Please Challenge
Create Fun

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By Andrew Ringler

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Cover Art: Captured screen designed by a user during a Draw Blocks installation. See Draw Blocks chapter to learn more about this project. 2015.

All uncredited photos are my own or thanks to my family and collaborators.

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An MFA Thesis By
Andrew Ringler

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Abstract

Increasingly, designers are building interfaces that minimize clicks, confusion, and time all with the presumption that this benefits the user. This narrow design focus leads to the creation of experiences that ignore vital human needs like: sensory experience, socialization, challenge, and learning. This thesis proposes a design philosophy and demonstrates realized works that return these vital human needs to the design process, ultimately creating more enjoyable and satisfying experiences for users.

The prominent interaction design philosophy of our time can be summed up in the title of Steve Krug's book *Don't Make Me Think*. Humans have evolved to seek out efficiency and designers have exploited this to create what has been termed "frictionless" experiences. As an experience designer, attempting to remove all friction can lead to efficient interactions, but can also lead to experiences that are merely addictive (Facebook, Netflix Streaming, and Candy Crush), yet unsatisfying, vacuous, and boring.

This thesis highlights the importance of providing a variety of challenges in the user experience, including physical and intellectual challenge and the act of learning. Additionally, this thesis explores challenges introduced through social engagement, such as: interacting with strangers and performance in front of others. Designing with these goals in mind allows designers to create experiences that users find more enjoyable, engaging, satisfying, and fun to interact with.

Many designers would argue that "reducing friction" is a valid technique for both initially engaging and keeping users. My research and projects question this assumption and propose that we can keep users engaged while simultaneously challenging them. As Mihaly Csikszentmihalyi has argued in his seminal work *Flow*: challenge is a vital human need. Through careful consideration of the process of learning and through consideration of the level and nature of challenges, creating engaging and simultaneously challenging experiences is a possibility.

The themes of creation, collaboration, and learning tie together this thesis, the work examples within, and its philosophies of experience design. The process of creating new things, new ideas, and new experiences is extremely fun, rewarding, and is an act of learning and personal growth. The projects in this thesis facilitate the process of creation by providing users with novel opportunities for creation. They do so while also creating holistic sensory experiences, engaging users in process of learning, socialization, and with physical and mental effort. Including such concepts during the design process ultimately creates experiences that are more enjoyable, engaging, and satisfying to their users. This thesis not only presents a design philosophy, but also documents many realized projects that were created using it. Please create something and challenge yourself, you will have fun.

This thesis is submitted in partial fulfillment
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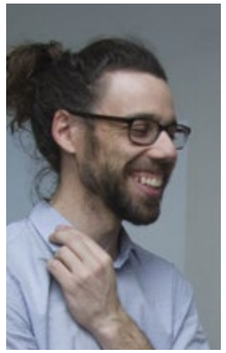

Thank you **ALL** for supporting me during my two years at MassArt.

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Introduction

A Short Story About Myself

My interest in filmmaking started early in life inspired by the Kastorfs. My parents had attended college with Gail and Karl Kastorf and had remained good friends. Although they lived a few hours away, we would usually see them at least a few times a year. Gail and Karl have two sons: Josh and Kurt. Josh, the older, was the filmmaker in the family. When they would come to visit, Josh would usually arrive with a film script idea.

Josh would explain the script to Kurt, my brother Mat (yes Mat with one 't'), sister Alyssa, and me. Josh would suggest roles, we would complain about our roles and Josh would adjust the roles until we were satisfied. He would then direct a movie recorded on my parents' video camera. Either Josh or my brother, being the eldest children, would always be the camera operators.

After watching Josh direct films for many years, I started making my own films with my local friends. We would usually make slapstick comedy action films inspired by films like *The Naked Gun* with Leslie Nielsen. We would re-visit old themes making first *The Ping-pong Showdown*, followed soon after by the less successful *Go-fish Showdown*, followed by the now infamous *Tennis Showdown*. We would explore topical ethical themes as in *Dog Fight* and post cold-war politics in the Russian film *Gulag*. All films (save a few) are now lost to the ravages of time, re-writable VHS technology, and careless teenage archiving practices.

I volunteered at the local community access television station in middle and high school. I would often help as camera operator or sometimes as assistant director. I studied some video production during high school. After college, while I was living in Aspen, Colorado, I again volunteered at the local community station, now experienced enough to direct a local political show. Although I had always been passionate about filmmaking, I had

Movie stills from *An Evil Sorcerer*, circa 1990. Directed by Josh Kastorf. Top: me, Center: me, Bottom, left-to-right: Mat Ringler, me, Kurt Kastorf.

never actually considered it as a career.

I come from a family with many artists. My mother is an artist and college professor in mixed-media visual arts and design. My sister is a photographer in addition to working in many other mediums including ink, print and collage. Two of my cousins are actors and playwrights. One of my cousins is a fine jewelry maker. It is from my mother's brother Peter, however, that I believe I became more interested in science than art. Peter is a physicist who owns his own company designing a diversity of custom products for manufacturing. I visited his company and workshop at a young age and immediately saw science as an interesting and viable profession, most likely due to viewing a workshop full of strange and fascinating equipment. I decided at that point that I should study science in school.

My interest in science was placated mostly by children's "science kits." I had chemistry sets, electronics sets, model rockets, and assemble your own remote control cars. I even pursued amateur radio for a while when I realized they could bounce radio signals off the moon and could connect to the Internet via free radio gateways. This interest probably revolved around my love of tinkering and quickly evolved into an interest in computers.

My father runs his own dental practice and has always been a technologist. He was an early adopter of computers and when he would upgrade office computers every few years I would be able to grab a few old ones to take them home. I was initially interested in making the old computers work better by taking parts from several to make a single upgraded machine. I soon started connecting to BBSs (electronic Bulletin Board Systems) via my parent's phone line. BBSs started in the 70s and were essentially a network of computers connected intermittently via phone line.

The BBS relied on a volunteer running a computer at his home and keeping phone lines available for people to call in. That BBS would then act as a hub, connecting with other BBSs to create a network of all the BBSs. At the time people usually had to pay extra for "long-distance" phone calls so there was strong incentive to call local free BBSs. This created a more neighborly feel to the network. I knew all the BBS owners by name and even went to school with one of them (he was 15). BBSs provided various services like chat, online multiplayer games, file downloads, research archives, and even global digital mail (a precursor to email).

The opening scenes of the 1983 film *Wargames* provide a fairly accurate depicition of BBS culture. In the film, Matthew Broderick writes a program that automatically calls every telephone number in California searching for the internal BBS of a game development company. Soon after the film's release, programmers started creating software applications that could search for BBSs, calling them "war-dialers."

During the late 80s and early 90s people were building BBSs with dozens of phone lines. Upon logging in you would see a list of other users who were logged in and many BBSs would even prompt you to chat with one of them. You could make new friends this way. It was sort of like the metaphor of bumping into someone on the street, or noticing someone reading the same book as you on the T (Boston's public transit). The BBS community was trying to create a virtual community modeled after a real world community. There was something very personal and human about the whole thing.

The Internet (as we know it today) was being developed simultaneously with the BBS. Unlike the BBS, in order for the general public to connect to the Internet they had to pay monthly service fees to a commercial provider like CompuServe, Prodigy, or AOL. The Internet was not built around a community model like the BBS, but was instead a collection of ad-hoc services one could connect to.

I think that my early experience with BBSs left me with a positive romantic memory of what digital networks could be, an idealized vision of what I thought the Internet would become, but certainly never did. I soon became more interested in the technical aspects of how these systems were built. During high school I learned to program by taking courses at the local

college where my mother teaches, leading to my decision to pursue computers as a career.

I studied computer science at the University of McGill in Montreal. Computer science, as the name implies, is the study of the science of computers. I was soon pleasantly surprised to learn that my program was designed to build a theoretical foundation in the sciences related to computers and not to teach programming per se. In my entire four years at McGill I attended only a single course that actually taught programming.

Despite this, after graduating I spent over ten years as a software developer. During that time I was always taking classes through various institutions. I took classes in filmmaking, design, acting, improv comedy, drawing, dancing, trapeze, interaction design, web design, and experience design. I have always been interested in learning and especially drawn to classes taught by an instructor. McGill had fostered my interest in conceptual computer science and for a long time I considered returning to university for a PhD. However, after having attended a diversity of courses over many years the prospect of studying computer science no longer felt like a good fit.

My interest in instructor-based learning broadened somewhat when I started working at Icosystem in 2007. I found a wonderful community there and ended up staying until I entered graduate school at MassArt in 2014. In 2010 Icosystem instituted a coaching program assigning each employee a coach (or mentor). My coach helped me to define goals and work towards them. Through coaching I decided to pursue user experience design. I started taking classes, attending conferences and reading as many books on the subject as I could. Through this learning, I started to build a more human centered view of technology's proper role in society. Additionally, as I learned more about user experience design, I realized that designed objects and experiences must allow for users to learn how to use them. Learning did not just happen in the classroom, but nearly everywhere all the time.

Around the same time my co-worker Zach Shaw was proselytizing a growing movement in our profession called software craftsmanship. Software craftsmanship seeks to treat the process of creating software and software itself, as a craft. There is a growing realization that, just as in craft, there are good programmers and better ones and everyone can get better with proper practice. Furthermore, better programmers produce better code. Software craftsmanship not only seeks to make better programmers, but also seeks to instill a system of ethics and accountability in software developers. One such outcome of this movement is to have programmers asking questions like: should I build this and, why am I building this. In 2011, the web designer conference, *Build Conf*, met around the topic of "Why We Build." I kept asking this question: why are we doing this?

Around 2013 I came to realize that I was spending more and more of my time and energy doing things that weren't my day job. The many hobbies I had taken an interest in had become the most important things I was doing. I had become more interested in the philosophy of the programming profession rather than programming. There were conceptual questions I wanted to explore that I just wasn't able to fit within a fourty hour week at a software development job. Searching for new opportunities I attended an online Coursera course called "Creative Programming". The course finally gave me a unique set of tools to express myself.

The course used the language, Processing, which had been created for interactive artists. Although I was well aware of Processing, as one of the creators, Ben Fry, had worked at Icosystem, I hadn't ever invested time in learning it. Through the course, however, I discovered the language's ability to facilitate art creation. I learned I could create conceptually driven work

that used but was not driven by the technology. This awareness finally allowed me to understand in a new way the vast body of interactive and digital art I had been seeing, but not appreciating my entire life.

I decided to go back to school. I already had a positive opinion of MassArt as I had taken several classes and attended many graduate shows there. I had attended two of the shows put on by the Dynamic Media Institute (DMI), read through their first anniversary book, and could see myself enjoying creating the kind of work I viewed there. I saw DMI as a place filled with many great resources and where my passions and skills could intersect.

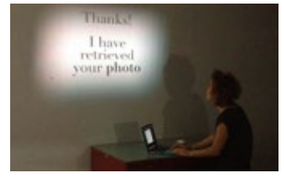
The Dynamic Media Institute (DMI)

At DMI, the learning process primarily involves making, research, and synthesis of the two (or critical thinking). Making is the process of building things or experiences and then observing how people interact with these things (also known as project work). Research is the further study of a subject through reading, listening, and observation. Synthesis is the process of making connections between the process of making and the knowledge gained through research. These threads, however, constantly weave back and forth informing one another and blurring the lines between each-other. Making informs research, becomes synthesis, informs more making and more research, and on, and on.

Many DMI alumni have told me, take a look at your project work, what you have done over the last year and half, and that is your thesis. For me, this is certainly true. I had been a software developer, but I had also been involved in construction projects and had always been active in physical activities. Upon entering DMI, I wanted to ignore programming and build interactive art that existed in the physical world as prominently as possible.

What happened instead ended up being both highly computational and highly physical.

My early work at DMI was often more useful in informing me of what I did not want to study than what I did want to study. With ***Something Digital***, I created an installation in which anonymous strangers could exchange digital gifts with each other using a public USB cable. The final experience felt cold and depressing to me as the human interaction became disconnected through time and space. Through this project I learned that I was primarily interested in experiences in which multiple could interact at the same time and place fostering verbal and non-verbal communication while sharing the same physical environment.



Something Digital. DMI student Ceren Paydaş submits a digital gift.

At many times in my life, in pursuit of new and interesting experiences, I've tended to abandon what I once loved. At DMI, such attempts to disregard past interests proved futile; I constantly revisit past experiences, skills, and passions as inspiration. One such repeating theme in my life is that of learning, which plays a prominent role in my thesis. I have always enjoyed learning new things; looking back I realize that I was enrolled in continuing education or community classes at least once or twice a week since graduating from McGill in 2003.

In addition to learning, I have had the opportunity to teach at MassArt. I have been a teaching assistant and have taught several of my own courses. This sparked an understanding of the importance of considering learning while designing experiences. How will users know how to use the systems I create? I realized that computationally-backed systems afford the designer numerous opportunities to teach users. Dynamic experiences can offer users rich new interactions, like animations and sounds while providing immediate and relevant feedback, all serving to aid in the learning process.

I believe that learning is an essential human value and nearly

all of my project work incorporates it in some way. In my piece Draw Blocks, a complex system requires a user to learn extensively in order to take advantage of all of its features. In ***Tangible Programming***, an environment is created to assist users in learning programming concepts. However, it is not just learning that I value, but the entirety of my past experiences and passions.

Over the years I have been engaged continuously in many physical activities and am only now discovering how important they are to me. It's clear my early attempts to abandon programming and embrace physicality were not caused by my dislike for programming but were instead based upon my assumption that software is at odds with physicality.

Thesis Topic

More and more, we are required to spend time interacting with interfaces locked behind glass touch-screens, LCD screens, and keyboards to accomplish life tasks like emailing, Facebooking, and Amazoning. We engage and spend time with these interfaces, sacrificing time spent in a more physically and sensory rich environment.

We live in a time in which technologies possess an intense ability to capture our attention; we can become engrossed in video games or watching Netflix TV series for hours at a time. Carrying our smartphones everywhere, we fill our downtime browsing Facebook, Instagram, and other virtual social and content-based websites. We are able to keep ourselves entertained and avoid boredom, but often we do so at the expense of long-term satisfaction, joy, and happiness. Our technologies like Netflix Streaming often cater to our addictions and desires, while ignoring our actual needs.

The primary interface has become the touchscreen requiring even less physical effort than the keyboard and mouse and even less physical effort than interfaces in the physical world (such as doorknobs, handles, buttons, and levers). Generally, holistic sensory experiences, activities that engage our entire bodies and minds often requiring both physical and mental effort (sports, yoga and sex), are more enjoyable and satisfying in the long-term than more passive activities like watching TV. Yet, we continually spend time engaged in the latter. Why is that?

We have created an entertainment engine that far succeeds in scope and power its humble beginnings in cinema and broadcast television. With software and an algorithm, we as designers possess an uncanny ability to steal our user's time with inventions such as subscription-based and free (advertiser supported) payment models for content, recommendation engines, and autoplay. Are we building interfaces that assist people in finding life satisfaction or merely exploiting addiction?

In the pursuit of absolute efficiency, our designs may keep users engaged, but often do so by neglecting critical human needs. A more holistic design approach should incorporate the needs of the body, person, and even society as a whole. We can start by designing for the human body.

One way to design for the whole body is to imbue physical objects with computational effects. Instead of using touch-screens and mice to manipulate software we can manipulate physical objects like blocks, balls, and sand with our hands, arms, and legs using digital sensors to detect changes, resulting in an experience that engages our senses of touch, hearing, sight, smell, and more. Allowing users to manipulate physical objects, takes advantage of our ability to quickly move objects, observe their status, making adjustments and exploring through trial-and error. Not only is this more enjoyable than using a mouse, but it aids in learning the system.

We have been trained since birth to manipulate physical objects: picking things up, putting things down, re-arranging items on a table, and putting away our laundry in a dresser.

When we create physical interfaces to software, we aid in the learning process by leveraging the affordances of physical objects people already know well. It is important, as designers, to have techniques that facilitate learning especially if we want to create challenging experiences, which, I will argue, we do.

When we engage in activities that require physical and mental effort not only are we more focused, but we often have greater satisfaction in the moment and upon completion. When tasks are trivial or too easy, we can become bored and disengaged. Activities must not be challenging just for the sake of it, but instead should always be meaningful. One such meaningful activity, the one I will be exploring exclusively in my thesis, is the act of creation.

Making is a wonderful skill. As we spend more and more of our time with highly mediated digital interactions, we lose the ability or chance to meaningfully affect our environment, to create things truly of our own device. The satisfaction received from putting in work, deciding what to build, and then building it, is immense. I want to provide new and exciting opportunities for people to create things. Primarily, that is what I have accomplished during my two years at MassArt!

Lastly, as designers, we should be creating experiences that involve physical collaboration between multiple people. As we design interfaces that are challenging and encourage moments of learning, having a more experienced peer nearby can significantly aid in the learning process. Group creation provides an opportunity for users to play off of each other, creating a new kind of dialog that adds additional dimensions to the experience. This dialog becomes a performance, adding more weight, importance, and consequently more satisfaction and pride to the experience. Most importantly, to live in society is to interact with others; our interactive and digital experiences should always reflect that.

These concepts, when applied to interaction design, create experiences that are more full and enjoyable in the short and long term. This thesis presents conceptual and realized projects that not only demonstrate how designing with these concepts is possible, but also how designing with them will create richer more satisfying experiences for users.

Thesis Book

In the *Create, Learn, Live!* section of this book I introduce external work from artists and designers that I have taken inspiration from and which frames my work. These projects include ***Play Me I'm Yours***, a public piano installation that serves as an example of many of the design principles I am recommending and ***Light Music***, a project that is in contrast to these principles. This section also introduces the work of Seymour Papert and Mitch Resnick whose findings on learning guides my design process as well as Mihaly Csikszentmihalyi's philosophies on motivation, challenge, and satisfaction. Lastly, I will introduce you to Hiroshi Ishii whose work on tangible interfaces provides a promising approach to incorporating many of the suggested design principles proposed.

The case studies section provides specific examples of my work illustrating how each of my suggested design principles: holistic sensory experience, the process of learning, the physical presence of multiple people, significant physical and mental effort, and the act of creation can be incorporated successfully in realized designed experiences. My intent is to provide insight into the conceptual basis for my thesis through these realized works.

Finally, in the conclusion of this book I will synthesis my thoughts and design philosophies leaving you with some open questions to ponder. Enjoy.

Create, Learn,
Live!

Michael Maloney on a *Play Me I'm Yours* piano. *#43 Post Office Sq "Let It Be."* Stills taken from Youtube video by Michael Maloney.

Play Me I'm Yours

In the Fall of 2014, seventy pianos were installed in public spaces around Boston. The project originally conceived by Luke Jerram in 2008 continues to be installed all over the world. In Boston, most of the pianos were placed on wide sidewalks or in tiny parks. Each was labeled: "Play Me I'm Yours". It was exciting to see the pianos constantly in use and serving as social gathering places for the entire month of the project.

One Saturday, I was wandering around Boston with a friend and we came upon a piano. It said "Play Me, I'm Yours," so we did. While we played, we met a guy named Mike. He had been walking all over the city trying to play as many pianos as possible, while also filming himself. He was nearing his fortieth piano. He taught us a song. Then he played and sang "Over the Rainbow" for us. It was beautiful.

Mike posted all the videos he had made on Youtube. I discovered one in which he was playing and singing "Let It Be" by the Beatles. A couple sat on a nearby bench listening and watching him play. Near the end of the song, a woman walked by, then paused. She inched closer to him, they made eye contact. Then she started singing with him. They finished the song singing together.

By placing a piano in a public place, Luke Jerram provides a catalyst for people to create and collaborate. The installation touches upon nearly all of the critical human needs I have mentioned including: holistic sensory experience, the physical presence of multiple people, significant physical and mental effort, and the act of creation.

As one participant said, "It was exhilarating, it was colourful, it was vibrant. I think it attacked all of your senses at once!" (Bailey and Yang Consultants 48). Music has the capacity to engage nearly all of our senses: the sense of hearing–listening to music, sight–watching people play, touch–playing the piano, and due to its outdoor location it engages our senses through the environment.

The piece is also about bringing people together physically. As one Melbourne participant said, "music gets people together" and another said "I've been walking around and I never see these pianos empty, it adds to the vibrancy and vitality of the city." The piano is a framework for shared experiences between strangers, and that is the essence of city vitality. It is this very aspect that attracted the event sponsor Miss Betty Amsden AO (Officer of the Order of Australia) to the project. She said, "I wanted to see people get together, I wanted people to contact with one another, I wanted people to talk to one another instead of playing with all of these mechanical things they have [her generation's expression for smartphone ;)]. I wanted them to join in and feel part of a lovely program."

Because the pianos are placed in public, just deciding to sit down at a piano bench, starts a performance. There is typically an audience and any actions by the participant become a public performance. As one young participant said, "people can just show what they can do to everyone," and another said, "I felt like a superstar." (Melbourne Video 2014). This public performance brings people together. For the piano player, they are engaged in the act of creation. They are creating music, whether they composed the piece or not.

During the two and a half weeks of the Melbourne project "400,000 people interacted with the [24] pianos." "98% of the general public who watched or played the pianos felt happy" and "three in four people said they interacted with people they might not have otherwise." (Arts Centre Melbourne Video). This is just one installation of the thousands that have been created worldwide over the past decade. The installation created two types of participants: performers (or pianists) and listeners. Many people felt uncomfortable banging on keys if they did

not consider themselves experienced pianists (Bailey and Yang Consultants). Some people just saw themselves as receivers: "A gift from a stranger. A great escape from my own little world." (Bailey and Yang Consultants 27).

To play a piano well, requires both sustained physical and mental effort. For most people, playing the piano requires years of practice to become competent. Although playing a piano provides an opportunity to fulfill one of my design goals: significant physical and mental effort, it does so by alienating the many people who do not know how to play the piano. Although the pianos are placed in public and have a prominent sign stating "Play Me I'm Yours," there are still significant barriers to participation. Even trained piano players might not feel comfortable playing in front of an audience.

Play Me I'm Yours used reclaimed upright pianos. The purpose of the installation was not to teach users to play the piano but instead to encourage public performances. The piano and most string, woodwind, and percussion instruments, are just too difficult to expect novices to learn quickly. They did not expect that novices would spend thousands of hours sitting at the public pianos learning to play, they did hope, however, that non players might become inspired to learn one day.

In contrast to ***Play Me I'm Yours***, ***Light Music***, gives the experience of music making to non musicians, not just appreciation. Yuko Mayumi and Nao Koike created ***Light Music***, a piece in which the metaphor of piano sheet music is used to allure participants and light bulbs are used in place of piano keys, providing a more approachable interface to beginners.

Light Music (光の楽譜)

Yuko Mayumi and Nao Koike's (マユミユウコ, コイケナオ) work ***Light Music*** (Hikari no gakuhu 光の楽譜) was installed during Smart Illuminations Yokohama 2013, in Yokohama, Japan. The piece consists of a vertical board containing a grid of household, white LED light bulbs, each with a touch sensor. The bulbs are arranged on top of horizontal grid lines to appear like notes upon a musical staff. Treble and bass clef icons (cut in wood relief) are installed on the left as in modern musical (western) notation

When participants press on the light bulbs, sounds are emitted. Although there are dozens of bulbs and each bulb plays a note, the actual quality and choice of notes was carefully selected by the artists to always result in harmonious sounds. In a sense, the artist provides the visitor with the pleasure of generating music, without having to actually know how to play any instrument.

Mayumi and Koike could have chosen to give the users all the notes of a keyboard. The bulbs could have been assigned the notes of a piano in order starting at middle-C, then C#, D, D#, E, F, and so on. Instead, through the decisions the artists made while programming the piece, they restricted users to a musical soundscape in which all possible explorations were similarly harmonious, and no mistakes were possible. Light Music was installed at a crowded citywide festival for a single night; it was a wise decision to design an experience that was both simple and beautiful for visitors.

Light Music,
Yokohama, 2013.
Photos by Nao Koike.

Unlike Jerram's ***Play Me I'm Yours***, in ***Light Music*** the sound output was controlled via computer algorithms. What the medium of computers afforded the artists was the ability to separate the design of the interface, light bulbs, from the output, music. As designers Mayumi and Koike were able to create a simple and novel input mechanism, touching lightbulbs, then in software, use those user touches to influence a musical composition.

Striking a balance between simplicity and complexity is a challenge interaction designers must constantly explore. The

design choices that Mayumi and Koike made ultimately influence the entire experience of the participant. ***Light Music*** was not designed to teach users about music creation, but instead give them a taste for musical and visual expression. ***Light Music*** inspired me to to wonder: what would an experience look like if it both possessed the approachability of ***Light Music*** as well as the intellectual challenge and depth of ***Play Me I'm Yours***? Could we take inspiration from both works?

Interaction designers have always been straddling a balance between curation and control. A defining characteristic of computerized interaction is to give users control. Even in very early public interactive works we see artists trying to push the limits, giving users as much control as the technology allows, adding complexity to their interactions.

Is It a Tool, Or Is It a Toy? The Osaka Expo 1970

One of the earliest, and most profound examples of interactive computer art installed in a public space was at the World Expo in Osaka, Japan in 1970. Experiments in Art and Technology (EAT), founded in 1966, had 3,000 artists and 3,000 engineers by 1969. EAT created many large public interactive events throughout their history. Their most ambitious work occurred at the Pepsi Pavilion in 1970 during the World Expo held in Osaka, Japan (Rieser). The project resulted from the efforts of American artist Robert Breer, EAT founder Robert Kluver, Japanese artist Fujiko Nakaya, and an ensemble of sixty-three artists from America and Japan.

The artists wished to create a "living responsive environment" or public theater space. The space contained a "mirror room" with interactive sound, an enormous work in fog by Fujiko Nakaya and large robotic "floats" by Robert Breer. The mirror room contained a mirror 90 feet in diameter, constructed of metallic Mylar. Because of the size and shape of the mirror, visitors could see their reflection in a way similar to that of a hologram. In the mirror room, a sound system contained 37 speakers with 32 possible inputs that could play pre-programmed spacial sound, or could be mixed live by artists at a console. Additionally, the floor was split into 10 distinct areas, each made of different materials. As visitors walked to each of the distinct areas they could hear sounds, specifically designed for that space, through portable headsets.

1970 World Expo. Pavilion engulfed in artificial fog. Breer's white domed sculptures are seen in the foreground. Photo by Takeyoshi Tanuma via YCAM.

On the pavilion terrace, Robert Breer installed 6-foot tall sculptures that moved around autonomously making sounds. When the sculptures ran into a wall or another sculpture, they would turn around. Additionally visitors could safely push or bump into the sculptures to cause them to move.

The entire pavilion exterior was continuously engulfed in an artificial fog designed by Fujiko Nakaya. Combined with various outdoor lighting effects, the fog created a distinct aesthetic for the piece and space. As seen in photos the fog would stretch to the ground creating a multi-sensory experience for visitors to interact with.

In the Osaka Expo piece, although visitors could experience different sounds by walking around, they couldn't actually change or curate the sounds. Forty years later, with computer-based interactive art, artists have an immense opportunity to give back a vast amount of control to their users. Still, there is often a tradeoff in interactive art between granting a user control over the aesthetic output versus tightly controlling the output. As my professor, Brian Lucid always says, "is it a tool or a is it a toy?" It's a design decision we must constantly consider.

1970 World Expo. Sound control room. Real-to-real tape decks feed sound to the mirror room. Photo by Shunk-Kender © Roy Lichtenstein Foundation via E.A.T.

Unlocking the Door. Challenge

I have discussed how the ***Play Me I'm Yours*** installation requires participants to be experienced musicians in order to approach a piano and successfully create beautiful music. A musician

has vast control over the sound output of a piano only if they possess the knowledge to play it. In Yuko Mayumi and Nao Koike's ***Light Music*** piece, unlike a piano, users quickly master everything the instrument provides. I believe, however, that engaging in challenging skill based activities (like piano playing) can be highly rewarding. In this thesis I take inspiration from both works, creating experiences that are both complex enough to challenge expert users, yet approachable and learnable to novices.

In Mihaly Csikszentmihalyi's seminal book ***Flow***, he presents the argument that sustained enjoyment in life can be achieved through the continued pursuit of challenging skill-based activities. Through numerous interviews with athletes and musicians, Csikszentmihalyi concludes that while we are engaged in a challenging activity we enter an enjoyable state he calls flow. Additionally, the pride of achievement felt after succeeding in challenges can be greatly rewarding.

Csikszentmihalyi writes, "when situational challenges balance personal skills, a person tends to attend willingly. For instance, a chess player will concentrate on the game only when the opponent's skills match his own; if they do not, attention will waver." (Flow and The Foundations of Positive Psychology 8). Thus, it is not only important to create challenge in our experiences, we must also carefully match the level of challenge with the experience of the user.

Merely challenging someone is not enough to guarantee enjoyment. The user must also feel like they are directing and in control of this experience. While designing experiences, the two concepts are intimately intertwined. If an interface is too simplistic, if its output is too limited, it is not possible to challenge a user. If the output is too random or uncontrollable, it is not possible for the user to manipulate anything and feel in control.

Summing up these concepts, Csikszentmihalyi says,

"Voluntary focusing of attention is a state of optimal interaction. In such a state a person feels fully alive and in control, because he or she can direct the flow of reciprocal information that unites person and environment in an interactive system. I know that I am alive, that I am somebody, that I matter, when I can choose to interact with a system of stimuli that I can modify and from which I can get meaningful feedback, whether the system is made up of other people, musical notes, ideas, or tools." (8).

Csikszentmihalyi builds a philosophical (or perhaps psychological) justification for why voluntary focus, or control, feels so satisfying. He writes, "the ability to enjoy challenges and then master them is a fundamental metaskill that is essential to individual development and to cultural evolution." (235). Yet, as designers we cannot simply add challenges to interactive experiences. We must design public interactive art that it is both accessible and usable to a diverse audience, just as architects and city planners ensure the public space (the art sits within) is both accessible and usable. While incorporating challenge into interactive experiences, designers must consider a balance between both challenge and accessibility.

Public installations often don't allow users unlimited time in which to interact, practice or learn a system. Creating new and novel experiences that are both challenging but also usable requires the creation of layered, learnable experiences. At first glance, an interface must appear approachable and engaging. A novice user should feel that they could control the system and it is in balance with their skill level. As a user continues to spend time with the system and continues to explore its potential, the system should fill their curiosity with increased depth and complexity.

To clarify, I am not proposing we use artificial intelligence

or computer "learning systems." What I am suggesting is that interfaces should be designed with obvious, explorable layers of complexity that are always present. Take an example in the physical world: there is a door with a knob; most of the time this door is unlocked and most people can pass through it by turning the knob. After 6pm, this particular door becomes locked. Only a select few, who have been given the key, may unlock and get past the door by placing their key into the keyhole.

The door, simultaneously presents (at least) two interfaces for interaction: the doorknob and the keyhole. One layer of interaction, the knob, is more obvious than the other, the keyhole (which may be safely ignored by most users). Designing in layers allows users of a large diversity of skill levels to have a positive experience. In addition to designing in layers we must carefully consider how users will master them. When interfaces are complex and challenging we must ensure that they are also designed to encourage and facilitate learning.

Teach Me, Robotic Turtle!

In the 1960s, Seymour Papert popularized the notion that when we engage in the construction of objects in the physical world we re-enforce construction of thoughts in our mind. In *The Children's Machine*, Papert writes that "One of my central mathetic [the science of learning] tenets is that the construction that takes place 'in the head' often happens especially felicitously when it is supported by construction of a more public sort 'in the world' —a sand castle or a cake, a Lego house or a corporation, a computer program a poem, or a theory of the universe." (142).

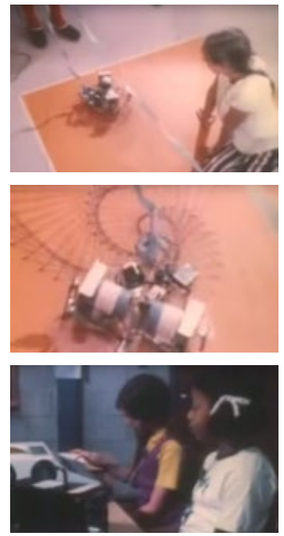
Papert applied his theories to the learning and teaching of computational concepts. He created a programming language called LOGO in which users type programs on a computer to control a robotic "turtle" with an attached pen that roams over paper taped to the floor, drawing and making sounds. Users could control the turtle movement creating complex computer generated patterns on the paper. The physical output of the turtle served to give users immediate feedback to their programs as well as providing a multi-sensory experience. Watching the turtle move and hearing its gears and music play enhanced learning.

Papert was not just interested in teaching. He empowered youth to develop their own skills of self-learning. In Papert's view it is more important to instill a passion for learning in children than it is to teach them facts: "the competitive ability is the ability to learn." (The Children's Machine vii). Papert developed LOGO to illustrate how technology allows unprecedented access to new methods of learning.

With LOGO, Papert wanted to teach children mathematics in a "meaningful context for use now" (Channel 5 Special). He tells the story of being told as a child that he should learn long division because he would need to know it later, but he had always had the feeling that was untrue. With LOGO, children are motivated to learn math by using the computer to "turn motors, to make sounds, to draw pictures," and "let a child learn mathematics by speaking in mathematics about things that really matter to him." These "things that matter" are physical things: motion, sounds, physically drawing with a pen on paper—tangible things.

Thus, the power of technology (in this example) is its ability to teach things like math in the context of situations that actually matter to children. Children are intrinsically motivated to create things and see the output of their creations. In Papert's view it is this motivation that should drive the desire to learn, propelling self-learning. We are willing to put in significant mental effort to the learning process when we can feel and see a tangible reward.

With LOGO, children program on a computer to control a



Top, middle: robot drawing images. Bottom: pair-programming, student at the keyboard is learning from the student mentor sitting next to her. Channel 5 Special on Seymour Papert at MIT CSAIL, 1972.

physical robot turtle walking across a piece of paper on the floor with an ink pen. The turtle creates drawings as he moves. This physical output provides motivation and allows the child to get immediate feedback from his own investigations. As Papert says, "the child doesn't have to be told by a teacher whether he's right or wrong he can see for himself whether it works and that's what science and knowledge is about" (Channel 5 Special).

Mitch Resnick expanded upon Papert's theories of learning, focusing on what he called "tinkering" as a critical component. In *Designing for Tinkerability*, Resnick writes, "we see tinkering as a valid and valuable style of working, characterized by a playful, exploratory, iterative style of engaging with a problem or project. When people are tinkering, they are constantly trying out new ideas, making adjustments and refinements, then experimenting with new possibilities, over and over and over." (164).

In the physical world an excellent example of tinkering would be watching children play with LEGOs. When building with LEGOs, a child can try out different pieces, removing and adding blocks as they work. The blocks allow the child to try out different ideas by snapping blocks into place. If the child doesn't like something they have done, they can change it. Physical objects create a pleasant feeling in the hands and are easy to move and manipulate quickly; the blocks allow for rapid exploration creating a strong sense of control and consequently satisfaction. With LEGOs, actions are usually reversible and "mistakes" have minimal negative consequences. LEGOs encourage exploratory learning and tinkering.

Just as Papert did, Resnick created a programming language designed for children. Scratch is a web-based language Resnick developed, that allows very young children to program interactive games, animations, sound machines, and more. Just like Papert, he wanted to create enough interesting outputs for his language that children would be motivated to learn on their own. In his acceptance speech for the 2011 McGraw Prize in Education, Papert said that we "need to provide opportunities for young people not just to browse and chat and play games but to be able to design and create and express themselves to develop their own voice to connect with others through their creations." Resnick not only created a language he established an online community where children could share their creations with others and build upon other children's creations they discovered.

As Resnick states, "it's so important to be a creative thinker, to come up with innovative solutions to unexpected situations, and if you want to be a creative thinker, you better be able to create." Scratch not only provides a framework for learning to program, but creates an opportunity for children to actually create something of their own and express themselves. By reframing learning in terms of exploration and creation, Papert and Resnick blur the line between learning and everyday living. Learning is not just a thing of the classroom, it the act of exploring and experiencing the world around us. They illustrate the beauty and simplicity of learning while also providing techniques we can leverage in our experience design process.

The Hand is Mightier than the Mouse. Tangible Interfaces

Since both physical systems of creation (like LEGOs, paint, and wood), and primarily virtual systems (like programming languages, Scratch, Photoshop, and Microsoft Word) have both advantages and disadvantages, there exists a desire to merge aspects of both into a single system. This idea of merging the tactile benefits of physical systems, with the computational benefits of virtual systems is the driving force behind the field known as "tangible interfaces."

I had the opportunity to work with Hiroshi Ishii and the

Tangible Interface Group at the MIT Media Lab researching tangible interfaces. They summarize the main benefit of tangible interfaces this way, "Humans have evolved a heightened ability to sense and manipulate the physical world, yet the digital world takes little advantage of our capacity for hand-eye coordination. A tangible user interface (TUI) builds upon our dexterity by embodying digital information in physical space" (Radical Atoms).

Urp is one of the lab's earliest works illustrating the potential of tangible interfaces. **Urp** was designed to give architects and city planners insight into the impact that a building's location would have on light, shadows and wind flow at different times of the day. The piece was installed on a tabletop with an overhead projection and included the following physical objects: scale models of 2 buildings, a clock, a compass, and a wand to choose between brick versus glass building facades.

Users can re-position the building models with their hands to simulate their final build location. Users can move the clock hands to simulate different times of day, move the compass to change the wind direction, and switch between building facade materials. An overhead projector creates simulated building shadows, and wind speed direction based upon realistic simulations of wind around the buildings. By moving the buildings and changing the time of day, architects can quickly gain insight into how different building locations affect shadows in the courtyards and create wind disturbances.

Functionality similar to **Urp** did already exist in architectural simulation software when the group created the project. **Urp**, however, has many advantages over a purely software simulation locked behind a keyboard and mouse. With **Urp**, users can rapidly move buildings or change the clock and wind direction with their hands. With a tiny building model users can explore potential options more rapidly than they could with a software solution. With your hands you can quickly translate and rotate the building immediately seeing results (only an experienced Quake user could hope to achieve this as quickly with a mouse and keyboard).

It is not just potential for achieving quicker results that **Urp** possesses. In Sherry Turkle's *Evocative Objects*, she states there is "a dynamic relationship between things and thinking. We tie a knot and find ourselves in a partnership with string in our exploration of space. Objects are able to catalyze self creation" (9). Turkle is re-articulating the thoughts of Papert and Resnick on learning: the manipulation of physical objects re-enforces thought, learning and memory.

Additionally, tangible interfaces can often be designed to be easily learnable. Industrial designer Donald Norman often speaks of the design of doors to illustrate this point. If a door has merely a flat panel and no knob, we know that we must push it to get through without any prior training. If the door has a handle we know that we are supposed to pull the door, because handles can be grabbed. We can embed "affordances" in the physical world that leverage our prior knowledge of physics and match the design of our human bodies. Objects that are smaller than the hand and look light enough, can be picked up, objects that are large and look heavy, we infer, shouldn't be moved.

As designers we can use the size, weight, and feel of physical objects to convey information to our users. This is the essence of what Donald Norman termed affordances. With an interface like **Urp**, a user does not need to be told that they can pick up a building to move it. As **Urp** demonstrates, with proper design, tangible interfaces can often be vastly easier to learn than purely virtual interfaces of similar complexity.

Case Studies

My work seeks to engage users in experiences that both challenge and delight. By leveraging Papert's constructionist theories of learning and tangible interfaces, I am able to create systems that are challenging, but also learnable in a public setting with minimal instruction. By challenging users, my work seeks to engage people in experiences more enjoyable than those requiring minimal mental investment.

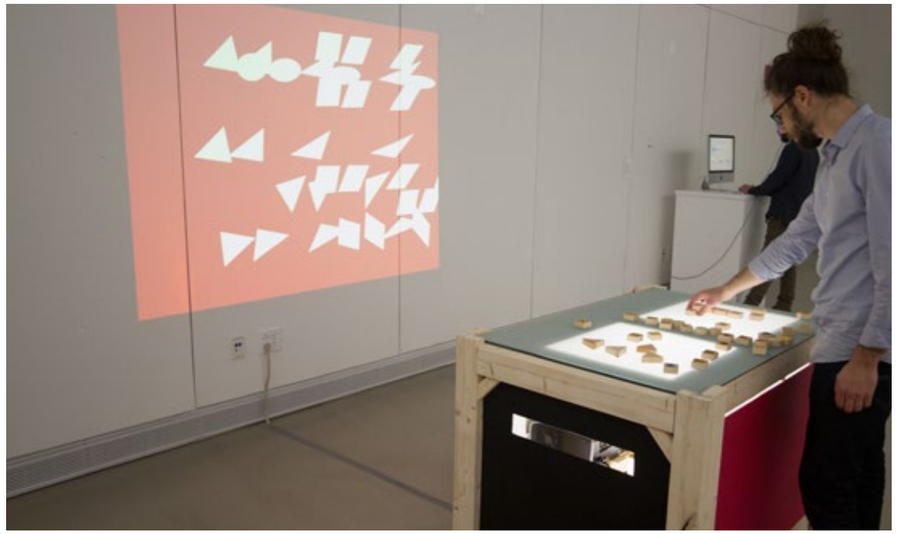
At DMI, we research, make, and test. This section documents the work and projects, aka the making I did while at MassArt. The works will give you a concrete footing on which to understand the philosophies and thinking I have outlined so far. Although the realities of time, money, and technology limit the scope of each project, each presents valuable insights. I will show you these works to clarify the concepts in this thesis and demonstrate their viability. Lastly, these works stand on their own as demonstrations of experience design and hopefully can serve as inspirations to you.

Draw Blocks

Andrew Ringler

Overview

Draw Blocks is an interactive tabletop play and design area where multiple participants collaborate in creating projected images. Patterned wood blocks act as tools within a rich and learnable novel visual language. Through the arrangement of blocks on a glass tabletop participants can build complex and beautiful forms and colors from a basic set of tools. Participants join in a shared experience playing or constructing designs, collaborating through verbal and non-verbal means. Sharing, borrowing, and manipulating the wooden tools allows participants to communicate intent and desire with each other through their physical actions.



Draw Blocks, Design and Media Center Opening, January 19th 2016

Draw Blocks in its final form is a beautiful, whitewashed wood table with a frosted glass top. The sides of the table are covered in black and pink panels to conceal the mechanisms inside. Small windows are cut into the side panels to vent heat and allow curious users to inspect the interior. Inside the table sits a digital projector. A small window is cut in the back panel to allow the projection to shine out.

Draw Blocks was installed for two weeks during the DMI show, Fresh Media, at the Boston Cyberarts Gallery in Jamaica Plain, Massachusetts. At the show, the backside of the table was approximately 6 feet away from the wall. This distance was chosen to be both far enough from the wall to maximize the size of the projected image (with a short-throw projector) and to be short enough to discourage gallery visitors from walking behind the table and thus block the projected image. Wood blocks sit on top of the table, ready for users to interact with. Hidden on the underside of each block is a symbol that can be read through the frosted glass by webcams concealed within the table. I wrote software that mapped the user's arrangement of blocks into a visual image. This image was then projected onto the wall.

Conception

Draw Blocks grew out of an independent project under the direction of Professor Brian Lucid during my first year at MassArt in the fall of 2014. The piece culminated in a public gallery show, but was conceived 6 months before to the show when I sent this email to Professor Lucid:

Date: Sun, 21 Sep 2014 22:09:52 -0400

Subject: independent study thoughts

From: Andrew Ringler <asringler@massart.edu>

To: Brian Lucid <blucid@massart.edu>

Brian,

…

1) I am very interested in providing opportunities for creativity in public.

For example, I loved the 70 pianos that were installed all around Boston last Fall. Every-time I walked by one, someone was playing and often several people were sitting down listening. There were a wide range of abilities on the piano. I think that in the digital realm there are ways to provide people with simple tools for creation. For example, imagine a video projection that is manipulated by small rocks on a table. As people move the rocks around they are able to control the projection mixing light in interesting ways, or adding affects. *Or more broadly, what are small units of creation, as Photoshop has a toolset of brush/pencil/eraser/fill/etc.. what are other tools we could create. What other programming constructs could be externalized into physical objects?

…

Looking back at this original email I was surprised to discover that most of what I wrote then, had a strong influence on the final work. I was initially inspired by the pianos that were installed as part of ***Play Me I'm Yours***, yet I wondered, do they exclude those who cannot the piano play well?

In my observation, non-players did occasionally sit down at the pianos, predominantly I saw, however, advanced players performing for an audience. What I like about the piano (and all learned skills) is the feeling of accomplishment I feel as I improve over time. I wanted to preserve this feeling of challenge, while simultaneously not excluding novices. It was through the constant consideration of the tension between these two goals that drove the design decisions within this project. In hindsight, this tension is also what drove the core of the design thinking within this document and my time at DMI!

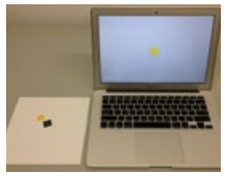
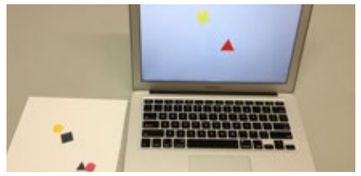
My initial seed of an idea was to "…imagine a video projection that is manipulated by small rocks on a table." I chose light projection as an output because at the time, I felt more competent with a visual medium. I chose rocks as the input interface because the location of pianos outside in ***Play Me I'm Yours***, reminded me of nature and consequently rocks. Additionally, rocks felt like a new form of input interface that would be satisfying for users to touch and hold. After proposing the initial idea, Professor Lucid urged me to consider carefully, the visual language of the input interface I was building. I took inspiration from Photoshop which contains a suite of distinct and visually consistent icons, representing a diverse set of operations such as a finger representing "smudge", a dashed-box representing "marquee", and a rubber stamp representing the "clone-stamp" tool. Similarly I wanted to create a set of distinct icons for my rocks. In addition to Photoshop I took inspiration from programming languages.

In my initial email I mentioned how "programming constructs could be externalized into physical objects." One such construct I had in mind is the for-loop, used to represent repetition. The idea of repetition in programming, is to ask the computer to perform a task repeatedly, varying some aspect of the task each time. For example, say we wanted to draw a brick wall (digitally). With looping we could draw a single brick then tell the computer to draw it again, but this time one brick width to the right. That would draw a one-layer brick wall. We could add an additional rule that states, after drawing a brick at the far right side of our canvas draw the next brick one brick height higher but starting at the left side of the canvas. So, by drawing a single brick, then using looping and defining how the brick should change each time it is drawn, we can fill the entire screen with bricks. I thought that adding a repetition tool to my work would allow users to quickly generate complex (and hopefully interesting) patterns.

Design Process

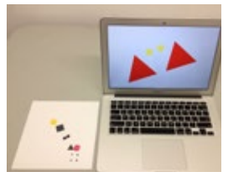
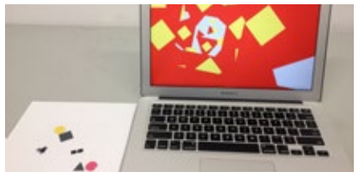
Professor Lucid asked me to define the rules of the system and more specifically, to define the inputs and outputs of the system. I started listing operations I thought the system should have. Initially the operations, inspired by Adobe Illustrator and the visual programming language Nodebox, included: draw a square, draw a circle, fill in shapes with color, make shapes bigger, make shapes smaller. It included operations from Nodebox such as layout shapes in a perfect grid and create a fractal pattern by duplicating the current shape at differing sizes. These lists of operations were good at describing the inputs but fell short of communicating the output behavior. Professor Lucid asked me to use a flowchart or create a narrative of the experience; it was at that point I realized a prototype would be able to explain my ideas best.

My first prototype was created with construction paper and Nodebox. I cut small pieces of construction paper to act as the input interface (originally conceived as rocks) and I programmed imagined outputs in Nodebox. Nodebox is a programming language built for visual designers. In Nodebox the user visually connects "nodes" to one another creating a pipeline of operations that culminates in a final static digital image. This is not dissimilar from the assembly line of a modern automobile in which the linear progression of small tasks combines to create an entire vehicle. I chose Nodebox because I thought it would allow me to quickly iterate on ideas without having to write code. Although I did consider using Photoshop, I ultimately decided on Nodebox because I wanted to utilize some of its programming features like repetition.


For this first prototype, I placed a black piece of construction paper to the left of my laptop that acted as the input canvas. I then imagined an input scenario, cut out paper and placed it on the canvas to represent that scenario. I used Nodebox to design the output that I thought should result from this input and then displayed this Nodebox generated image, full screen and took a photograph of the entire setup to communicate the process. For example, I first cut out a small black paper square and placed it on the canvas. I then drew a small square in Nodebox and photographed the system, demonstrating the first and most simple operation: square. I then rotated the paper square counterclockwise 45 degrees. I also rotated the digital square counterclockwise 45 degrees to demonstrate that as the user tactilely rotates objects, their translated digital output would also rotate.

By this point my initial idea of using rocks had materialized instead as pieces of construction paper, during prototyping. This gave me more flexibility than rocks, as it allowed me to cut out different shapes, each piece (of paper) representing a different behavior. I imagined that each piece would represent a single digital operation. Multiple pieces could be combined by physically placing them near each other allowing the user to build up more complex operations and consequently designs. For example, the user could place the square

Above: a fractal operation clones the current view at varying scales and angles.

piece next to a yellow piece to create a yellow square. Or place the square piece next to a blue piece to create a blue square.

This initial paper prototyping method communicated the design of the system, allowing me to get feedback over a period of several weeks. Professor Lucid asked questions such as, what is the balance between control and abstraction? What is the visual hierarchy of the input icons (maybe properties are smaller than objects)? What is the positional vocabulary and how does position influence the output?

Through many sessions with Professor Lucid and iterations of my system vocabulary, I finally settled on four categories of operations: shape, color, transformation, and looping. I also settled on some basic rules such as: locations of physical pieces on the input surface would map directly to similar virtual locations within the output design and operations would act in concert with one another when placed near each other.

Professor Lucid then encouraged me to explore what collaboration should look like. I continued to use the method of cutting out shapes from construction paper, mocking up the imagined output with Nodebox, and then photographing the result. My first attempt to define how collaboration should work was to create two independent canvases, one per user, and add a mixing function to blend the two. The user could choose between overlap or blend modes. However, after some consideration it seemed this idea wasn't collaborative enough. I was afraid that by having a separate blend function it might lead people to spend time creating their own drawings and then, only when they were ready, minimally interact with the other person to decide on a blend mode.

In order to encourage more active collaboration throughout the entire process I decided that I would limit what each person was allowed to do. Since I had four categories, I decided to create one canvas for each. Four people would be able to simultaneously use the system. The first user could only create the shapes: square, circle, and triangle. The second user could only color the shapes of the first user. The third user could only transform the shapes of the first user by making them bigger or smaller. The last user could only perform looping functions. Each person could contribute something interesting to the drawing, but no one person could really make a final drawing thus strongly motivating users to collaborate with the each other.

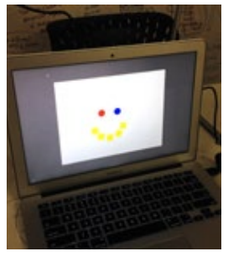
Prototyping

As the concept of the system solidified I started to think of the form of the final piece. Professor Lucid suggested that I look into the Reactable tabletop technology. Reactable (in addition to commercial products) produces an open-source software library called reacTIVision (React) that detects the location of "fiducials." The fiducials are symbols, like barcodes, but, unlike barcodes, they are designed to be read by a standard USB webcam. The React software (combined with a webcam) can detect the 2-dimensional position and angle of rotation of each fiducial symbol. The React website contains a PDF of all the fiducials, so I printed them out to see how they worked. I ran the React software on my laptop and then held up the printed sheet in front of my webcam. After some trial and error I determined that the software could detect the fiducials fairly well from a distance of about 3 feet.

Up until now I had created all of my prototypes with construction paper and the Nodebox language. Nodebox served me well during prototyping, however, the language is designed for creating visualizations of data and would not be sufficient for creating a complex interactive work. I switched to the Processing programming language since I knew it well and it had reasonable integration with React. First, I made the square operation functional. Within Processing I was able to detect the

location and rotation of a fiducial. I could move the fiducial in real-space within view of the camera and a black square would appear on the screen moving in real-time as I moved my hand. After this first step I was quickly able to program the functionality for a circle and triangle, completing the full set of shape operations I had chosen to include in my vocabulary.

Ceren Paydaş, a DMI classmate, designed some simple visual icons for each of the operations I planned to program. I printed



Ceren Paydaş (DMI 15') playing with an early *Draw Blocks* prototype. Right: resultant image from the paper icons in center photo.

out small cards, each containing a visual icon and the associated fiducial. With the card, the camera could recognize the fiducial and the user could recognize the icon. I installed a USB webcam on my studio wall, pointing down at my worktable. I could then, at any time, plug the webcam into my laptop and test my system with the paper fiducial icons.

Next I programmed the operations for yellow, red, and blue. I decided that colors would behave as operations. For example yellow could operate on a square, creating a yellow square. So in order to make the colors work I also had to program an algorithm that clustered the fiducials into nearby groups and only apply operations within the group. For example, say a user placed a square next to the yellow symbol on the left side of the canvas and on the right side of the canvas the user placed a circle next to a red symbol. The output I wanted in such a case was a yellow square and a red circle. In order for this to happen my software needed to be able to recognize two distinct groups: the left group of two symbols and the right group of two symbols. Once grouping was programmed the rest of the operations came very quickly.

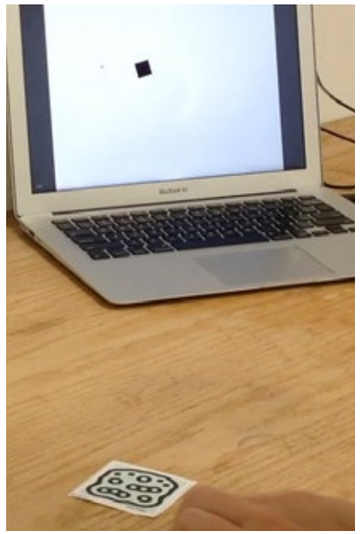
I added the transform operations: smaller, bigger, and skew leveraging similar operations built into Processing. The smaller operation makes the entire group smaller, the bigger operation makes the entire group bigger. The skew operation skews (aka shears) the entire group; the output would be similar to taking a square rubber sheet and pulling on opposite corners. I then added the looping operation (repetition).

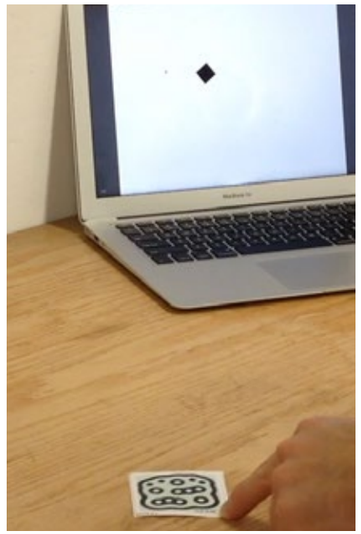
I started with just a single looping operation that I called a grid. The way the grid operation worked was it would take whatever you had created so far. Then it would shrink it to say 1/10 the size then tile it vertically and horizontally across the screen. With the grid operation the user was able to quickly build up a more complex looking pattern just by adding a single symbol to the canvas.

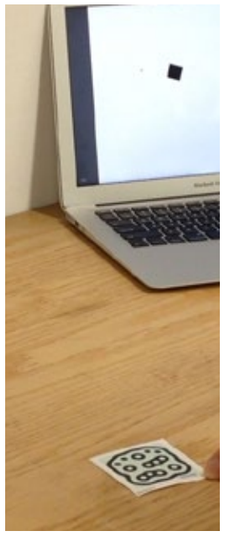
I then added a second USB webcam so I could start to test out collaboration. Although I ultimately intended to have four cameras and four canvases each with defined roles, at this point I only had two cameras. The first canvas would only control shapes and the second canvas would then color those shapes. For simplicity of programming, with the first implementation of the two-camera system I allowed all operations on all canvases. I taped both cameras on the wall above my studio table pointing down at the tabletop. I then marked out work areas with tape and allowed classmates to come and play with them.

I tested this system with many classmates. Even with this rudimentary prototype, I realized many of my design principles. Users could move the paper icons across my desk, generating patterns on my laptop monitor. Most found the interactions very intuitive, as they moved paper shapes on my table, the digital

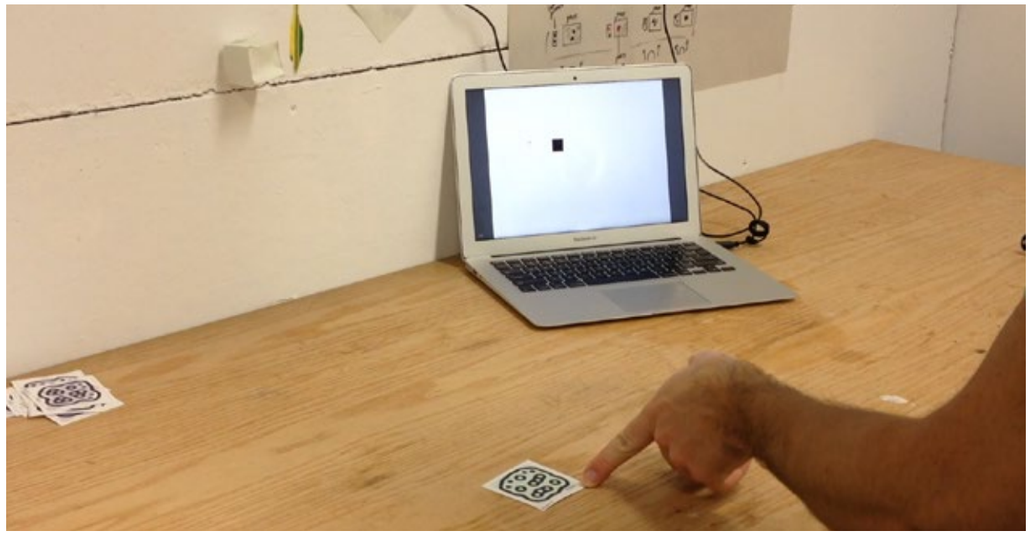
Some of the Operations





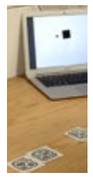


Counterclockwise rotation. Processing prototype with webcams.



Two squares

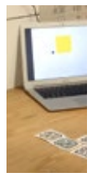
Smaller



Bigger

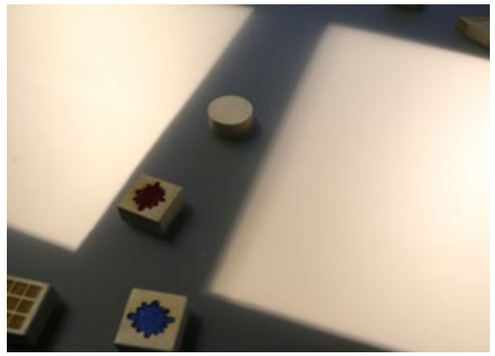
Bigger + bigger

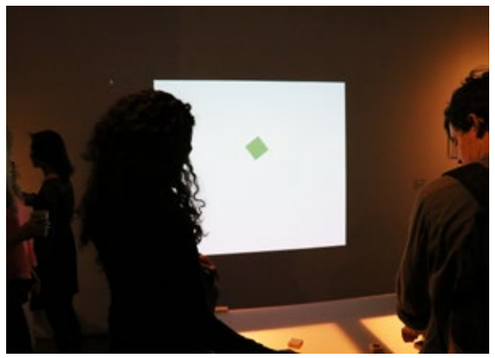
Blue (small square)

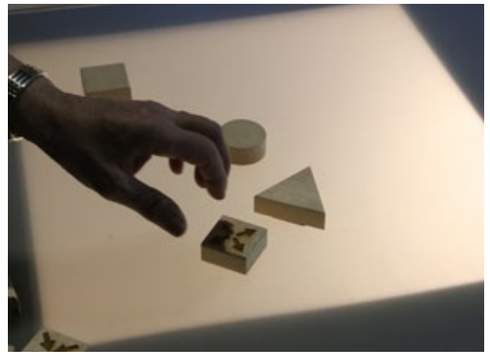


Yellow

Mix colors. Add red to the yellow square to make an orange square



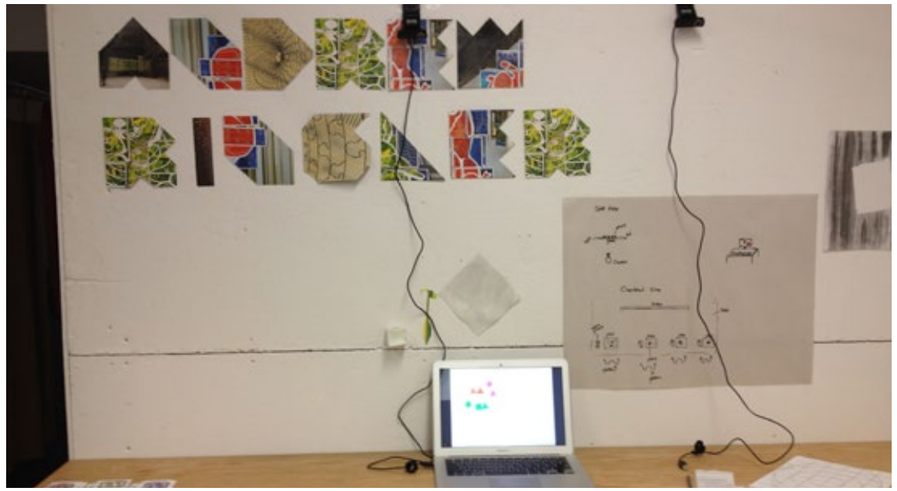




Draw Blocks,
Fresh Media 2016,
Boston Cyberarts Gallery

objects moved in the same direction on my screen. I did have to give verbal instructions and hints to users, but there was still plenty of opportunity to learn the system even after my explanations. For example, I would tell people that they could color in the shapes by placing the color icons near them. Then, people would explore how that actually worked.

Most people enjoyed that the system was not simple and that it challenged them. They were excited when they discovered



Draw Blocks prototype on studio desk with two overhead webcams

new functionality the system possessed, especially the grid operation, suggesting this would be great for designing textile patterns. Users were able to create designs on my laptop and many asked if I was saving them all; some took pictures of their creations. They were really excited about this new way of designing patterns.

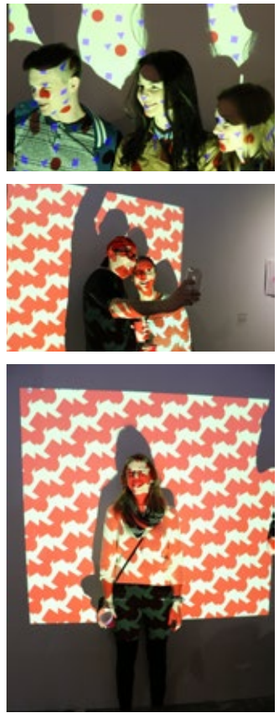
I soon realized that restricting what operations a user could do on each canvas was not going to be necessary. Just the fact that user one could color in user two's shapes and visa-versa, led to rich collaborations. However, I still wanted to have four canvases which would require four USB webcams. This turned out to be problematic because after a lot of research, I discovered that standard computers can only reliably support two simultaneous USB 2.0 webcams. There are some workarounds to this limitation but each had its own problem: using a desktop tower computer with auxiliary USB cards (heavy), using USB 3.0 webcams (expensive), using firewire webcams (expensive), and using USB 1.0 webcams (hard to find).

As I was struggling with this issue, I had also been speaking with my MassArt studio neighbor Cory Ploessl (MassArt 3D 2015), about collaboration within my project. Cory encouraged me to consider that an experience with two people could differ from one with three or four people. A two-person experience might be more intimate or provide more opportunity for personal communication. Since both of these qualities were compelling to me and since I was struggling with the technology for a three or four person experience, I settled on the two-person, two-camera setup.

Findings

After many iterations, I built my final prototype for the DMI show, Fresh Media, in the spring of 2015. I worked with my classmate Valeria Lalinde to create a final set of icons that would communicate each operation clearly and would be simple enough to be etched into wood. I then laser-etched the icon designs onto the top face of 1" squares by ½" thick pine wood blocks. I then stuck the fiducials on the reverse side. I custom built a new, larger table with a frosted glass top. The Fresh Media gallery opening was packed and my table was in constant use.

During the show, I noted several different types of collaborations. First, it served as a gathering place. I believe this was due to several reasons: it was physically installed in the center



Draw Blocks,
Fresh Media 2015
selfies.

of the gallery, it had a large compelling projection, and it was constructed large enough that people could comfortably stand around it while waiting for their turn to use it. Not only did this encourage sociality, it added to a rich sensory experience of the piece. Just like with ***Play Me I'm Yours*** users could experience the piece not just by using it directly but also by viewing the performance of others and socializing with those gathered around.

Another form of collaboration I found was that people who had used the table were very eager to explain how it worked to newcomers. It was very satisfying to see these self-appointed teachers. When initially testing my prototypes I had seen two people collaborate in creating a single image. Typically, people interacting with the system would quickly discover that there was only a single output that both people were contributing to. Once a user had made this realization, additional collaborations become possible. For example, a user would start looking over at their neighbor's blocks in order to understand how they were influencing the output. I saw various forms of sharing including people asking for someone else's piece, or even just reaching over and taking it. I did see this type of behavior at the Fresh Media opening as well, but as a result of the dense crowds, this type of collaboration wasn't as prominent as in testing.

I was most surprised by a spontaneous bout of selfies that arose because my software was constantly freezing. At many points during the night the input blocks would become too complex for my algorithms and the computer would stop responding to users. It would slowly tesselate, animating very intricate patterns. During these times, since no one could use the table, and blocking the projector would not be considered rude, people decided to take selfies. They stood in front of the wall letting the patterns project on top of them, creating interesting photo opportunities.

Draw blocks successfully provided an opportunity to create, collaborate, and socialize. One interpretation of the selfies is to consider it as documentation of what the user had created. The selfie and sharing of that selfie (on Facebook or Instagram) is a reward for putting in effort to create something new. Providing a platform for people to create things that they were proud enough to want to share was an incredibly satisfying outcome.

This piece was installed again at the Doran Graduate Gallery at MassArt in January of 2016. I received positive feedback like: "really cool," "dope," "the fun piece," and "it's awesome!" People liked the physicality of it: "I like the way the blocks feel." Many people were really excited that they could make colors: "there's colors!", and that colors could be changed, "can you mix colors? Will that [blue and yellow] make green?" (Yes).

One user started moving two blocks back and forth (with both hands), creating an undulating animation; after continuing this for several minutes, she said that it was "mesmerizing." Because the show was less crowded than the previous year, many people had extended opportunities to learn the system. One user thought it was broken, but persisted. They cleared all of the blocks off of the table then placed them down one at a time until they learned their behavior. After several minutes they exclaimed: "so that's how it works!" One group of 5 or 6 teenagers started using the system, then after pushing tons of blocks on the table and turning the entire screen brown said: "we're overloading the system" and walked away. The system had created self-appointed guardians because as soon as the group walked away, someone walked up and cleared all the blocks off of the table.

One woman, Brittany Marcoux, a fellow MassArt graduate student, was responsible for watching the gallery giving her a lot of time to use the system. She said that lots of people would come up to her and say, "how did you do that? I really like it!"

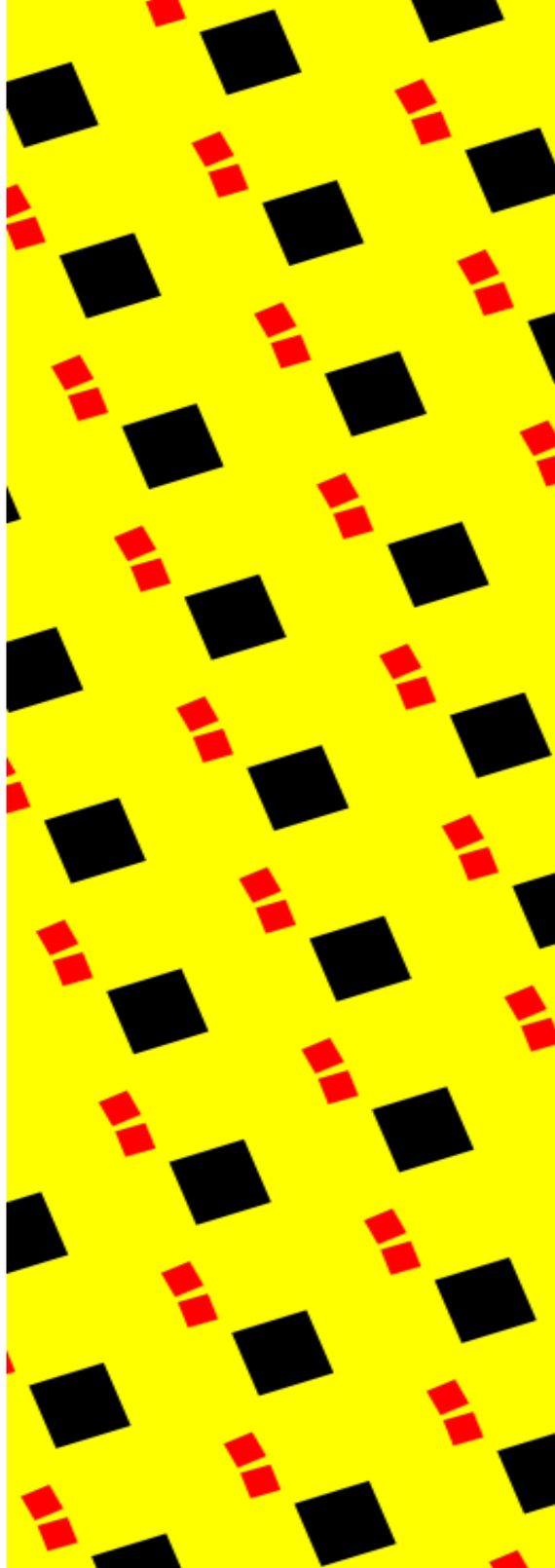
Brittany Marcoux
(MassArt 16')
Facebook Post.

She even posted a picture of herself in front of her creation on Facebook. In designing the piece I had never envisioned the peer learning that would take place. I would frequently see strangers explaining to newcomers how the system worked.

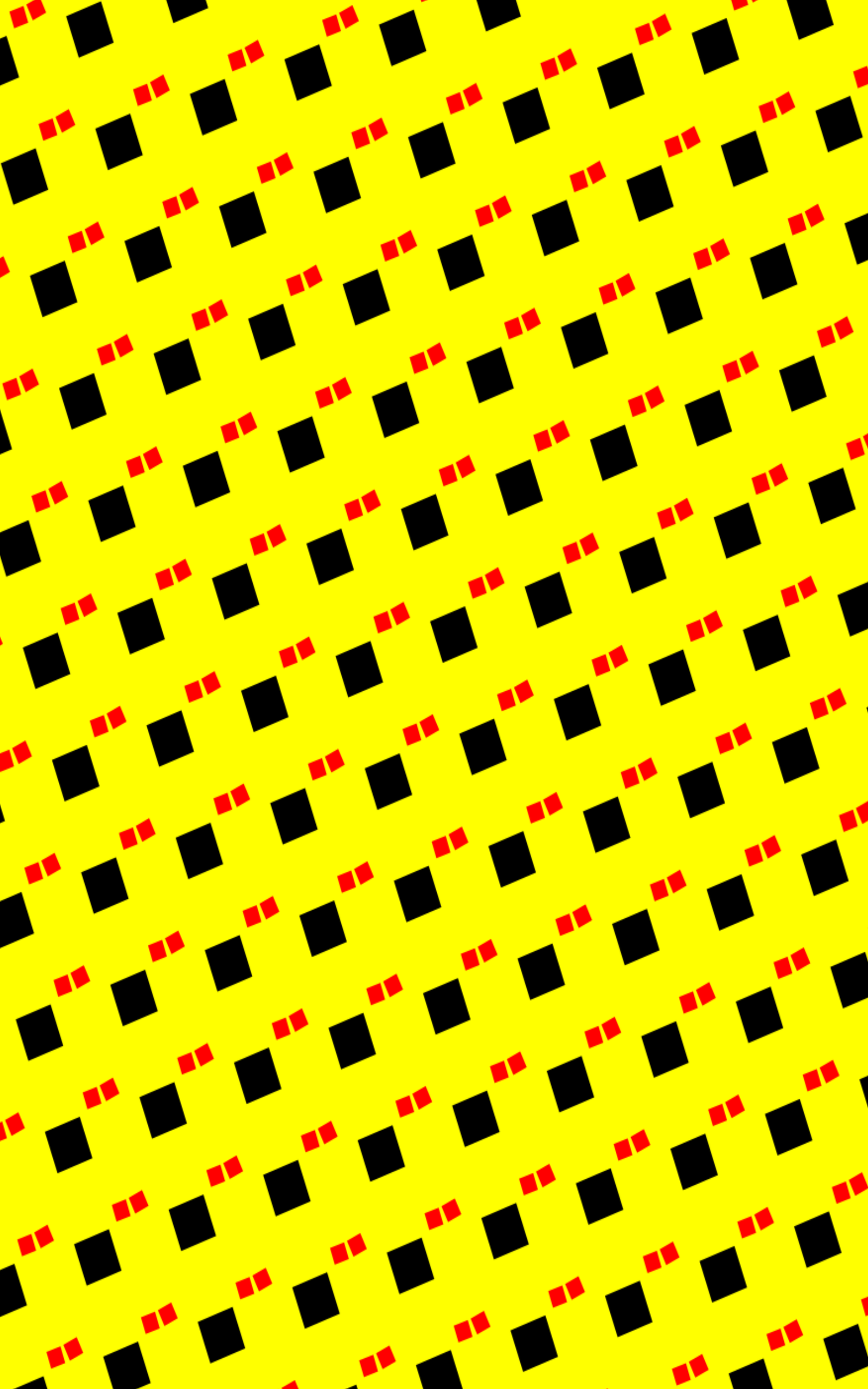
I had imagined that because one can explore continuously with the blocks, people could learn the system through trial-and-error. In fact, lots of learning did take place this way, in addition to peer learning. One user said, "it is good it has immediate feedback so you can tell what is going on."

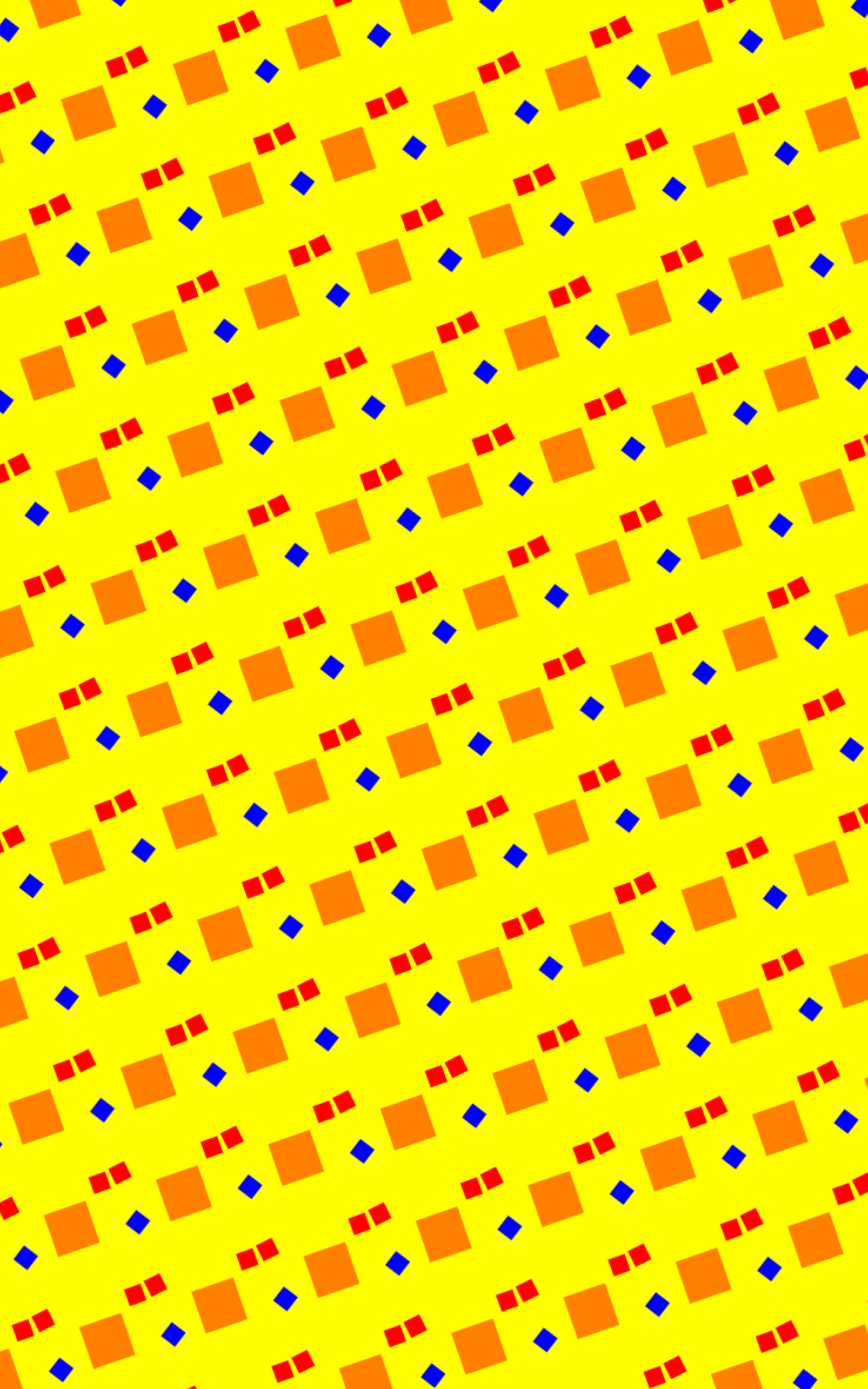
The difficulty of the system allowed people to be tremendously excited, and proud, when they finally figured something out. While the final installation of this piece was in a gallery, the next step is to install it in a public space. I really wanted to see what types of interactions might happen between strangers and I only started to get a hint of this at the gallery opening. Otherwise, I am very pleased with the types of collaborations this piece facilitated. Testing with actual users was a vital component to the success of Draw Blocks. No matter how many times I learn this lesson, unexpected interactions with my work continues to surprise me!

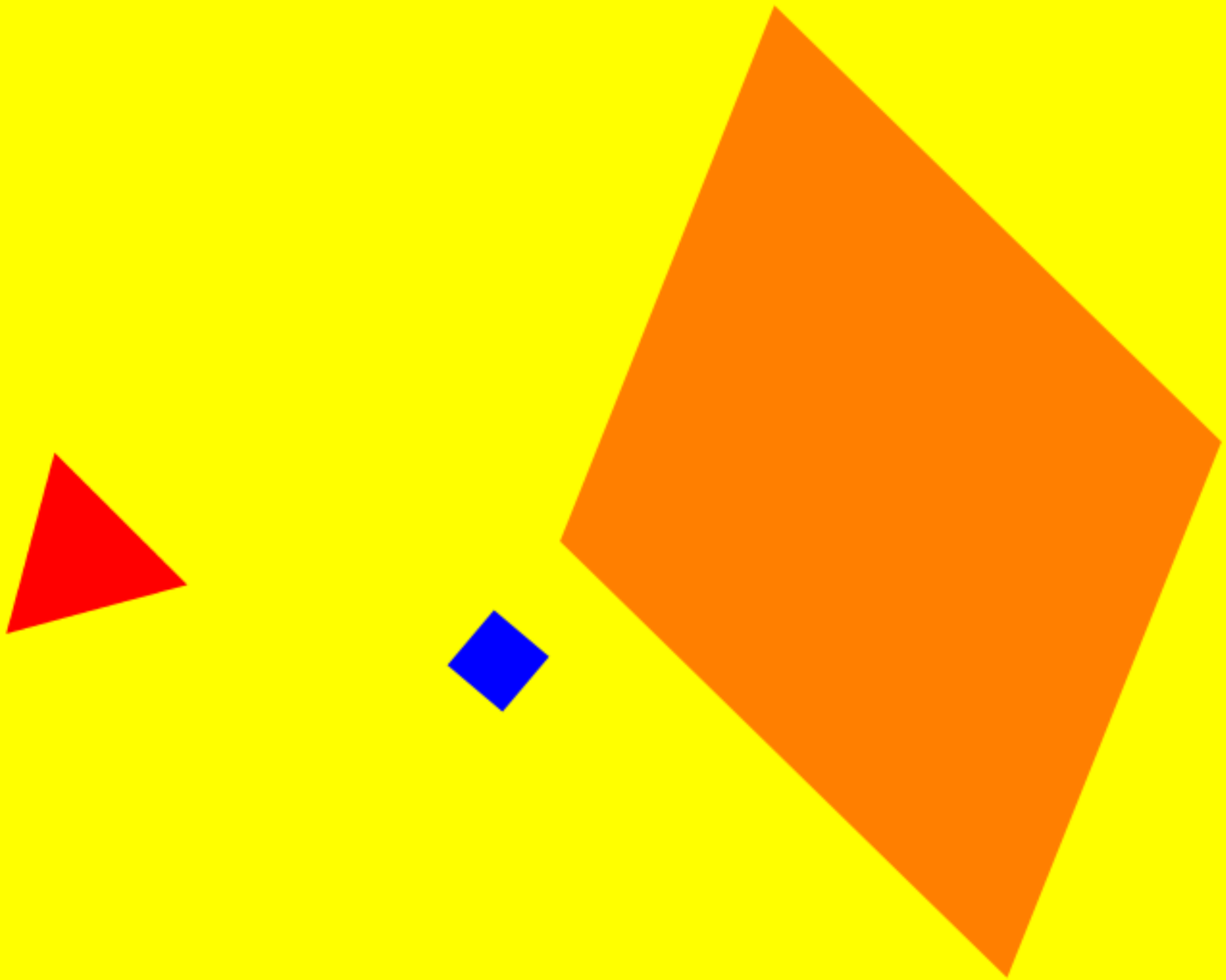
Wooden blocks on a table created an environment in which novices were eager to approach. The simple and novel interface engaged newcomers while providing them an explorable system with tremendous depth and complexity. Draw Blocks provided many opportunities for learning, creating, performing, and collaborating. The piece generated a lot of fun, excitement, and joy for users, and this was very fulfilling for me.

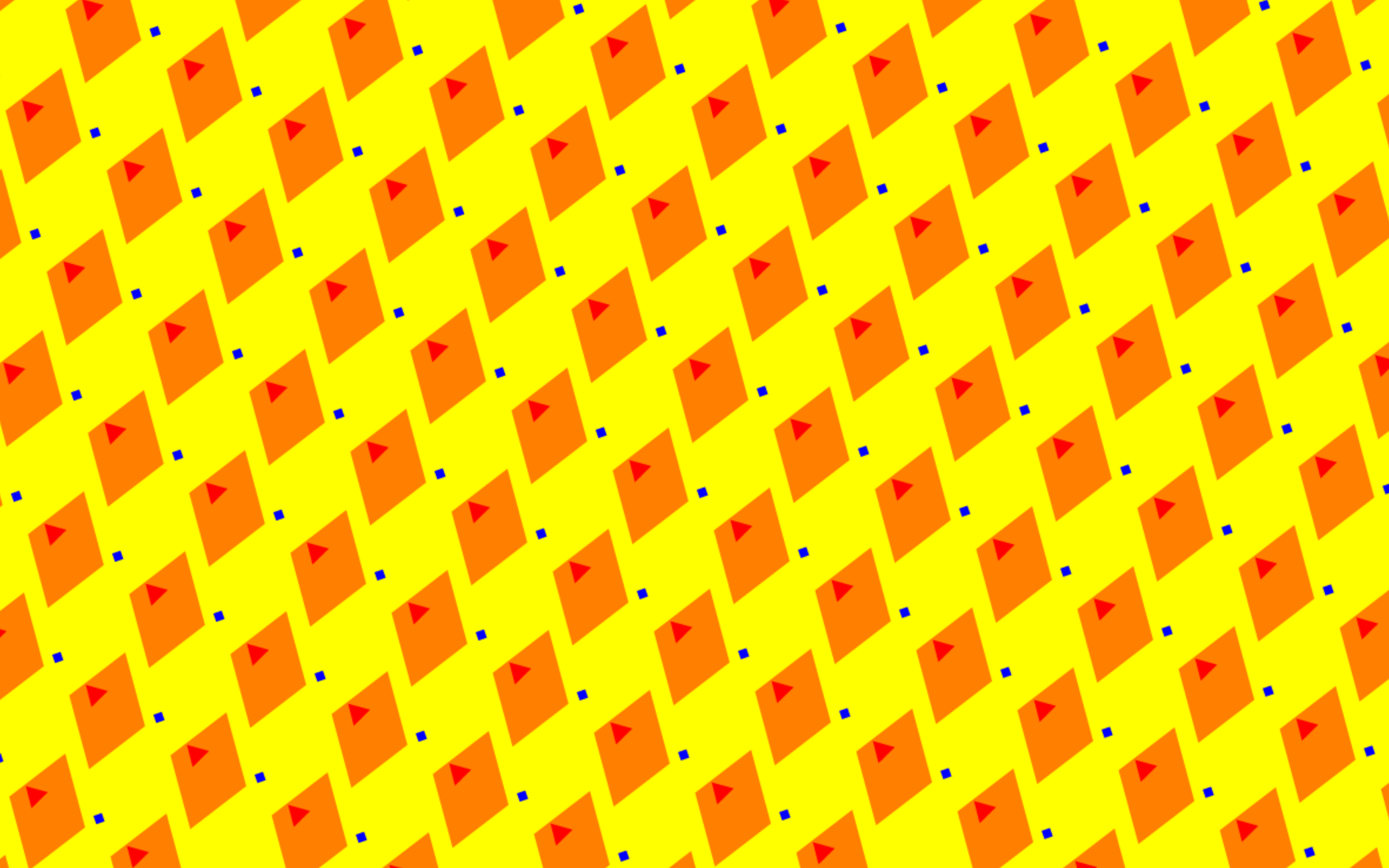


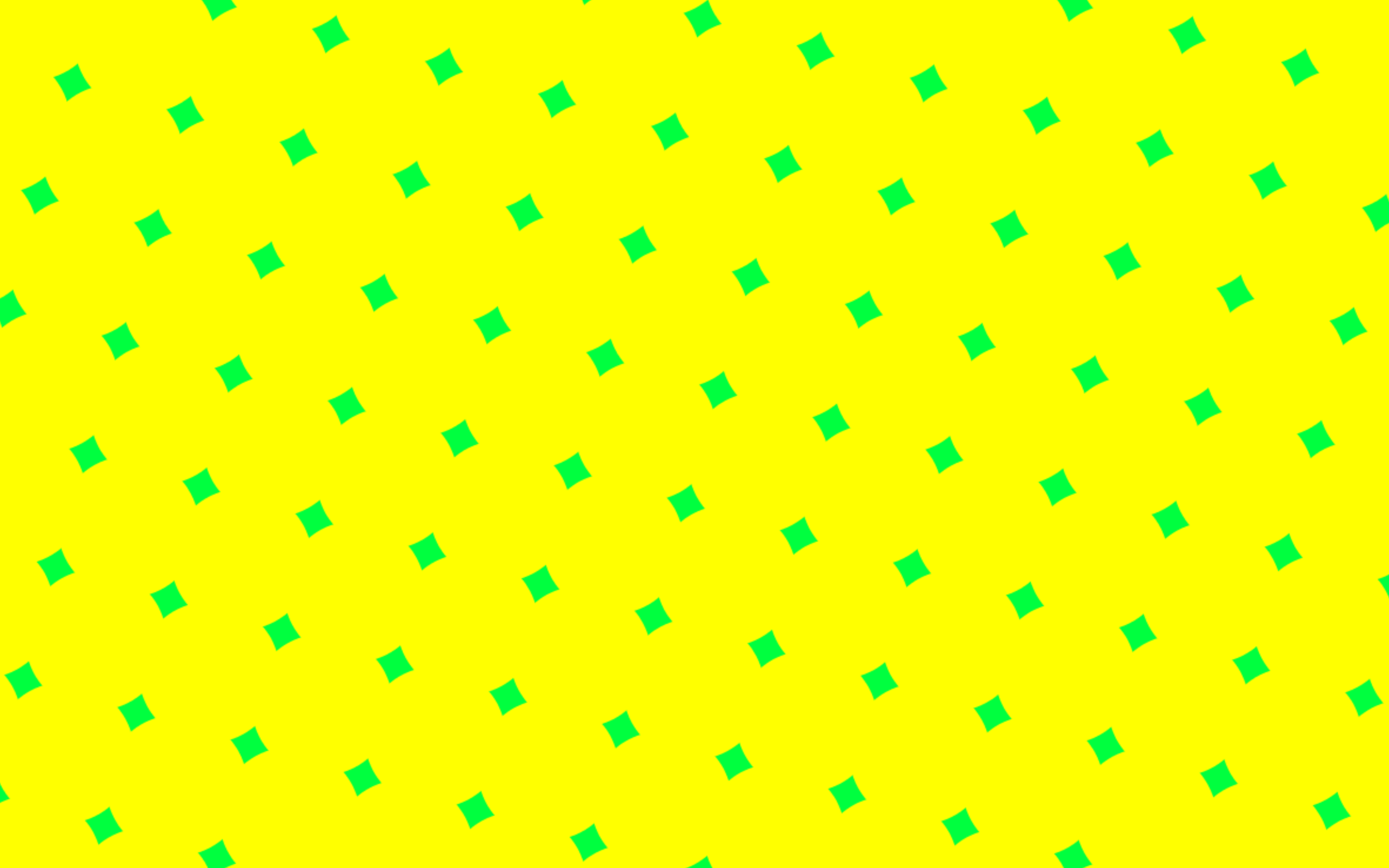
The following pages contain designs created by users interacting with *Draw Blocks*. Captured from 2015—2016.

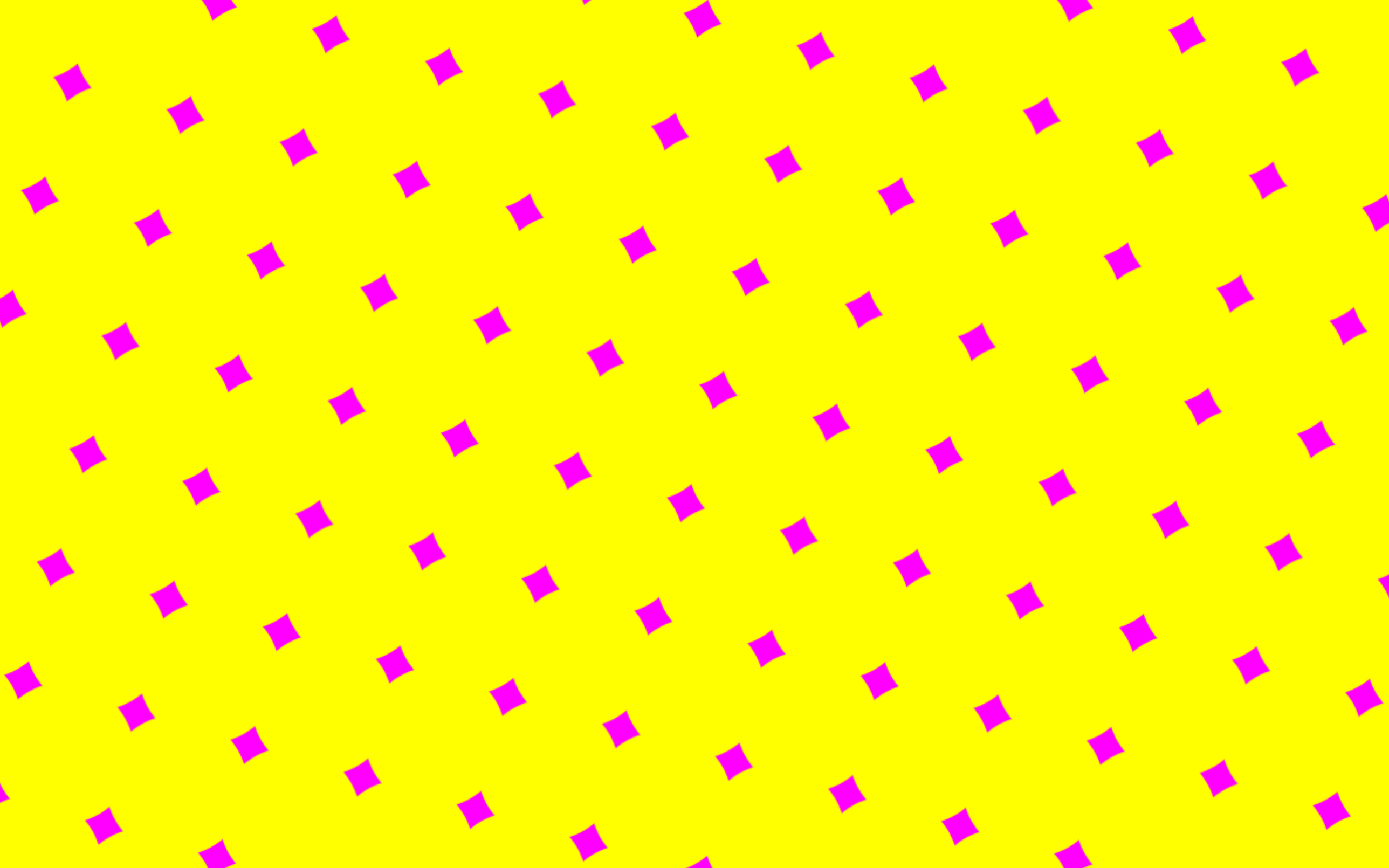


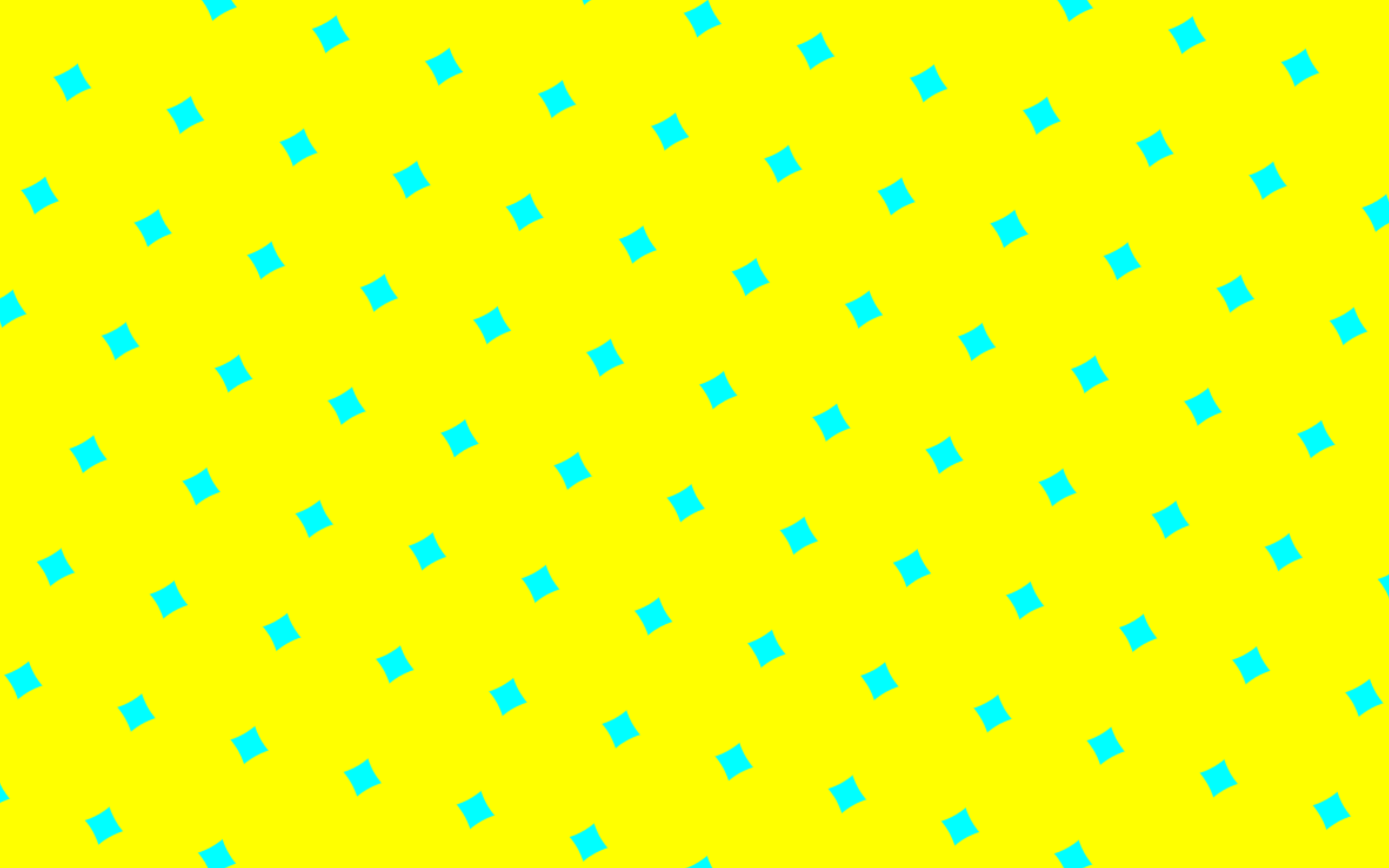


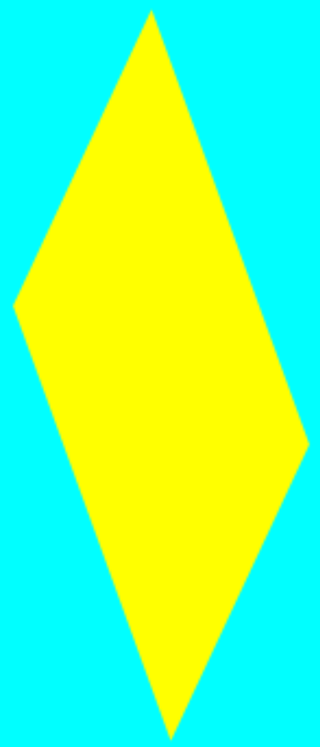


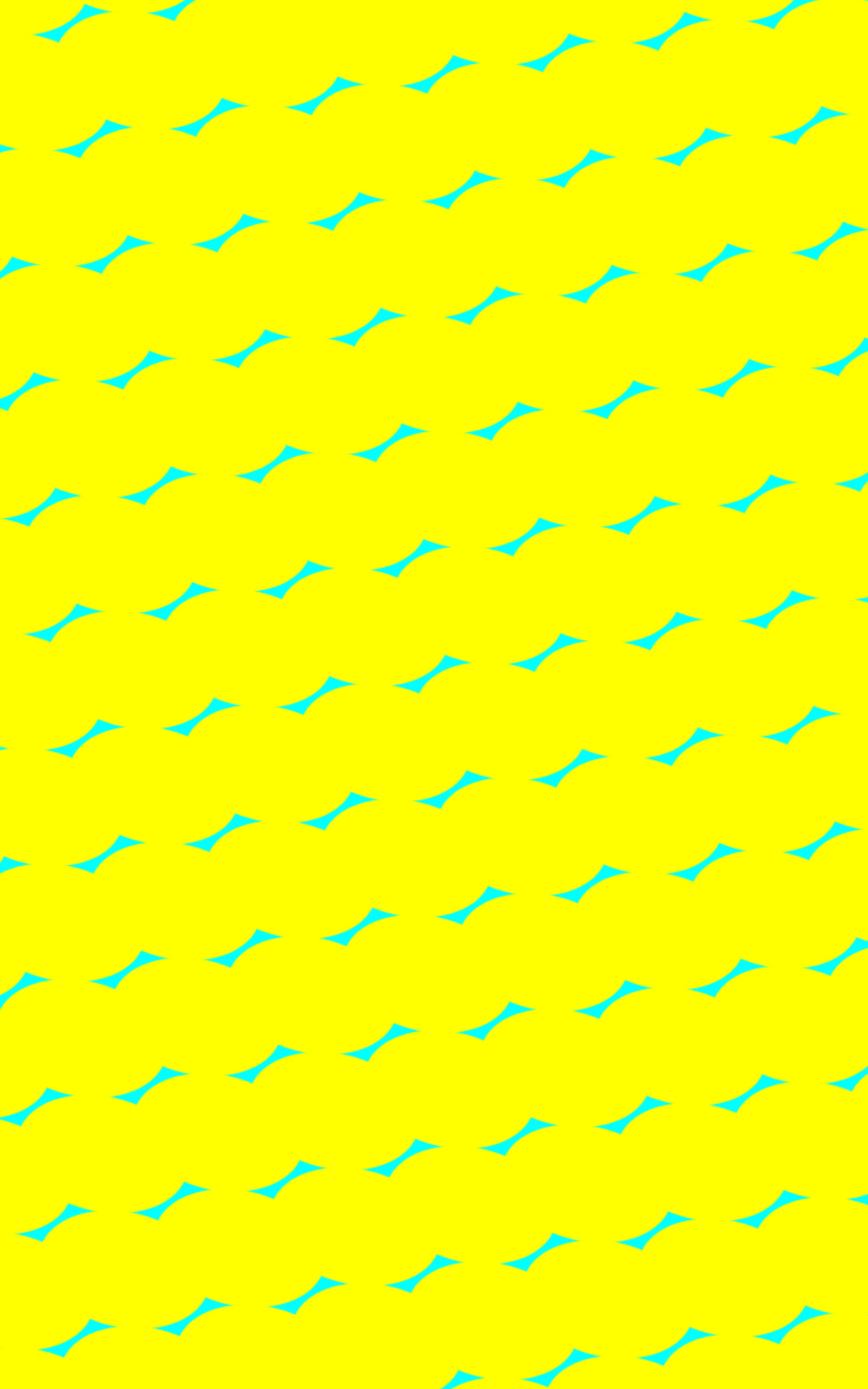


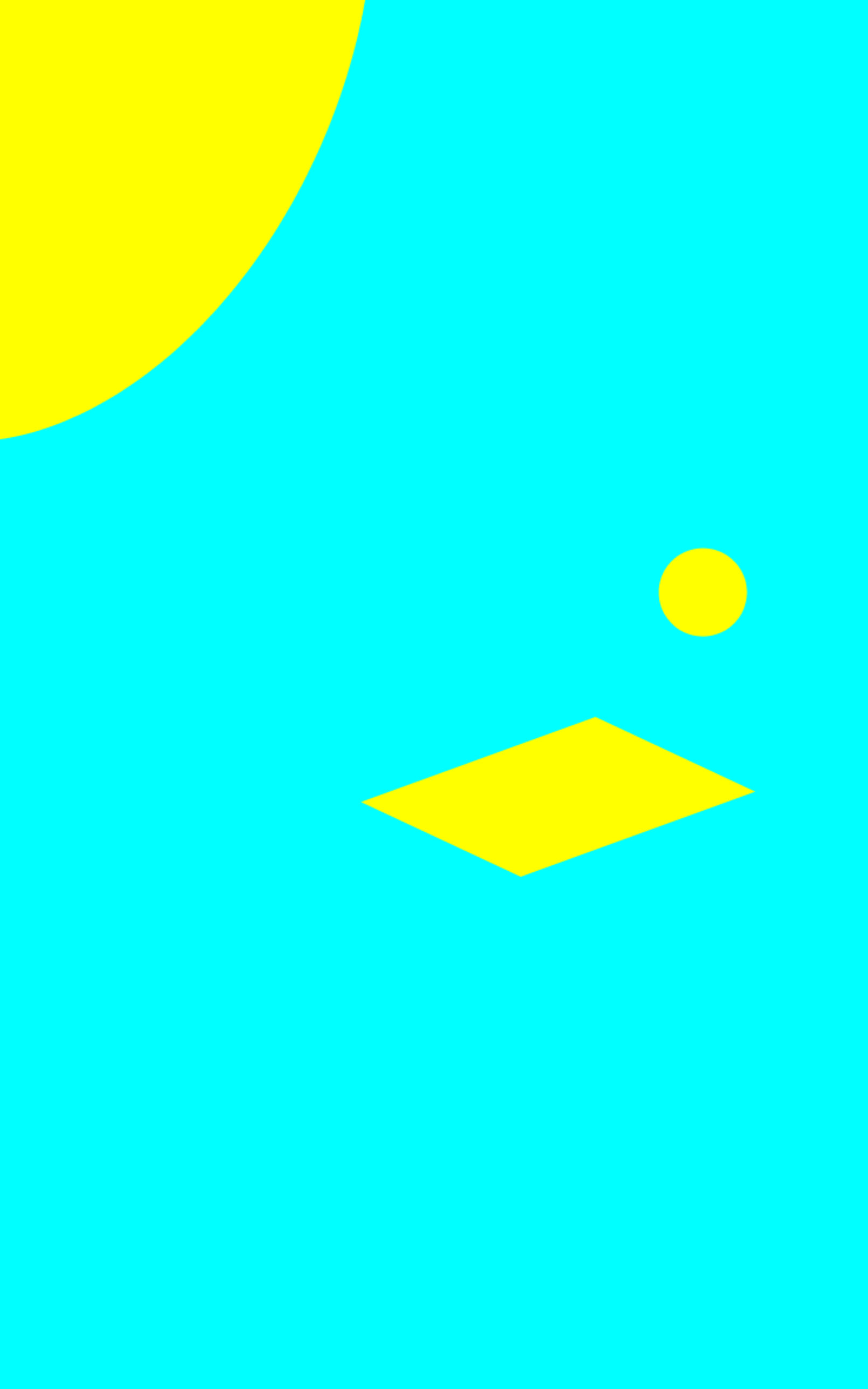


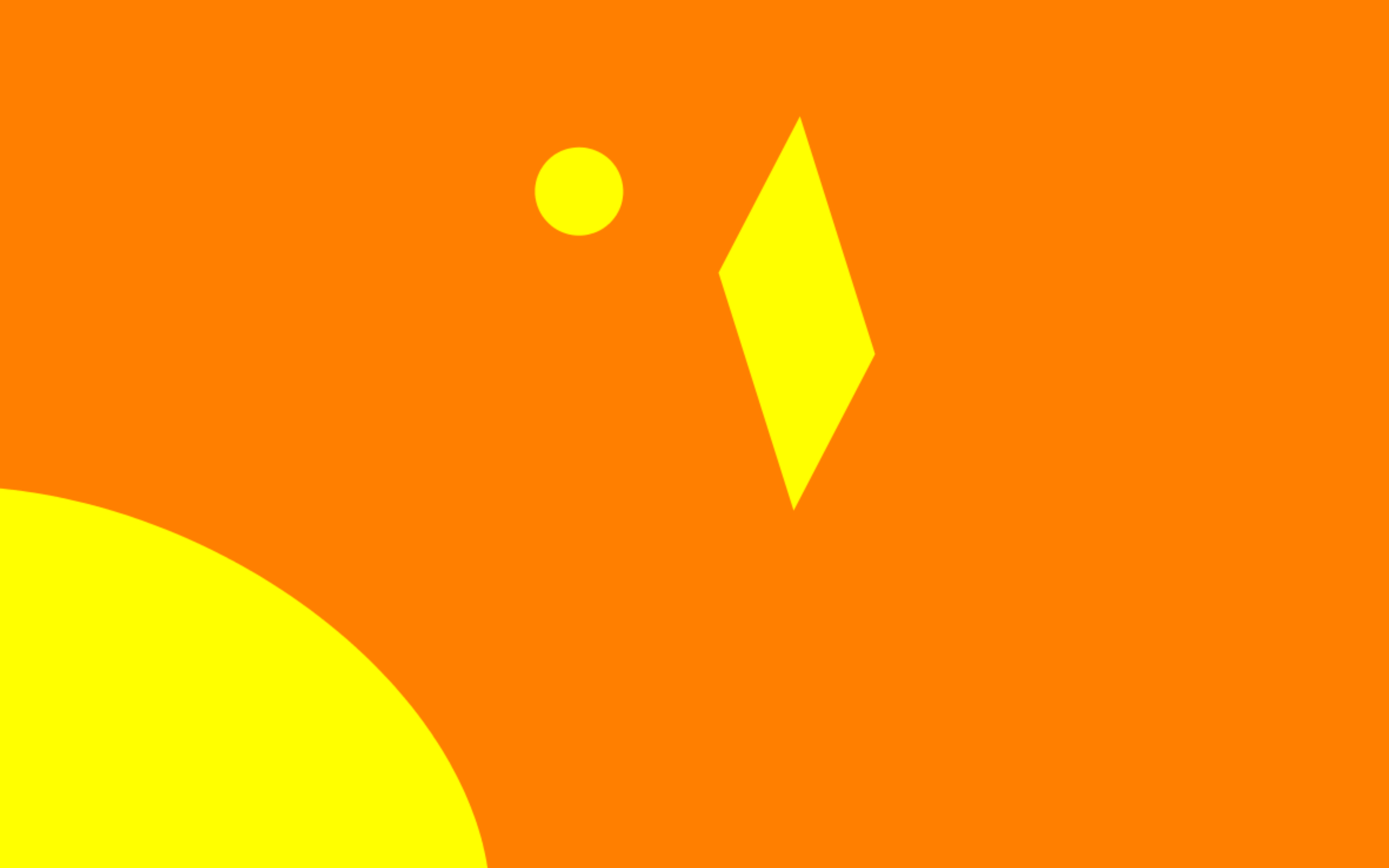


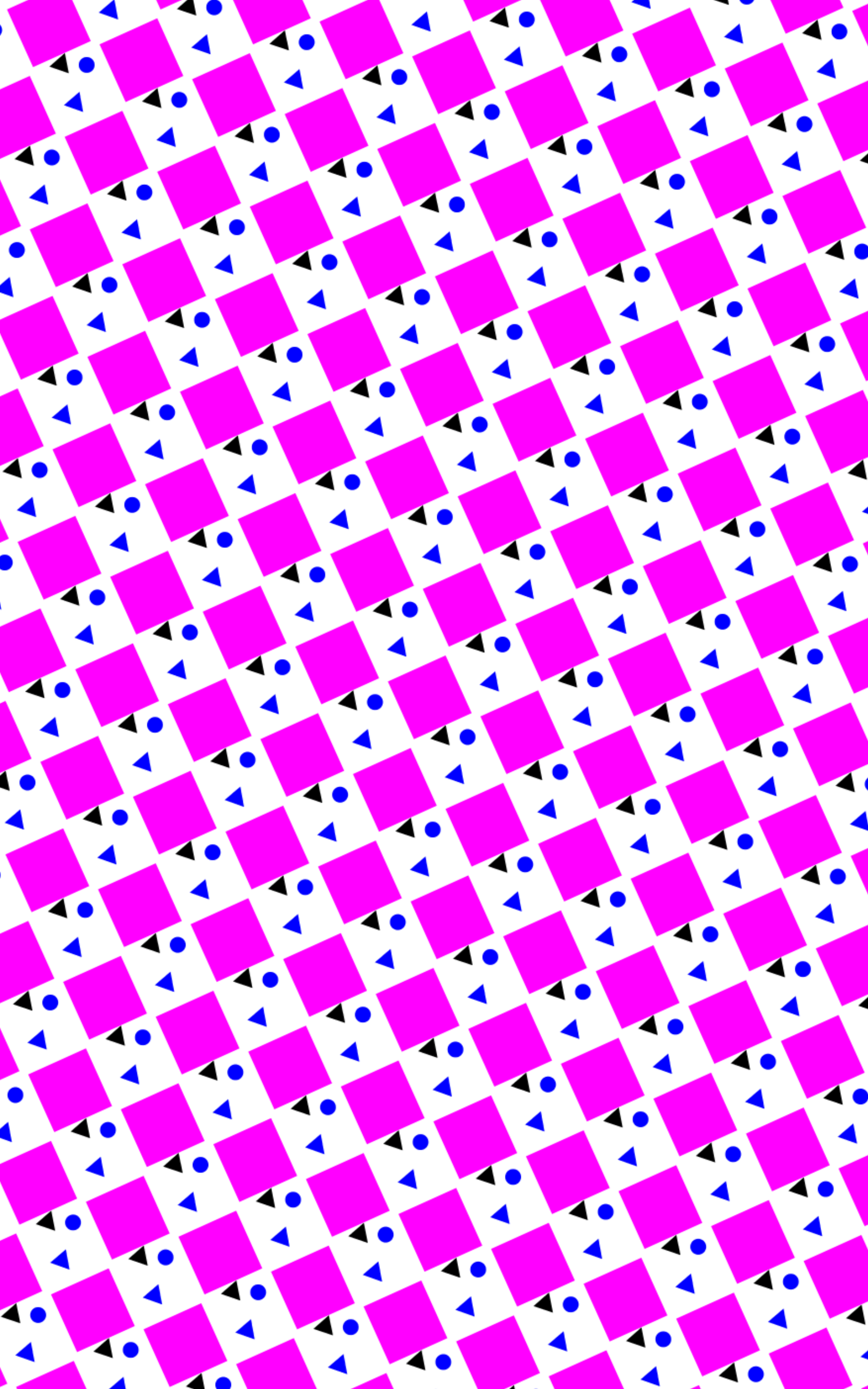


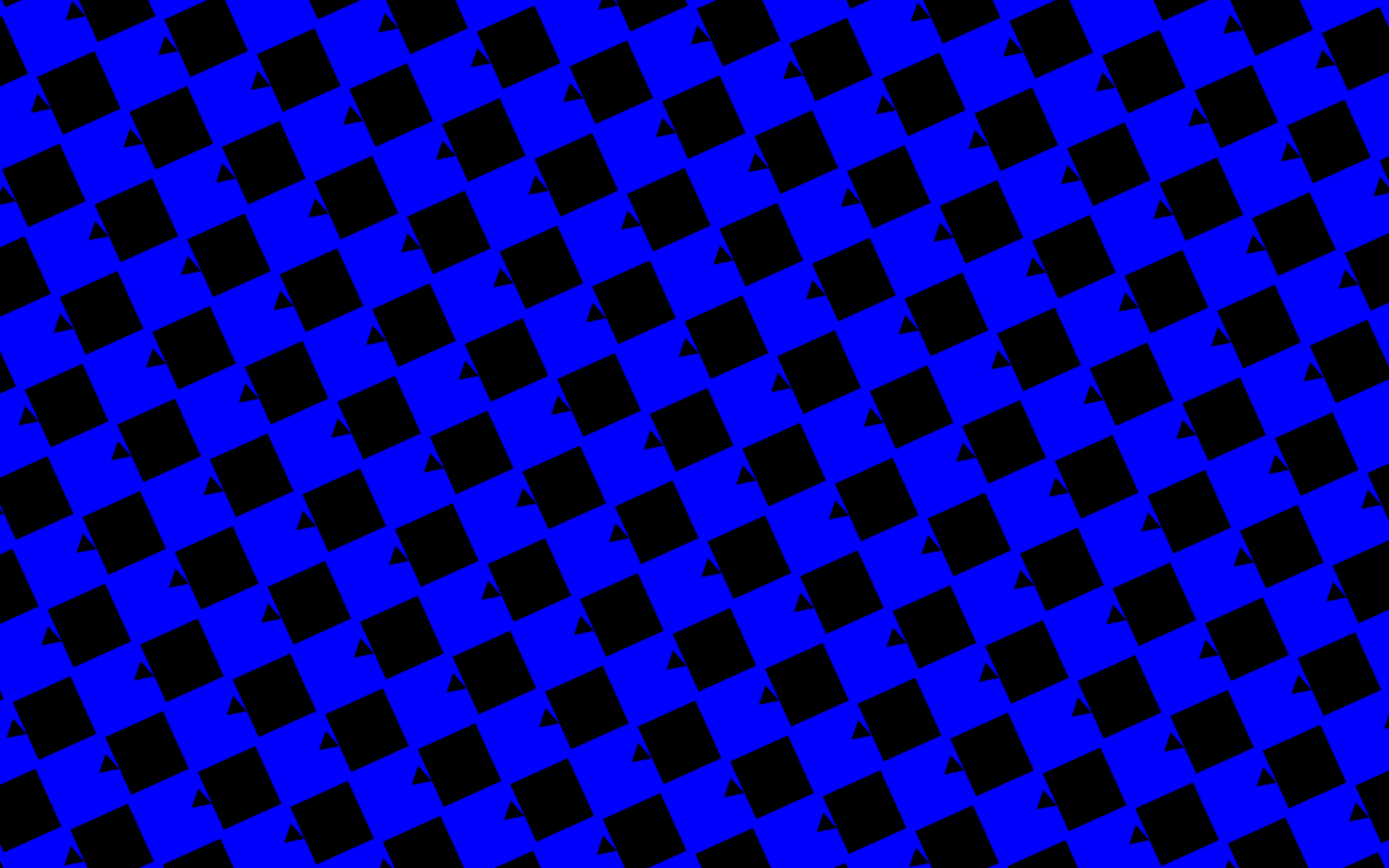


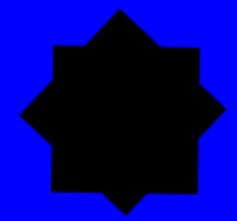


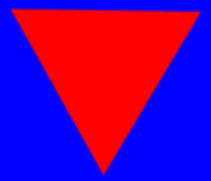


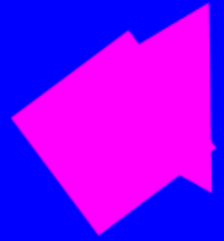


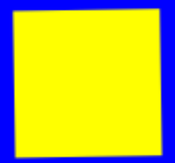


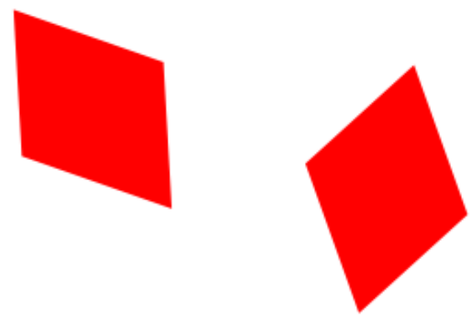


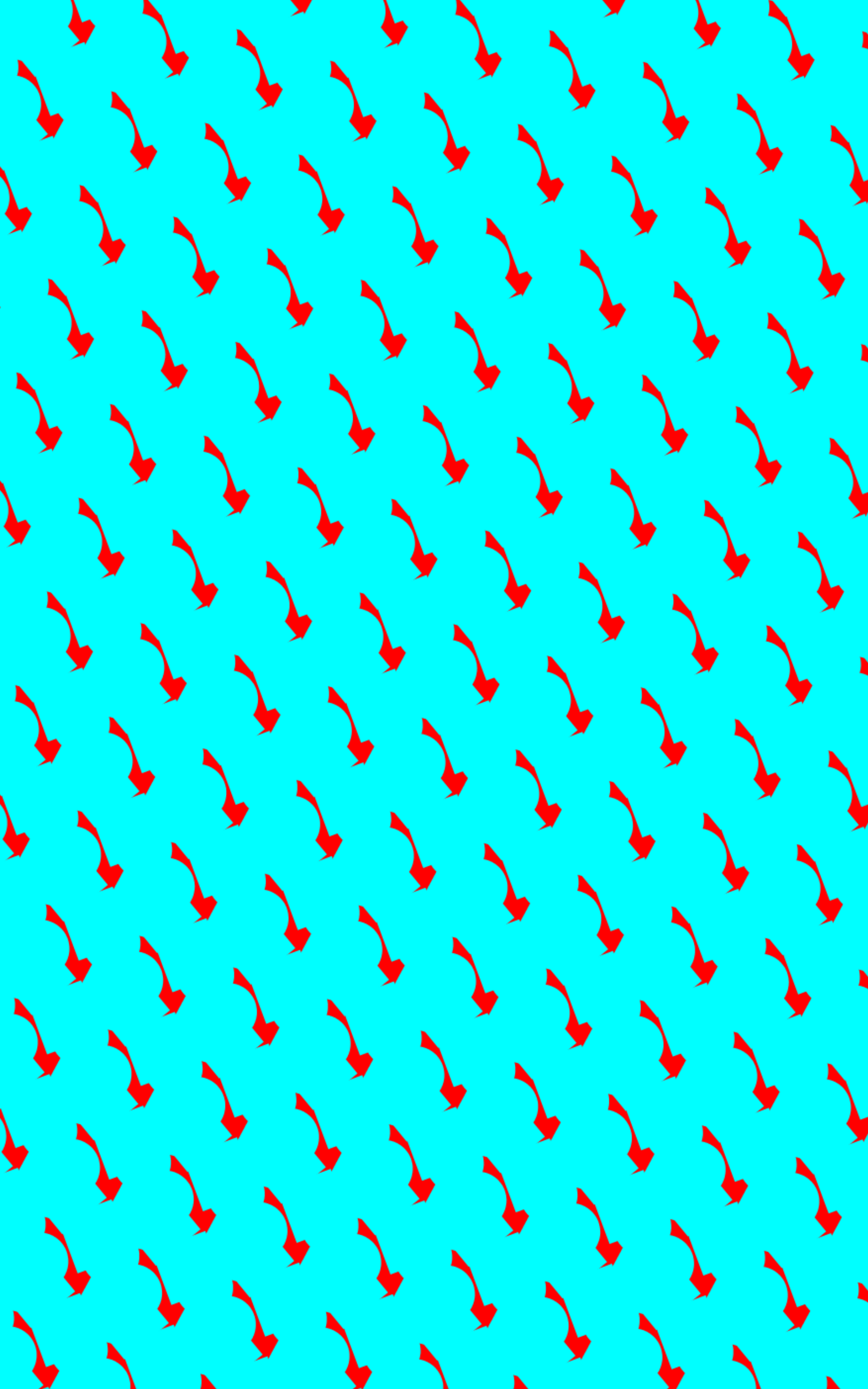


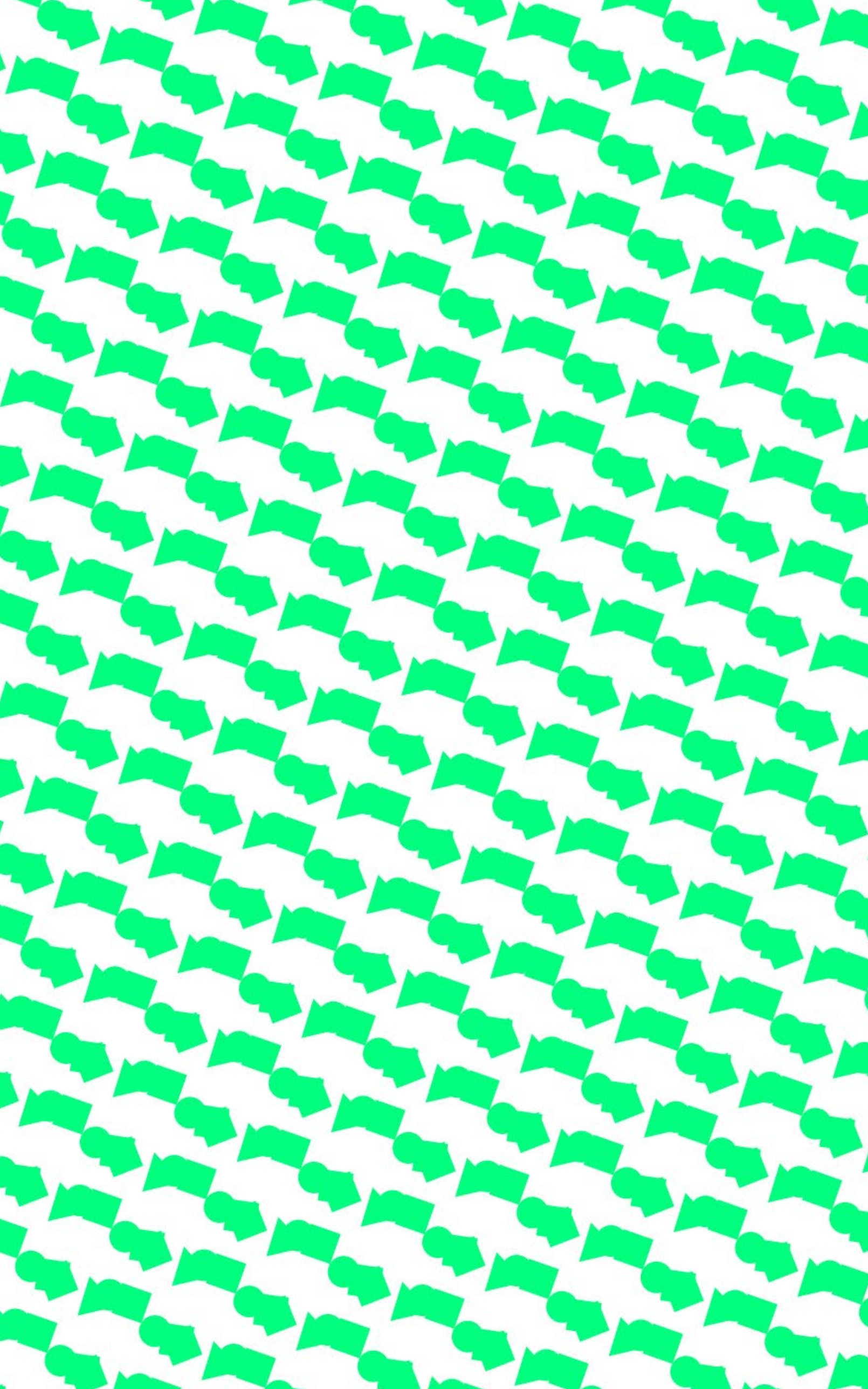


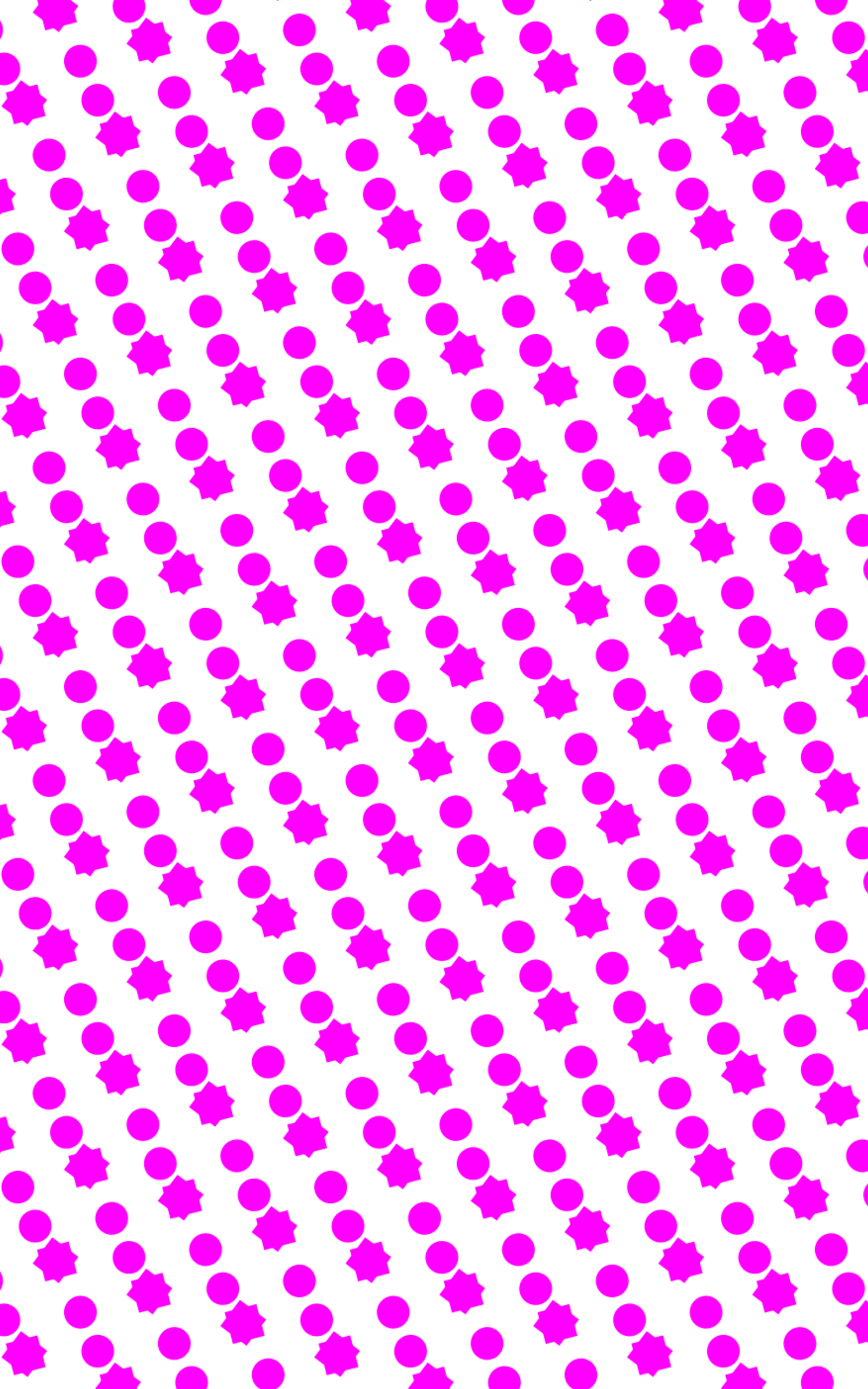


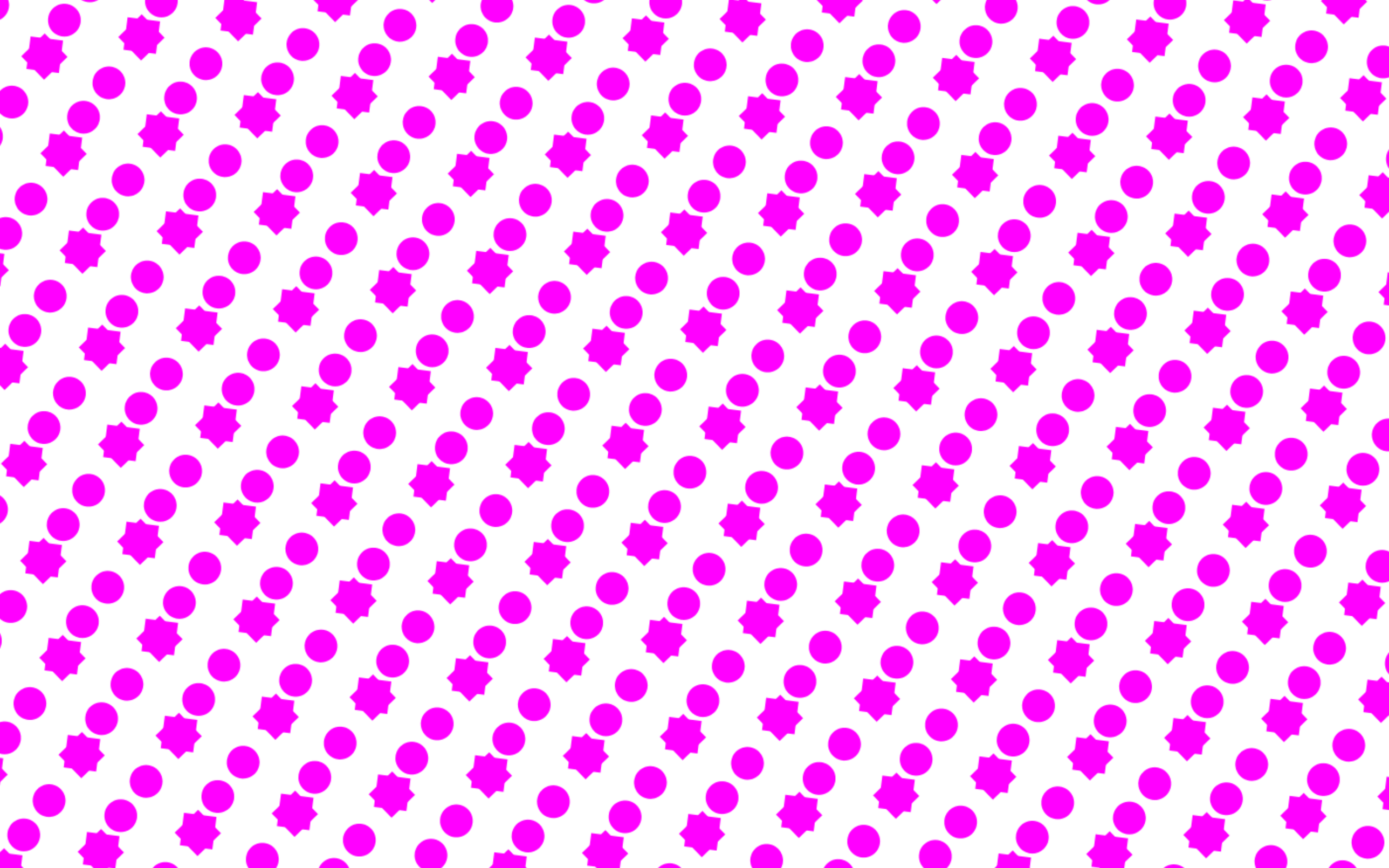


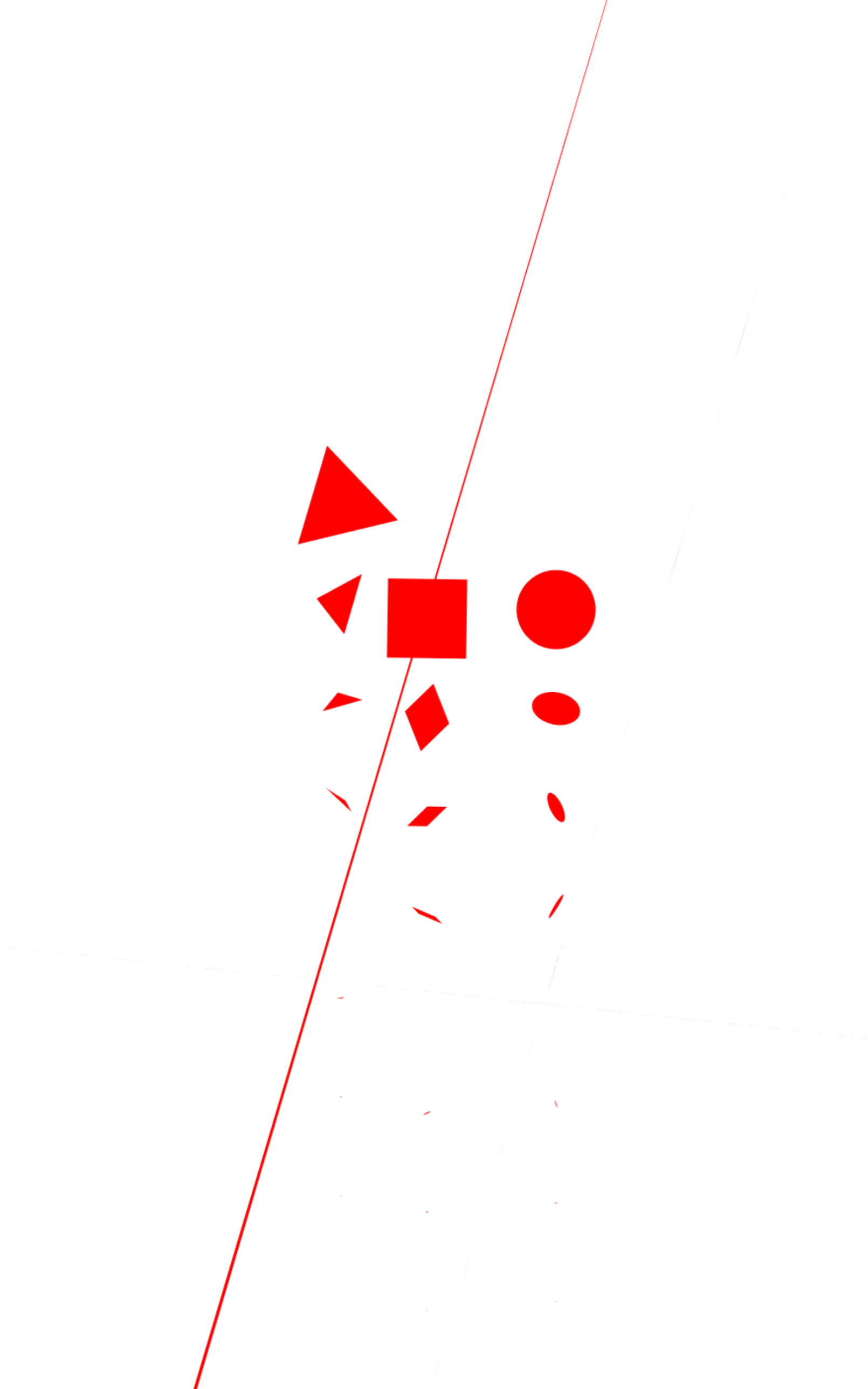


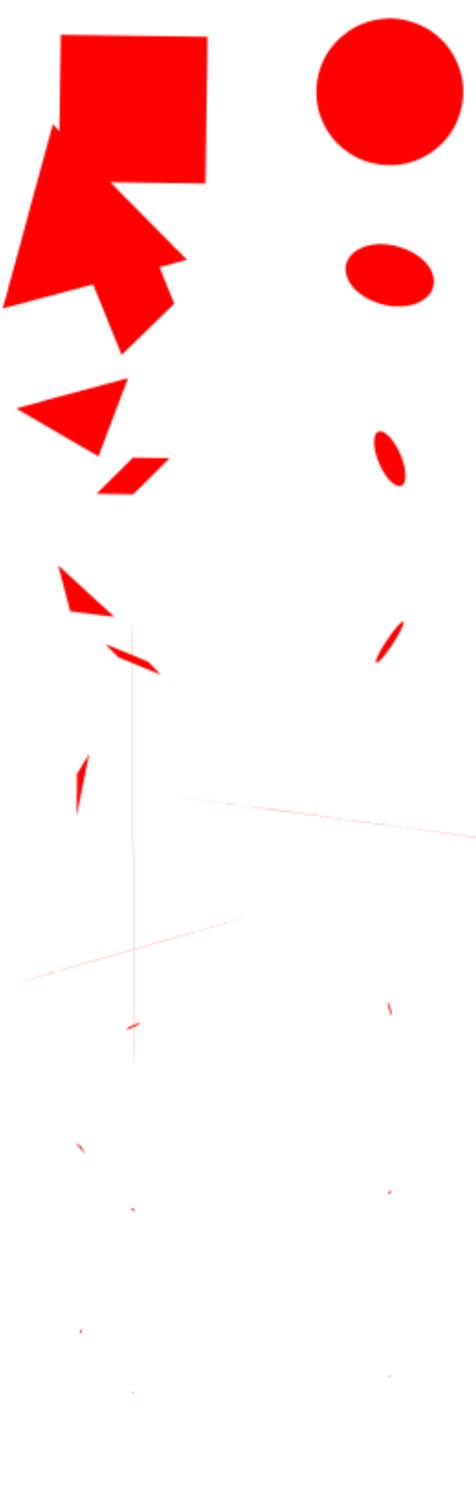


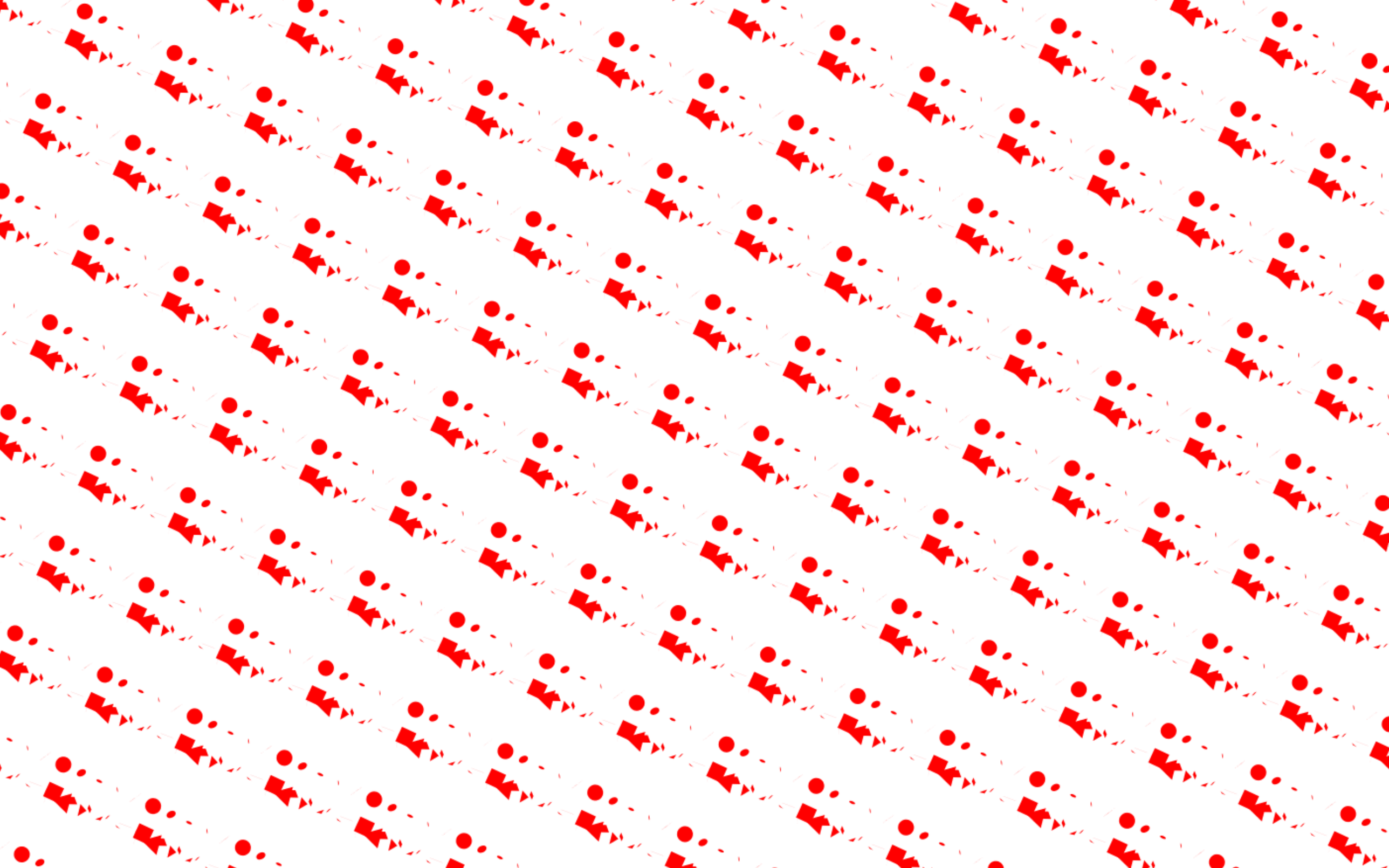


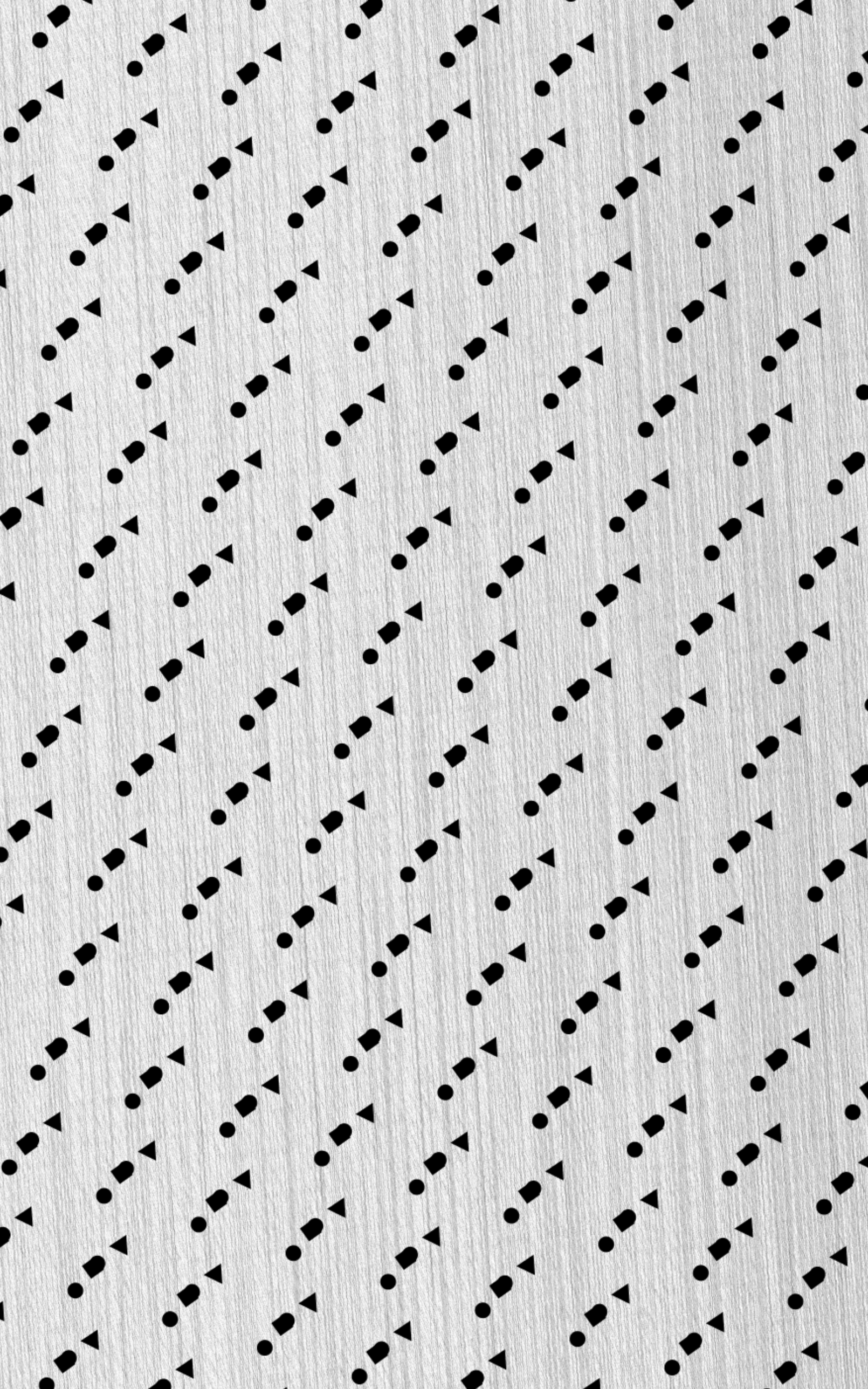


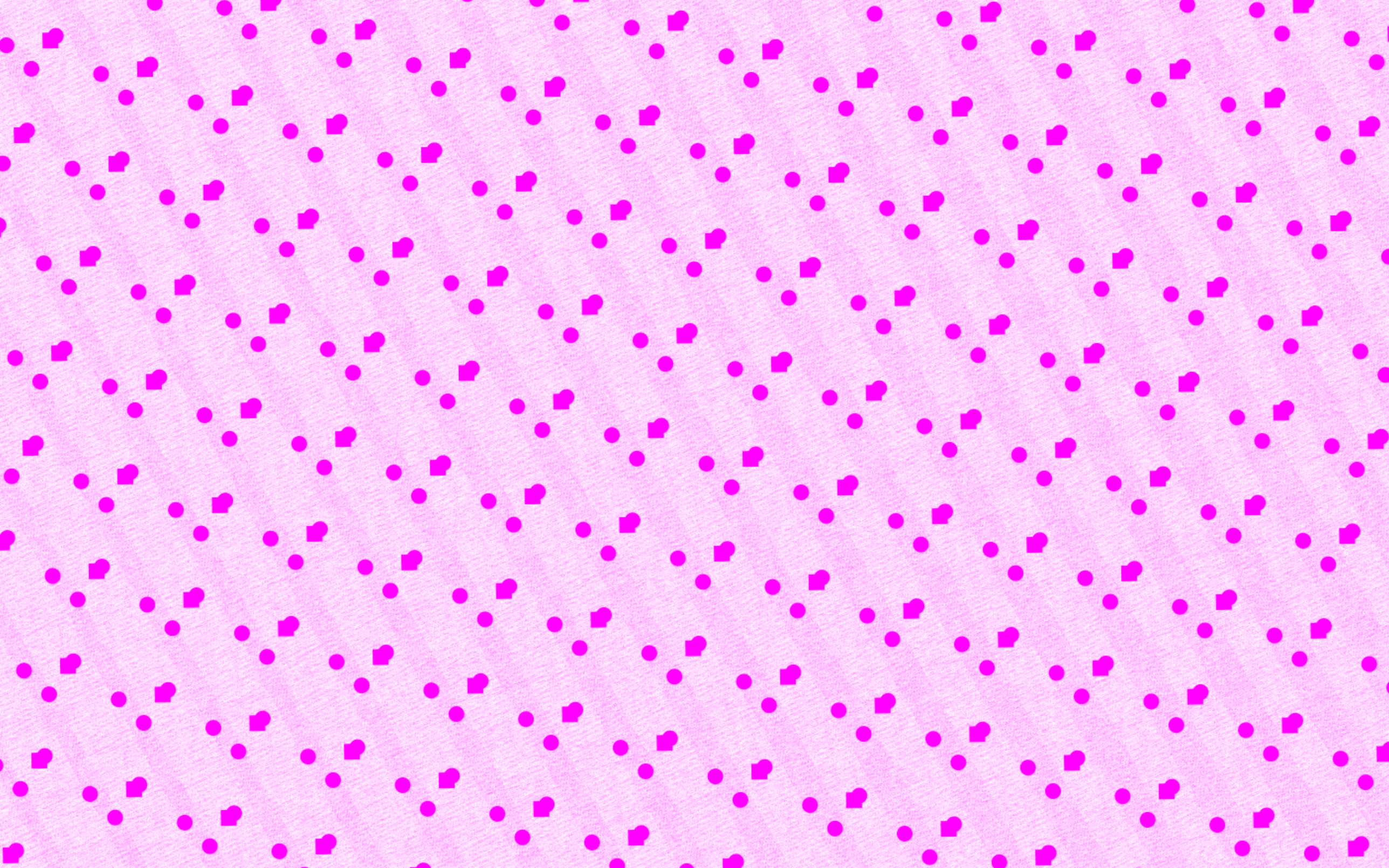


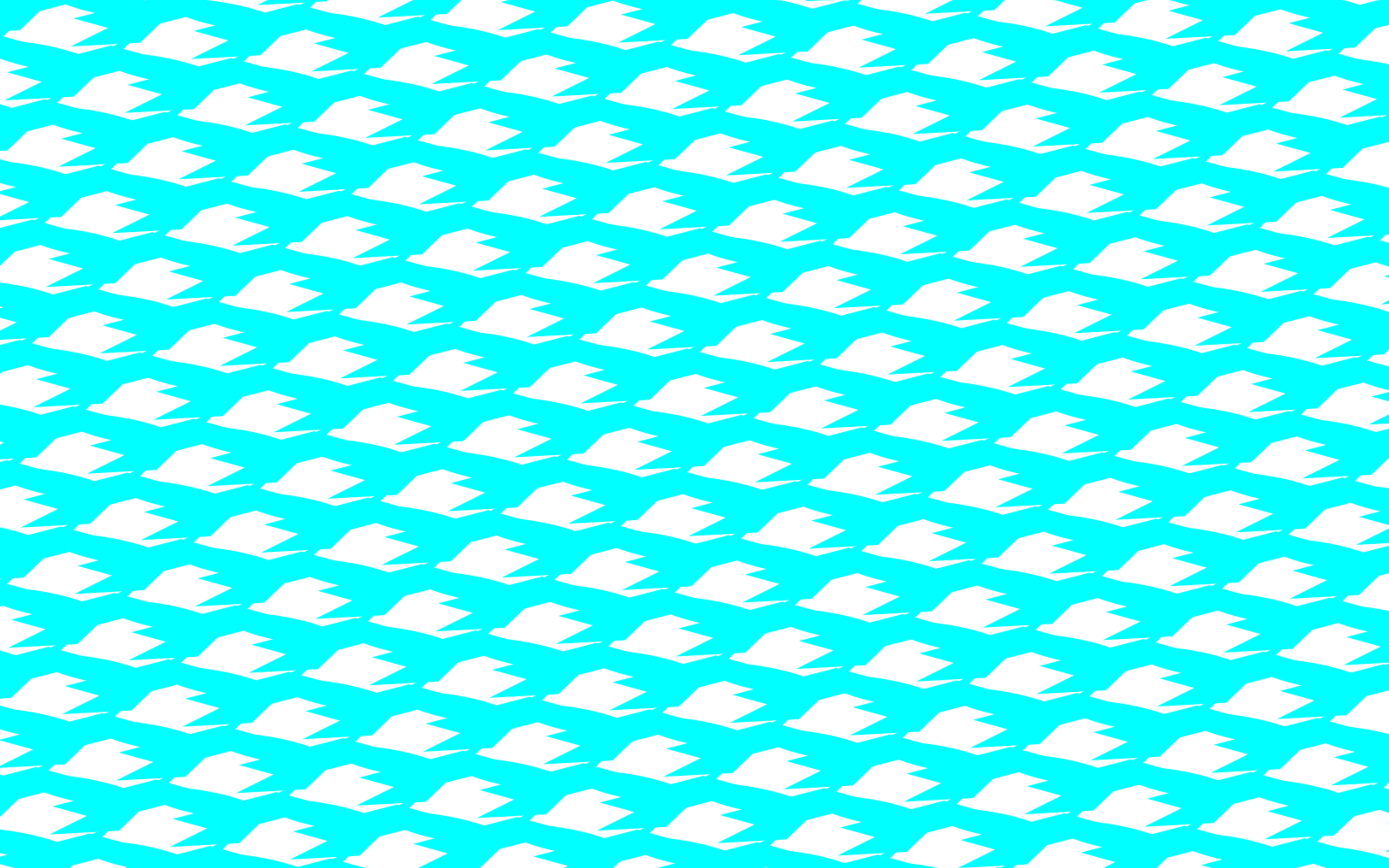


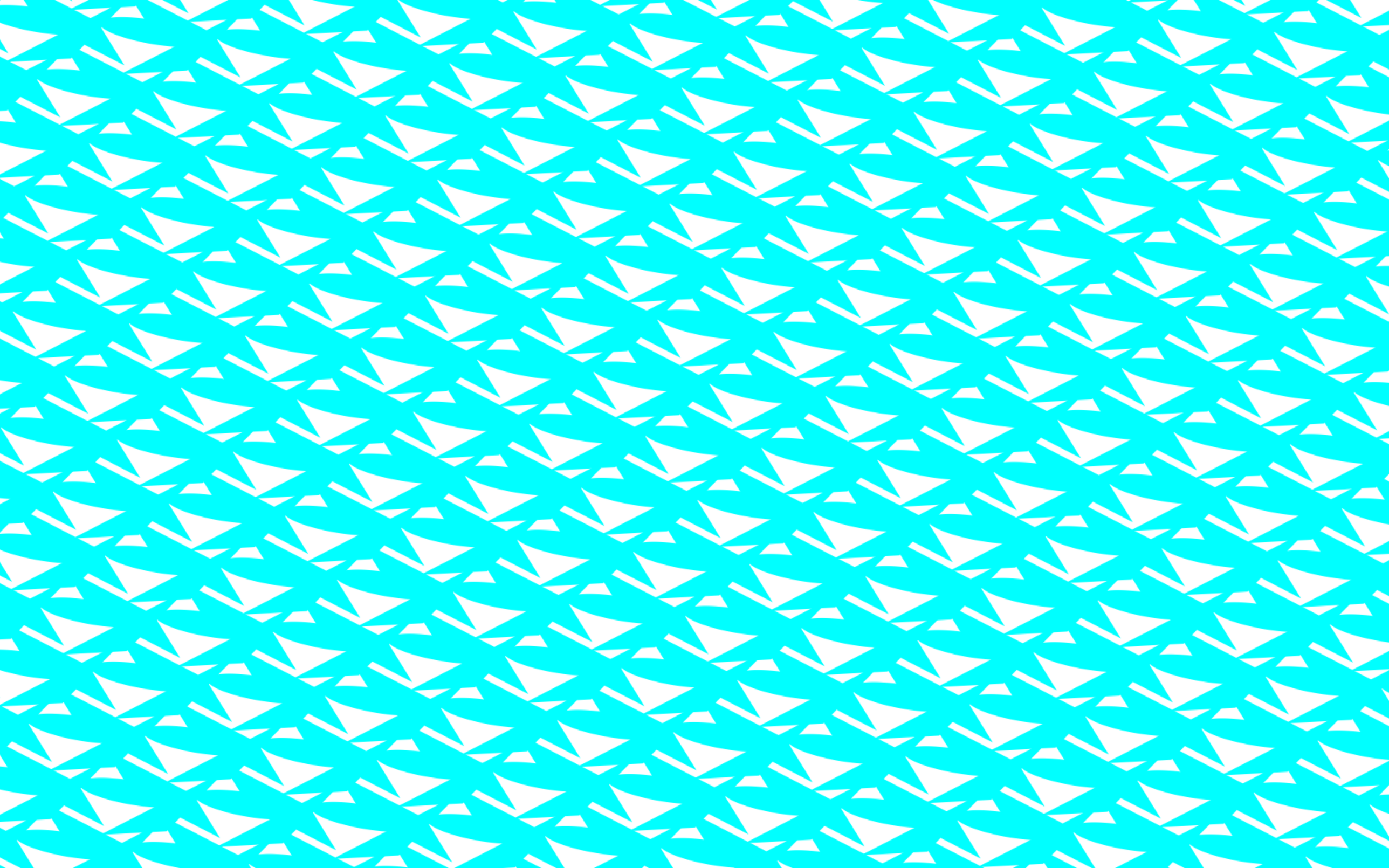


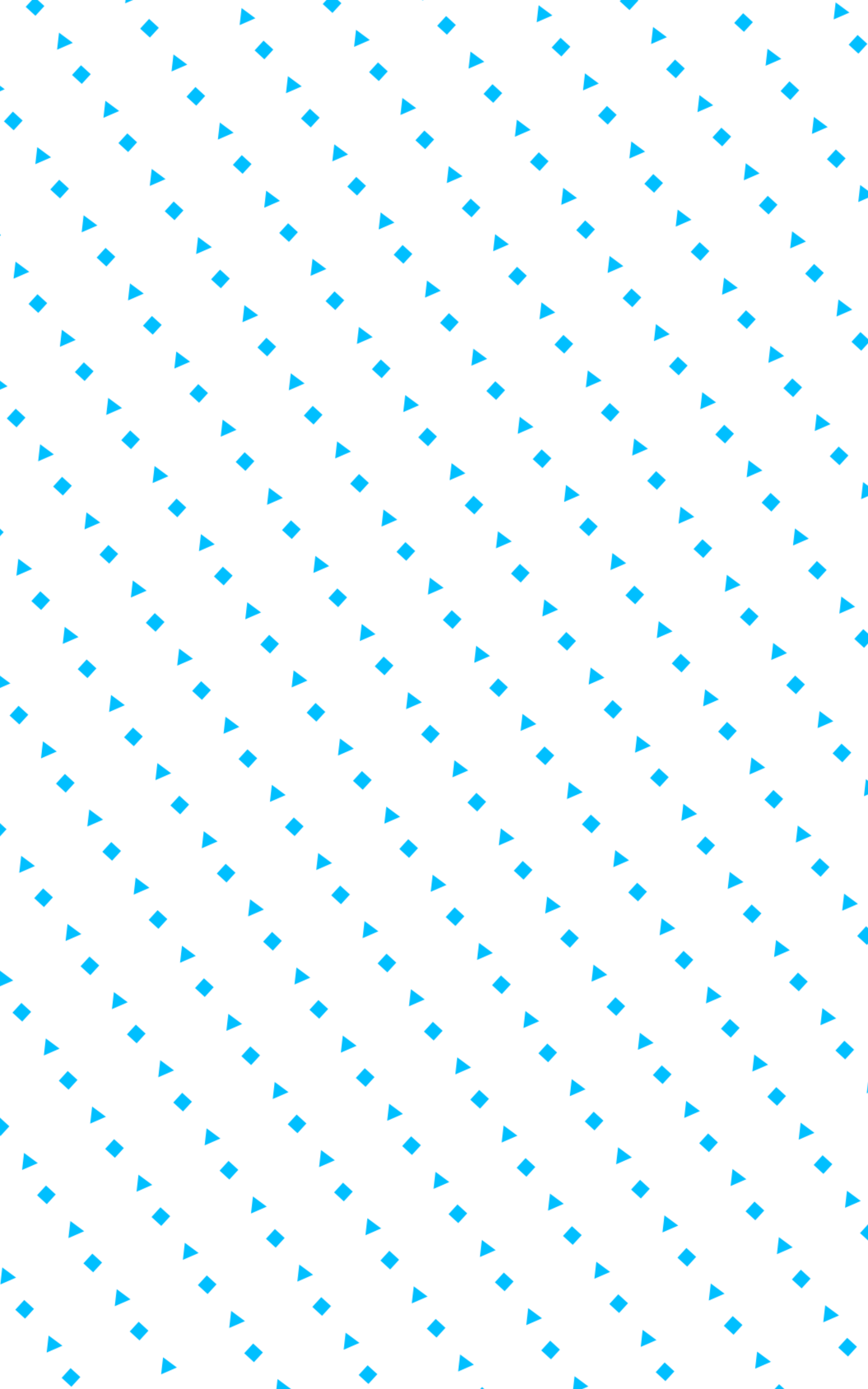


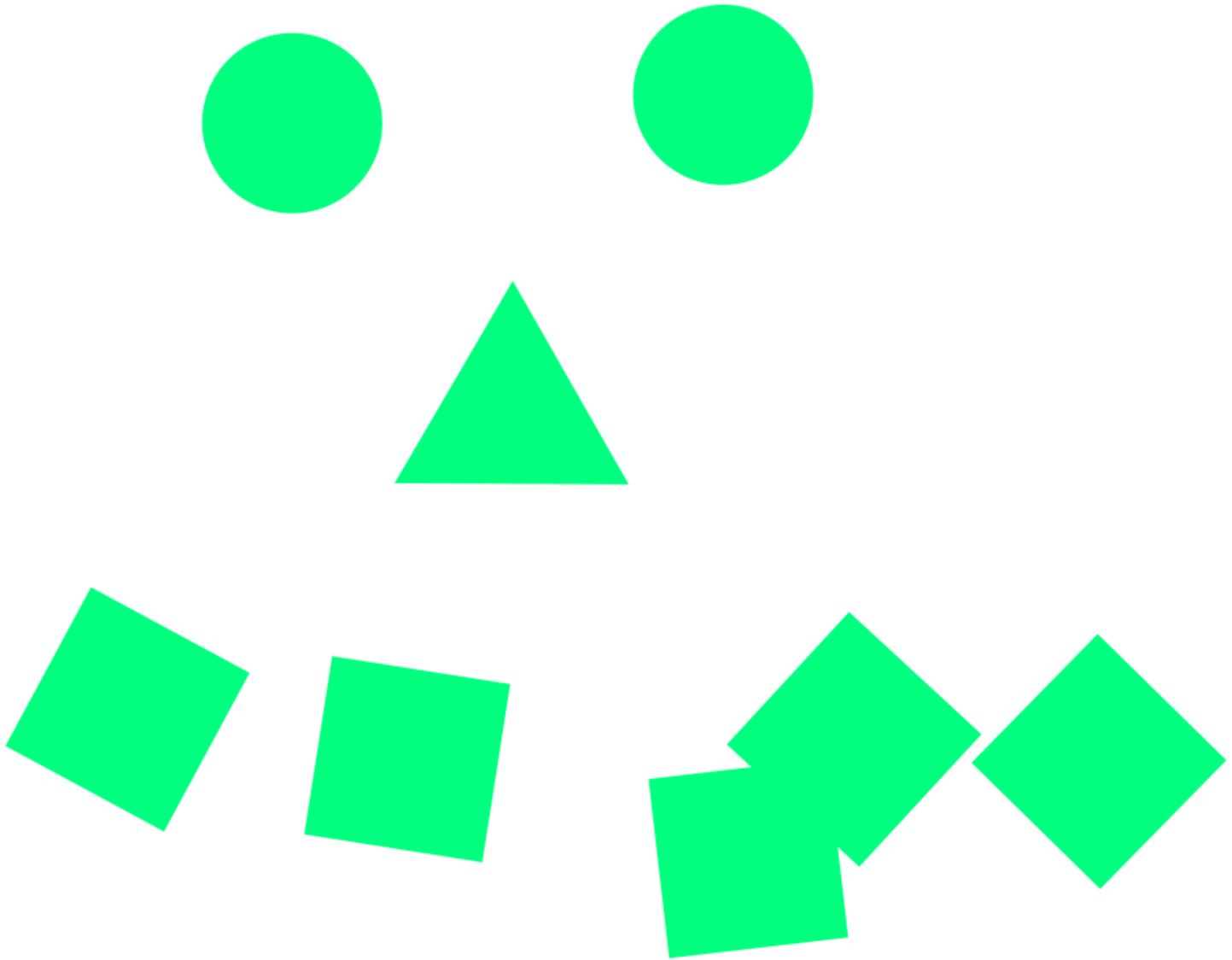


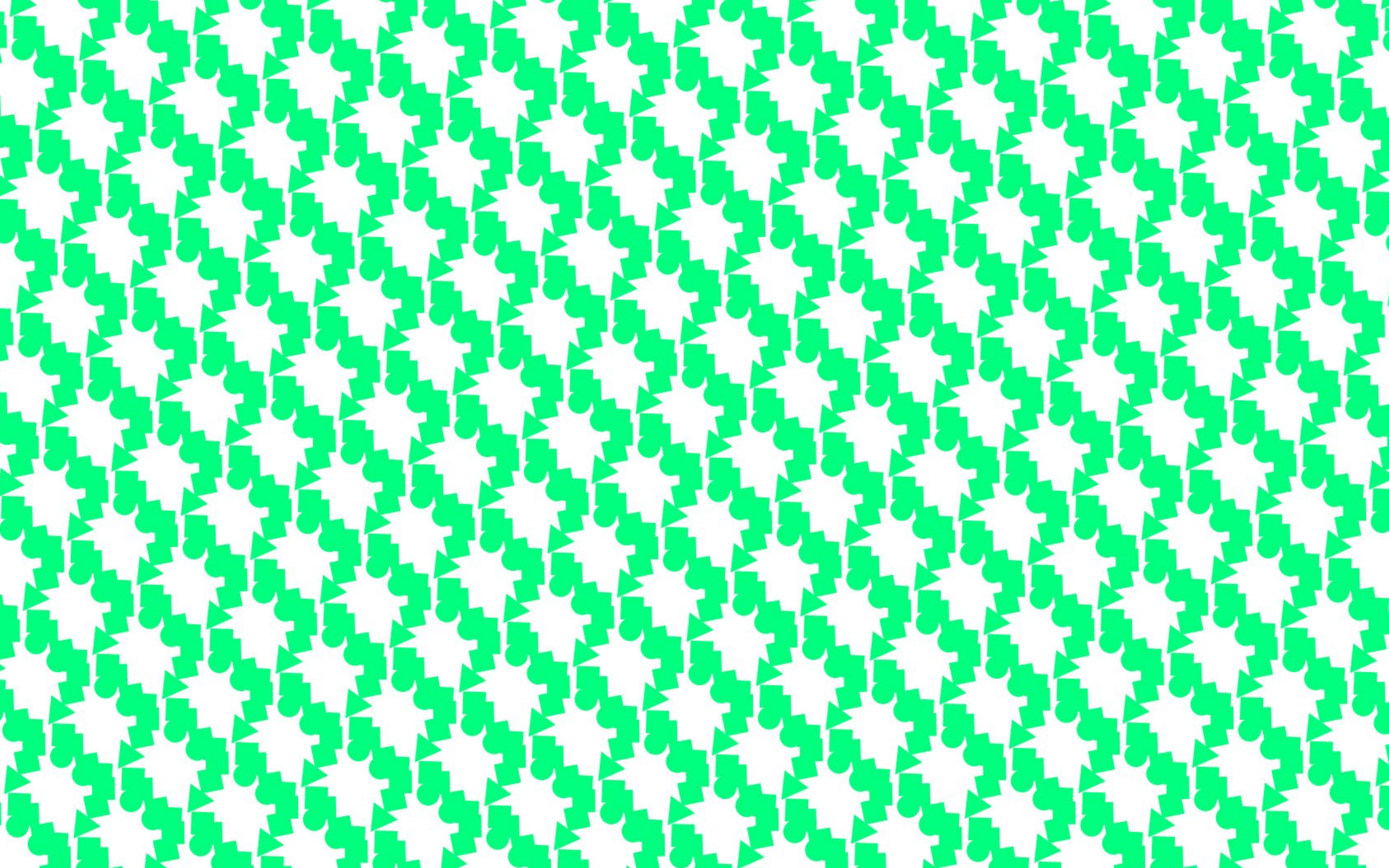


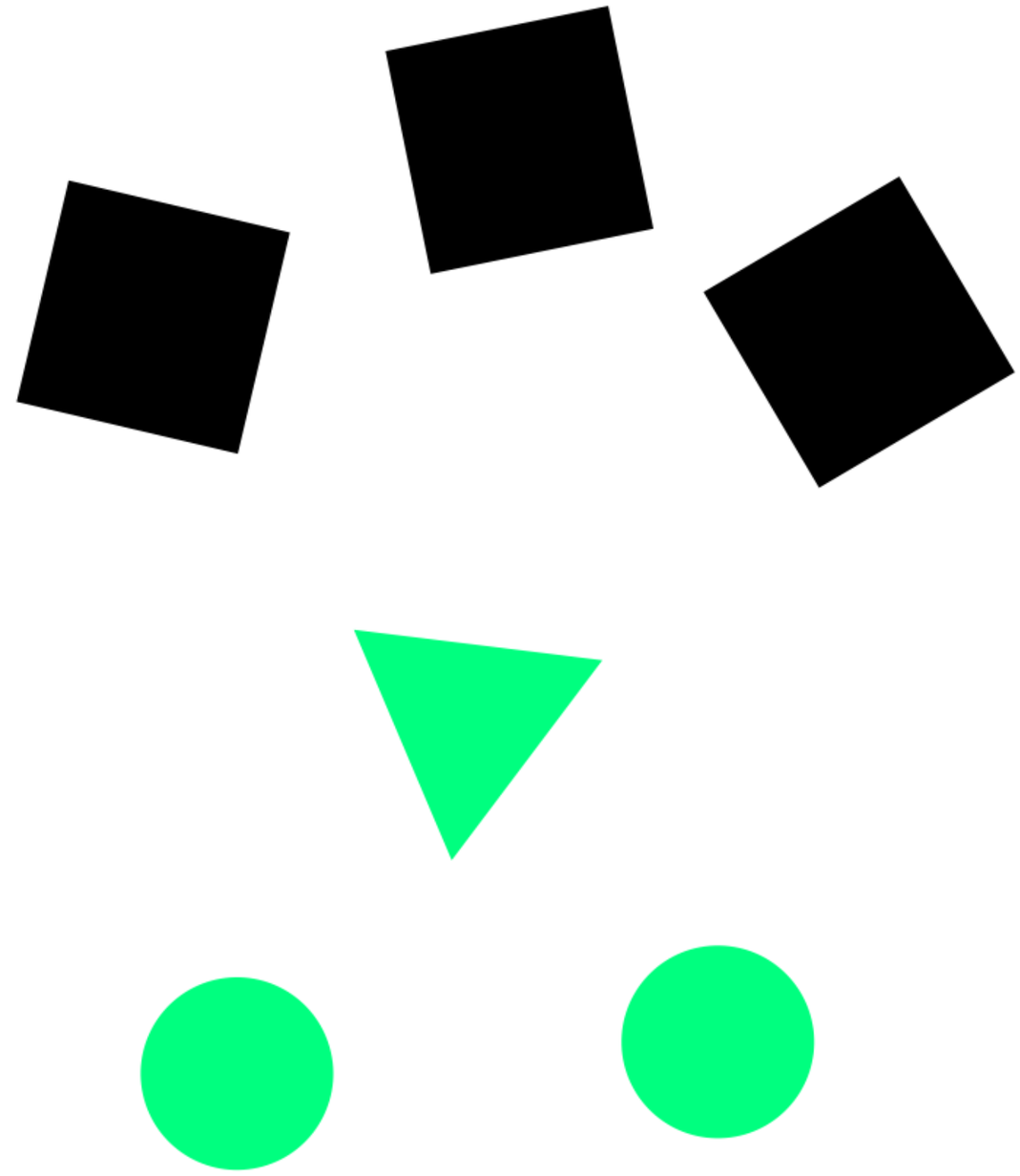


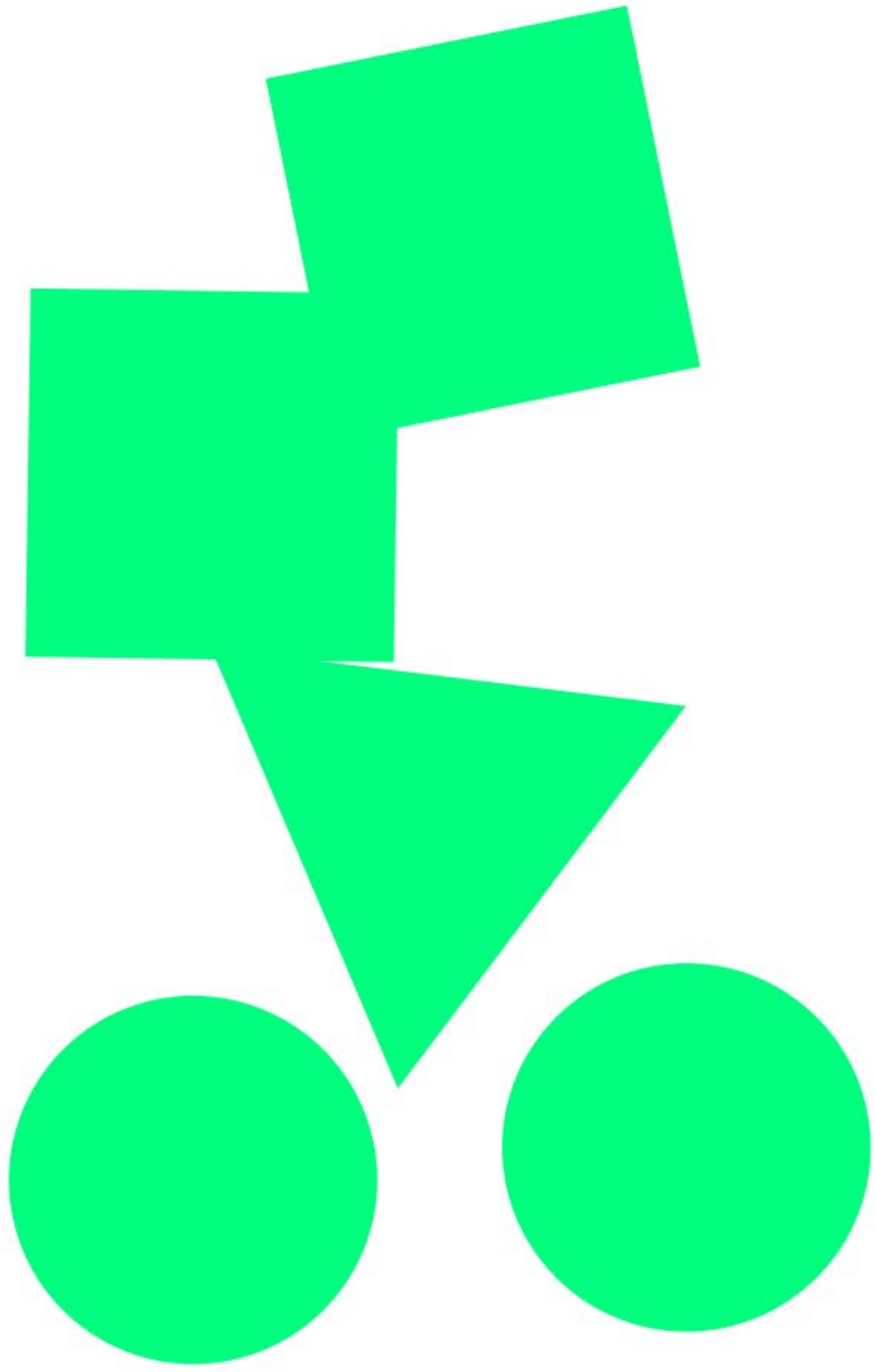


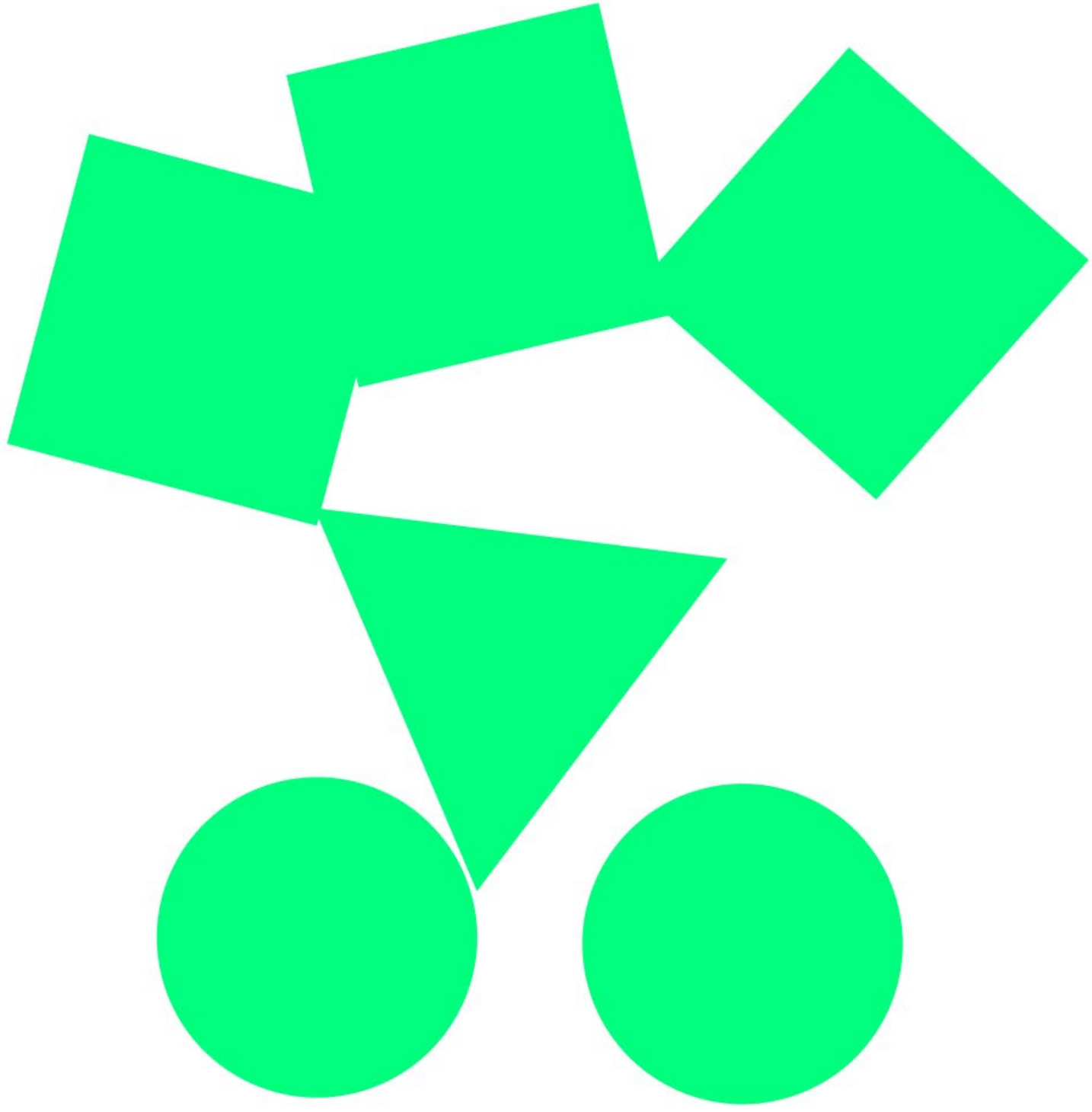












The Drawing Machine

Andrew Ringler

The Drawing Machine is a 9-inch wood drawing table. A stack of paper sits on the left, tiny colored pencils in the center, and sand on the right. The user selects a pencil and starts making marks on the paper. The sounds of their mark-making is picked up by microphones under the paper, then re-broadcast to speakers underneath the sand, mapping their marks to vibration, automagically creating intricate patterns in the sand. The result of spending time interacting with the ***Drawing Machine*** is not just designs in the sand, but the appearance of colored marks on the paper. The goal of *Drawing Machine* is to reduce inhibition towards the act of drawing, framing the act of holding a pencil not as drawing but as asking a machine to draw for you.

All of the acoustic vibration works I investigated had used a single sound source. I decided that using multiple speakers would be an interesting addition, arranging them in a grid to enable higher resolution outputs then, using multiple microphones arranged in a similar grid to serve as inputs. I wondered what type of mechanism could a human use to generate spatially significant sounds? I realized a pencil could serve that purpose. A pencil is already used to make 2D drawings and it makes sounds as it moves across the page; how poetic for a drawing machine to use pencil as input! Although the ***Drawing Machine*** is a novel work, users need little instruction because they already are familiar with the use of a pencil. They use what they know and discover what new functions it provides for them.

.fluid by Hannes Jung. Speaker creates patterns in semi-solid fluid in response to user touches. Photo by Hannes Jung.

Hans Jenny. Cymatics: studies of the effects of acoustic waves on small particles and fluids. Photo credit unknown.

Nine inch wooden prototype. Left tray: input; microphones and paper. Center tray: pencil storage. Right tray: output; speakers and sand.

Drawing with tiny colored pencils onto the drawing surface. Microphones are embedded underneath.

Output on the sand (idealized output).

Actual user drawing obtained during testing.

As I showed the ***Drawing Machine*** table to people, several suggested tables can act as a gathering place. Although this prototype is only nine inches, my Draw Blocks table is full size. I had not previously considered the importance of the scale of my works. Making Draw Blocks large enough for five or six people to gather around facilitates additional social experiences like peer learning, gossiping, observing, and performing.

I was inspired by Fish McGill's thesis, Play Process and Reciprocity in Dynamic Media Experiences (DMI 2014). McGill's projects reduce the inhibition of users towards the act of drawing through inspiring prompts and team exercises. With the ***Drawing Machine***, user inhibition is reduced because the writing surface is so small and the pencils are tiny, creating a casualness and looseness to the exercise.

My piece asked users to think of the pencil not as a drawing implement, but instead as an interface to a computer. It just so happens that when they are done scribbling, in addition to having patterns in the sand, they have created a drawing on paper. ***The Drawing Machine*** actually creates two drawings: it facilitates the process of creation by both mediating an output (sand patterns) and reducing inhibition towards the act of drawing by presenting drawing as an input to a system. In future iterations I would like to incorporate additional complexity and depth for a user to master. For example, different pencil colors could create different sound patterns, or a larger surface could provide higher resolution and more opportunities for creation.

The Friending Machine

Andrew Ringler

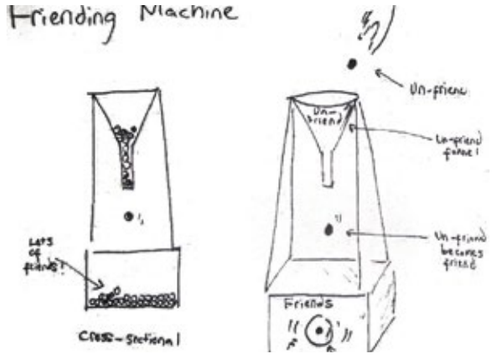
The Friending Machine is inspired by the series of works by Bruno Munari, beginning in the 1930s, titled: ***Useless Machines***. The artist and writer Siobhan Keam explains Munari's work, "… they do not have an obvious utilitarian function, yet they are not entirely useless. They function to indicate the whimsical exploration of his childhood, encouraging the viewer to contemplate their own relationship with the work." The term useless machine was also used in the 1950s to describe a hypothetical machine imagined by Marvin Minsky (Pesta). In Minsky's machine there is a single "on" button. Pressing the button turns on the machine; the machine, once on, immediately proceeds to turn itself off (Minsky).

We can think of "useless machines" as those machines whose obvious mechanical function produces no immediate benefit to the user but whose design or function can have the effect of raising broader questions in the user's mind. The question raised by the very title useless machine is: what does it mean to be useful?

The Friending Machine's function is to read dozens of tweets simultaneously, which serves not to communicate information but instead to create an un-listenable density of sound resembling white noise. The machine is meant to encourage the user to consider: does the noise remind me of my twitter feed? Does the rapid shouting of tweets make me feel anxious? ***The Friending Machine*** is designed to encourage users to consider their relationship with Twitter and more generally, to any online digital network of people.

The Friending Machine was prompted by an assignment titled "Useless Machine" in the course Design Symposium at MassArt. A requirement of the assignment was to integrate with a "social network" API. I immediately gravitated towards Twitter because it is prominent and is largely made up of public accounts (versus Facebook and Instagram). Public accounts mean that by using the Twitter API I would actually have access to the majority of the network (unlike networks on Facebook and Instagram).

With the ***Friending Machine*** I chose to explore the concept of physical effort, but after extended time with this project I realized that it wasn't physical effort that intrigued me, but physicality in general and intellectual effort. Instead, I wanted to offer users a physical and sensory rich experience and reward them with intellectual challenges and the act of creation.

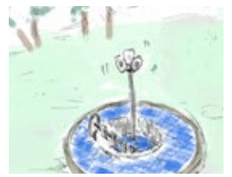


Prototype 1. People I follow on twitter represented as tiny marbles. The machine reads aloud the tweets of those I follow. Users may "un-follow" by placing a marble in upper basin. Which then falls back down into the lower basin, thus re-friending the tweeter. I recieved feedback that the marbles seem arbitrary, why do they represent tweeters? Classmates also expressed concern that the marbles would fall through the funnel too quickly and the user didn't have enough control.

Drinking from the firehose (information overload). MIT. hacks.mit.edu.

Archimedes Screw. Schönbrunn Palace, Vienna. Evelyn Chang.

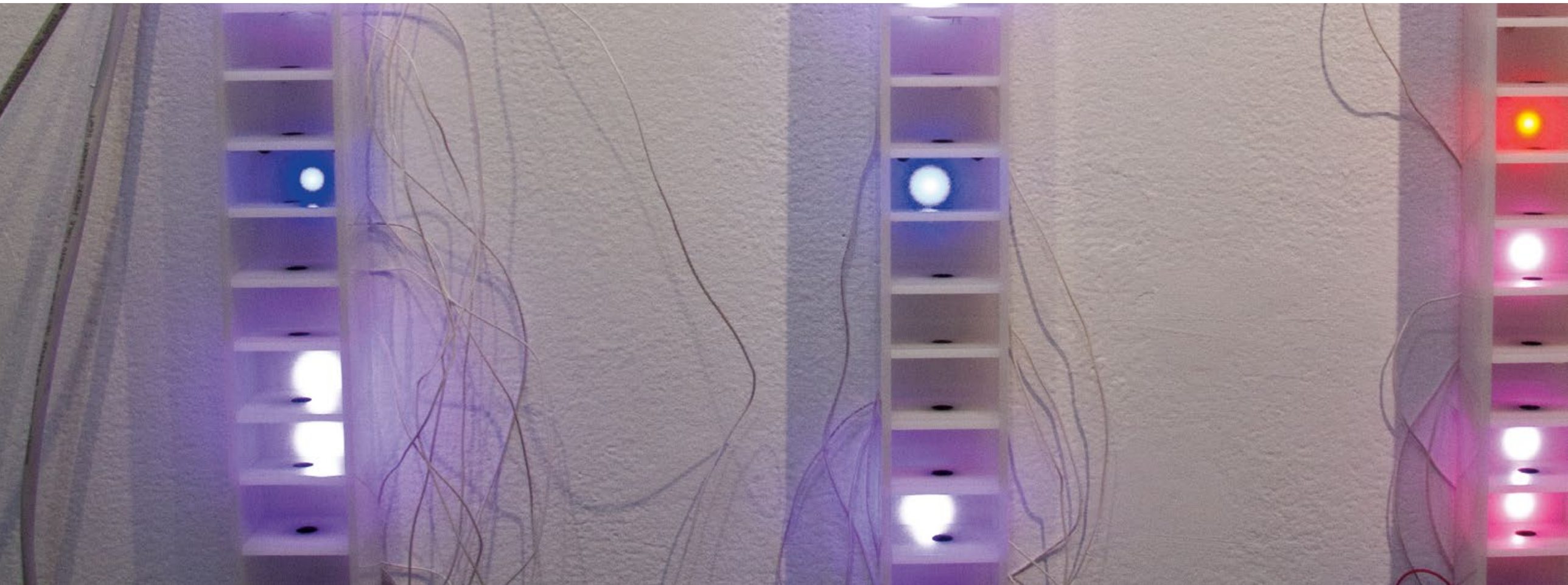
Prototype 2. Tweeters now represented by water. Use an Archimedes Screw to transfer water, thus "un-following". I recorded eight different people reading tweets from eight different twitter accounts, to make it easier to distinguish dissimilar voices, thus adding to the illusion the possibility of understanding. I was able to illustrate the connection between more noise means more followees and less noise means less followees.



Prototype 3. Larger Scale. Users must wade through water to un-friend. Loudspeakers installed in the fountain play the sound of tweets being read aloud.

Sequencing Marbles

Patlapa Davivongsa, Andrew Ringler



Sequencing at
Fresh Media Opening,
March 2nd 2016

Overview

Sequencing Marbles, a collaboration between myself and fellow DMI student Patlapa Davivongsa (Pat), allows users to compose music through the simple act of moving marbles between physical shelves, providing opportunities for musical composition, learning, and collaboration in a multi-sensory environment. Expert and non-musicians, can find interest and challenge in a learnable musical composition system. Ten composition interfaces are distributed throughout a room, each interface contributing to the entirety of the musical soundscape.

We created ten tactile interfaces, each contributing either percussion or musical notes to a single composition. *Sequencing Marbles* is inspired by a piece of software called a drum sequencer which allows users to compose drum beats by turning on and off cells in a screen-based grid. Our piece, instead of using an onscreen grid, uses physical cubbies. Each interface is a three by twenty-four inch custom designed vertical column containing sixten laser-cut Plexiglass shelves, similar in shape to a very tiny bookcase. In the center of each shelf a circle is cut on which users may place a marble.

Conception

Pat and I had originally proposed separate projects for DMI's Fresh Media 2016 show. My original proposal was to allow gallery visitors to control the ambient lighting of the gallery from a set of physical controls. Often the gallery lighting is fixed as part of a curated experience for patrons. I wanted to give users the control to change this, also creating an interesting social dialog between an individual changing the light and the rest of the gallery patrons experiencing that person's performance.

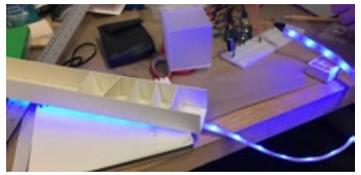
Pat had proposed creating an ambient soundscape influenced by gallery patrons walking past a video camera. The curator, Katie Liguori (MassArt DMI), in seeing our two proposals recommended we collaborate.

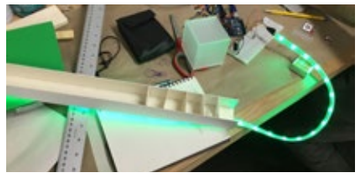
Pat is interested in music composition as well as space, geography, and ambiguity all of which influenced the design of the work. After several meetings, Pat and I conceived of our final idea which maintained each of our original core concepts. The final concept was to allow gallery patrons to compose the ambient music of the gallery by interacting with controls geographically distributed around the entire gallery space.

Design Process

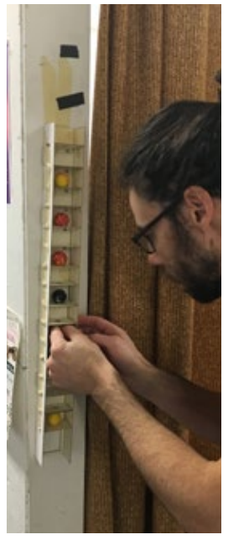
Pat and I brainstormed several interface ideas including: a projected wall with touch sensing, a podium with touch pads. Eventually we developed the idea of having distinct interfaces each representing a single sound (or note) that could be hung independently on the wall. We both liked the idea of manipulating physical objects to influence the state of the system. We decided to make a set of shelves that would hold the objects. Users could then place objects on the shelves to turn on that cell. Although time is typically represented in U.S. culture as left-to-right, we rotated our interface (to take up less wall space), making a vertical shelving unit, with time flowing from bottom to top.

For the objects we decided to use opaque black marbles. We cut a tiny hole on each shelf to allow a marble to sit. We then placed a light sensor (phototransistor) inside each hole. Placing a marble onto the hole would block out any ambient light triggering our light sensor. This would allow us to detect the presence or absence of a marble, activating or deactivating the physical cubby.



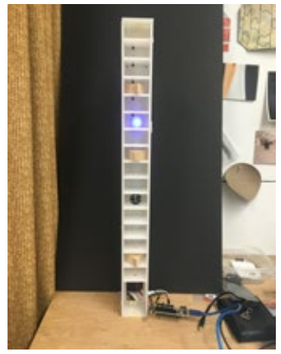


Testing various LED colors, and verifying spacing of LEDs behind cardstock prototype.



Choosing a Plexiglass material that would diffuse light the way we desired.

Lasercutting columns out of the final Plexiglass material.



Testing LED diffussion and size of balls in final prototype.

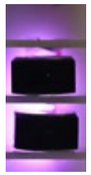
Images taken at the 2016 MFA Thesis Show, Doran Gallery, MassArt. In this second iteration the marbles have been replaced with wood blocks.

An initially empty shelf is silent.

Upon placing a block in a cubby a purple light glows to indicate that a note will be played when the time cursor arrives.

The time cursor, bright whitish-blue light at the bottom of photo, approaches the cubby with the block.

The time cursor has arrived at the cubby containing the block. The light turns red to indicate that a sound is currently playing.



Placing two blocks in a sequence will cause a sound to be played twice in a row.

Sound is played when the cursor gets to the lower block (left photo), then sound is played again when the time cursor reaches the upper block (right photo).

3

2

1

Each column produces a unique sound. With three columns the user can compose three different sounds. All three columns are synchronized, time progresses from bottom to top. In this photo sequence the time cursor approaches three blocks. Read images starting from the bottom.

The time cursor has reached the cubbies containing the three blocks. All three columns will play a note simultaneously. In this fashion one could compose a three-note chord.

Prototyping

During the Fresh Media install we realized that the light sensors were going to be extremely problematic. During the day the sensors became too oversaturated with light, and during the night there was too little light. Additionally Cyberarts had switched most of their lights to efficient LEDs which didn't provide enough of the light our sensors wanted. Additionally we were struggling with making the various interfaces communicate reliably with each other.

Despite the many issues, Pat and I installed five interfaces during the Fresh Media opening. Our instruments started to fail toward the end of the opening, as the sun set, but for the majority of the time our piece worked well. Some people just walked right up to the instruments and started moving around marbles. Both Pat and I received a lot of feedback that it was "really cool."

Unfortunately the gallery opening was extremely loud, so it was difficult for users to understand the relationship between placing a marble on a shelf and the audio changes that resulted. Additionally, many of the shelves were not behaving properly (because of the phototransistors) so many people were confused with what they were actually able to control. A few times during the opening, all of the instruments would stop working and I would have to jiggle the wires to get them working again! These reasons all contributed to it becoming very difficult for users to actually understand how the piece worked, let alone compose music and learn about music through it.

Overall, we ended up producing an extremely beautiful, eye-catching, and interesting piece, that people had fun with. The work was tactile and multi-sensory but due to the many technical issues the experience was too confusing to be learnable or facilitate music creation. We decided to design a second iteration to try and resolve the most critical issues.

We replaced all of the photosensors with a simple electrical circuit and made the communication wiring more robust using a new connector. Instead of using marbles we created wood blocks with metal washers glued onto each face. The blocks could then be placed into the cubbies to complete the electrical circuit thus triggering the Arduino sensor.

We installed six interfaces (columns) at the MassArt MFA Graduate show in April 2016. No longer using marbles we renamed the piece from *Sequencing Marbles* to just *Sequencing*. The technical improvements we made paid off. At the show opening nearly every cubby worked flawlessly. The acoustics ended up being excellent because the opening was not as crowded as previously, there were not any other sound pieces being shown, and a concrete floor and high ceiling created pleasant reverberations.

I observed many positive outcomes. The show was up at MassArt for ten days so people had opportunities to spend significant time with it. Several people approached me during the week to say they had spent time in the gallery composing music. I stopped into the gallery nearly every day and always I would discover a new musical creation someone had left.

Findings

One design decision that worked really well in *Sequencing Marbles* was: the use of marbles. Most people expect that they may pick up marbles. The most obvious layer of interaction within the piece is allowing users to move marbles. Just by moving marbles, users are able to explore the system. If they spend enough time with it, eventually they could learn how it works. The small size of the marbles however, does pose a problem, they are difficult to hold and manipulate well. In addition to the small marble size, the shelves were very tiny, promoting a slowness and delicateness that inhibited rapid exploration. *Draw Blocks*, in comparison, allowed users to rapidly push blocks

across a slick glass surface.

The cubbies posed an addition problem (both with the marbles and blocks). Often newcomers would come into a gallery and find dozens of full cubbies producing a complete musical composition. This made it more difficult for users to understand how the piece functioned; it is much simpler to understand the workings of the piece when only a few blocks are present. With Draw Blocks I had observed several times users dragging their arm across the glass surface to quickly clear all the blocks. With *Sequencing* such an action was not possible.

In our second iteration we replaced the marbles with wooden blocks that were easier to hold. Since we didn't change the shelf size we needed to add tiny thumbtacks to let users pull the blocks out of the shelves easily. I did observe with one user she wanted to hold the entire block and then struggled trying to get the block out of the shelf without using the thumbtack. This is definitely something to consider in future iterations.

Sequencing Marbles provided users with a very holistic sensory experience. Users can pick up and touch marbles, they can see how the light shines over them when placing them on shelves, they get visual feedback with LEDs, and then of course, they get audio feedback from the musical composition.

In Fresh Media we installed three interfaces on one wall, and two interfaces on the back-side of that wall. Thus, if you were in front of an interface, there was no way to physically see the other interfaces. Our hope was that this would create an interesting dialog between unseen users, communicating through the soundscapes they composed. Unfortunately, the gallery opening was just too noisy for this to happen. We did see other collaborative experiences though. Since we had groups of two and three interfaces, it provided a lot of room for couples, and groups of people to approach our piece and use it simultaneously. I did observe people explaining the piece to others.

Collaborating with Pat on this project, I was able to explore new ideas that I would never have done on my own. We each worked to our strengths and were able to build a very ambitious project we couldn't have done as individuals. We have built a system for music composition that I look forward to improving and testing further over the next few months.

My main goal for this piece was to build an expansive environment for musical creation—to provide opportunities for anyone, with any musical ability, to compose music. With our second iteration we were able to accomplish this. In further iterations I would like to explore giving users more control over the character of the sounds. Letting users change the key, sound effects, or timing would add additional depth and learning opportunities to the piece.

Tangible Programming

Anthony Baker, Scott Penman, Andrew Ringler

The ***Tangible Programming*** project was created as the result of a collaboration between Anthony Baker (Harvard Graduate School of Education), Scott Penman (MIT Architecture Design + Computation), and myself during Hiroshi Ishii's Tangible Interface course at MIT in the Fall of 2015. We decided to use the already existing ***Transform*** table Ishii's lab had already built to create a tactile programming language.

Transform shape "display". Unlike an LCD monitor, which conveys information by changing light intensity, a shape display (or tactile display) conveys information by physically adjusting its form. In the case of *Transform* it changes the height of its pins.

Transform is a massive, beautiful, programmable table containing three "shape displays." Each display contains a grid of plastic "pins" with 16 columns and 24 rows for a total of 1,152 independently addressable pins. Each pin can be actuated in the vertical direction, programmatically, or by user touch. Various sensors detect user touches and gestures.

We were inspired by Mitch Resnick's Scratch language (see *Create, Learn, Live!* chapter). Scratch was designed to teach children programming; we wanted to take inspiration from Scratch creating an easily learnable programming language for the ***Transform*** table. Scratch lets users create programs by dragging and connecting "block" icons visually. We thought that ***Transform*** could make such an experience more tactile and understandable.

In addition to Scratch, we researched many tactile programming languages and many languages designed for teaching. Ultimately, however, what gave us the most direction was creating a list of programming concepts we wanted to teach through our language and a list of affordances the table could provide. We wished to teach the programming concepts of: repetition (looping), drawing, abstraction, and state (variables). The shape display allows users to squish and move pins, which we thought could support the tangible editing of code with hands. We used four "displays," a portable "toolbox" running on a tablet computer, and the three existing displays of the table (see photos above).

The toolbox allows the user to select functions to add to the program

Left display. Manipulate functions: rotate, scale, change duration

Center display. View, update, run "source code."

Right display. View, update, output (or result) of program.

In the confines of a single semester our group created a limited programming language for the ***Transform*** shape display. Not only did we design a new programming language, but we also defined the language of our interface. Human languages like English, Spanish, and Chinese let humans communicate with one another; in other disciplines languages also facilitate communication. A programming language lets humans communicate with computers (or just tell them what to do). The language of an interface informs a user how to interact with it and the scope of what is possible.

In our tangible programming language a user can physically press down on lines of source code to "run" code. That is the language of the interface. Every other work I have mentioned in my thesis, possesses a language of interface as well. With Draw Blocks, Professor Lucid had encouraged me to define the language of the interface: what is it capable of doing and how is it capable of doing it? In Draw Blocks, a user may move blocks on the table and group blocks together. In *Sequencing Marbles* a user may add, remove or move marbles (or blocks) from cubby to cubby.

The language we created for ***Transform*** requires training and explanation. There are a lot of different surfaces, each with different behaviors, and no obvious clues to their function. With Draw Blocks, there is a single mechanism of interaction (moving blocks across a table) so the language of interaction is simpler. The experience we built on the ***Transform*** table is a general purpose environment for programming, it is more complex, with more potential, but a steeper learning curve.

With ***Tangible Programming*** we built an environment that encouraged rapid exploration through physically manipulating the shape display. In future iterations I would like to develop a simpler language that could be learnable in a short period of time. I think if the language were simple enough we could install this in a public location. I would love to see strangers collaborating on writing software programs. I would love to see a version of ***Tangible Programming*** that was simple enough for users to approach and learn with minimal initial instruction. I think that with careful design we can build languages that are easily approachable for users, yet contain a richness discoverable with extended effort.

Macropavilion

Miguel Espino, Valeria Lalinde, Andrew Ringler

Casco Viejo or Old City is the 2nd site of Panama City, the 3rd site is the current modern city center, the first site called 1st city containing only ruins. Casco Viejo serves as an attraction for Panamanians and tourists, and although it still serves as home to natives it is quickly gentrifying.

Overview

Macropavilion is a public outdoor pavilion providing visitors with shade from the sun as well as an interactive LED light experience. It was installed for a single weekend in March 2016, in Casco Viejo (Old Quarter), Panama, as part of Festival Macro. We constructed a large structure supporting hundreds of interactive fabric funnels. The overall effect for visitors is that of an inviting cave of soft colored lights, providing a cool reprieve from the hot Panama sun.

The structure consists of seven, three-meter tall columns of CNC cut plywood and welded steel that support a connected latticework roof of aluminum beams. The beams crisscross, forming a grid pattern of 138 diamonds, each with sides measuring one-by-one meters. Each diamond holds an upside-down fabric "funnel" with the large end connected to the diamond and the small end hanging freely downward. At the small end of each funnel is attached a circle of LEDs one meter in circumference. The entire structure sits on a circular concrete platform approximately twenty meters in diameter. Visitors may walk under the structure freely, interacting with the funnels.

Conception & Background

Macropavilion resulted from the collaboration between Valeria Lalinde, Miguel Espino, and myself. I had previously collaborated with Valeria in 2014 on my *Draw Blocks* project and also provided coding support on some of her projects. Valeria, after having completed the Post-baccalaureate program at the MassArt Dynamic Media Institute, had returned to her home city of Panama City, Panama. Miguel after having just completed his architectural degree at Northeastern University in Boston had also returned home to Panama.

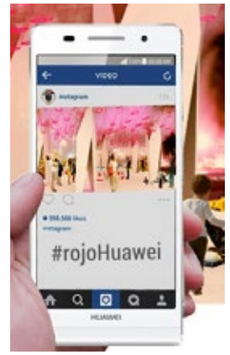
Festival Macro is an annual, weeklong festival centering around fashion, art, music, and food. Valeria and Miguel had created a proposal for an interactive pavilion during the festival and asked me to collaborate with them. Miguel, the architect, designed the pavilion structure. After completing his initial design, I started meeting with Miguel and Valeria over Skype regularly in February of 2016.

Miguel proposed having rings of controllable LED lights suspended at the bottom of hundreds of fabric funnels. I started brainstorming various interactive experiences centered around this design.

Valeria wanted a strong virtual component such as Facebook, Twitter, or Instagram. I proposed that users could change the color of the pavilion (all 189 rings, later downsized to 138) by posting a photo to Instagram with the caption "#huaweipavilion purple," or "#huaweipavilion azul", (Huawei was our sponsor for this project), changing the entire pavilion to purple or blue (azul is blue in Spanish). Users would have the power to control the color of a large pavilion visible to everyone.

We are not often granted the opportunity to perform in front of a large audience. In this case, the performance would be somewhat anonymous, all you have to do is post to Instagram, and you get to influence the character of a large space. I thought this could be quite rewarding for people. This is similar to a design goal I had with the *Sequencing Marbles* project. With *Sequencing Marbles*, we had wanted to grant people the opportunity to control the ambient sound of an entire gallery. Similarly, with *Macropavilion*, we had wanted to give people the power to change a huge swatch of colored light, thus influencing the entire ambiance of the Macro Festival!

Additionally, I wanted people to be engaged in the pavilion in a physical manner, not just through their phones. The three of us agreed that users should be able to touch the fabric funnels, and have something happen. We designed twenty-two of the funnels to be longer than all of the rest. These "longer" funnels

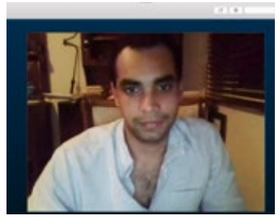


A user changing the pavilion color via an Instagram post. Mockups by Valeria Lalinde.

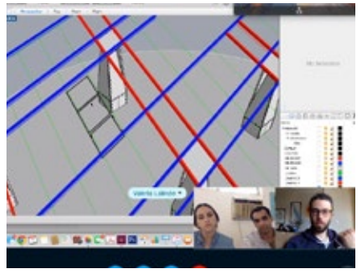
would stretch down to head height, so most adults could easily reach up and touch them.

I had originally proposed to put an accelerometer in each of the twenty-two long funnels. An accelerometer is a sophisticated sensor that can measure tilt, rotation, and other movements. I envisioned users being able to rotate the fabric funnels in one direction to get one effect, in another direction to get another, and tilting to get yet another effect. Valeria, thankfully convinced me that this would be too complicated to understand for a large public pavilion, so instead I focused on just a single interaction.

I switched out the accelerometer for a simpler sensor, a vibration sensor. This could be used to tell us every-time someone touched one of the long funnels. The LED ring at each long funnel would be the color red (which would not be used for any



One of many Skype meetings with Miguel.



Miguel describing the latest architectural plans.

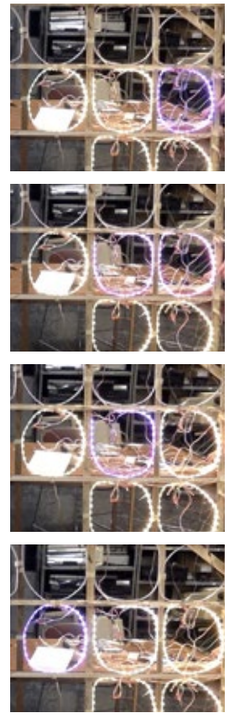
Valeria sharing pavilion mockups via Skype.

of the other funnels). The color, in addition to the long funnel length would be used to re-enforce to users that the funnels were different (and could be touched). Touching the funnel would cause rays of light to radiate out from the touched funnel.

I realized that even with this simpler interaction, touching a funnel, I could still build a complex and interesting system. I wanted to encourage people to collaborate with each other through the design of the system. One way in which this could happen is when two people touched funnels simultaneously their light rays could radiate towards one another and cross. At the point where they cross, the light could change color. Thus, users, by carefully timing when they chose to touch funnels, could create different effects. This was important to me, because it allowed hidden layers of additional complexity to be learned over time by users, creating a more rewarding experience for users.

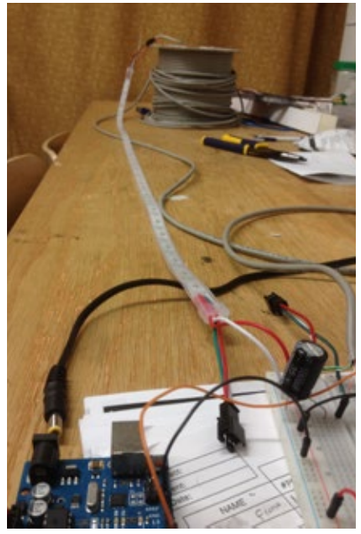
Prototyping

There were two main goals during prototyping: first, understand the technology enough to order the correct parts and second, build and test some of the final pavilion components while still in Boston. I am always interested in trying new things and inventing new things, so a lot of the technology chosen was unfamiliar to me. This meant I had to order and test many parts before I became confidant they would work in the final piece. Additionally, I needed to order just enough parts to be sent to Boston so that I could prototype, but not too much that I couldn't take them on the plane with me down to Panama.

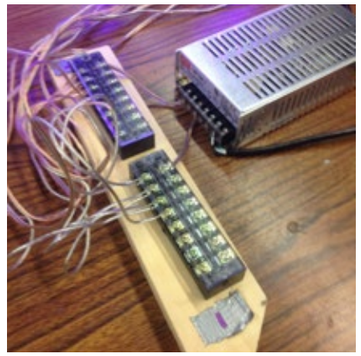


Rings of purple radiate from right to left over time. Video stills in order from top to bottom.

Control LEDs
through long lengths
of ethernet cable
(cat5)

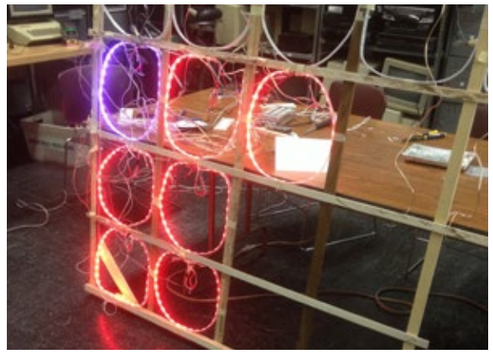


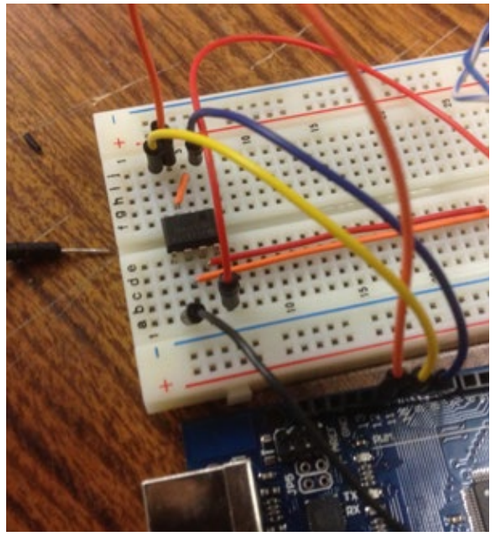
Chaining LED
control wires, while
powering each LED
ring individually



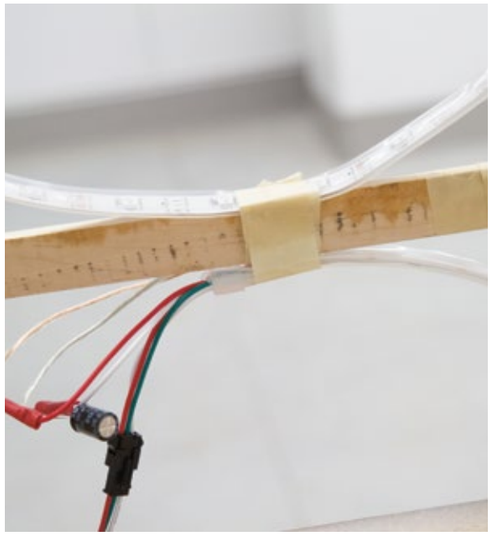
Design of power
distribution from DC
transformer to each
individual LED ring

I built a temporary wooden grid to allow me to test multiple rings in Boston. This allowed me test and program the final code that we would eventually use in Panama.

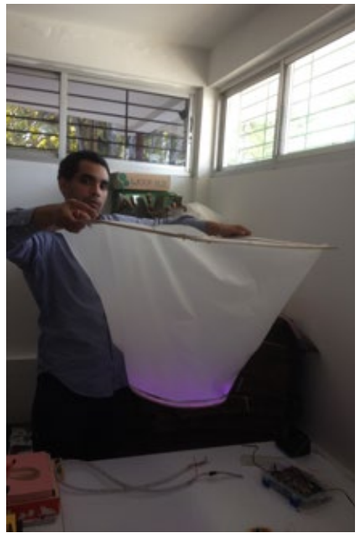




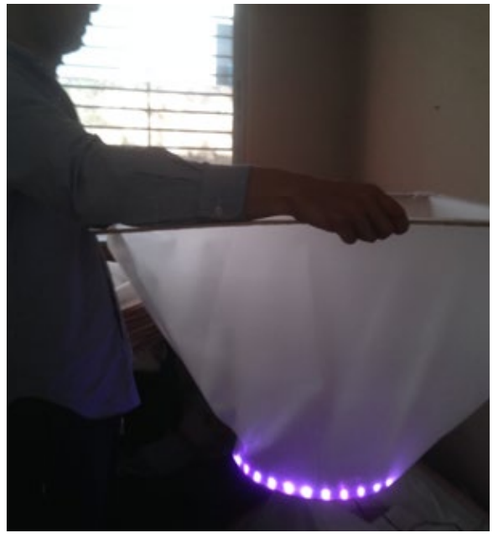
RS-485 communication tests over ethernet cable (cat5) using the Texas Instruments SN75176B differential bus transciever



Pre-construction in Panama



All of the fabric was shipped to Panama; here we test for the first time how our LEDs look within the fabric funnels. We were extremely pleased to discover they diffused light really well.

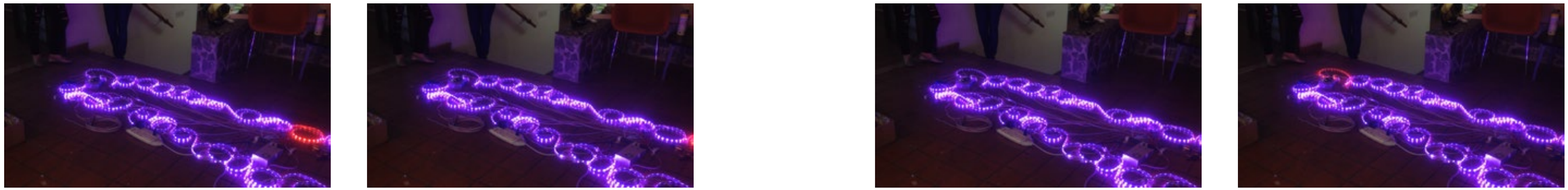


We tried installing the LED strips with the bulbs facing outwards. This did not diffuse light as well so the final installation was with all LEDs strips facing inwards.

The LEDs shipped in five meter sections. Since we needed one meter sections for our pavilion we needed to cut and resolder 148 one-meter sections of LEDs. This took a team of helpers many, many hours.

Touch Sensor Tests in Panama

Valeria kicks the touch sensor located at the first ring of LEDs to trigger the rays of light animation

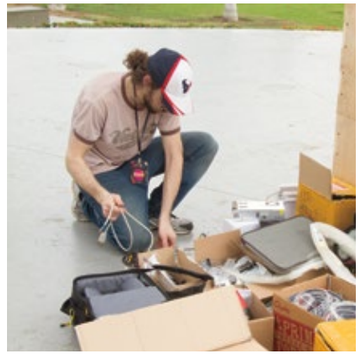


Ring of LEDs at the first funnel (touchable funnel) returns to the color red to indicate it is ready to be touched again

Top left: Miguel, Valeria, and the builder measuring and spray-painting the locations of the wood support columns.

Empty site, ready for our pavilion.

Top: Interns from my Alma mater (McGill University) attending a semester abroad in Panama, helping to build our pavilion. Bottom: Miguel hanging the very first fabric funnel.



I am in Panama onsite; preparing to install all of LEDs, wiring, and Arduinos onto the structure.


ARTE
DISEÑO
EMPRENDIMIENTO

Although the Instagram software was tested in Boston, onsite we did not have suffient time to toubleshoot issues that prevented all the rows of LEDs from updating according to Instagram posts. In the above photos only the center colum of LED rings are being updated by Instagram posts. This was confusing for users because they didn't have strong feedback to inform them that their Instagram posts had an effect on the pavilion.

Valeria showing some friends how to post to Instagram in order to update the pavilion colors.

Touching Funnels









Findings

With *Macropavilion* we built a multi-sensory experience including: beautiful architecture, multi-color LED lights, interactive touchable fabrics, interactive Instagram components, and shade from the Panamanian sun. Although we were not able to fully implement all of our ideas, given the time constraints, we were rewarded with many successful user interactions.

Miguel after meeting one couple and their baby showed them how the interactive funnel worked. We observed them as they touched the funnel and watched light propagate out across the entire length of the pavilion in response to their touches. For several minutes the couple touched the funnel and were holding up their baby so he could touch the funnel too. Although we had only time to get this single interactive funnel working, many people including the couple were captivated by it. I can't imagine what the experience would have been like if we had succeeded in getting all twenty-two interactive funnels working.

As Mihaly Csikszentmihalyi discovered, people want to control their environment and when given the opportunity gain greater satisfaction from experiences. The pavilion we created serves so many valuable functions to guests: shade from the sun, aesthetic beauty, and novelty. Layering on additional interactive components became greatly rewarding and surprising to users. For a future installation I am still curious to find out what types of social interactions we could encourage by having additional working interactive funnels and if users could receive greater rewards by layering additional effects onto the interactions.

In addition to users touching the interactive funnel, a surprising thing happened. Because we were using vibration sensors to detect user touches, the sensors also detected loud drum beats from the live band. We were surprised and delighted to see our pavilion responding to the band, an unexpected collaboration. Loud drum beats would coincide with streams of light jetting across the pavilion!

It was very rewarding for me to have the opportunity to work with a talented architect, Miguel. I enjoyed seeing his design process and how his decisions and concerns had shaped the project. He knew that the structure that was built last year for this festival had trapped heat and was terribly hot. So, with *Macropavilion* he designed a structure that could protect people from the sun as well as vent heat. Each of the fabric funnels was white, thick enough to reflect the sun, with a hole at the bottom for heat to vent out. Walking under the pavilion during the festival was always a cool reprieve, despite the sunny 93° Fahrenheit weather!

Another interaction our pavilion supported was changing color via Instagram posts. Because of time constraints only the very center of the pavilion changed color. This confused users because we had posted instructions stating that the entire pavilion would change color upon posting to Instagram. We had to explain to many users, exactly what was happening and how to use Instagram to update the color. After we had explained it though, many users continued to change the color without our guidance and were quite pleased to see the pavilion change.

For future public projects I would definitely like to have more stable and reliable user interactions. I think having some pre-built solutions (instead of small prototypes) in addition to having more time to build the structure would be ideal. I look forward to building more public structures, watching the public interact with my creations, and collaborating with more architects and designers.

The following pages contains images of the pavilion taken during the festival weekend.


BAC


HUAWEI


HUAWEI
HUAWEI
HUAWEI

Posing in front of the team poster. From left to right: myself, Miguel Espino, and Valeria Lalinde.

Conclusion

What I Just Told You

Designing for efficiency only leads to interfaces that are easy to use but often shallow and unsatisfying. In this thesis, I have argued that we should be designing experiences that maximize sensory experience, socialization, challenge, learning, and the act of creation. Ultimately, I believe this creates more enjoyable and rewarding experiences for users, which are also more fun for designers to create.

Mitch Resnick's research on tinker-ability and the research of others in the field of learning, offer promising techniques for integrating self and peer learning into experience design. The continued progress in the field of tangible interfaces by Hiroshi Ishii and many others promise to provide more holistic sensory experiences and viable techniques for creating highly self-learnable interfaces. Mihaly Csikszentmihalyi and other psychologists attest to the value of creation, learning, and challenge in pre-serving day-to-day human satisfaction.

In my works, I have strived to explore a design process including these human needs. All of my projects, in some way, allow users to create. I think, that through the act of creation, we learn, we find enjoyment, and hopefully discover something new about ourselves. My work presents opportunities for users to create in externally visible (or hearable) ways tying the act of creation to that of performance. My work facilitates the process of learning through creation and making translating external processes to the internal.

What I Learned

Before coming to MassArt DMI, I thought (from my previous experiences in interaction design) that I fully understood the value of testing with users. I was mistaken. At DMI, I was constantly surprised observing what users would actually do with the products and interfaces I designed, what aspects they would

enjoy, and what aspects they would struggle with. Before coming to DMI I had the idea that it is possible to create something, put it into the world, and be done with it. It works well. Done. This is rarely the case.

Even for projects that worked well, I discovered they provided opportunities to inform my design thinking and inspirations for future iterations. With my Draw Blocks piece, I am constantly thinking of ways to improve upon, or explore different types of experiences within the framework of the system I have built. I think when we build computationally driven systems of any sufficient complexity, we can never call them done. The current technology is just a stepping-stone to the next technology. Often I found myself engrossed in the new technology.

I have now written many chapters proselytizing design philosophies placing an emphasis on holistic sensory experience, socialization, challenge, learning, and the act of creation. Despite this, it has been a constant struggle to keep these present within my realized works. In *Sequencing Marbles*, struggling with a sensor technology, swallowed up all other concerns; our first gallery showing presented only a partial taste of the original conceived idea. In our second iteration, with more time, we were able bring back challenge, learning, and the act of creation. In my Panama *Macropavilion* project, the sheer scale of the piece, and accelerated timeline again swallowed all other design concerns. Instead of taking a mental pause and re-considering my initial design goals, I let momentum guide us down an unwavering path. In the end we created a mostly functional piece at the scale desired, but lost sight of many of the original design goals like: holistic sensory experience and the act of creation.

I have found that my ideas need time to breath. Sometimes, stress and timelines are good motivators to getting work done, but often they can lead to compromises and oversights when demanding experimental technology is involved. I find the most enjoyable projects for me are ones in which I have left them somewhat open-ended. When creating interactive experiences and using new technologies, often it is more important to have a general direction than a concrete goal.

Future, bye

Designing for efficiency and usability have worked well over the past century in guiding decisions during tool design. These design philosophies, however, are insufficient guides for the design of software and computationally backed experiences. This has become especially pertinent as software has grown into a system that pervades all aspects of our lives including: decision making, friend making, time management, purchasing, health, entertainment, and education. The last decade has seen an interaction design philosophy emphasizing engagement: how to grab and keep users through usability, efficiency, and utility.

Some propose to avoid technology, such as when Nguyễn Hà Đông pulled his game Flappy Bird from the Apple App Store, amongst guilt that it was too addictive for users. But, most technologies have become so integrated within our lives that it is too impractical to avoid them. It is time for designers to enter into a philosophy in which we carefully consider the human needs of our users, not just how engaged they are. In this thesis I have proposed several design concepts that should be considered just as important as designing for efficiency, designing for: holistic sensory experience, socialization, physical and mental challenge, learning, and creation.

As designers, we must constantly make tradeoffs between competing goals while designing products and experiences. I do not suggest including any one philosophy is a sufficient condition for good design. There are always additional values a designer must consider and within this thesis work the most notable omission is that of accessibility.

I have not had sufficient time or space to research and discuss the implications of designing for the accessibility of those with physical and mental disabilities, the vast diversity of human bodies, learning styles, and desires. Some of my projects, as presented, exclude people, but it should be recognized that these are prototypes. An acceptable, general approach would be to build interfaces that are multi-modal, offering alternative interface paths to ensure we fit in with the diversity of our user's abilities and desires. Although universal design concepts can support accessible design, ultimately no single interface is universal; eventually we must build diverse layers of interaction catering to our diverse audiences.

In this thesis I have proposed a design philosophy that I am proud of. Over the years I have been fascinated to read about and listen to designers discuss their design philosophies and the personal stories that helped shape those philosophies. These stories have helped me develop a design process, one that I am sure will continue to grow and change. Ultimately, we must let our design process guide us to place of personal enjoyment and fulfillment. Design should be fun. Design whatever you want, just think about what you are doing, and why, occasionally :). Please challenge, create fun!

References

Organized by Category

Culture & Technology Essays and Rants

Carr, Nicholas G. *The Glass Cage: Automation and Us*. First edition. New York: W.W. Norton & Company, 2014. Print.

Carr chronicles the history of automation and its impact on humanity. He distinguishes between tools which humans control and manipulate versus machines which force humans into restricted inappropriate roles. Carr writes that machines are being designed that force us into roles that cause mental atrophy. He proposes problems that I strongly relate to. He documents strange industry solutions to the problem such as creating machines that periodically force manual control in a patronizing attempt to reduce human atrophy.

Costanza-Chock, Sasha. *Out of the Shadows, into the Streets!: Transmedia Organizing and the Immigrant Rights Movement*. Cambridge: The MIT Press, 2014. Print. <http://mitpress.mit.edu/sites/default/files/titles/free_download/9780262028202_Out_of_the_Shadows>. PDF.

Gladwell, Malcolm. "Why the revolution will not be tweeted." Annals of Innovation, October 4 2010: Issue Small Change. Web. May 12 2015 http://www.newyorker.com/magazine/2010/10/04/small-change-3

Kane, Carolyn L. *Chromatic Algorithms: Synthetic Color, Computer Art, and Aesthetics after Code*. Chicago ; London: The University of Chicago Press, 2014.

Kane uses the history of color technology to address more universal or general concerns of technological progress. Her most relevant concept to me was her introduction of the term democratic color. She uses it to mean both our newfound ability to choose from millions of colors while simultaneously being restricted to displaying these colors on very restrictive LCD displays (171—173). She describes the vast differences in perceptable light quality between LCD screens and the CRTs which they have almost completely taken over. One surprising oversight I found was that Kane uses

a color reproduction in her book of colored squares to illustrate simultaneous contrast; but having just seen original hand printed Josef Albers plates illustrating this same concept I was barely able to see the effect in Kane's book. The same could be said for her attempt to print Day-Glo (fluorescent) colors in her book which didn't fluoresce at all.

Keam, Siobhan. "Bruno Munari futurism function and useless machines." Web. May 12, 2015. <http://theculturetrip.com/europe/italy/articles/bruno-munari-futurism-function-and-useless-machines-/>

Tufekci, Zeynep. "Social Media's Small, Positive Role in Human Relationships." The Atlantic 25 Apr. 2012. The Atlantic. Web. 31 Oct. 2015.

Frames social media as proof that the younger generation is social and wants to connect. Presents a problem of growing suburbia, and "organized activities where the activity -- hockey, violin, debate club -- dominates, not the leisurely social conversation with each other adolescents naturally crave" as the real societal issue. Very compelling arguments against demonizing Facebook. One of many articles by Zeynep who focuses on surveillance, algorithmic accountability, communication and technology.

Kidder, Tracy. *The Soul of a New Machine*. Boston: Little, Brown, 1981. Print.

Documents the business, culture, and people responsible for building a microcomputer computer in 1978. At one point they recount going to the store when the cash register was down and noticing that the cashier couldn't figure out how much money they owed. At which they stated: "Ummmmh, one of the problems with machines like that. You end up making people so dumb they can't figure out how many six-packs are in a case of beer." I was surprised to learn that many of the people building the computers weren't really using them one of them stating: "computers are irrelevant."

Lanier, Jaron. *You Are Not a Gadget: A Manifesto*. New York: Alfred A. Knopf, 2010. Print.

Lanier writes about software lock-in: large software systems must communicate with each-other we must make compromises to make that happen and large software systems are hard to change. We are allowing our software to dehumanize us and treat us like machines. Web 2.0 is obsessed with fragments of information without context. We treat creative production as a human-less commodity. We overvalue the potential of utilizing algorithms to turn many tiny partial things into one big good thing. Suggestions on valuing and getting paid for creative work.

Pesta, Abigail. "Looking for Something Useful to Do With Your Time? Don't Try This." March 12, 2013. Web. May 12 2015. http://www.wsj.com/articles/SB10001424127887323628804578348572687608806

Porter, Joshua. "Relationship Symmetry in Social Networks: Why Facebook will go Fully Asymmetric." March 29th, 2009. Web. May 12, 2015. http://bokardo.com/archives/relationship-symmetry-in-social- networks-why-facebook-will-go-fully-asymmetric/

Postman, Neil. *Technopoly: The Surrender of Culture to Technology*. New York: Alfred A. Knopf, Inc. 1992. Print.

A history of how technology has changed cultural expression.

Rose, David. ***Enchanted Objects: Design, Human Desire, and the Internet of Things***. First Scribner hardcover edition. New York, NY: Scribner, 2014. Print.

I find the introduction compelling. Rose starts by writing about his worry that physical objects will be absorbed into flat-screen digital devices. His choice of chapter titles, however, inspired me to re-create his entire table of contents with opposite phrases. For example, I renamed Omniscience to "being satisfied with what you know" and Immortality to "mortality: it makes us human."

Turkle, Sherry, ed. *Evocative Objects: Things We Think With*. Cambridge, Mass: MIT Press, 2007. Print.

Victor, Bret. "A Brief Rant on the Future of Interaction Design." Bret Victor 8 Nov. 2011. Worry Dream. Web. 31 Oct. 2015.

Complains about a future of gestural interfaces where no physical feedback on the hands is provided. Describes the benefits of tools like the hammer which are designed to work with and augment our hands. Presents a fantasized future in which we build digital objects that can be directly manipulated by the hands.

Zuckerman, Ethan. *Rewire: Digital Cosmopolitan in the Age of Connection*. New York: W.W. Norton & Company Inc, 2013. Print.

Diversity and serendipity. Algorithms and filtering destroy our ability to discover fortuitously. The networks we create on Facebook and Twitter often contain people who re-affirm our existing beliefs. Serendipity, public spaces and being forced to interact with those different from us allow us to expand our beliefs, but our algorithmically controlled lives are taking this from us. Zuckerman seems primarily concerned with stagnation of ideas with respect to scientific innovation.

Thinking from Architects. Cities, Community & Public Space

Burklin, Thorsten and Peterek, Michael. *Urban building blocks*. Birkhäuser Verlag AG: Basel,Boston,Berlin, 2008. Print.

Each chapter describes a basic "building block" or architectural form in common use in urban design. Includes: "The row, The city block, The courtyard (inverse block), The arcade, The ribbon, The solitaire, The group and The Shed." It gives me some vocabulary for writing about the types of spaces that appeal to me. I am especially interested in the row and city block as they are very common in Boston.

Gehl, Jan. Life Between Buildings: *Using Public Space*. Van Nostrand Reinhold Company: New York, 1987. Print.

Good analysis of what specifically makes places full of activity. Details types of activities people are involved in including where to sit, different ways and reasons they walk, and different reasons for standing still. He attempts to explain why we are attracted to public spaces and writes about the "need for contact."

Halprin, Lawrence. *Cities*. New York: Reinhold Publishing Corporation. 1963. Print.

Lots of photos, chapter per category. "…and the city, like a stage set, demands modulators for people in motion—objects of use and comfort and artistry—guides for activity" (51)

Jacobs, Jane. *The Death and Life of Great American Cities*. New York: Random House Inc. 1961. Print.

Jane Jacobs was instrumental in redefining how city planners and architects viewed planning in large cities. The main thesis of this book is defining city diversity as a place with a diversity of people (economic, background, and education), doing a variety of diverse activities (shopping, entertainment, and passing-through). She then states that this type of diversity is something we should strive for.

Rudofsky, Bernard. *Streets for People; a Primer for Americans*. Garden City, NY: Doubleday, 1969. Print.

Lots of information on streets, sidewalks. Good chapter on moveable chairs vs fixed chairs. Essentially a catalog of different types of architectural and moveable objects that affect how people interact with cities.

Walters, David. *Designing Community*. Routledge, 2007. Print.

Walters describes how the choices architects and planners make during design and construction affect the community around the project. I especially

enjoy this quote:

" At the most minimal level 'community' is a term coined by developers to cast a superficial romantic gloss over their latest mass-produced subdivisions or housing estates, usually called into being by photographs of happy families in front of their new homes. A particularly egregious use of the term could be found in August 2006 in a developer's advertisement for a subdivision amidst the sprawl that surrounds Charlotte, NC, in the USA, which offered a 'new way of life' in a 'full brick community.' For British readers, 'full brick' means a housing estate where the detached houses are built of light timber frame faced with brick on all sides instead of simply a veneer on the front. Brick is a sign of status in American house building, as opposed to cheaper vinyl siding, and here the potentially rich concept of community is reduced merely to a marketing ploy of snobbish aesthetics. "

Whyte, William H. *City: Rediscovering the Center*. Philadelphia, PA, USA: University of Pennsylvania Press, 2009. ProQuest ebrary. Web. 22 December 2014.

Communication

Carey, James. *Communication as Culture, Essays on Media and Society*. 1989. New York: Routledge, 1992. Print.

Good analysis of technology, reminds me of Ong and McLuhan.

Hogan, Kerry. "Nonverbal Thinking, Communication, Imitation, and Play Skills with some Things To Remember". Web. The University of North Carolina TEACCH Autism Program. <http://teacch.com/communication-approaches-2/nonverbal-thinking-communication-imitation-and-play-skills-with-some-things-to-remember>

This article provides an overview of early learning and play with an emphasis on providing skills for educators working to foster communication skills for autistic children. It provides a good overview of non-verbal communication types, as well as defining terms including "expressing general needs", "expressing specific needs" and gestures.

Sociology

Csikszentmihalyi, Mihaly. *Flow and the Foundations of Positive Psychology: The Collected Works of Mihaly Csikszentmihalyi*. Berlin: Springer, 2014. Print.

Csikszentmihalyi, Mihaly. *Flow, the Psychology of Optimal Experience*. New York: Harper & Row, 1990. Print.

Goffman, Erving. *Behavior in Public Places; Notes on the Social Organization of Gatherings*. New York: Free, 1963. Print.

Interactions between people in public places, types of interactions we have and motivations for them. Good discussion on the interactions between strangers. Formalizes many of the public interactions we all see everyday.

Morrill, Calvin, David A. Snow, and Cindy H. White. *Together Alone: Personal Relationships in Public Places*. Berkeley: U of California, 2005. Print.

Each chapter summarizes a sociological study. Starts with a brief history of sociological research related to how people behave in public, and how relationships are different in public vs those in private.

Public Art & Participatory Art

Bishop, Claire. *Participation: Documents of Contemporary Art*. Cambridge: The MIT Press. 2006. Print.

Koike Nao. "Smart Illumination 2013." Koike Nao. 2013. Web. 16 Dec. 2015. <http://chai70.tumblr.com/post/72541302012/smart-illumination-%E6%A8%AA%E6%B5%9C2013>. <http://smartillumination.tumblr.com/>.

Kwon, Miwon. *One Place After Another: Site-specific Art and Locational Identity*. First MIT Press: Cambridge, MA. 2004. Print.

Representations of public art and their relationship with the cultural identity of the area. The book explores topics such as interventions and the potential for social interruption through the installation of public art.

Lossau and Stevens. *The uses of art in public space*. New York: Routledge, 2015. E-book.

A well edited collection of essays and research on art in public spaces with an emphasis on engagement and interactive art. Sections: Perception, Interaction, Participation, Appropriation, Reception.

Mayumi, Yuko. "2013 スマートイルミネーション横浜 | Smart Illumination Yokohama." Dec 18 2013. Video. Nov 1 2015. <https://www.youtube.com/watch?v=Gfm541APFhc>

Michael Maloney. "PlayMeImYoursBoston - #43 Post Office Sq 'Let It Be'". Video. Oct 14, 2013. Web. Feb 8, 2016. <https://www.youtube.com/watch?v=Yp2Ih96HQok>.

"Play Me, I'm Yours", Street Pianos. Web. Feb 8, 2016. <http://www.street-pianos.com>.

"Play Me, I'm Yours - Arts Centre Melbourne." Arts Centre Melbourne. Jun 19, 2014. Video. Feb 29, 2016. <https://www.youtube.com/watch?list=UUTEx4DhrLdk4RihWNkMNtDQ&v=rHvTmRcT4_8>.

"Play Me, I'm Yours Melbourne 2014: Program Evaluation Full Report." Bailey and Yang Consultants commission for Arts Centre Melbourne. PDF.

Rieser, Martin. "Forgotten Histories of Interactive Space." Architecture—Technology—Culture 5 (2010): 55–65. Print.

"Smart Illumination Yokohama 2013 (スマートイルミネーション横浜)". PDF file. Smart Illumination. 2013. Web. 16 Dec. 2015. <http://www.smart-illumination.jp/archive2013/>. <http://www.smart-illumination.jp/archive2013/files/2013_smartillumination.pdf>.

Design

Hiroshi Ishii, et al. "Radical atoms, beyond tangible bits, toward transformable materials". In Interactions 19, 38-51, 2012. PDF.

Krug, Steve. *Don't Make Me Think!: A Common Sense Approach to Web Usability*. Indianapolis, Ind: Que, 2000. Print.

Norman, Donald A. *Living with Complexity*. Cambridge, Mass: MIT Press, 2011. Print.

In Living with Complexity Norman distinguishes between complication and complexity. He defines complexity as the innate, un-avoidable minimum level of detail a process or task possesses. He defines complication as un-necessary confusion created through poor design. Norman's claim is that we actually do perform complex tasks and we shouldn't try to hide complexity behind "simple" interfaces as that only adds to confusion in how interfaces might behave. Norman uses service design extensively to justify his claims.

Norman, Donald A. *The Design of Everyday Things*. 1st Basic paperback. New York: Basic Books, 2002.

Norman, Don, and Bruce Tognazzini. "How Apple Is Giving Design A Bad Name." Co.Design. N.p., n.d. Web. 12 Nov. 2015.

Changes in Apple's user interface guidelines over time and demonstrates how they have influenced or represent the current state of affairs on IOS. They complain about the lack of discoverability in gestural interfaces, the lack of a back or undo button, the change from a focus on designing for user experience design to designing for Bauhaus minimalist aesthetics.

Learning

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Fish McGill is a 2014 alumnus of DMI. His projects exploring inhibition and drawing served as great inspiration to my projects and this thesis.

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Please Challenge

Create Fun

Colophon

Body text is set in Eric Gill's Joanna (11/15.5), designed in 1931 and digitized in 1986. Captions and italics are set in Joanna Nova designed in 2012 by Ben Jones from Eric Gill's original 1931 designs. Headings are set in Ong Chong Wah's 1998 typeface Abadi. Joanna, Joanna Nova, and Abadi are all distributed by the Monotype foundry in the United States. Japanese text is set in IPAexMincho from the Information-technology Promotion Agency of Japan.

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