railroader's Breakfast*

April 29-30
Village

MAY

Outdoor Living Lab Tour*

May 1-October 7
Ford Rouge Factory Tour

Day Out With Thomas™*

May 6-7 and 13-14
Village
Locally presented by Meijer

Railroader's Breakfast*

May 6-7 and 13-14
Village

House Industries Exhibition Preview*

May 25
Museum

House Industries Exhibition

May 27-September 4
Museum

Civil War Remembrance

May 27-29
(Open Saturday 'til 9 p.m.) (Village



RUDY RUZICKA



American Style and Spirit: 130 Years of Fashions and Lives of an Entrepreneurial Family

KRISTINA SIKORA/KMS PHOTOGRAPHY

JUNE

House Industries Exhibition

Running through
September 4
Museum

Member Appreciation Days

June 2-4

Cinetopia International Film Festival*

June 2-11
Giant Screen Experience

National Get Outdoors Day

June 10
Village

Historic Base Ball Games

June 10-11, 17-18 and 24-25
Village

Historic Base Ball in Greenfield Village is made possible through the generous support of Cynthia and Edsel Ford II.

MOTOR MUSTER

June 17-18
(Open Saturday 'til 9 p.m.) (Village

Sensory-Friendly Saturday

June 24
Ford Rouge Factory Tour

Summer Camp*

June 26-30, July 10-14, July 17-21, July 24-28, July 31-August 4 and August 7-11
The Henry Ford



EMILY BERGER

Annual Salute to America*

June 30 and July 1-3 (Village

JULY

House Industries Exhibition

Running through
September 4
Museum

Historic Base Ball Games

July 1-2, 8-9, 15-16, 22-23 and 29-30
Village

Annual Salute to America*

July 1-3 (Village

Maker Faire® Detroit*

July 29-30 (Open Saturday and Sunday 'til 6 p.m.) (The Henry Ford
In collaboration with Maker Media
Presented by GE Digital

AUGUST

House Industries Exhibition

Running through
September 4
Museum



Historic Base Ball Games

August 5-6, 12-13 and 19-20
Village

World Tournament of Historic Base Ball®

August 12-13
Village
Historic Base Ball in Greenfield Village is made possible through the generous support of Cynthia and Edsel B. Ford II

National Aviation Day

August 19
Museum
Admission fee waived courtesy of Delta Air Lines

SEPTEMBER House Industries Exhibition

Running through September 4
Museum

67th Annual Old Car Festival

September 9-10 (Open Saturday 'til 9 p.m.)
Village

Member Appreciation Days

September 21-22
The Henry Ford

Fall Flavor Weekend

September 23-24 and September 30-October 1
Village

Farmers Market

September 23 and 30
Village

OCTOBER

Fall Flavor Weekend

October 1
Village

Hallowe'en in Greenfield Village*

October 13-15, 19-21 and 26-28
Village

Hallowe'en in Greenfield Village Dinner Package*

October 13-14, 19-21 and 26-28
Village

The Science Behind Pixar Exhibition*

October 14-March 18, 2018
Museum
Presented by Meijer
This exhibition developed by the Museum of Science, Boston in collaboration with Pixar Animation Studios.

NOVEMBER The Science Behind Pixar Exhibition*

Running through March 18, 2018
Museum

Member Appreciation Days

November 18-20
The Henry Ford

Members 24th Annual Holiday Lighting Ceremony*

November 20
Museum

Visits with Santa

November 24-December 24
Museum

DECEMBER The Science Behind Pixar Exhibition*

Running through March 18, 2018
Museum

Visits with Santa

Running through December 24
Museum

Holiday Nights Supper with Santa Package at A Taste of History®**

December 1-3, 8-10, 15-17 and 19-23
Village

Holiday Nights in Greenfield Village*

December 1-3, 8-10, 15-17, 19-23 and 26-30
Village

Holiday Nights in Greenfield Village Dinner Package at Eagle Tavern*

December 1-3, 8-10, 15-17, 19-23 and 26-30
Village

Get an insider's view of The Henry Ford. Find out what's new. Sign up for free eUpdates at TheHenryFord.org/enews.

2017 HOURS

Henry Ford Museum of American Innovation
Open 7 days a week, 9:30 a.m.-5 p.m.

Greenfield Village
April 15-October 29, open 7 days a week, 9:30 a.m.-5 p.m.

October 30-November 26, open Friday-Sunday, 9:30 a.m.-5 p.m.

November 27-April 14, closed; open select evenings in December.

Giant Screen Experience
Open daily with extended hours.

Ford Rouge Factory Tour
Open Monday-Saturday, 9:30 a.m.-5 p.m. Call for bus times and seasonal hours

Benson Ford Research Center
Reading room open Monday-Friday, 9:30 a.m.-5 p.m.

For the latest updates and more information on special events and programs, call 313.982.6001 or visit thehenryford.org.

All attractions closed Thanksgiving and Christmas days.

All programs and dates are subject to change.

The Henry Ford is an independent nonprofit organization. We depend on ticket purchases, income from our stores and restaurants, and tax-deductible contributions and memberships for support.

*Additional fee and/or advance reservation required.

⌘ Special evening hours during these events.

DREAM BIG ON THE GIANT SCREEN

New film shows how engineers change our world

Dream Big: Engineering Our World joins the lineup of traditional films at The Henry Ford's Giant Screen Experience. The film, which premieres during National Engineers Week 2017 (February 18-25), shows off all the amazing and imaginative ways engineers push the boundaries to build everything from the tallest buildings to bridges that seem to touch the clouds. It's a movie that's changing perceptions about engineering as a profession and is sparking the interest of students in search of career options.

Dream Big is a MacGillivray Freeman film, joining *National Parks Adventure* as part of the Giant Screen Experience lineup. Expect related programming and events surrounding the movie to be announced.

Admission to *Dream Big* is free to members. For showtimes, visit thehenryford.org.

DID YOU KNOW? /

You can enjoy classic and cult films from the '70s, '80s and '90s on select Thursday evenings. Check out Throwback Thursday Nights at the Giant Screen Experience. Visit thehenryford.org/tbt.



COURTESY OF MACGILLIVRAY FREEMAN FILMS

Connect **3**

Curators uncover curious connections between artifacts and ideas

→ Interwoven Influence on Personal Computing

▼ JACQUARD LOOM, 1934

The earliest program-mable loom uses punch cards as templates to create textile designs. Swapping out the cards reprograms how the threads are lifted and changes the pattern.

MAKE THE CONNECTION:

Punch cards are the inspiration for an English mathematician Charles Babbage's Analytical Engine, the first mechanical computer. The cards are eventually replaced with integrated circuits that get smaller and smarter.



▲ HP-35 SCIENTIFIC CALCULATOR, 1973:

The world's first hand-held scientific calculator was still a very powerful processor. It was also an early device featuring an integrated monitor. That meant when you pushed a button, the number would appear on the screen.

MAKE THE CONNECTION:

Steve Wozniak, before he was Apple Computer's co-founder, had an HP-35 and wanted to apply its interface design to a personal computer he was tinkering with.

▼ APPLE 1 COMPUTER, 1976

Steve Wozniak's tinkering eventually led to the development of the Apple 1, the world's first preassembled personal computer.

MAKE THE CONNECTION:

The Apple 1 is the iconic symbol of the computing age — a pure, primary, physical document of the turn in the home computing revolution.



“So much like the Jacquard loom and the HP-35 calculator, the Apple 1 is truly the beginning of something, yet it owes so much to the web of earlier history.”

— Kristen Gallerneaux, curator of communications and information technology, The Henry Ford

WATCH

The *Interwoven Influence on Personal Computing* Connect 3 video narrated by Kristen Gallerneaux, curator of communication & information technology at The Henry Ford
thehenryford.org/interwoveninfluence ▶



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HISTORIC



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Accommodations at a Glance

HOTEL	LOCATION AREA	DRIVE TIME*	SLEEPING ROOMS	POOL	PETS	MEETING ROOMS	MEETING SPACE (sq. ft.)	AD ON PAGE	
FULL SERVICE	Best Western Greenfield Inn	Dearborn (I-94 corridor)	10	209	Indoor	•	4	1,047	65
	DoubleTree by Hilton Detroit-Dearborn	Dearborn	10	347	Indoor		16	12,000	70
	Edward Hotel & Convention Center	Dearborn	5	773	Indoor	•	30+	62,000	70
	Holiday Inn Southgate Banquet & Conference Center	Downriver (I-75 corridor)	15	160	Indoor		8	9,000	75
	The Henry, an Autograph Collection by Marriott	Dearborn	5	323	Indoor	• \$	14	26,000	68
	Sheraton Detroit Metro Airport	Airport (I-94)	15	359	Indoor	•	14	14,000	67
	Westin Hotel Southfield/Detroit	South Oakland County	15	338	Indoor	•	25	24,732	74
HISTORIC	The Dearborn Inn, a Marriott Hotel	Dearborn	3	229	Outdoor		17	17,000	77
	The Westin Book Cadillac	Downtown Detroit	15	453	Indoor/Spa	•	13	26,000	72
LIMITED SERVICE	Comfort Inn & Suites - Allen Park	Dearborn (I-94 corridor)	10	163	Indoor		2 (15 each)		77
	Comfort Inn & Suites - Dearborn	Dearborn	4	116	Indoor		1	250	66
	Comfort Inn & Suites - Taylor	Dearborn (I-94 corridor)	10	78	Indoor		1 (15)		65
	Comfort Suites - Southgate	Downriver (I-75 corridor)	15	78	Indoor		1 (50)		69
	Country Inn & Suites - Dearborn	Dearborn	7	100	Indoor	•	1 (55)		66
	Courtyard by Marriott - Detroit Dearborn	Dearborn	10	147	Indoor		2	1,274	68
	Hampton Inn - Dearborn	Dearborn	3	96	Indoor		0		67
	Hampton Inn - Detroit/Southgate	Downriver (I-75 corridor)	15	114	Indoor		5	1,340	74
	Hawthorn Suites by Wyndham	Detroit	10	128	Outdoor	• \$	0		74
	Marriott TownePlace Suites - Dearborn	Dearborn		148	Outdoor	• \$			75
	Marriott TownePlace Suites - Livonia	I-275 corridor	20	94	Outdoor	• \$	0		75
	Red Roof Inn - Detroit-Dearborn	Dearborn	7	111		•	0		67
Staybridge Suites - Dearborn	Dearborn	7	99	Indoor	• \$	(1) 35		73	
BED & BREAKFAST	Bishop-Brighton Bed & Breakfast	Downriver	20	3			1	350	74
	York House Bed & Breakfast	Dearborn	10	3			0		74
CAMPING	Camp Dearborn	NW Oakland County	45	191	Outdoor		0		74
	Detroit Greenfield Campground/RV Park	I-94 corridor	20	212	On lake	•	Outdoor pavilion	600	74

*Drive time in minutes to The Henry Ford.

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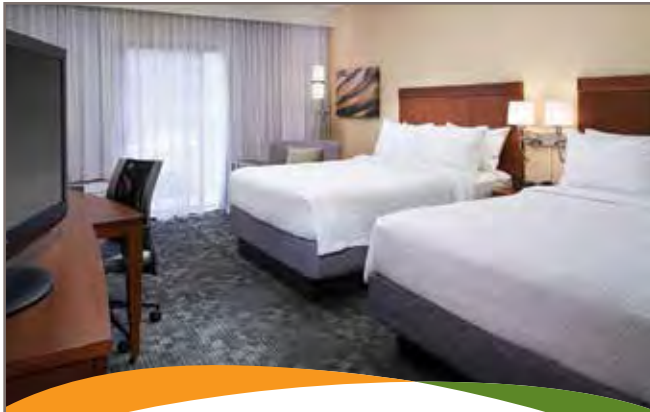
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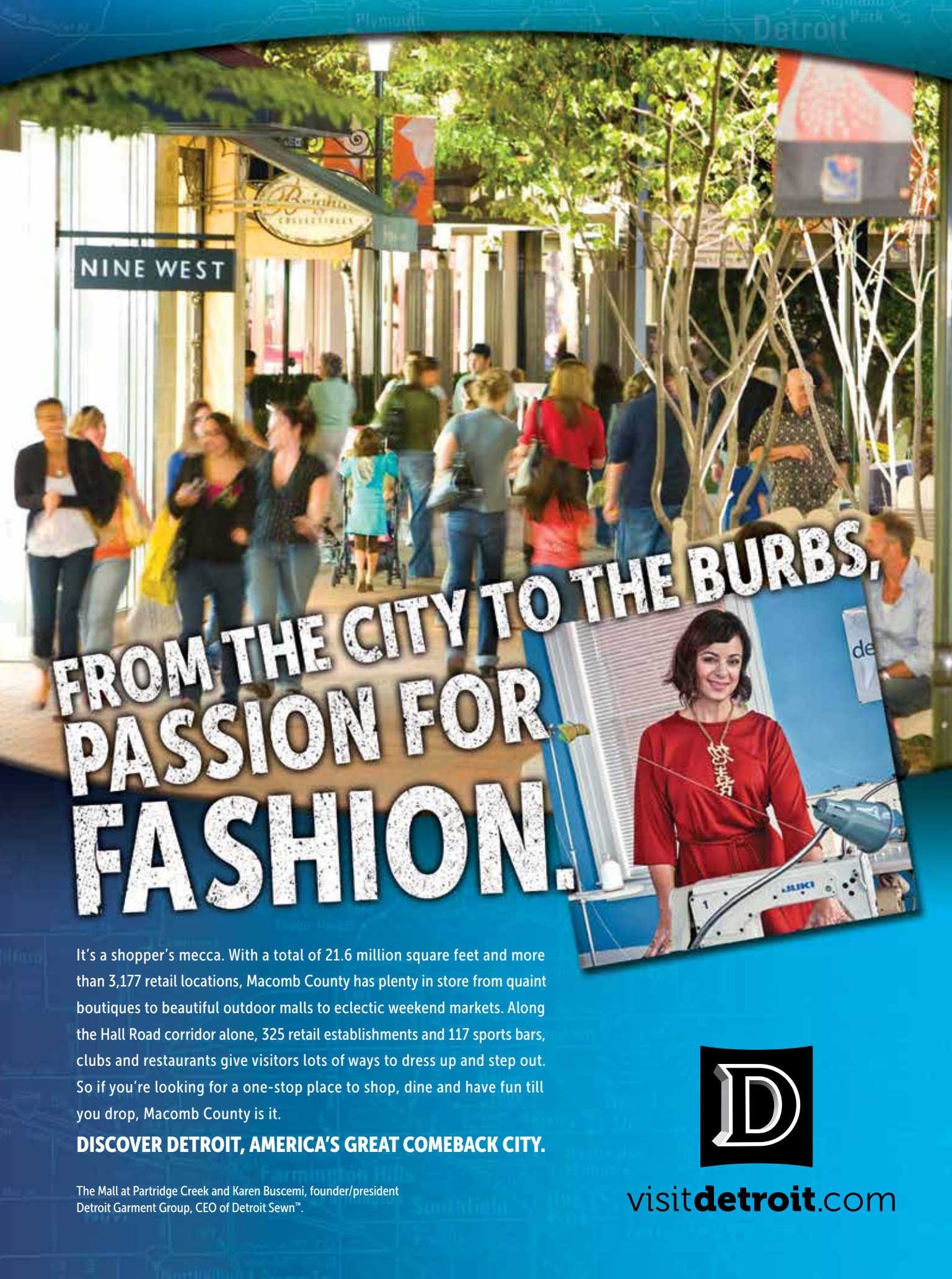
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A LOOK BACK

OCTET TRUSS

It's 1899. R. Buckminster Fuller is a kindergartner. He and his classmates are given toothpicks and half-dried peas one day in class and are told to build something. So farsighted and cross-eyed that he was virtually blind (he started wearing glasses a year later), Fuller didn't really see the world like all the other kids did. Consequently, he didn't follow the crowd in thinking structures were supposed to be cubical. As his classmates constructed their cubes, young Fuller messed around with his picks and peas until his structures felt sturdy rather than looked "right." Much to the teacher's surprise, his creation was a complex mashup of alternating geometric octahedrons and tetrahedrons.

At the ripe young age of 4, Fuller had built his first octet truss. He would be awarded U.S. Patent 2,986,241 for it in 1961. A structural framework so common in modern architecture today, lots of us think buildings have always been made that way.



FROM THE HENRY FORD ARCHIVE
OF AMERICAN INNOVATION

DID YOU KNOW? / Ford Motor Company's Rotunda building was renovated and reopened to the public in 1953. The renovations included a geodesic dome designed by R. Buckminster Fuller.

READ *A Fuller Explanation: The Synergetic Geometry of R. Buckminster Fuller* by Amy C. Edmondson ►

READ *Synergetics: Explorations in the Geometry of Thinking* by R. Buckminster Fuller ►

READ *Inventions: The Patented Works of R. Buckminster Fuller*, St. Martin's Press, 1983 ►

ONLINE Read more on our blog thehenryford.org/explore/blog/searching-for-structural-integrity ►

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