THE MAKER MOVEMENT MOVES INTO THE SCHOOL ART STUDIO

Erin E. Riley explores the intersection of coding, art, and digital fabrication

People learn best through creating and sharing the objects they make. Every time someone makes art with any kind of material – clay, cardboard, or computer code – ideas are brought into the world. While ideas are being expressed, a parallel process is taking place, unlocking previous understandings and experiences and connecting them to new ones. This web of knowledge that develops through 'doing' is a cornerstone of progressive education. Education giants like Seymour Papert, through the theory of constructionism, underscored the expressive power of computers as creative tools. Today we have an unprecedented opportunity to put these tools in the hands of the next generation.

So what does a contemporary art studio look like today? How do artists meld digital tools with more traditional ones? With the enthusiasm around the maker movement, and its growing influence on education, an exciting opportunity exists to forge new pathways for making art using digital technologies and fabrication.

Turtle art on clay: drawings created with code and expressed as fabricated objects

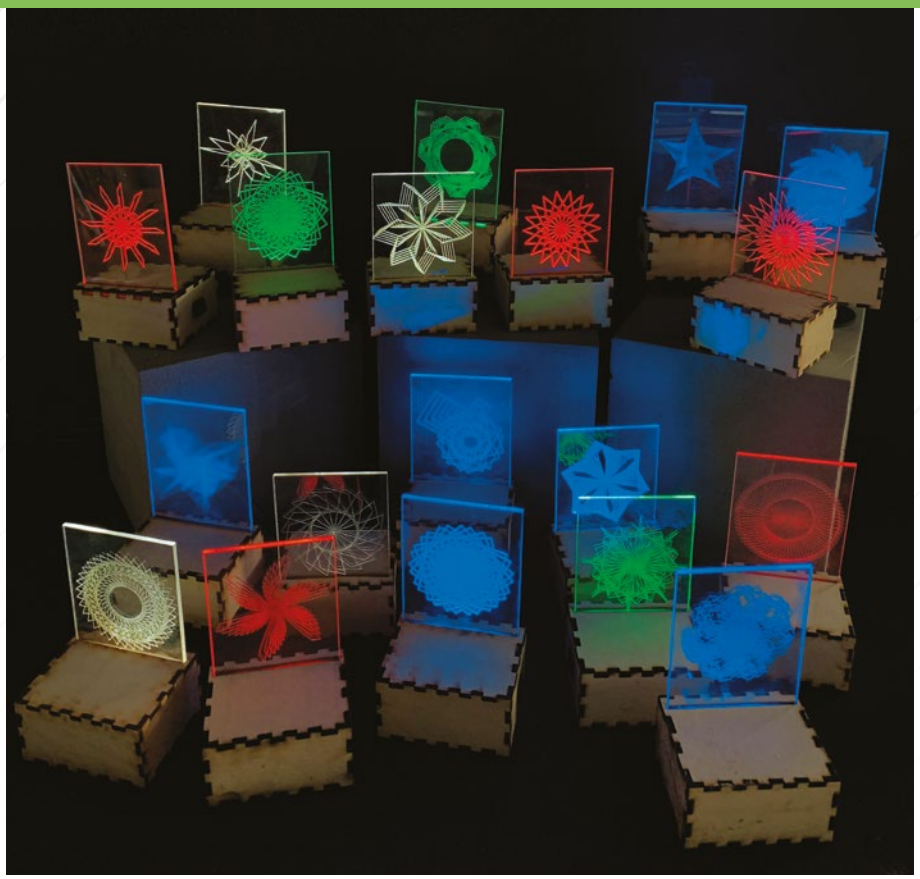
Digital fabrication machines, such as laser cutters and 3D printers, were developed for engineering and commercial design, but also have direct applications in art and design in a school setting. Educators can now fold the knowledge of tools and materials for art, into the advancement of ideas in making. As the field of art and design continues to expand, it seems fitting that artists look to the design processes used in engineering, architecture, and commercial design to inform their process. At the same time, elements of art and design bring relevance and beauty to school subjects.

> "ELEMENTS OF ART AND DESIGN BRING RELEVANCE AND BEAUTY TO SCHOOL SUBJECTS

Digital and physical materials combine

Studio practitioners needn't abandon materiality when using digital technology. Fabrication produces objects from tangible materials and the art studio is a rich source of raw materials for projects. Digital design parallels physical design, and digital tools can mirror the push/pull responsiveness of physical materials. What we imagine and create digitally can be produced with machines that understand code, and the ingenuity of the artistic creation that is a product of that process ultimately depends upon the vision of the maker.

A makerspace is full of machines that can interpret drawing – the universal visual language – in familiar ways, but also can allow exploration of the very idea of what drawing means. Drawings can be created

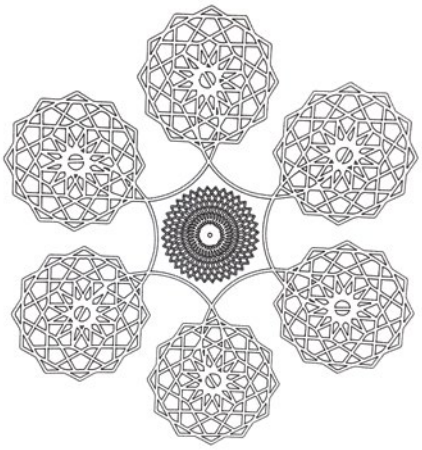


Edge-lit pieces of acrylic facilitate 'drawing with light'

with code and expressed as fabricated objects. We can substitute a pen for the cutting tool on a computer numerical control (CNC) machine or vinyl cutter, or extrude very thin prints on the 3D printer to make flat shapes. We can 'draw with light' by attaching a light to a programmed robot or laser-etch/score a design for an edge-lit piece of acrylic. Machines can be used to explore variance and imprecision in a process. A loose pen or varying the settings in a laser-cut etching or score line brings artistic line quality to a work. There are infinite combinations of materials, machines, and software awaiting the curious artist interested in machine drawing. And drawing is only one of the myriad artistic processes that can be explored and expanded using digital technology.

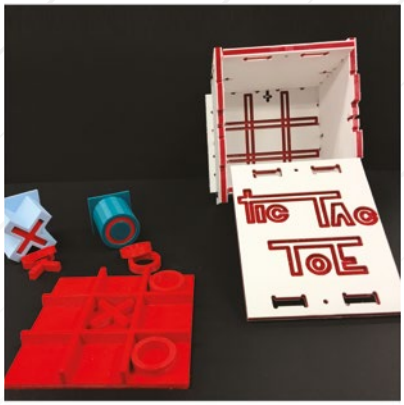
Design on purpose and by accident

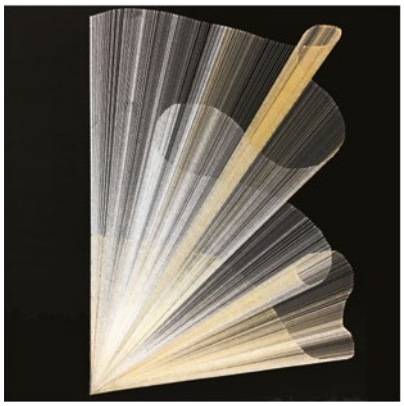
Digital design parallels physical design. Pixels, or tiny elements of graphic information, are the elemental unit of a raster image, and have been a part of the art and design vocabulary since early computer graphics. When small,



Pens can be substituted for cutting tools

manipulating the pixels can be a painterly application of digital information. But as pixels increase in size, a gridded order emerges. Using the Pixel by Numbers Processing application created by Erik Nauman (**helloworld.cc/pixels**), students experience 'pixellation' as an artistic element while exploring digital tools. Students convert images into a 'colour by number' pixel map and the program generates a numbered grid with a colour





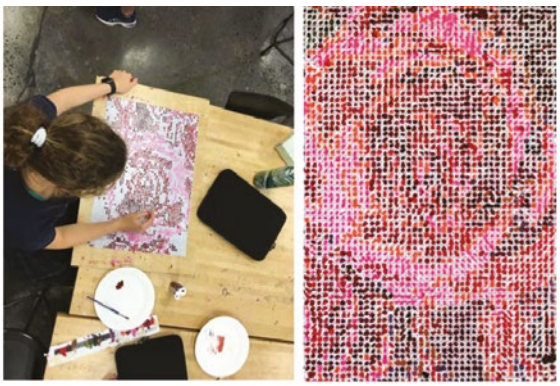
Merging physical art materials with digital design, fabrication, and code broadens the toolset for our artists, designers, and makers *Credit: Erin Riley*

Varying the settings in a laser-cut etching or score line brings an artistic line quality to a work

key. The grid is in vector form and can be printed or exported for digital fabrication. Not only do students enjoy selecting images to convert to pixel art, they are excited by the process as their pixellated image emerges from the blank grid.

Finding beauty in mistakes or random actions, or 'misthetics', is an accepted design approach in art. Like drips and drizzles of action painting, data-bending a digital image by modifying image text, gives rise to an unexpected, glitchy result. Students experiment with additions and deletions in the text file, and the raster image linked to the text file progressively degrades.

> SOME MODERN DESIGN APPLICATIONS HAVE CODABLE ELEMENTS

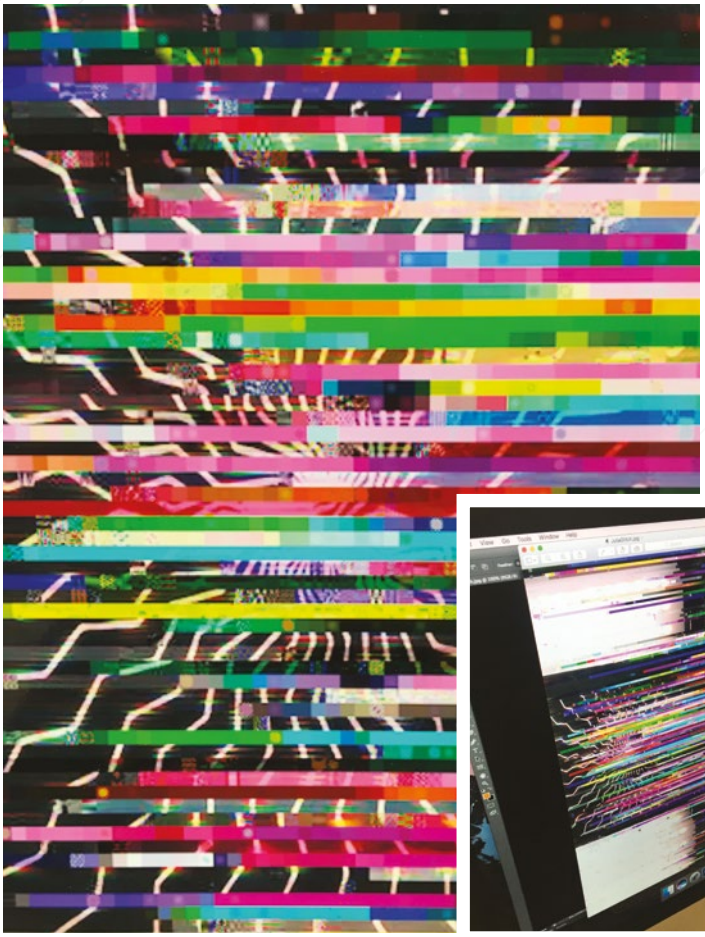


Erik Nauman's Pixel by Numbers tool allows students to convert images to pixel art

Artists interested in exploring the extent of variance of change in a design can use code. Some modern design applications have codable elements, allowing students to experiment with variables or random number generators in their designs. The unknown variable creates surprise combinations when the code is executed and the artist looks for the serendipitous result to capture and send to the fabrication machine.

The power of iterative design

The computer has the capacity to do things differently than the human hand. Sometimes what we want to achieve with our work requires algorithms. Similar to how a drafting machine can be a tool to aid precision, a computer program can do the same. We write code and the computer executes our intention. Designs for digital fabrication machines like 3D printers, laser cutters, vinyl cutters, and CNC machines are output as machine directions and generate



Students can experiment with 'glitches' in digital artworks just as they might explore the effects of drips and drizzles in action painting

toolpaths. These machines are programmed to exact locations and pair well with design ideas that are very precise.

For educators interested in STEAM, design and fabrication builds competencies across all areas. Maths, which is applied in art, is foundational to image and space building. Artists use maths to build compositions, patterns, or structurally solid 3D constructions. Students have the opportunity to test their designs in the physical world through fabrication. Mistakes in measuring, scale, and transformations show up in the model that is sent to be fabricated. Mistakes may result in failed prints, machines cutting in the wrong place, or machines not working at all. But as artists know, mistakes are not failures. Mistakes lead to new discoveries or are improved upon as modified designs reimagined and iterated upon.

We can equip our students with a new language for speaking about technologies in relation to their work that is true to our fundamental methods of how we make and teach art. Digital materials and fabrication add to a vast menu of options for bringing impressive, and personally meaningful objects and ideas into the world. (HW)

Erin E. Riley's book, *The Art of Digital Fabrication*, is reviewed on page 96, and available to buy now at **artofdigitalfabrication.com**.

ERIN E. RILEY

Erin (@eeriley99) is Director of the Engineering and Design Lab at Greenwich Academy, a K-12 school for girls in Connecticut. Her work centres on STEAM – she collaborates with teachers in the development of hands-on making activities that intersect the arts, STEM subjects, and humanities.

ART AND CODE

Coding gives artists and makers a powerful tool for introducing pattern and complexity to designs. Digital fabrication machines found in makerspaces, like 3D printers, vinyl cutters, and laser cutters, can be used to draw, carve, and cut intricate designs that students make. Programming variability into code using parameters can amplify the iteration process with parametric design tools and open up possibilities with generative art.

THE ART OF DIGITAL FABRICATION:

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Casting with chocolate or concrete?

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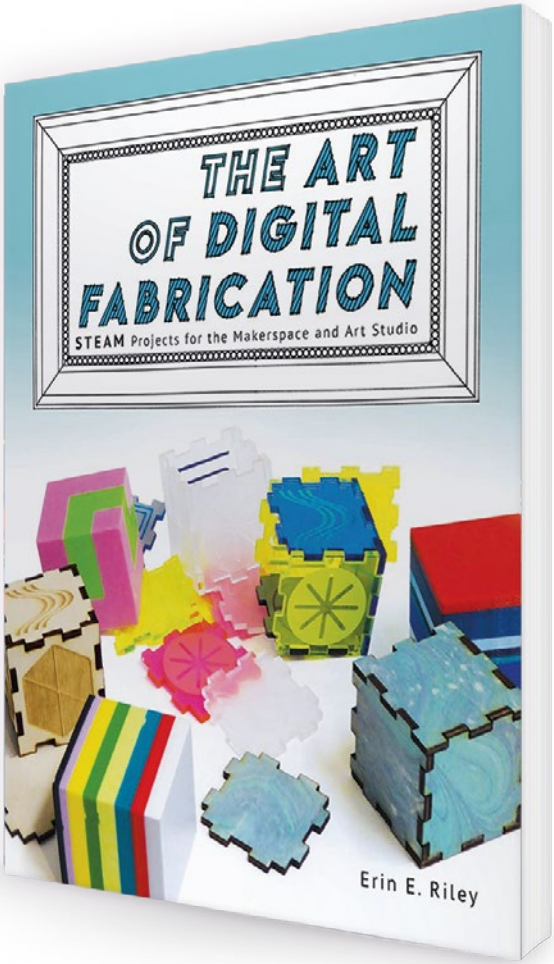

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