Digital Design: a History

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Princeton University Press
Princeton and Oxford

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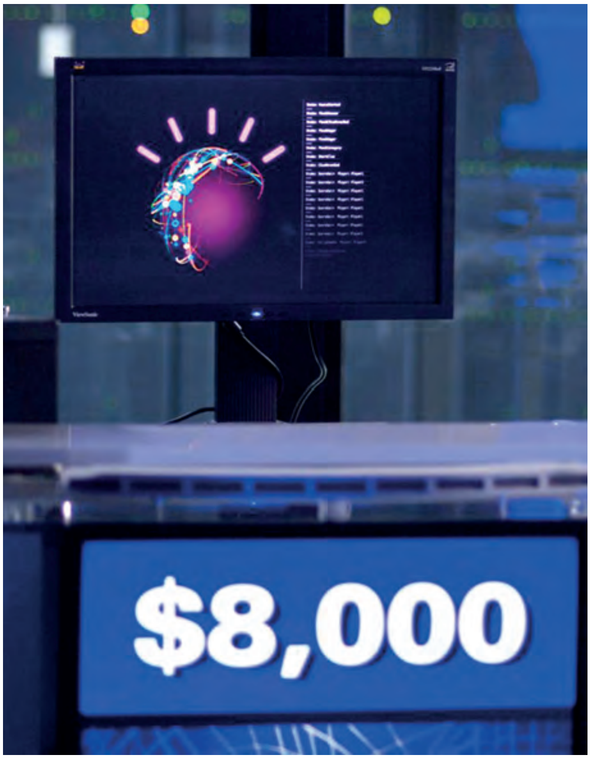
Ten. Algorithms and Artificial Intelligence

Artificial intelligence (AI) has long been more of an aspirational goal than an absolute when it comes to digital design and culture. This situation has made the term a murky one, as there are gaps between what different groups mean when they proclaim something as an example of AI. The digital iterations of artificial intelligence can generally be traced back to the legendary computer scientist Alan Turing, who published a paper in 1950 called "Computing Machinery and Intelligence." In this essay, Turing proposed a test, the aptly named Turing Test, that could be used to evaluate the success of a given AI. The Turing Test was based on a machine's ability to understand and provide conversation in so-called natural language. A true AI would converse in a way that was indistinguishable from human conversation. Turing's article marked the onset of a great deal of experimental research into the field, including at the 1956 conference, “Dartmouth Summer Research Project on Artificial Intelligence,” organized by John McCarthy, where the term “artificial intelligence” became the consensus name for the field. Subsequent decades leading up to the twenty-first century saw much experimental work and incremental progress, but no real breakthroughs.

Not only scientists have contributed to the AI discussion, but multivalent purveyors of popular culture and science fiction have also had their say. The popular culture definition of artificial intelligence has helped to create one model of AI along the lines of Turing’s hypothesis: a sentient being that can communicate and problem solve at or above the level of a person. Arthur C. Clarke’s HAL 9000 is a perfect embodiment of this genre of AI. According to Clarke’s book *2001: A Space Odyssey*, HAL was “born” (or activated) on January 12, 1997 (the film moved the birthday up five years). HAL is sentient and has a perfect grasp of natural language yet at the same time has superior processing power than a human. HAL also exemplifies another key component of AI theory, “machine learning.” This term, also coined back in the fifties, refers to a computer that can gradually improve its problem-solving ability and general intelligence, not by being reprogrammed by a human, but through understanding its past experiences. While HAL is networked throughout the environment, like humans, he is made manifest through his eyes, glowing red orbs set into a console (looking suspiciously like today’s digital doorbells, hmmm). Finally, HAL’s cognitive abilities are wedded to very human flaws, as his emotional life at times impedes his workflow. Sentient AIs such as HAL abound in popular culture, where, like the people they emulate, they can appear as heroes, villains, love interests, conflicted protagonists, and the like.

Perhaps the closest real-life example of a sentient AI in popular culture came in the form of Watson (figure 10.1), a 2011 IBM supercomputer that appeared on the game show *Jeopardy!*. In this contest against two human former champions, Watson showcased an ability to understand and speak natural language, while accessing data that allowed it to answer general questions quickly and reliably. Watson also benefited from machine learning and eventually won the game despite some glaring errors caused by misunderstanding a given question’s context. The “face” of Watson had been designed by Joshua Davis as an animated version of IBM’s 2008 Smarter Planet logo (the original logo was designed by Philippe Intraligi). Strikingly, the



10.1. Joshua Davis's "face" design on the IBM Watson computer on *Jeopardy!*, 2011

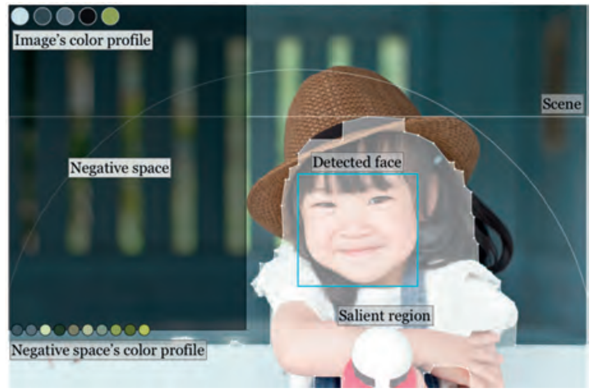
logo was designed not to be expressionless, but to select from twenty-seven variations of color and form that appear in relation to Watson's predicted "confidence" in its answer.

Just as HAL embodied the dream of the sentient AI, Watson highlighted the reality of artificial intelligence: algorithms. Watson and other AIs are not sentient; they are in fact running problem-solving programs that depend on quickly sorting vast amounts of data to arrive at a result. A note on algorithms: although algorithms have been a part of mathematics for time immemorial, the term first appeared in the modern sense—a predefined set of computations that form a sorting mechanism—in the twelfth century. At that time in Europe, works by the ninth-century Persian mathematician Muḥammad ibn Mūsā al-Khwārizmī were first translated into Latin. In particular, the book *Algoritmi de Numero Indorum* (roughly "al-Khwārizmī on the Hindu Art of Reckoning") led to the European understanding of Hindu-Arabic numerals, decimals, and a great deal of algebra. The translator of this book used a transliterated spelling of al-Khwārizmī's name as Algoritmi, which eventually led to the coining of the new words "algorithm" and "algebra."

Algorithms really came into their own with the arrival of the digital age. The basis of all things digital from search engines to Snapchat, the history of algorithms also played a role in the establishment of computer science as an academic discipline. Maarten Bullynck has noted how the early works of computer scientists, such as Donald Knuth's *The Art of Computer Programming* (1973), sought to embed their new profession into the history of mathematics. Knuth wrote, "One of the ways to help make computer science respectable is to show that it is deeply rooted in history."

While functioning more like calculators than people, computers such as Watson have become capable of almost instantaneously implementing myriad algorithms on a vast trove of data, and they have therefore become able to simulate the intelligence and general knowledge of a sentient machine. At the same time, multiple researchers are trying to build AI systems that are human centered and project sensitive rather than dominating. Fei-Fei Li, a professor of computer science at Stanford who specializes in AI, has stated, "If everybody thinks we're building Terminators, of course we're going to miss many people." Li worries that this aggressive image has led fewer women to work in AI, which has reinforced the notion that the field consists of men making dangerous machines. Li has sought to collaborate with scholars in other fields, such as psychology, to find ways to design algorithms that are more human centered.

The fear of sentient machines has been a consistent trope throughout industrial history. In 1935, for example, the famed American poet



10.2. The Grid website, 2014

Stephen Vincent Benet published "Nightmare Number 3" in the *New Yorker* magazine. Also known as the "Revolt of the Machines," this poem offered a tragicomic vision of artificial intelligence run amok: "It was only the best machines, of course, the superhuman machines / The ones we'd built to be better than flesh and bone, but the cars were in it, of course. . . . And it's fair enough, I suppose. You see, we built them / We taught them to think for themselves. / It was bound to come. You can see it was bound to come." Benet's dark vision of technological progress is usually interpreted as a reaction to the economic struggles and rise of fascism of the thirties. While correlation is rarely causation, it is interesting to note how few dystopic visions react to contemporary digital culture. Perhaps because the digital world—despite two financial crises affecting the industry (2000 and 2008)—has merrily thrived in a historically strong economic and societal situation across the developed world, there has been little consternation among the digerati. The generalized "gee whiz" lust for riches and new wizardry remains unchecked; from the nineties printed pages of *Wired* to the latest social media filter, a consistent sense that "in five years" a given technology will transform life for the better or, at the very least, become a $100 billion industry, remains the word on the street.

Many design projects today that are branded as using artificial intelligence are more aptly described as examples of algorithmic culture. For example, the web design company the Grid launched to much fanfare in 2014 as a purveyor of websites that would be designed by thinking machines (figure 10.2). "The Grid harnesses the power of artificial intelligence to take everything you throw at it—videos, images, texts, urls and more—and automatically shape them into a custom website unique to you. . . . What's possible when an AI does all the hard work for you." To make the process more relatable while also suggesting that one is working with a higher intelligence, the Grid's interface features Molly, the skilled AI designer who is at work on your website. The idea behind the Grid is a powerful one in comparison to a standard template DIY shop. Molly will analyze the palette and composition of your uploaded images and avoid startlingly poor design choices that the average

10.3. Adelia Lim, *Machine-Made, Human Assembled* Float typeface, 2018

small business owner (the target customer) might make on their own initiative. As with many products that are branded as artificial intelligence, however, there is a gap between what the term conveys to most people—think Molly as HAL—and the reality of a system where your content is being processed by algorithms, not curated by an omniscient digital machine.

Artificial intelligence has also shown promise as a facilitator of hybrid projects, whereby a machine and its human colleague work together. Often the designer's role is to create the algorithm—to set things in motion—while the resulting work is devised by a machine. Such was the case with Adelia Lim's experimental typography project *Machine-Made, Human Assembled* (figure 10.3, 2018). A recent graduate of the Glasgow School of Art/Singapore Institute of Technology, as global a program as one can find, Lim used Ben Fry and Casey Reas's open source Processing language to devise her project. Machine-Made is a group of typefaces created as a result of Lim's collaboration with a machine. One of the typefaces, Float, is a motion-tracking project whereby the AI uses its camera to follow a specific color and place white dots on the path created by the movement of a gesture. Lim has written, "The project aims to challenge and redefine the role of the designer—from one that is directly involved in formal aesthetic choices to one that simply indicates the ingredients and margins and allows a somewhat autonomous system to work out the consequences of those possible decisions."

10.4. Andy Clymer's Obsidian typeface, 2015

Algorithmic type can also play an important role as a time saver in the design of type. For example, when Hoefler & Company wanted to make a three-dimensional variation of the decorative typeface Surveyor, they turned to algorithms to facilitate the process. Surveyor is a historicist type based on nineteenth-century engraved maps. The designer at Hoefler, Andy Clymer, wanted to make a shaded version but recognized that the labor involved would not be economically sensible. A company blog notes that shadowing the letters of a serpentine typeface such as Surveyor was incredibly arduous by hand (in the sense of hand and RoboFont software), as an "ampersand alone would require the designer to draw and coordinate 284 different curves, defined by placing more than 1,100 points." Coded in Python (a programming language first written in the late eighties by Guido van Rossum), algorithms were able to dramatically cut the amount of time necessary to produce the new font. This is not to say that the new typeface was simply spit out by a machine, but rather that the hundreds of hours saved in processing the basic forms allowed Clymer to devote himself to the finer details of the letters. The resulting work, called Obsidian (figure 10.4, 2015), quickly became available as a large character set that supports more than one hundred languages. Marian Bantjes opined in a review, "This is the typeface you want to sit next to at a dinner table."

No artist or designer has built a more intimate relationship with AI than the composer and computer scientist Holly Herndon. Born in the United States but based today in Berlin, Herndon considers her most recent album, *PROTO* (2019), to be a collaborative effort that includes her AI "baby" Spawn. Herndon refers to Spawn with female pronouns, speaking of the neural network as if she were part of the human group—producers, programmers, and chorus members—that worked on the album. Through machine learning, Spawn has been taught to recognize and respond to the human voices on the recording. *PROTO*'s electronic folk sound can be haunting and even uncanny, especially if a listener attempts to parse out the human and machine contributions. The title of the album refers to protocols in the digital sense as the algorithmic building blocks that facilitate communication. Herndon wants to communicate the human side of technology through Spawn, noting, "There's a pervasive narrative of technology as dehumanizing,. . . I don't want to live in a world where humans are automated off stage. I want an AI to be raised to appreciate and interact with that beauty."

10.5. Joris Laarman, *Bone Chair*, 2006

10.6. Arthur Harsuvanakit and Brittany Presten, *Elbo Chair*, 2016

In the field of industrial design, probably the most influential breakthrough regarding algorithmic, or generative, creation came through Joris Laarman's 2006 *Bone Chair* (figure 10.5). As has often been the case, Laarman created this work through adapting an algorithmic process first used by industry to design automobile parts. Specifically, he became aware of how the German company Adam Opel used algorithms to find out what was the most efficient shape for a given mechanical part. The company had sought to find the optimal blend of strength and weight for certain car parts. In pursuit of this outcome, Adam Opel used algorithms to identify superfluous material that could be cut out of the part without compromising its integrity. In emulating this process, Laarman used a parametric strategy whereby he defined certain points—the basic chair shape of seat and back and three legs—and allowed the algorithm to complete the design.

One way in which Laarman's *Bone Chair* transcends the realm of industry and enters a more conceptual space is through his recognition that this specific algorithm emulated the natural process of bone formation. The *Bone Chair* hybridizes technical sophistication and the biological traits of living organisms. For Laarman, this placed the chair firmly in the historical context of modern design. Just as artisans of the nineteenth century and art nouveau sought to emulate the beauty of natural forms, Laarman sought to digitally encode a natural process into his work.

The advances in software of recent years now allow pretty much any designer to outsource the design to a machine. In 2006 Laarman, like Frank Gehry before him in the architectural context, had to rely on access to specialized industrial software to complete his work. In 2016, Arthur Harsuvanakit and Brittany Presten could pursue the same sort of parametric project with an off-the-shelf CAD program. Harsuvanakit and Presten work for Autodesk, and their *Elbo Chair* (figure 10.6) represented a demonstration of that company's Dreamcatcher program. Dreamcatcher is a beta "generative design" program, meaning that the designers input a few parameters and then allow algorithms to complete the work. Autodesk offers the program as not just a tool but a creative partner, suggesting that the software may assist designers who finds themselves short on ideas: "design alternatives—many that you'd never think of on your own."

Both the *Bone* and the *Elbo* chairs point to a limiting factor in digital furniture design; the desire to execute projects in metal (*Bone Chair*) or wood (*Elbo Chair*). Neither of these pieces could

10.7. Patrick Jouin, *One Shot Stool*, 2006
10.8. Ron Arad's 3D-printed *Genius: 100 Visions of the Future*, 2017

be manufactured with a 3D printer, the logical, economical final step. The *Bone Chair* was cast by hand in aluminum, while the *Elbo* was carved out of wood using a CNC machine. Although the laser sintering process can print with metal, it is still mainly an industrial technique that is extremely costly. Sintering of polyamide resins to form plastic, however, has been successfully implemented in the work of Patrick Jouin. His *One Shot Stool* (figure 10.7, 2006) highlighted how 3D printing could simplify the productions of complex compositions. It was formed as just one piece yet can be folded along hinged elements integrated into the work. The *One Shot Stool* was created as part of the MGX project at Materialise, a company devoted to bringing 3D printing to the consumer market. While the technology is admirable, to a certain degree it has stalled out because of materials; few people want furniture made out of nylon resin as opposed to wood or metal. In addition, using 3D printing for invisible parts of furniture—in, for example, a structure finished with cloth or leather—makes little economic sense as yet because conventional manufacturing is less costly and widely available. Works like the *One Shot Stool* are aimed at the high-end design trade, not the broader consumer market, as the piece retails today for over $2,500 despite the relatively low cost of its manufacture.

As 3D printing became a hot, stylish process in the 2010s, at times it has looked like a solution seeking a problem. For example, in 2017 legendary industrial design Ron Arad was commissioned to design a 3D-printed book. The book, a compendium of visionary projections titled *Genius: 100 Visions of the Future* (figure 10.8), was not a commercial product per se but a limited-edition object created in celebration of the centenary of Albert Einstein's general theory of relativity. As a physical object, the book was shaped so that the unbound edge forms a likeness of Einstein's face.

Computational design has also affected the design of running shoes. Nike has taken to using algorithms to make size-specific alterations to its sneakers. The algorithms can be programmed to tweak the sole for any number of combinations of speed, stability, traction, and so forth. In a strategy similar to that pursued by Laarman for his *Bone Chair*, the algorithm can also remove material that it recognizes as superfluous to the shoe's performance goals. For a company that has been estimated to sell twenty-five pairs of shoes per second, the cost savings and related environmental advantages of removing a small amount of material are immense. This type of algorithmic customization is currently ramping up, and soon individuals will be able to wear bespoke trainers that have been computationally designed.

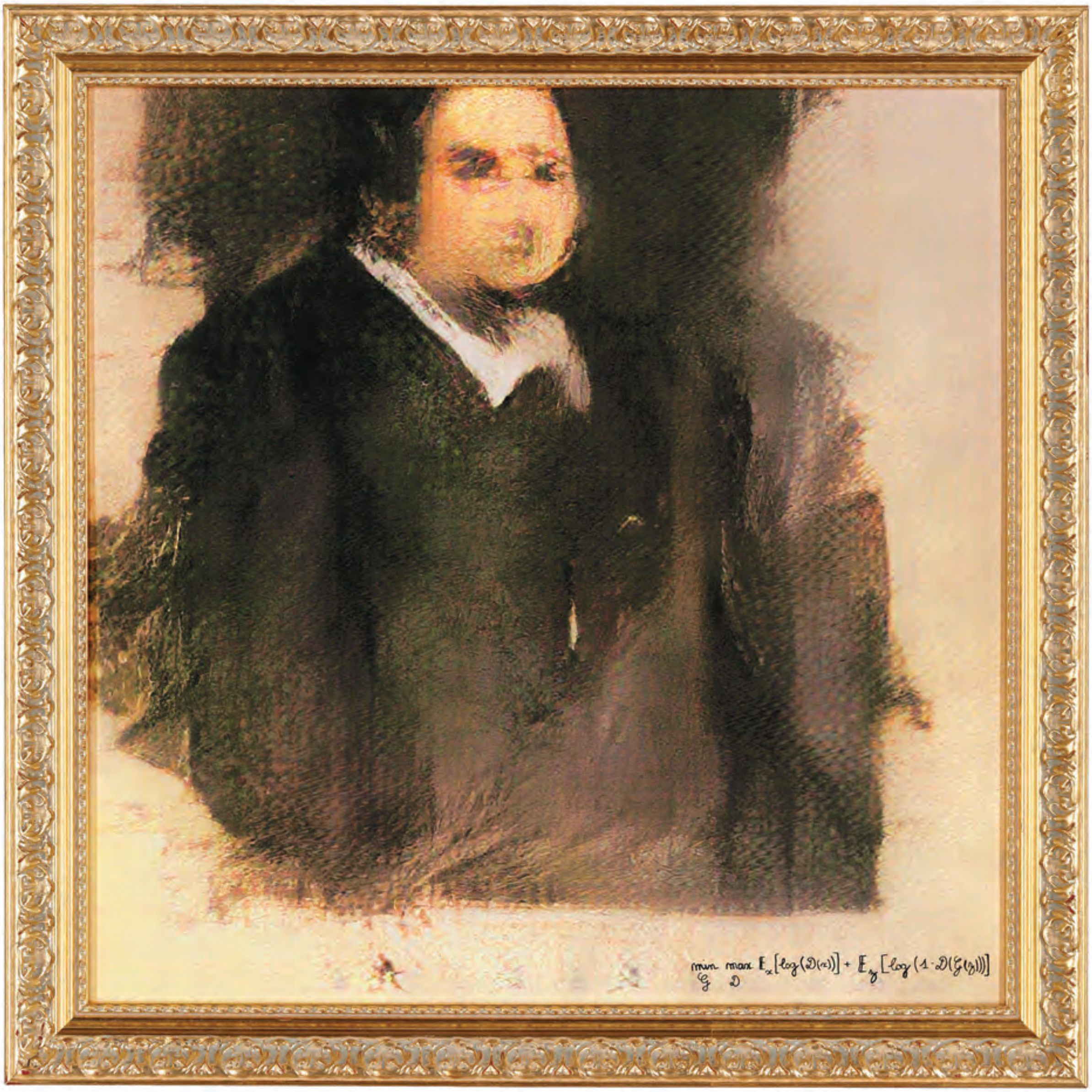
Another striking example of the potential outcome of generative designers using, in this case, Ben Fry's algorithmic Processing system came in the form of the experimental project Komorebi (figure 10.9). Representing the graduate work of designer Leslie Nooteboom, Komorebi consists of a programmable digital projector mounted on a base. In urban homes where natural sunlight may be at a premium, Komorebi is able to provide a variable simulation of natural light. Users would be able to program specific light effects, evoking, for example, the dappled sunlight of a forest scene. This is another example of computer technology that is personable and seeks to clasp rather than distance people from the digital.

10.9. Leslie Nooteboom, Komorebi lamp, 2017

Algorithms that can distribute light or design a chair and shoes have also caught the attention of the art world. In 2018, the three-person collective Obvious presented their machine-learning piece *Portrait of Edmond de Belamy* (figure 10.10). Part of a larger series of portraits of the imaginary Belamy family designed by a generative process, *Portrait of Edmond de Belamy* looks like any of thousands of relatively indistinguishable portraits of the moneyed elite one might find in an obscure national gallery. It could be a representative example of art from any number of European countries of the past few centuries. The Paris-based members of Obvious have explained that the work was generated by a pair of algorithms. The first crunched the data—scans of thousands of European portrait paintings. The second algorithm was tasked with combing through the result. The resulting *Portrait of Edward de Belamy* is not signed by the artists but by the machine: “min G max D EX [log (D(x))] + Ez [log(1 – D (G(z)))].”

The artificial intelligence behind this project is called a generative adversarial network (GAN), and the code was first released in 2014 by Google engineer Ian Goodfellow. A GAN can be used for advanced machine learning, and is one of the components in the creation of “deepfakes,” digitally derived photographs that cannot be recognized as such by the human eye. *Portrait of Edward de Belamy* is in a sense a deepfake of an oil painting, as it was printed and framed so that it appears to be a rough, unfinished study for a portrait. Google has also dabbled in the algorithmic art space, with projects that include DeepDream, which creates new artworks out of fluid, surreal mash-ups of photographs. DeepDream, part of the Google Magenta experimental lab, is an example of a “deep neural network,” a biological metaphor that refers to advanced machine learning using discriminative algorithms to essentially check the work of the generative ones, teaching the GAN to better its capabilities through critical feedback. Another Magenta program, David Ha’s modestly titled Sketch-RNN, features a deep neural network that has learned to draw after analyzing big data, in this case a series of human-created artworks.

One factor that unites both Silicon Valley and the upper echelon of the art world is the ability to market and monetize innovation. While Google has employed GAN for its facial recognition and sorting capabilities to improve the company’s photo apps and Google Assistant, the members of Obvious have tapped into the cash stream channeled by contemporary art auctions. In October 2018, *Portrait of Edmond de Belamy* was offered for sale in New York City at Christie’s, and it sold for $432,500, hundreds of thousands of dollars above its initial estimate. Notably, the portrait’s success is based on how it elegantly conflated cutting-edge technology and a tangible product—it is a painting



10.10. Obvious, *Portrait of Edmond de Belamy*, 2018 after all—that resonates with nostalgia and has proved to be the art world's most enduring commodity. While it is hard to speculate as to what the future of AI art may be, based on this result, we should brace ourselves for a flood of works branded as the product of artificial intelligence to appear at auction in the coming years. DALL-E's and Sketch-RNN's works are not too far behind.

Another dimension of generative design—interrogating identity—appears in the work of Yeohyun Ahn. A professor of graphic design at the University of Wisconsin, Ahn's algorithmic typography responds to "her sense of invisibility as a woman of color and as an immigrant." Ahn began her series *Selfie + Code* in 2015, using Processing and Ricard Marxer's Geomerative library to blend the ubiquitous selfie with expressive typography. The works' deconstructed, calligraphic lines blur the designer's identity while projecting diverse emotional states.

Digital design, with its complex technical demands, would seem in many ways to spell the demise of the amateur, DIY lifestyle. While analog crafts such as woodworking offer obvious space for the hobbyist, digital design demands specialized software that is built to serve professionals. The will to create has overcome these obstacles, however, and today a thriving culture of DIY design makes use of new digital tools. Probably the breakthrough product was the consumer 3D printer, a device that is understandable to anyone with basic computer skills. The key technology behind many 3D printers is stereolithography, an additive process whereby a three-dimensional form is built up out of thin layers. It was first patented in the eighties. Stereolithographic printers (known by the acronym SLA) make use of photopolymers, liquid acrylics that harden on exposure to ultraviolet light. A rival system, also invented in the eighties, fused deposition modeling uses a spool of plastic filament that is melted and extruded by the machine. About a decade ago, these machines became financially and technologically accessible to hobbyists. Costing as little as a few hundred dollars, the craft world's "makerspaces" today feature a sea afloat with millions of iterations of 3DBenchy (for "benchmark"), the little boat that many 3D printers use for initial calibration. For those who desire a more complex machine and have deeper pockets, companies such as Materialise now also accept paid commissions from DIY designers.

Beyond basic 3D printing, DIY culture has spawned an ecosystem of hardware and software services that enable more advanced projects. Utilizing Creative Commons and GNU open source licensing, websites such as Thingiverse contain vast repositories of design templates. The DIY community in many ways still embraces the inspirational, even utopian spirit, of the early computer age—think GeoCities—so designs and ideas are freely communicated, disrupting the "monetization" at the heart of Silicon Valley culture. It is common in the digital hobbyist world to admire a template or block of code online and ask the author to add something new to their design. In this way, people with different skill levels and experience can be a part of the scene, be they veteran coders, designers, or rank novices.

Autodesk, the company known for its CAD software, has been a willing partner of the DIY community. Their free web-based app Tinkercad is an accessible way to get involved in DIY

10.11. Gary Walker, Bauhaus-inspired USB lamp on Thingiverse, 2019

design. Tinkercad is widely used in schools as a way of introducing students to coding and CAD. For more advanced hobbyists, Autodesk also offers free licenses of its sophisticated Fusion360 software. Fusion360 is a cloud-based program used mainly by industry professionals and runs the gamut of acronyms: CAD, CAE (engineering), and CAM (manufacturing). For those capable of mastering its intricacies, a basement workshop can have the same tools as a professional design studio.

Finally, one of the essential products of digital DIY culture is the Arduino, a micro controller that is paired with open source software. The Arduino hardware was first invented around 2003 by Italian university students seeking an inexpensive controller for their digital projects. Since the initial board was released a few years later, a global community of hobbyists has built a countless number of sensors, motors, and the like, while others have produced vast amounts of code. Today web platforms such as GitHub—founded in 2008 and acquired by Microsoft in 2018—are replete with libraries and code that are freely downloadable and allow hobbyists to use an Arduino as the basis for an astonishing range of projects.

Putting all these tools together, a DIY designer can, for example, design a lamp from scratch: First, download templates from Thingiverse, design an additional part with Tinkercad, and print all the parts on a 3D device. Next, download code from GitHub for the Arduino, attach the board to a bank of LEDs, and, voilà, you have fabricated a Bauhaus-inspired USB lamp (figure 10.11). In essence, digital hobbyists today are far closer to simulating the realm of, say, Jonathan Ive at Apple than they ever could have been in the predigital industrial age. The internet has facilitated access to design strategies and technical knowledge in a way never before thought possible. The designer of the aforementioned lamp on Thingiverse goes by the screen name gewalker (né Gary Walker), and his description of the project offers an inside look at the supportive, human-centered element of digital DIY culture. “This is still very, very much a work in progress. I like to share my source code early, though, and give interested people a chance to mess with it themselves. This is inspired by, but cannot honestly be said to be based on Serge Mouille’s 1957 Tripod Lamp design. Eventually, I hope to have a full kit with links to the electrical parts I’ll use. Update: decided on electronics. The round panel is intended for mounting an Arduino/Adafruit Gemma [a Gemma is a small Arduino-compatible controller] and an array of addressable LEDs on the reverse side.”

Bethany Koby began her career in digital design as a graphic designer and creative director, but she entered the world of digital DIY through a

10.12. Bethany Koby's Gamer Kit, 2013

personal experience. Frustrated with the toy industry's offerings for her son, she decided to build a new company that would make technologically sophisticated kits for children. In 2012 she cofounded Technology Will Save Us, a London-based firm whose products attempt to channel technology into a more creative direction. Koby decries the "consumptive experience" that most children have with technology, mesmerized and immersed in screens. Technology Will Save Us makes DIY kits that allow children to assemble electronic components through hands-on techniques such as soldering, while also learning the basics of computer coding. For example, the Gamer Kit (figure 10.12), first released in 2013, combines making and programming, as well as two preloaded video games as well as the tools and instructions to build one's own. In a collaboration with the BBC, Technology Will Save Us—whether the company name holds an ironic undertone is unclear—played a large role in the creation of the micro:bit, an Arduino-like board that can serve as the basis for coding projects. Part of the BBC's Make It Digital campaign, the micro:bit was designed to foster a hands-on understanding of digital technology for students whom Koby has termed the advancing "creator generation."

In Roland Barthes's 1957 critique of consumer culture in *Mythologies*, he opined, "I think that cars today are almost the exact equivalent of the great Gothic cathedrals; I mean the supreme creation of an era, conceived with passion by unknown artists, and consumed in image if not in usage by a whole population which appropriates them as a purely magical object." While automobile companies in the aggregate have been at the forefront of digital design for decades, no brand has fired the imagination of the digerati more than Tesla. Founded in 2003 by digital celebrity and cofounder of PayPal Elon Musk, Tesla successfully sought to make electric vehicles sexy and glamorous with the release of a sporty roadster in 2008. Since that time, the company's sleek vehicles and a cult of personality around Musk have created one of the most powerful digital brands, even though only a tiny sliver of consumers can afford its products.

Barthes was referring to engineers and industrial workers as the passionate "unknown artists" who designed cars at midcentury, but today that anonymous group is joined by the faceless computations of big data and the algorithms that manage them. Tesla cars represent today's apogee of data collection and machine learning (figure 10.13). Especially as the

10.13. Tesla Roadster, 2008

company works toward the goal of autonomous vehicles, the myriad sensors on a Tesla collect continual streams of data that are automatically uploaded back to the firm. Front-facing cameras, radar, and other sensors record every mile driven. These networked cars foment machine learning on a massive scale, as algorithmic intelligence works to better the cars' ability to navigate without human input. In pursuit of machine perfection, a Tesla vehicle works more like an app on a smartphone than a conventional product: it is not finished when you drive it off the dealer's lot but will receive software updates continually throughout its useful life.

Perhaps inadvertently, Teslas, like the whole range of smart devices and social media services, have developed the wherewithal to become part of a dystopian surveillance machine. Most consumers choose to ignore the fact that many digital conveniences are based on the collection of big data, and—if they so choose—the machines can record who you are, where you are, and what you are doing moment by moment. Take Google's Clips camera, released in early 2018 (figure 10.14). An elegant little device that looks like the Instagram icon has been made actual, the square video camera "learns to recognize familiar faces." It essentially surveils your pets and family, gradually learning who you interact with the most. As Google emphasized, "it gets smarter over time," which may have been a promise or a threat. The camera was quietly discontinued in 2019. Clips exemplifies the trend toward machine surveillance that is abstract and nebulous for most people; of course, data today are freely given and anonymized when bought and sold, but nonetheless it casts something of a pall over big technology that the digital industries must confront as technology advances. In the autumn of 2018, none other than the CEO of Apple, Tim Cook, came out strongly in favor of greater privacy protections for consumers. "Our own information—from the everyday to the deeply personal—is being weaponized against us with military efficiency. Today, that trade has exploded into a data-industrial complex." Many critics argue that some sort of tipping point that will spark a backlash against data culture is within sight, although complacency continues to rule the day.

Facial recognition is yet another surveillance technology that combines big data and algorithmic processing. The American artist Zach Blas has created works that investigate the impact of facial recognition with a special focus on how vulnerable groups can be targeted

10.14. Google, Clips camera, 2018

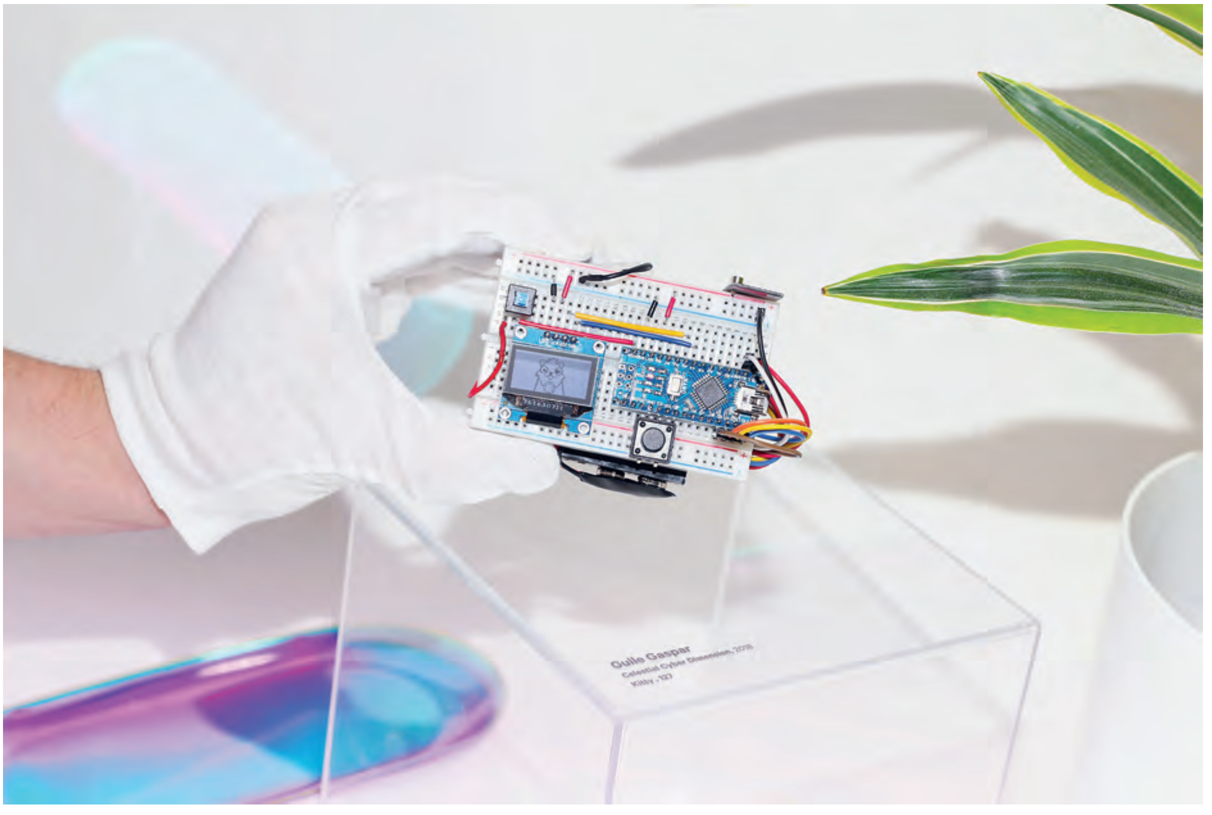
by the machines. For example, his *Facial Weaponization Suite* (2011–14) is a meditation on how biometrics can be an instrument of power. Blas subverts recognition by creating masks out of aggregated faces of different groups. His *Fag Face Mask* of 2012 (figure 10.15) consists of a pastiche of queer men's faces that have been digitally scanned; then a CNC machine was used to carve out the work. The resulting mask is purposely grotesque and unreadable via biometric recognition, defying the scientific research that has attempted to link sexual identity to facial features. Of course, masking one's face to resist authority has both a long history and a contemporary presence, as it has been conspicuously revived by self-styled anarchists who favor the Guy Fawkes mask to conceal their identity.

Algorithmic processing is also at the heart of blockchain cryptocurrencies such as Bitcoin (2008) and Ether (2018). The mining of the coins, the "proof-of-work" that verifies the system, and the recording of transactions all depend on algorithmic calculations. Remember that while a blockchain—a type of shared digital ledger book—is mainly associated with exotic virtual currency, it can be easily coded and can be used to catalog the value of just about anything. Combine this fact with the immense semivirtual fortunes that people amassed in the blockchain bubble of 2017–18, and strange and wonderful designs are one result. Such was the case after the launch and stratospheric rise of Ether, a currency tied to the Ethereum blockchain assembled by Vitalik Buterin and launched in 2015.

Cryptocurrency has found itself at the center of the ongoing debate about the environmental impact of the digital world. Virtual currencies, like so much of the digital, seemingly free people from the pollution of industrial manufacturing and landfills. The virtual world's energy consumption, however, is unheralded in the history of new technologies. While estimates vary, the blockchain today uses more than 100 terawatts of electricity per year, a massive amount of power for a technology that has yet to develop a strong raison d'être outside building speculative fortunes for a few early adopters. The digital world is in fact replete with screen-based experiences that feel sustainable but are in fact powered by vast server farms with huge carbon footprints.

As Ether exploded in value as a part of cryptomania, legions of newly minted millionaires and billionaires reveled in their piles of what

10.15. Zach Blas, *Fag Face Mask*, part of *Facial Weaponization Suite*, 2012



10.16. Guile Gaspar, Celestial Cyber Dimension, 2018
10.17. Guile Gaspar, NFT hardware for Celestial Cyber Dimension, 2018

surely felt somewhat like the house's money. Additionally, they felt loyalty to the blockchain that had enriched them. And CryptoKitties was born. As one of the cofounders of the feline-themed blockchain explained, "We're just like, man, people want cats." Within a few months the CryptoKitties blockchain had recorded over $20 million in Ether transactions of virtual cats, some costing more than $100,000. Unlike their not-so-distant digital ancestor, the Tamagotchi, CryptoKitties are not demanding, just cute. While feline, CryptoKitties can also be bred like racehorses, and certain early, desirable cats have garnered stud fees of more than $20,000.

In what appeared at one time as peak hubris in the cryptocurrency boom, in the spring of 2018 a CryptoKitty sold at a charity auction for $140,000. Designed by the art director at CryptoKitties, Guilherme Twardowski (aka Guile Gaspar), the work once again showed how virtual designs often betray a hunger for hardware. The virtual pet, called Celestial Cyber Dimension, is purple and as wide eyed as an anime character, wearing a glowing orb necklace (figure 10.16). But Celestial is not just virtual, as the auction offered a piece of hardware complete with an ERC-721 token, essentially a physical repository of the code that records the cat's place in the kitty blockchain (figure 10.17). A thumbnail screen shows Celestial looking out at you from the circuit board in which ($)he is entrapped for eternity.

Of course, CryptoKitties turned out to be just the point of the NFT spear. These so-called non-fungible tokens—powered by blockchain smart contracts—exploded into the mainstream in 2021, as everything from basketball highlights and artworks (Beeple!) to music and colors can be marketed as NFTs. Major corporations have immediately jumped on this hotter-than-hot market, while celebrities have found new ways to monetize themselves: Canadian musician Claire Boucher, aka Grimes, sold almost $6 million worth of her NFTs in a short span of 2021. NFTs have also powered a new wave of designer-artists like Brendan Dawes (see chapter 7), a Flash artist whose abstract graphics have been reenergized through the blockchain. As of this writing, the entire crypto universe has teetered on the brink of collapse as many question its utility—even its entire raison d'être—amid a spasm of financial scandals.

One last point about algorithmic culture: How will future historians make sense of social networks that are ruled by personalized computations? Would it ever be possible to understand the experience of a photostream or newsfeed that is tailored to the individual in real time? Additionally, the simple quantity of posts, memes, and snaps seem likely to bedevil even the most assiduous student of the digital past.

13.1. Zach Blas, Icosahedron, 2019

Coda. The Digital Future

Whereas Stanley Kubrick's HAL provided an earlier generation's first and only taste of human–machine interaction, today discussions with relatable assistants have become part of the mundane fabric of life. Two of the most pervasive interlocutors are barely a decade old: Apple's Siri came on the scene in 2011, followed by Amazon's Alexa in 2014. Neither really crossed the threshold of mainstream utilization until the last few years.

As digital assistants like Alexa continue updating and evolving, making them warm and personable has become a central goal of their designers. While HAL was voiced by the Shakespearean actor Douglas Rain, Alexa is a synthetic voice that uses natural language processing algorithms to drive a text-to-speech system. Machine learning of this sort has its limits, and Amazon wants to avoid even the hint of a robot voice. For this reason, Amazon has sought out a nontraditional group of professionals to give personality to the device. As *Wired* put it in a 2017 article, "Our Robots Are Powered by Poets and Musicians." The title refers to three women who collaborate in the creation of Alexa's persona. Farah Houston has a background in psychology and helps mold the humanness of Alexa. A writer, Michelle Riggen-Ransom, writes the basic responses. Beth Holmes, a mathematician, also contributes to the content and texture of the machine's personas. A fourth woman, Susan Kaplan, is the voice actress. In this regard, Alexa represents a type of "affective computing," a term coined by Rosalind Picard in the late nineties. Picard's current research is aimed at "enabling robots and computers to receive natural emotional feedback and improve human experiences," and eventually allowing computers to "have" emotions.

Alexa and Siri's original female voices also bring up the issue of gender and ethnicity in digital culture. The age of computer design began at a time of entrenched sexism, with women excluded from the fields that launched the digital age. Anecdotally, the difficulties that women faced are evident in the career of Poppy Northcutt. A mathematician, Northcutt was one of the only women computer scientists that worked on both the Gemini and Apollo programs at NASA. She was often presented as exemplary of the agency's forward-leaning culture for publicity purposes and made note of the paradox implicit in her role at NASA. On the one hand, she felt that computer programming offered a gender-free environment: "The nature of this business doesn't lend itself to discrimination. If you write a computer program, it either works or it doesn't. There's no opportunity for anyone to be subjective about your work." On the other hand, however, she has marveled in recent years over how her role was defined at NASA. Northcutt recounted to *Time* in 2019 that her official title was "Computress." She remembers pondering the awkward sexism of this job description: "Not only do they think I'm a computer, but they think I'm a gendered computer."

Another way of interpreting people's relationship to voice assistants like Alexa is through the history of brands. Corporations started the widespread use of brands in the nineteenth century as a way of establishing trust and a sense of reliability with consumers who had, until recently, bought most of their products from people personally known to them. In large industrial cities, purveyors of mass-produced items, especially foodstuffs, pioneered intentionally designed brand representatives—personifications of otherwise faceless industrial companies—to establish an emotional connection with their customers.

One of the most prominent early brand ambassadors was a character called Aunt Jemima. In 1890, the Davis Milling Company purchased a pancake mix named after the minstrel song "Old Aunt Jemima." The song had been composed in the 1870s—the beginnings of the Jim Crow era—by Billy Kersands, one of the most popular Black entertainers of the time. Importantly, the owners of Davis Milling decided to enhance the Aunt Jemima brand by hiring a real person to act as a live-action character in promotional settings. The first actor to take on the role was Nancy Green, a fifty-six-year-old woman who had been born enslaved in Kentucky. She continued to act as Aunt Jemima until her death in 1923. Over the ensuing decades a series of actors took on the role: Ana Robinson, Anna Harrington, Aylene Lewis, Edith Wilson, Ethel Harper, and Rosie Hall. The Aunt Jemima character was of course a racist stereotype aimed at white people who casually accepted plantation-era representations of Black Americans. Although Quaker Oats started downplaying the brand in the sixties, and in the eighties modernized the character to appear more like an affluent housewife, it did not retire the character and brand name until 2021.

In 2014, Amazon had introduced its own virtual, live-action digital assistant: Alexa. For six years the two brand ambassadors overlapped, seeming to symbolize the societal advances of a new age. Alexa acts as a branding personality for the retailer and by extension a simulacrum of the digital world itself, warm, helpful, and relatable. In some ways, her partly synthesized voice attempts to represent a clean, new digital world apparently washed of biases and inequities of any sort: a postracial, postbias utopia of gleaming efficiency. The virtual environment branded by big tech, however, often seems decidedly racialized, and Alexa speaks with what most people take to be the pitch and cadences of a white woman. And woe to the nonwhite person who converses with the digital; research at Stanford University has shown significant disparities in the ability of speech recognition software to correctly understand Black voices.

Digital assistants may put an engaging voice on an unequal world, but their work is mainly symbolic. The most intractable societal problems are hidden in the machines. Behind Alexa's warm tones lies a treacherous world of analog human behavior and structural bias. It has become clear that the combination of big data and artificial intelligence behind so much of our digital world is imbued with the same problems that have plagued the analog world. As computers using machine learning perform more and more of society's hiring and firing, lending and incarcerating, the problem of algorithmic bias is emerging as a vital threat to digital culture.

The Digital Future

The question remains as to where the digital age will go next. Visionaries still abound. Philosopher Yuval Noah Harari has asserted that humanity will soon attempt to attain superhuman powers through algorithmic processes: each of us our own Alexa, a Homo Deus dominating the mirror world. Or the future may be depersonalized by AI, our texts written by chatbots and our self-images by DALL-E. But, of course, this future is all quite unknowable, and in the digital age even more so than before. Harari has noted, "Centuries ago human knowledge increased slowly, so politics and economics changed at a leisurely pace too. Today our knowledge is increasing at breakneck speed, and theoretically we should understand the world better and better. But the very opposite is happening. Our new-found knowledge leads to faster economic, social, and political changes; in an attempt to understand what is happening, we accelerate the accumulation of knowledge, which leads only to faster and greater upheavals."

Digital artist Zach Blas has added his own whimsical take on the digital future through his Icosahedron (figure 13.1), a contemporary update of midcentury's twenty-sided Magic 8-Ball, which could playfully "predict" the future. Blas has loaded his work with twenty visionary texts, and through machine learning, the AI in Icosahedron will offer its predictions for the future. The original Magic 8-Ball offered ten positive responses and only five in the negative, so one can hope that the digital version will maintain that optimistic bias. As Blas has written, "Skip the TED Talk: to find out what's shaping the future, ask Icosahedron."