I am incredibly grateful to the many people who played a role in bringing my thesis to life. This book is a reflection of my passions, daily routines, and design practice.

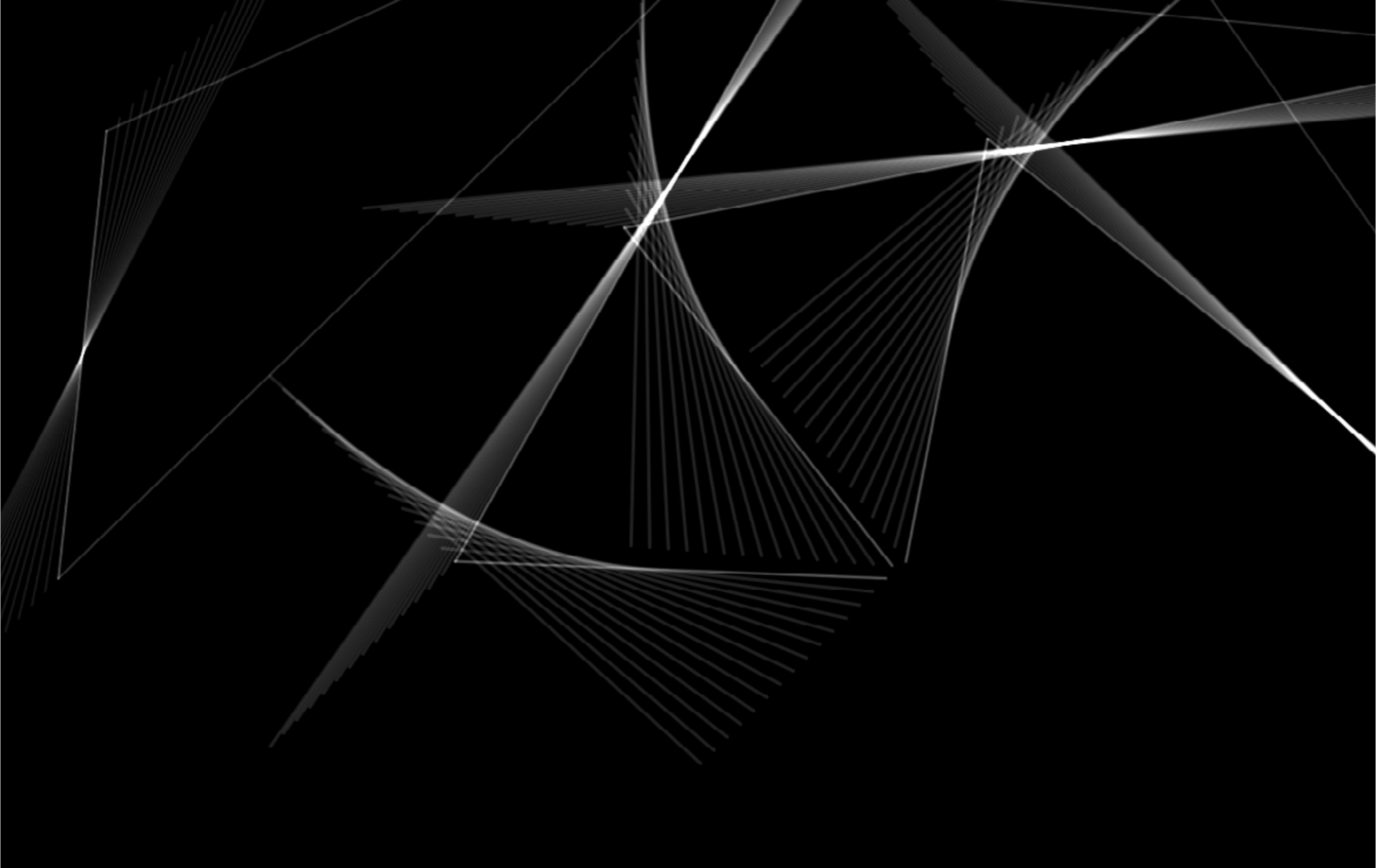
To my faculty advisor, Monica Schaug, your thoughtful advice, encouragement, and appreciaiton of running helped shape this project into what it is today. I'm also deeply thankful for my cohort and pod members — going through this journey together make the experience all the more meaningful.

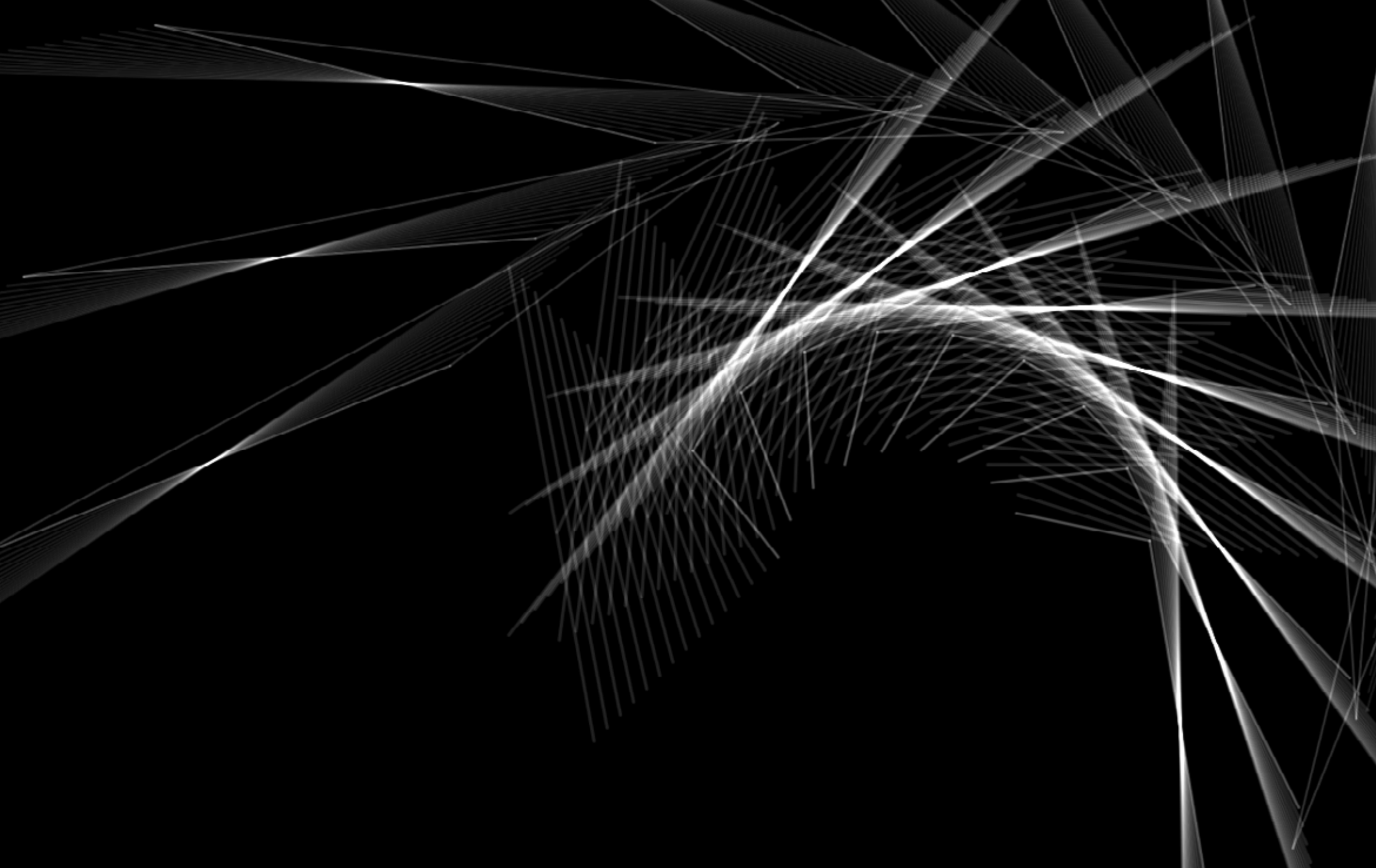
A special thanks to Linda Mei Lotti for her invaluable guidance in the early stages of my thesis. Your insights planted the seeds that grew into the work I'm proud to share. And to Logan Monroe, thank you for capturing this project through your photography, and somehow always capturing the perfect shot.

And, of course, thank you to my legs for carrying me through countless miles and my body for holding up (more or less) through my graduate studies. My Pasadena running community, you've been my unwavering support system, reminding me that sometimes the best way to clear my mind is to run to the mountains.

This book may be a solo endeavor on paper, but in reality, it's a product of the collective.

gabby escobar

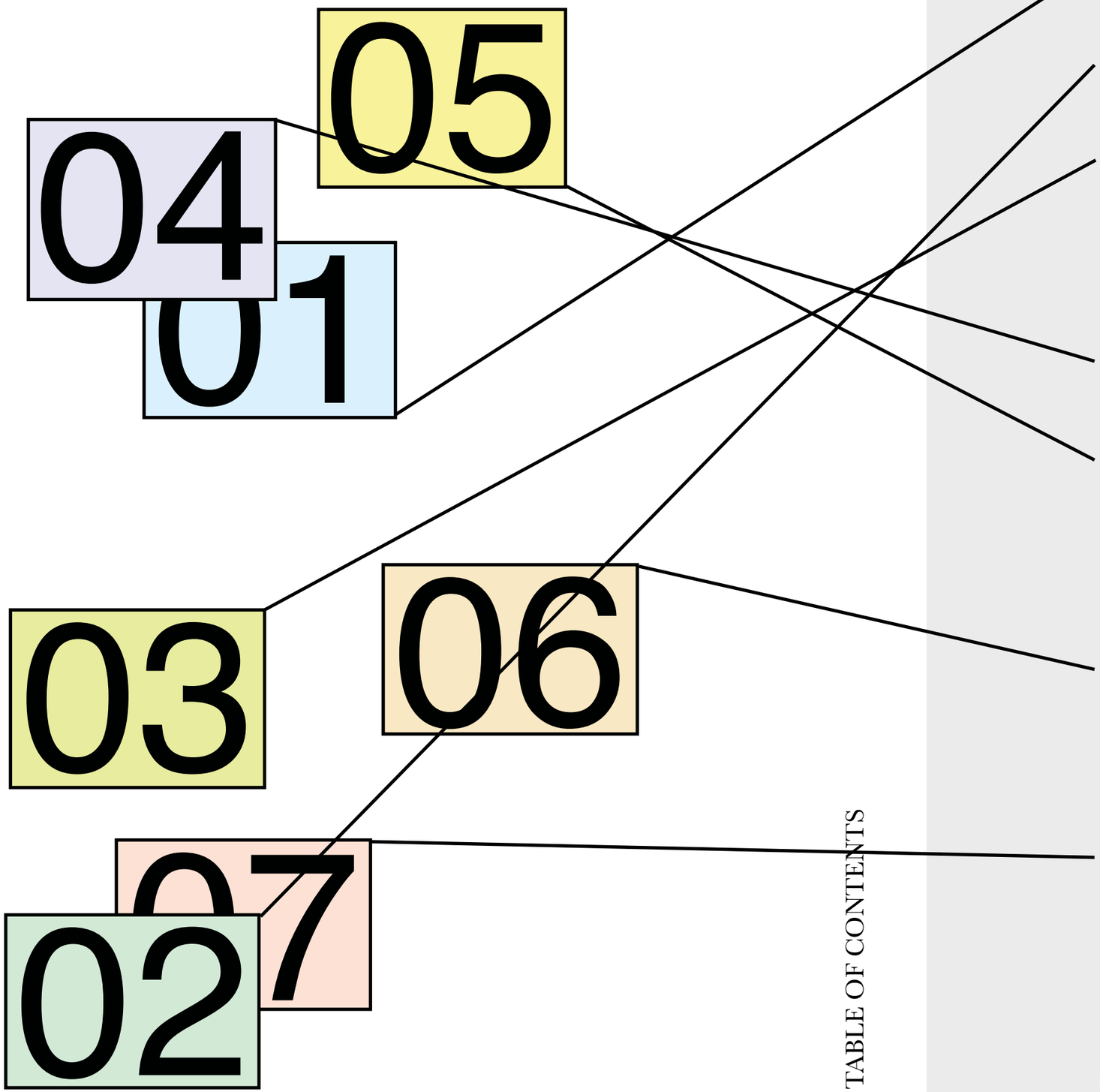




PERFORMANCE BY DESIGN

AN EXPLORATION OF BODY CENTRIC DESIGN SYSTEMS

GABBY ESCOBAR



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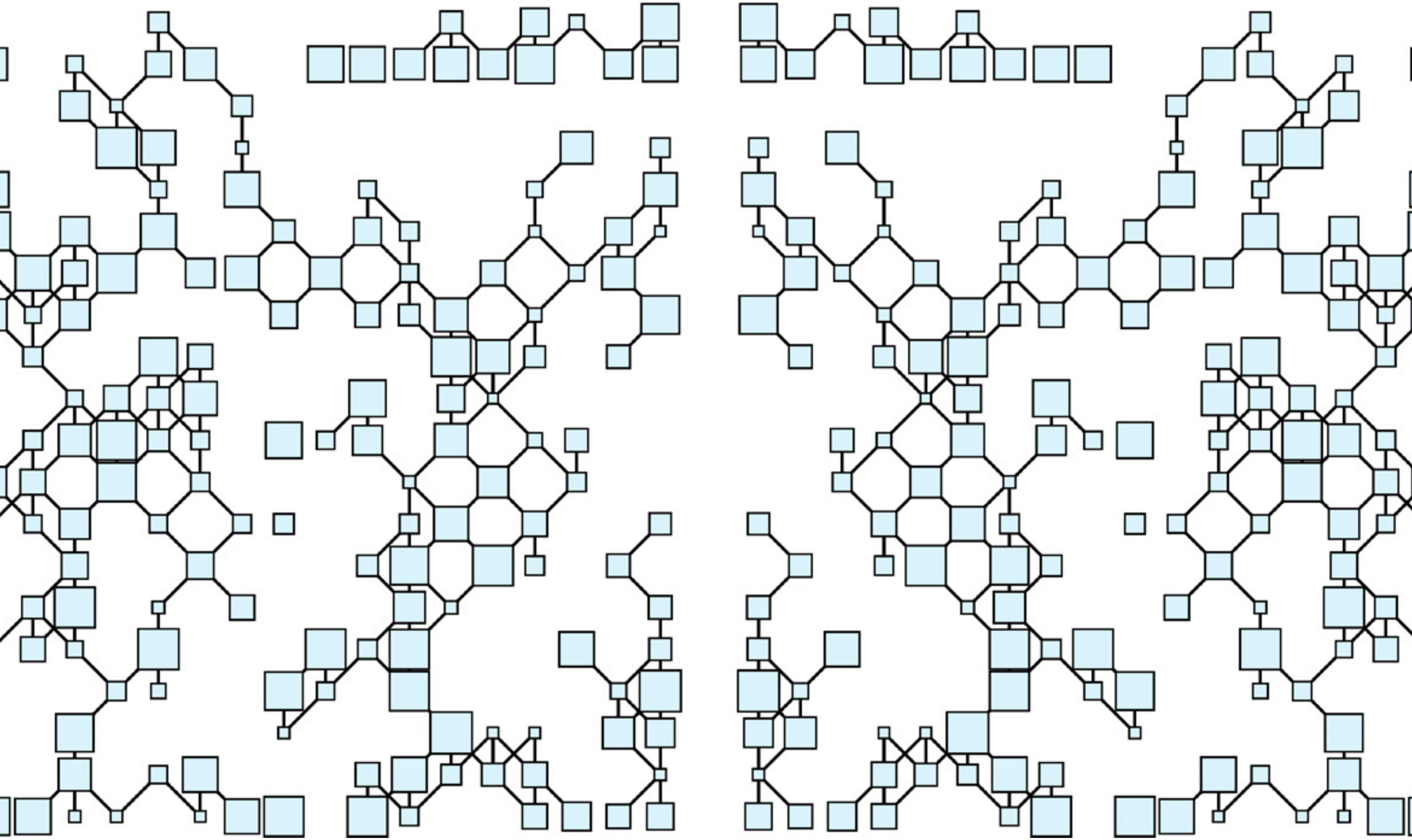
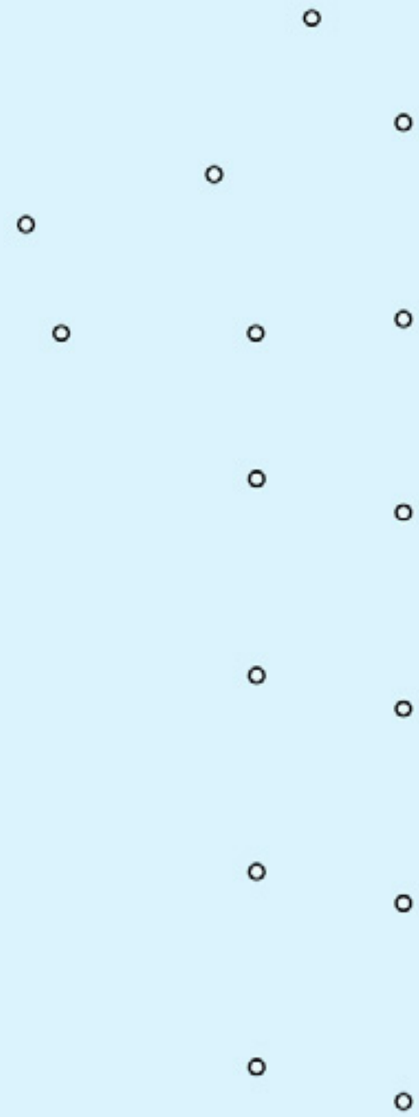




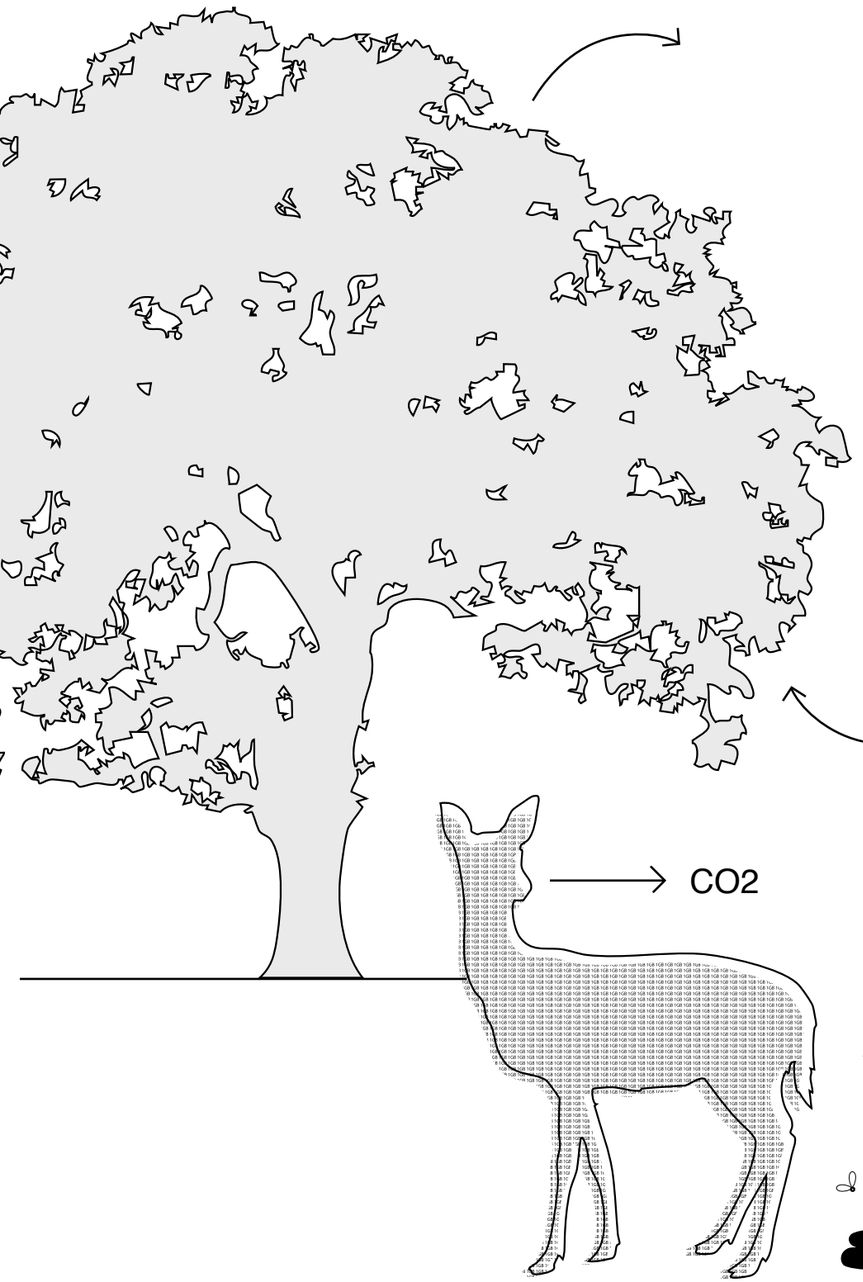
INTRODUCTION

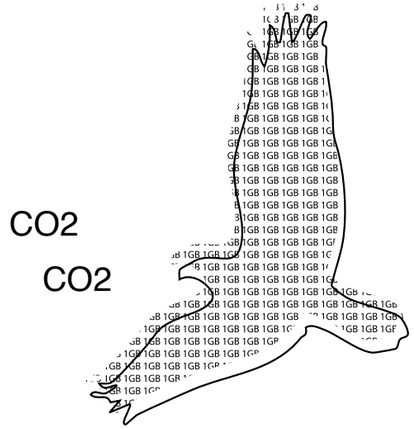
design ideology

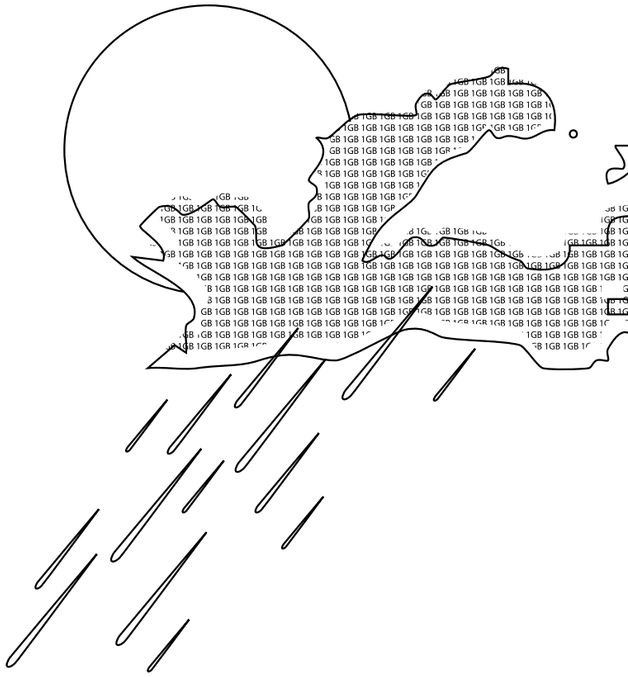
Graphic design is an evolving ecosystem where each element—typography, color, imagery, grid—collaborates to serve a unified purpose within an endless space for discovery. Like a body, a design system must maintain balance to thrive. The relationship between designer and design is symbiotic: one cannot exist without the other.

As the world shifts, the designer adapts, innovating while preserving the core integrity of their system. Through this, design is shaped by culture and crea tes the platform by which culture evolves.

While the digital age may create a sense of disconnection from the physical, the essence of design remains grounded in human interaction with the world around us. In this way, design creates a discourse—between the designer, an audience, and the environment of cohabitation.


O2
O2
O2
O2
CO2
CO2
CO2
O2


CO2
CO2



the average data generated by smart wearables is about 5GB per person, per day

the data we generate is an extension of our identities, as personal as our DNA.

- how much of this data do we
- what can we learn from it?
- what can we create from it?
- what is the DNA of graphic design?

abstract

This thesis examines the opportunities presented by data-informed design systems, emphasizing the concept of “body-centric design.” Defined as a methodology that uses data from human anatomy, movement, and physiology to inform design choices, body-centric design aligns graphics and interactions with the natural mechanics of the human form. This approach aims to create a seamless dialogue between design and the audience, resulting in experiences that feel natural and engaging. Particularly relevant to the outdoors and sports industries, body-centric design empowers designers to craft personalized and functional solutions with the data of their audience. The research redefines how designers approach data, transforming it from abstract information into dynamic, human-reflective design systems.

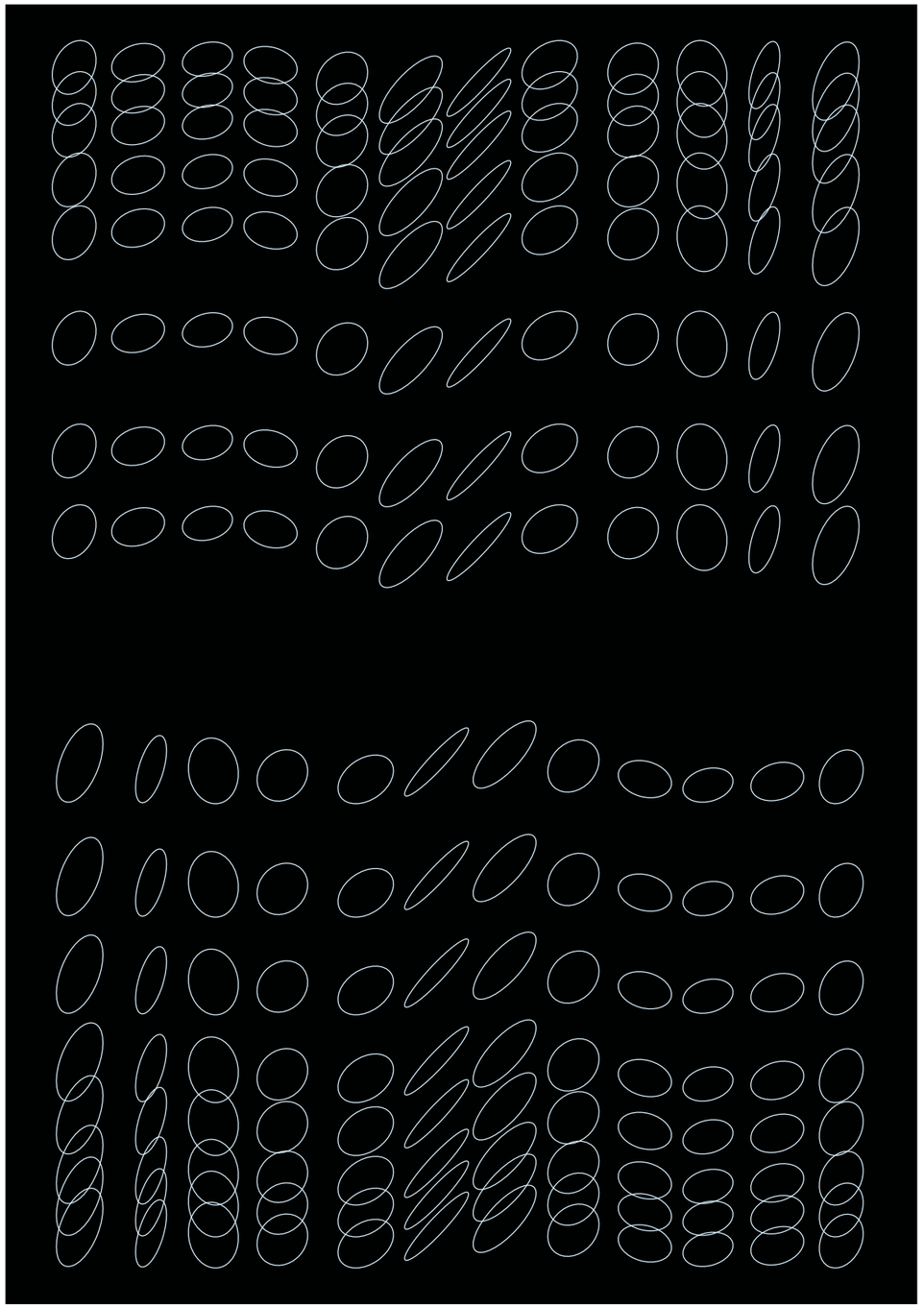
Key insights include:
1) The potential to build functional design systems from experimental principles.
2) The use of data visualization to inform the aesthetics of a design system.
3) The ability to foster deeper, instinctual connections with audiences by integrating the DNA of data derived from the body and its mechanical systems.

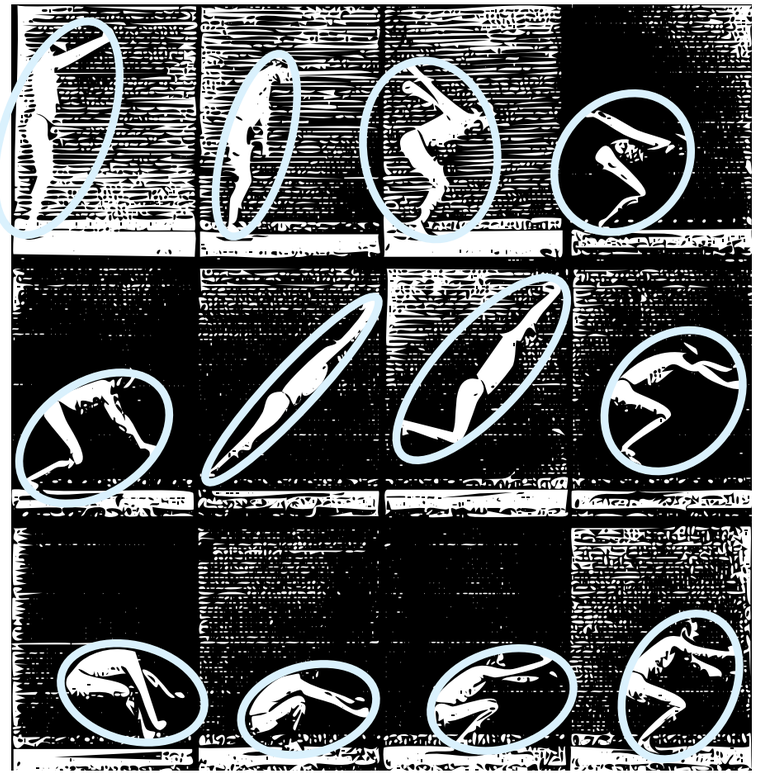
I have drawn inspiration from the philosophies of integrating design with surrounding life in architecture, product design, and performing arts. Frank Lloyd Wright approached architecture by integrating his structures with nature in order to create a sustainable system between the two. Furthermore, the principle of ergonomics in product design, adapts physical forms to the human body. Graphic design is designed to exist in human centered spaces so I aimed to explore a practice of graphic design based on the body. Lastly, Growing up in the world of professional ballet, I was trained to trace and connect lines within the body and through space. These movements formed compositions linked by specific body points, such as the pinky finger to the outer knee, creating a cohesive and aesthetically pleasing flow in several dimensions. This research addresses the contemporary challenge of harnessing the vast, often underutilized streams of data generated by society, offering a transformative perspective through body-centric design. By embedding human-generated data into the core of design processes, this thesis introduces a dynamic and personalized framework that redefines data as an extension of human identity—transforming it into a living, integral component of creative expression.

As graphic design influences evolve from nature, comes the opportunity to embrace a human-focused framework through body-centric design.

body-centric design.

I am reconstructing graphic design systems around data generated by the human body. This “body-centric design” will create a deeper and more authentic connection between graphic design and the human experience.





movement made pattern →

THESIS SUMMARY

Data is as personal as our DNA, generated through our own movements—yet it's often overlooked or disconnected from our lived experience. With smart devices producing an average of 5GB of data per person each day, critical questions arise: **Where does it go? Who uses it? And what are we missing by not accessing it ourselves?** In a time when data is abundant but impersonal, designers have a unique opportunity to reclaim it as a tool for meaningful creative expression. **As graphic design evolves beyond traditional, nature-inspired influences, there is a shift toward embracing a human-focused framework—what I define as body-centric design.** My work reconstructs design systems around data generated by the human body, establishing a more authentic and emotionally resonant connection between visual communication and human experience. By transforming abstract data into dynamic, living design systems, this approach challenges conventional methods and proposes a new model for integrating design, movement, and individual identity. It opens the door to hyper-personalized experiences where the digital DNA of each person shapes the visual language of communication.

AN EXPLORATION OF BODY-CENTRIC DESIGN SYSTEMS

The foundation of my thesis is rooted in both my undergraduate studies in Speculative Design and my personal relationship with my own data. **Speculative Design pushes the boundaries of traditional thinking, offering critiques of the present and proposing possible futures that either drive innovation or inspire social change.** While conversations around data and privacy often provoke discomfort, the reality is that we are surrounded by publicly accessible data—far more than we can fully comprehend. Within our publicly available data lies more than just its use in targeted ads or selling products—it holds deep personal insight and the potential to bring comfort, reflection, and self-understanding.

Over time, I've developed a stronger sense of self by engaging more intentionally with my own data. My physical and creative practices have long been interconnected—from over a decade of professional ballet training to the point when I began running and studying graphic design. What began as two separate paths—one physical, one creative—have since merged into a unified practice. **As a graduate student and ultramarathon runner, I turned to data as a strategic tool for optimizing time, balancing recovery, ideating concepts, and building endurance.** Long trail runs became moments for creative ideation, classwork became recovery time for my body. With a strategic approach to my schedule, every minute served a purpose. The more closely I read the data from platforms like Garmin, Strava, and Training Peaks the stronger I became—physically and creatively.

This symbiotic relationship between data and self-discovery is the core of my research. **Through my thesis, I propose a future in which designed experiences help us better understand ourselves and our audiences, using body-generated data as a bridge between human insight and graphic expression.**

As I began looking closely at data generated by the body, I noticed it held a unique quality: semi-predictable structure with moments of random variation. **This led me to consider data not just as numerical outputs, but as embodied movement—like step patterns or shifts across terrain.** I launched my thesis with a series of experiments aimed at expanding this definition of data. One early exploration involved photographing body movement with light, capturing the subtle, semi-predictable pathways of motion—even in controlled environments like treadmills or stationary bikes.

While grids have traditionally represented order and stability, the body is inherently fluid. **I began developing a series of dynamic grids derived from human form.** Using stills of bodies in motion, I created a set of rules to connect lines, angles, and directional movement—resulting in adaptable, body-centric grids. For this project, I focused on the form of a sprinter, analyzing key phases like flight, toe-off, and midstance. These grids became the foundation of my design system and were used throughout the year to construct every deliverable of my thesis, including this book.

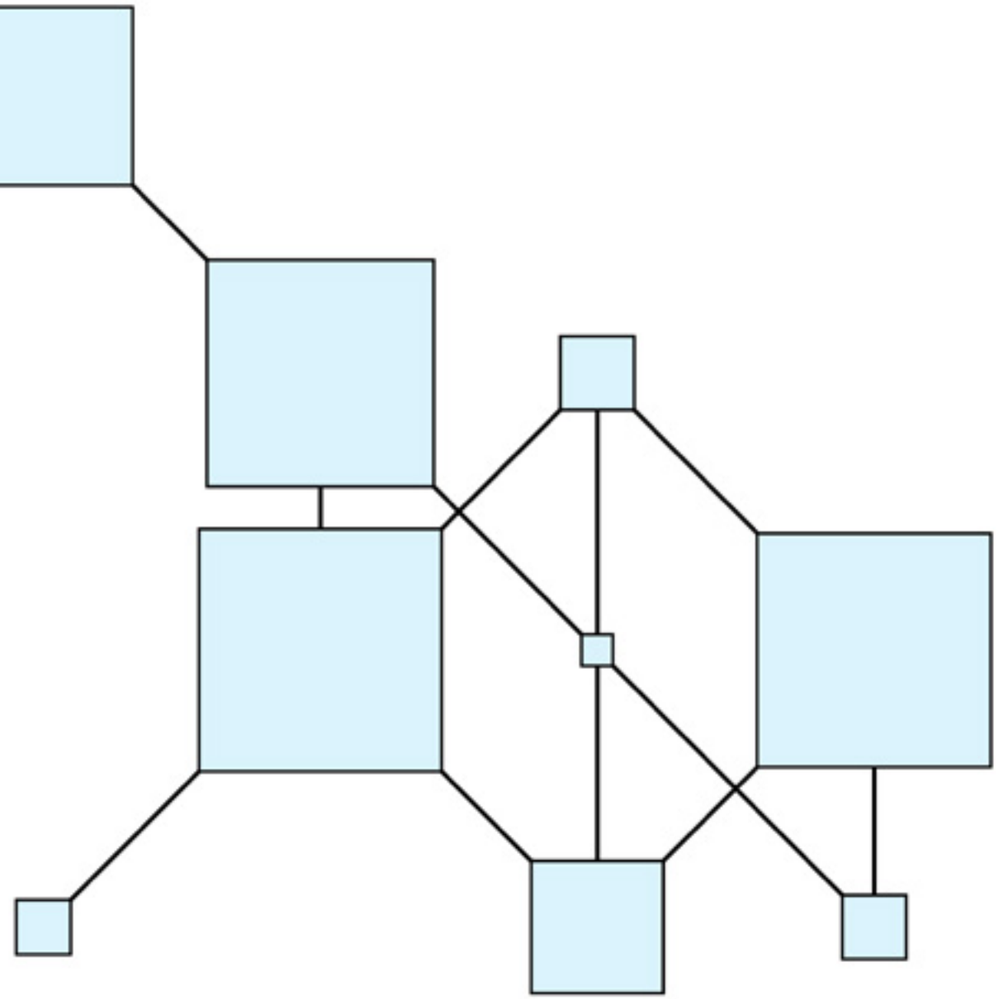
In parallel, I spent the early months of thesis development training for an ultramarathon. I turned my training into a creative experiment—**after each run, I reimagined my performance data through a new visual lens. This led me to develop an interface that visualizes runs using two universally accessible data points: pace and distance.** The system avoids favoring longer or faster runs, producing a unique and visually engaging outcome every time. **The goal is simple: to celebrate movement as a form of creation.**

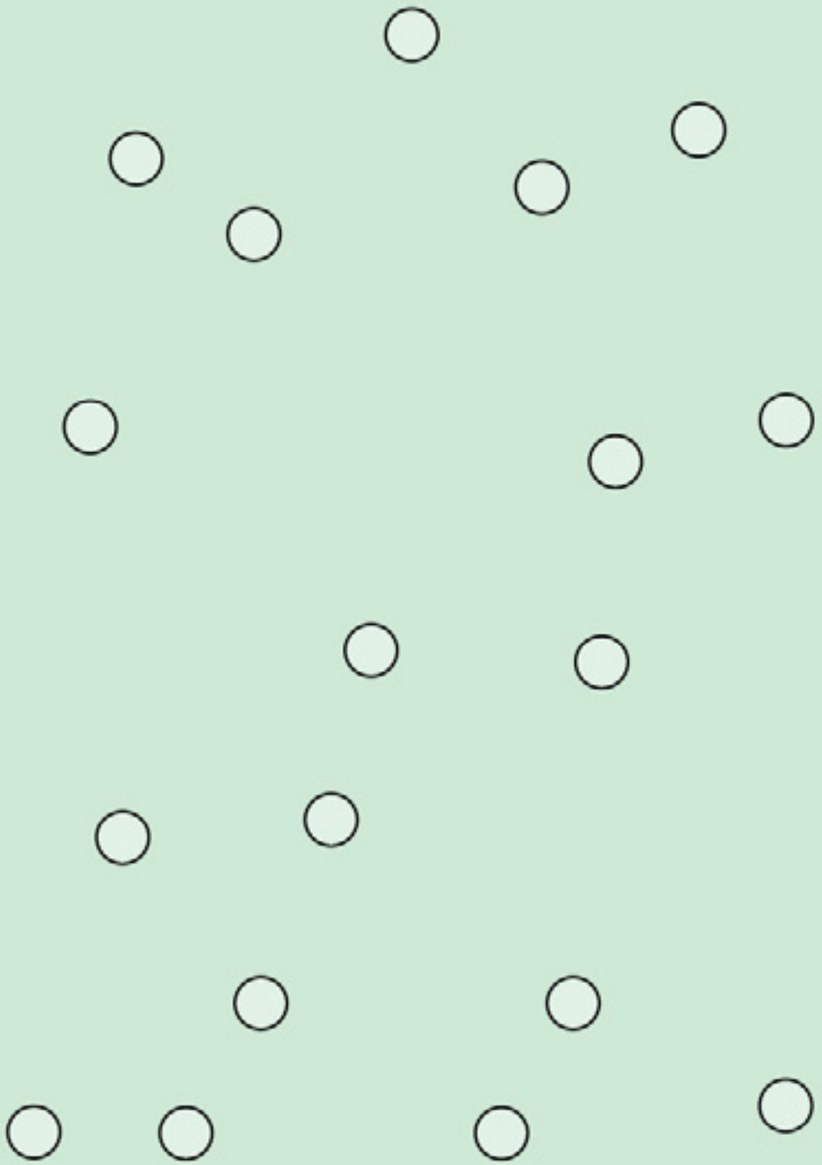
The outcome of these design experiments culminated into a **graphic system for a hypothetical event I named, Onda Run —** a run organized and designed to celebrate movement, wherever you are. There is no timekeeping, no set distance—just participation. The visual identity of Onda Run is rooted entirely in body-centric design principles. The name Onda, meaning “wave” in Spanish, not only plays on the rhythmic flow of running but also evokes the movement of the body through space.

This system explores innovations in form and motion, placing the individual at the core of its visual language. Data becomes the source of color and variation, introducing transparency and reactive materials to enhance the sense of interaction between the design and the athlete. **The goal was to build a highly visual, yet viable system—one that translates experimental methods into a compelling brand identity.** In doing so, it challenges traditional design systems and opens up possibilities for how they can evolve to better reflect human experience in the future.

Through this work, I’ve discovered a new way of thinking about graphic design—**one that sees the human body not just as a subject, but as a system capable of generating meaningful data to drive form, rhythm, and narrative.** What’s new is the integration of movement-based data as a foundational design material, offering a more personal, responsive, and embodied approach to visual communication. By reframing performance metrics as expressive tools, I’ve learned how deeply creative and physical practices can inform and strengthen one another. This thesis challenged me to rethink what qualifies as design input and pushed me to build systems that prioritize individuality, presence, and process. Ultimately, my work shows that body-centric design can unlock hyper-personalized, emotionally resonant experiences—grounded in data, but driven by the human spirit. **It is a call to reimagine the systems we rely on, and to build new ones that reflect who we are and how we move through**

AN EXPLORATION OF BODY-CENTRIC DESIGN SYSTEMS





PROJECT OVERVIEW

MOVE HOW YOU MOVE. NO SET DISTANCE, NO TIME—JUST YOU AND THE RHYTHM OF YOUR BODY IN MOTION. WHETHER FAST OR SLOW, BIG OR SMALL, EVERY STEP IS A STATEMENT. YOUR MOVEMENT IS THE ART.

NOW GO MAKE IT.

IN RHYTHM WITH YOU

ONDA RUN 2025


ONDA RUN
2025
CORRAL B
MONICA
1215
IN RHYTHM WITH YOU


ONDA RUN
2025
CORRAL A
3029
FELIP
IN RHYTHM WITH YOU
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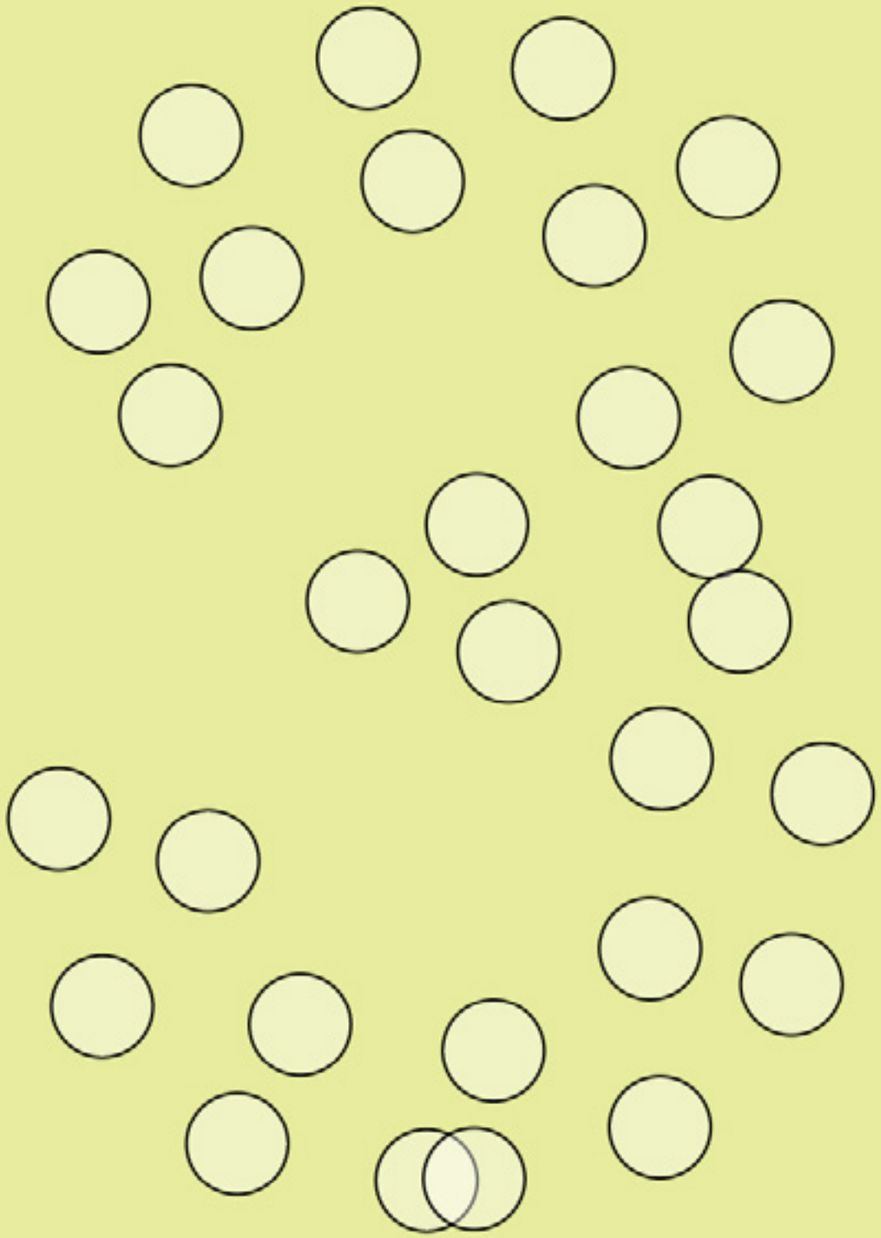
2025
CORRAL B
MONICA
1215
IN RHYTHM WITH YOU

gabby escobar


ONDA RUN 2025


ONDA RUN 2025



PROCESS AND DEVELOPMENT

PERFORMANCE DATA VISUALIZATION
ANALOG EXERCISES

I have long been passionate about running and dedicated the entirety of the Fall term (three months) to training for an ultramarathon. Throughout this period, I consistently ran more than three times per week, incorporating a variety of workout types into my regimen.

For every recorded run during this time, I systematically explored different methods of visualizing performance statistics.

My experimentation included mapping both individual data points and multiple variables to assess their effectiveness. I evaluated these visualizations based on readability, aesthetic appeal, and the extent to which they revealed unexpected insights.

The findings from this analysis informed the parameters for my digital interface design.

This first graph demonstrates vertical gain and loss over the span of my run. Each step to the right signifies one mile.

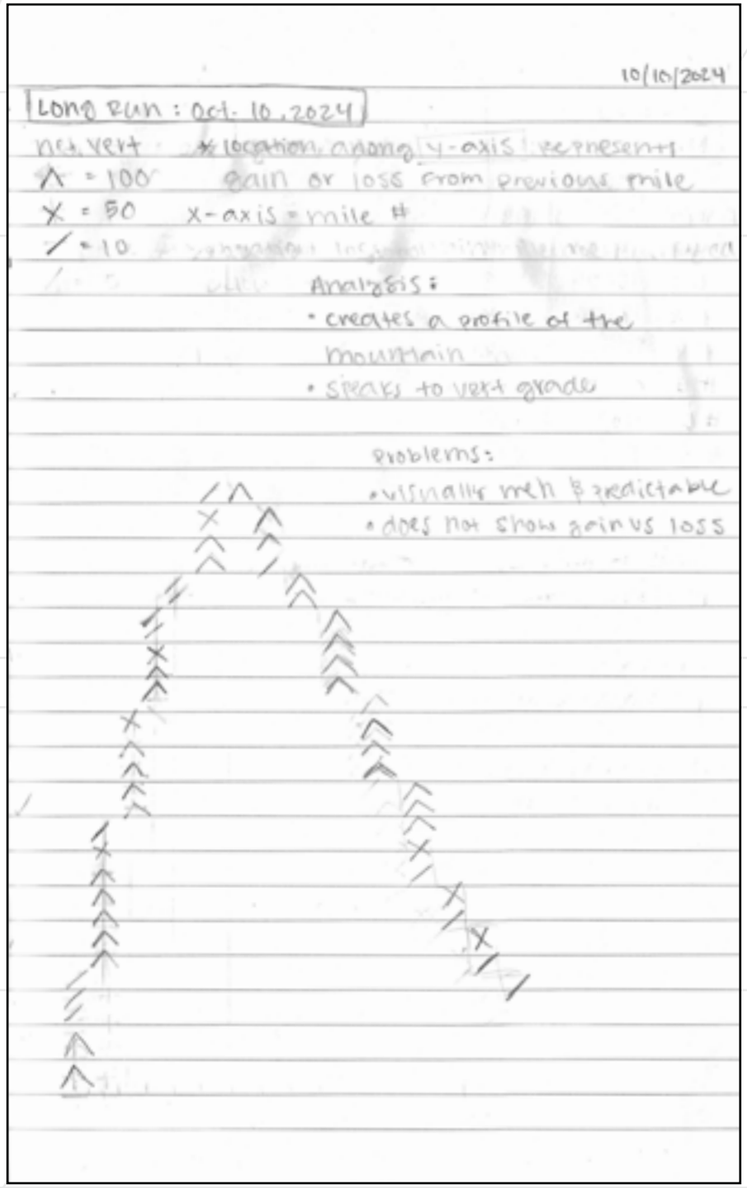
I broke down the net vertical increase or decrease into a series of symbols that can be added together.

The graph building upwards signifies a positive net gain, the graph downwards signifies a negative net gain.

Data Set: Net Vertical gain/loss

Net gain/loss = positive gaing - negative gain

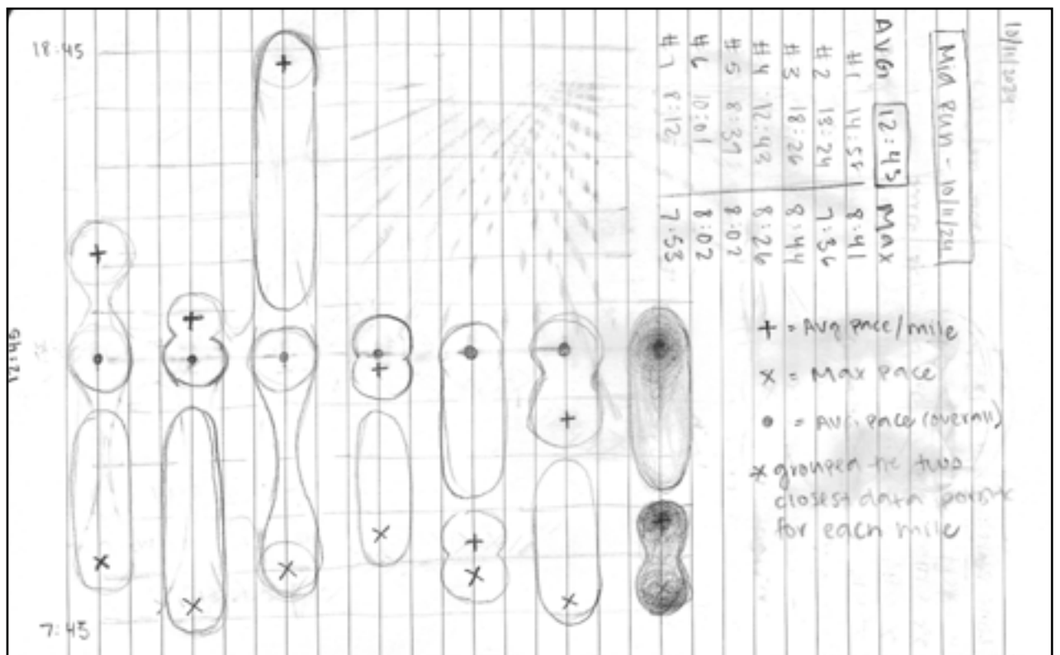
ie mile #1 was +130



insights:

the overall graph created a profile of the mountain. This is not too different as to how performance data traditionally presents vertical gain/loss data

The challenge is, can I present data to draw more unpredictable conclusions.



Data Set: Pace, Avg Pace, Max Pace

Data Set: Pace. Avg Pace, Max Pace

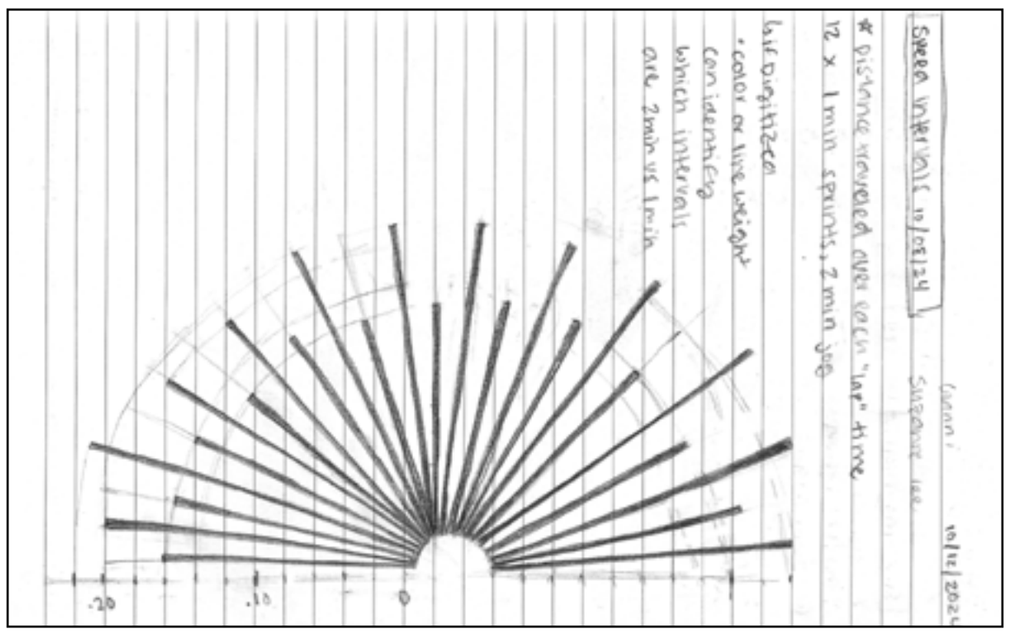
I explored mapping the Average pace in comparison to the max and average pace per mile.

I grouped the closest two data points to demonstrate outliers and add a different visual appeal.

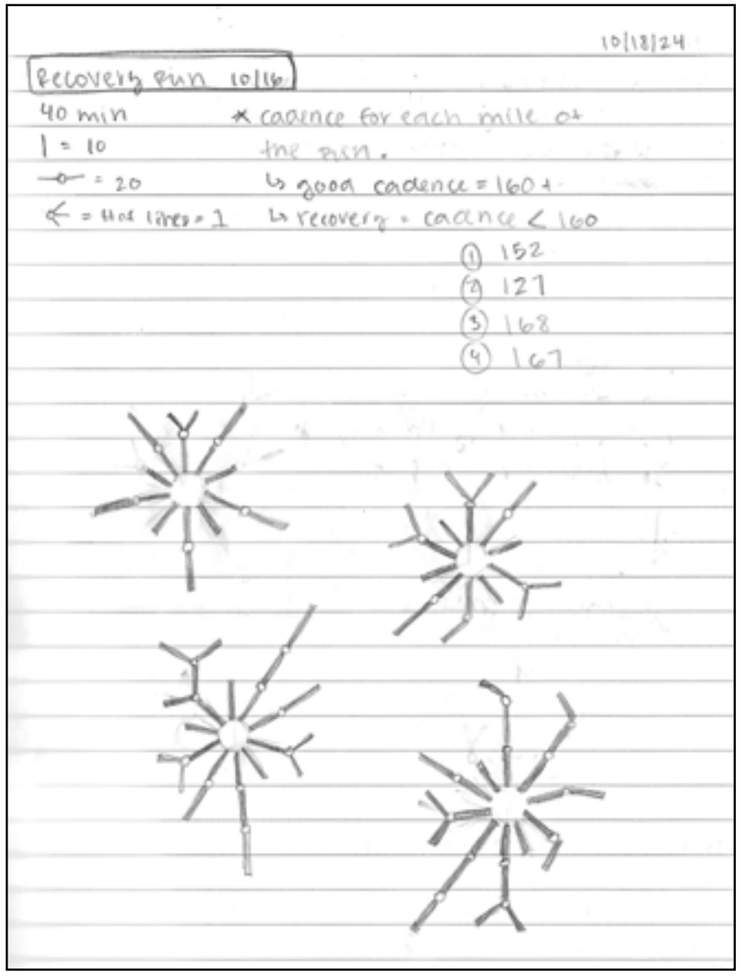
Data Set: Distance traveled per “lap” segment

Lap 1 = 1 minute sprint
Lap 2 = 2 minute jog
Lap cycles repeat X12

The end result of this exploration was somewhat of a predictable variation with high with visual appeal.

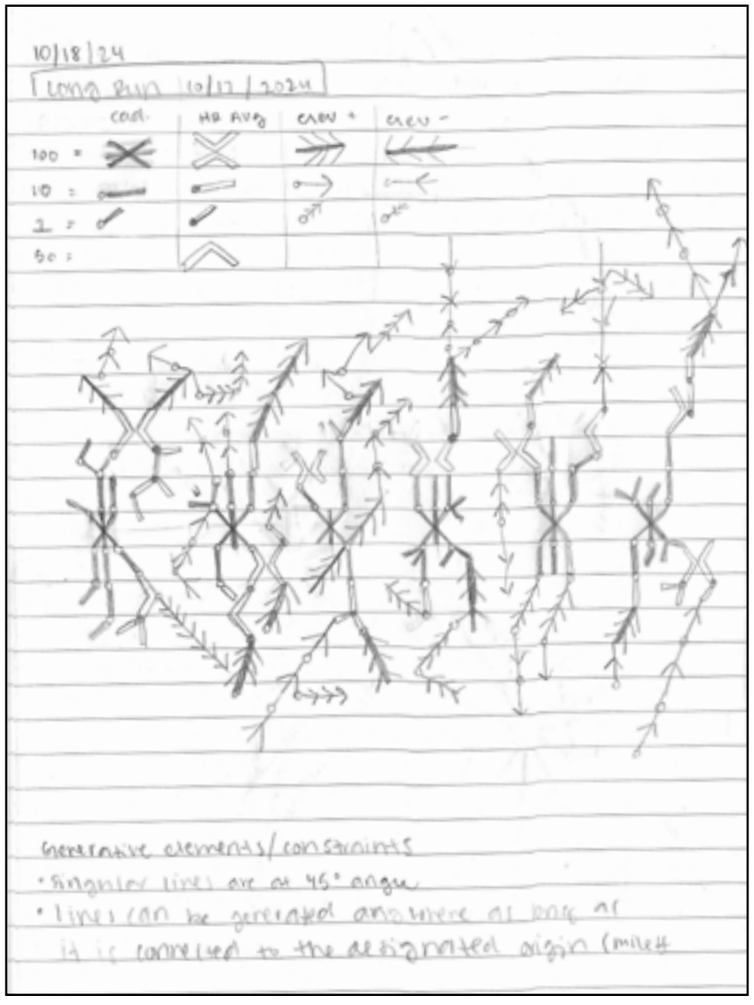


Data Set: Cadence
1 layer around the circle = 100
1 lap = 1 mile

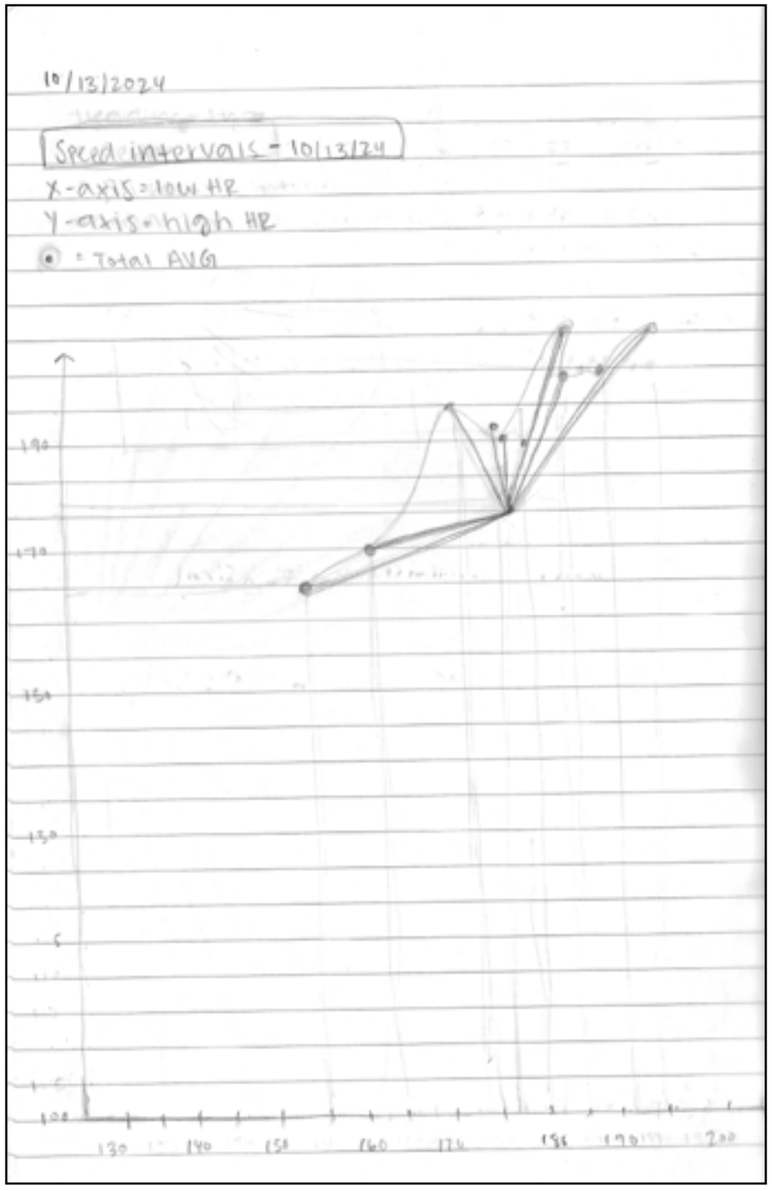


I broke down one variable into its laped segments. Using line segments to determine the numerical value, I arranged them in a circle. While illustrating this graph, I realized that I did not place parameters for how these segments are to be placed after the first circle has been created so, I placed them freely. This became a human-generative aspect to this exploration that mimmics what some outcomes could be if this were generated in code.

With the same idea as the previous graph, I layerd several data sets. this created a chaotic and cluttered composition and a graph that is not likely to be read.

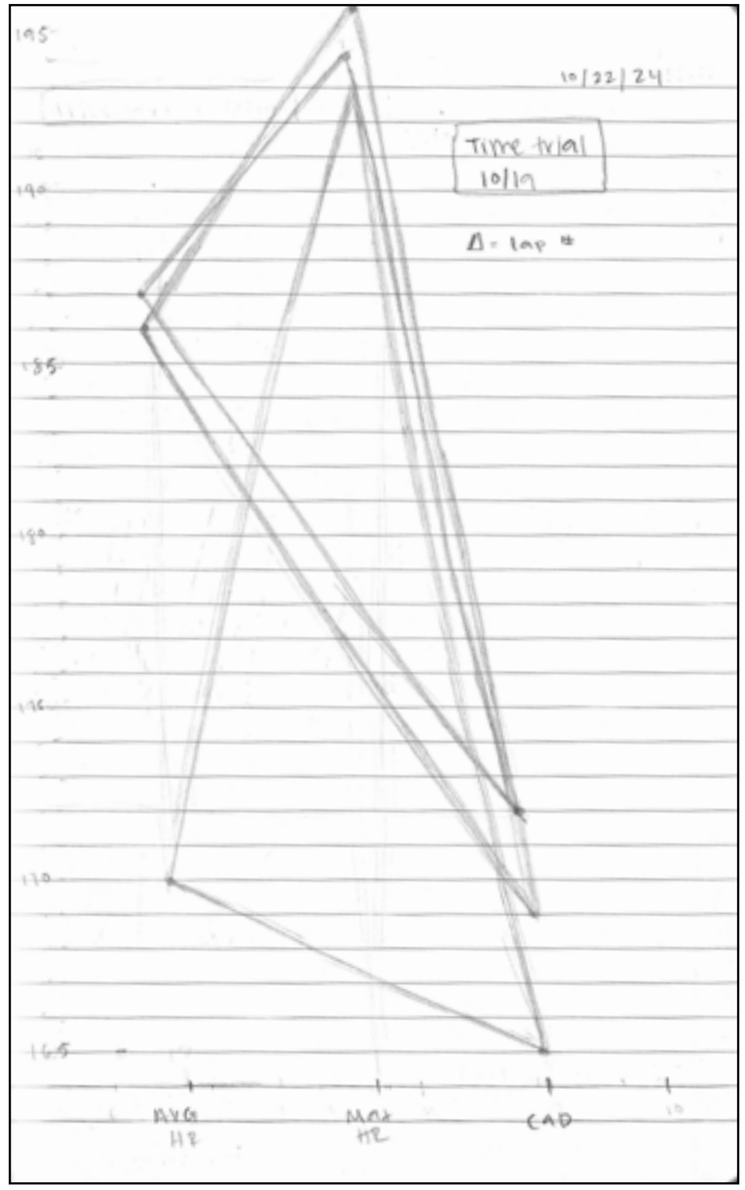


Data Set: Cadence, Average Heart Rate, Elevation gain, Elevation Loss



Data Set: Heart Rate
(x,y) = (Low HR, High HR)

I plotted low and high heart rate relative to the average heart rate from the entire activity.

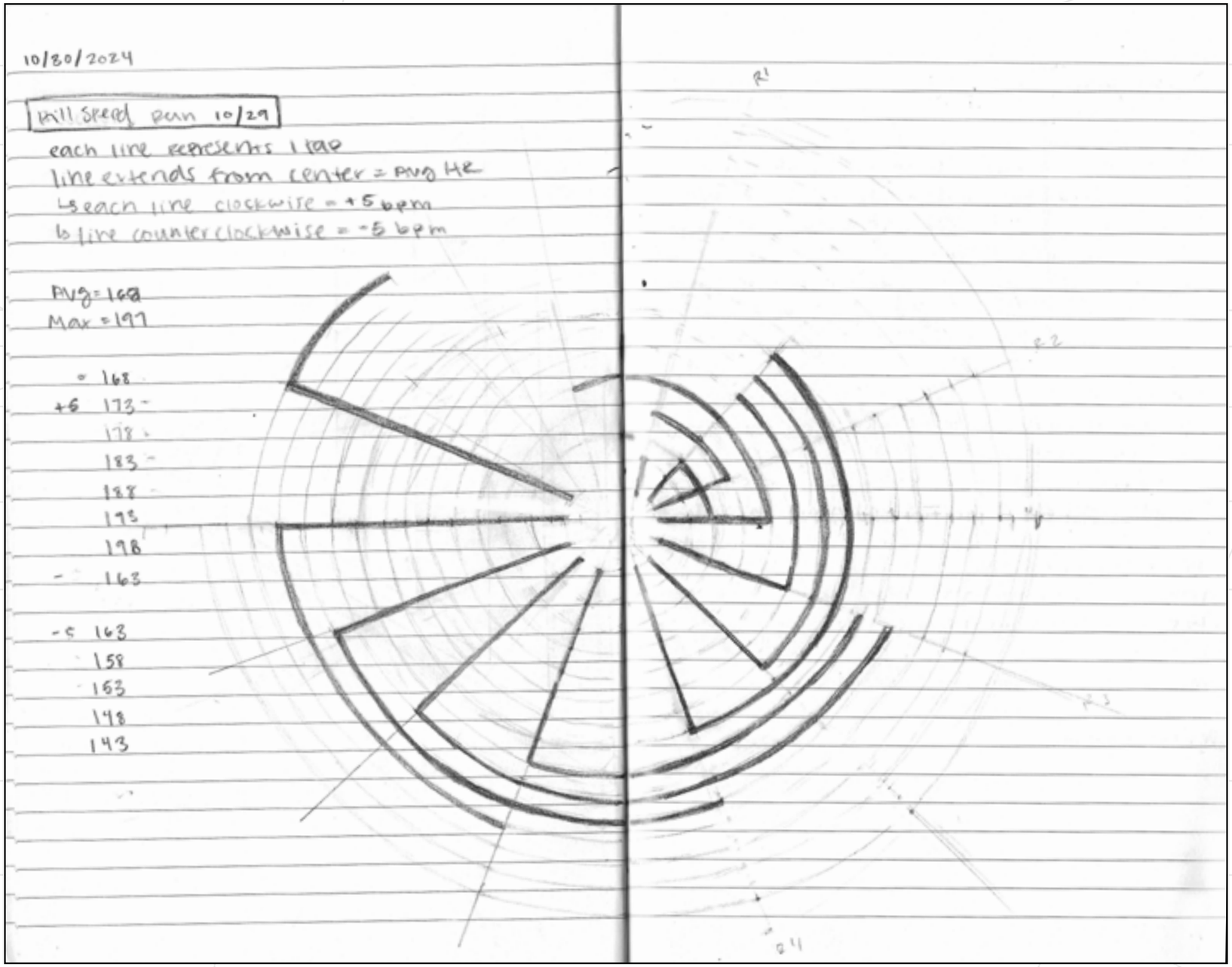


Data Set: Heart Rate Average, Max, and Cadence
(x,y) = (Data Set, ###)

Each data set was plotted on the same y-axis scale. Each triangle shape produced signifies data points from each lapped segment.

Data Set: Heart Rate

Line extending from center = 1 lap = Avg Heart Rae
1 step clockwise = +5 bpm
1 step counterclockwise = -5 bmp

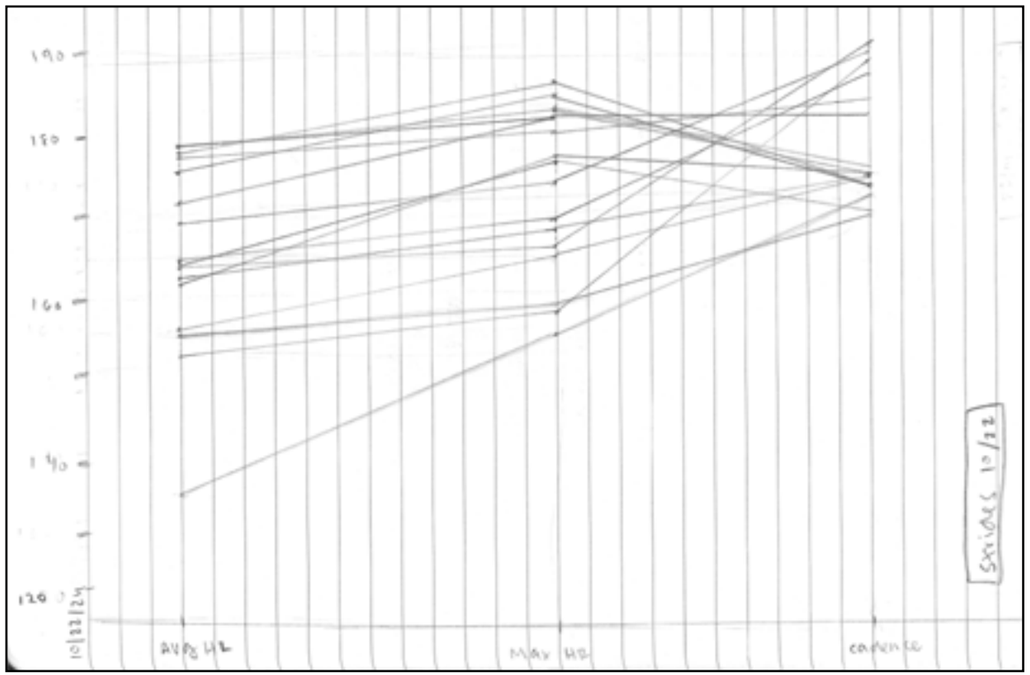


Circular shapes of my graphs speaks to the paths are joints move when running. Like the swing of an arm or sweep of our legs from the hip.

insights:

This gaph was created wtih the same parameters of a previous exploration. The only difference between the two is the spacing between each on the x-axis.

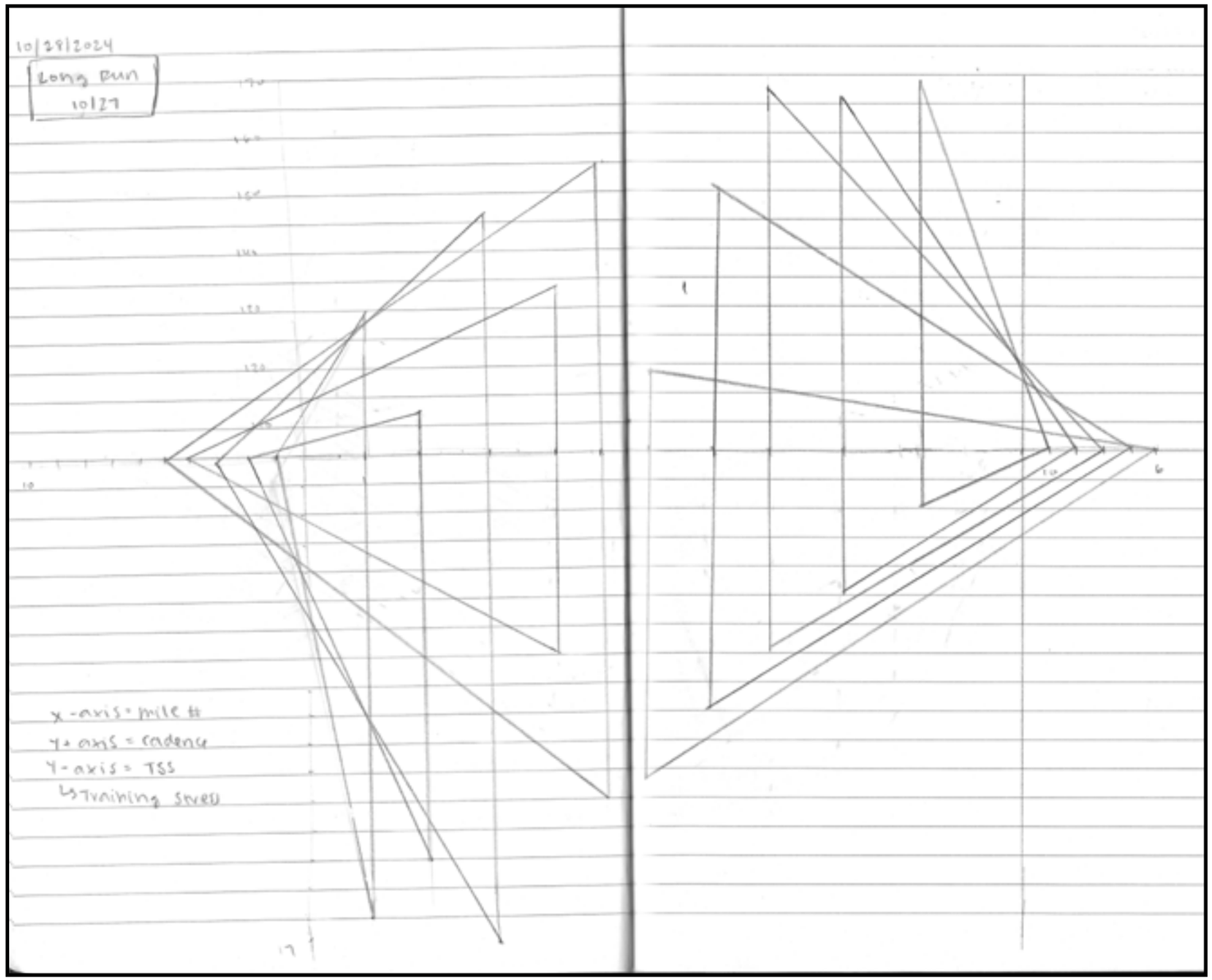
This experiment got me thinking ?about how slight changes to the parameters can create vastly different results. How can I utilize this to create greater visual appeal while still maintaining readability?



Data Set: Heart Rate Average, Max, and Cadence

(x,y) = (Data Set, ###)

Data Set: Cadence, TSS (Training Stress, Score)
(x,y) = (Lap/Mile, ###)
y positive = cadence value
y negative = TSS value



←

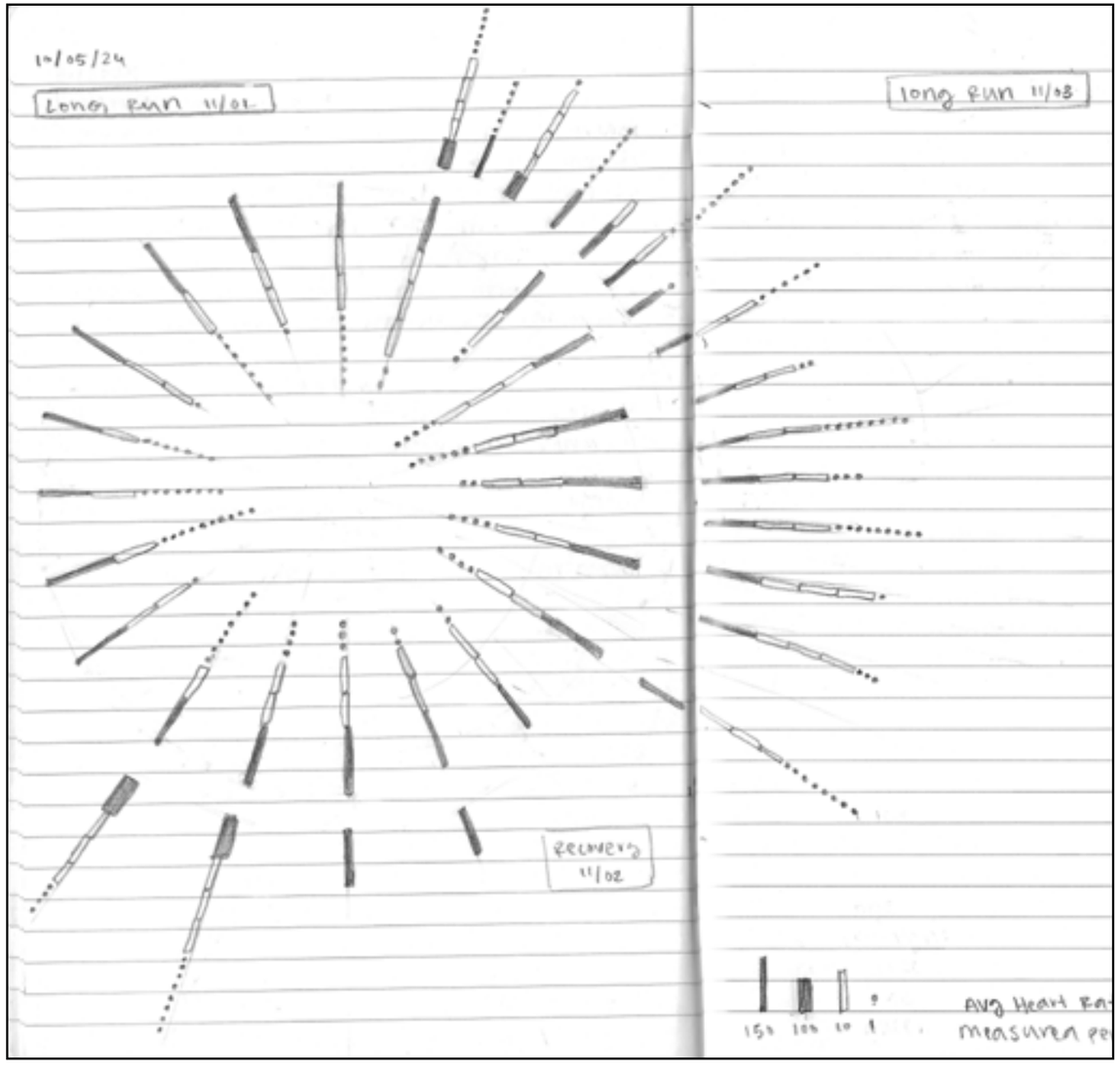
on the left side is the first 5 miles of an out and back trail.

First 5 miles display a low cadence and high effort. Coincidentally this was uphill. Whihout including vertical in the data set, you are still able to conclude from the data that it was an uphill effort.

For the last 5 miles, taking the same trail in the opposite direction, the graph appears to be mirrored horizonally and vertically.

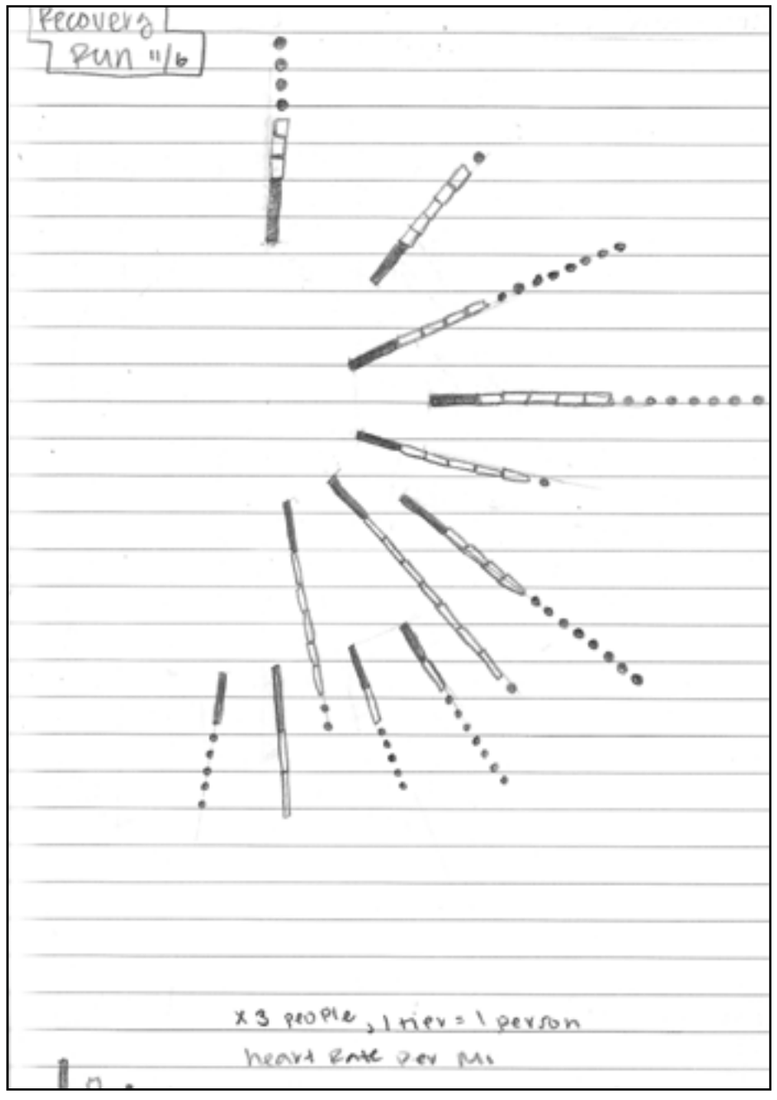
It was very exciting seeing how this data produced this effect that felt precisely computed. This graph was a breakthrough in displaying unpredictable conclusions and a beautiful visual result.

Heart rate per lap segment is broken down into symbols that can be added together. Here, I have three runs demonstrated in one graph. You can decipher between runs based on how the segments are grouped.



Data Set: Average Heart Rate

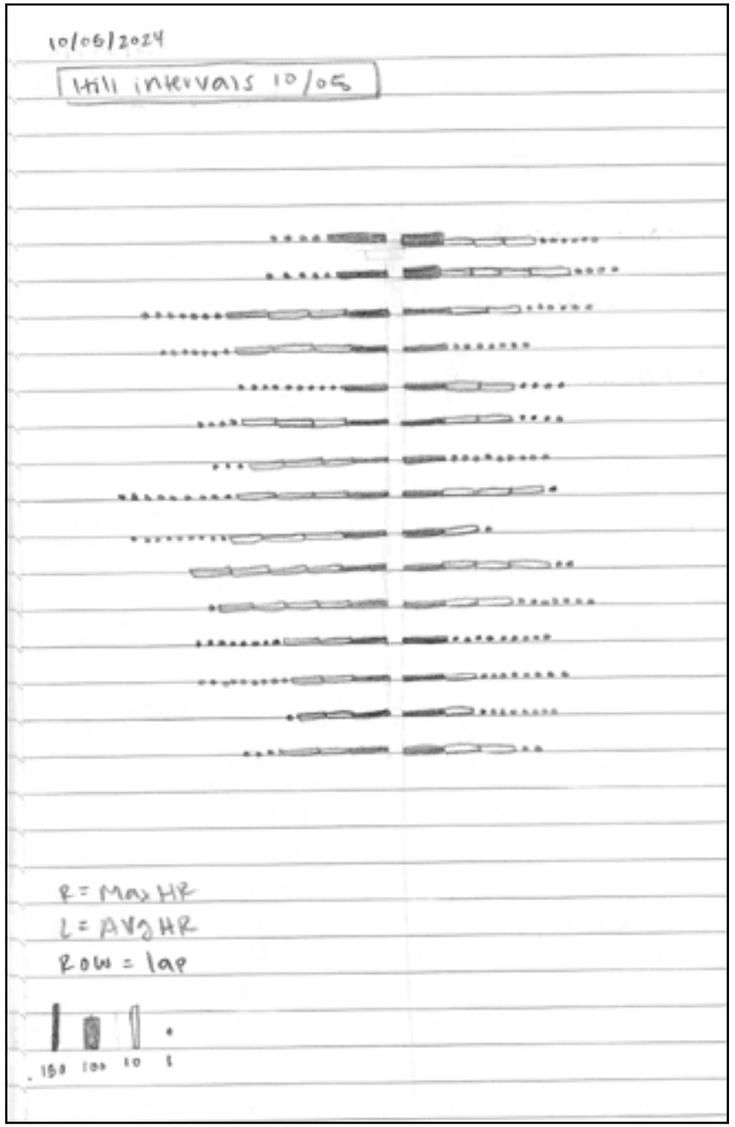
Average heart rate per lap segment of one run with three people in a group.



insights:

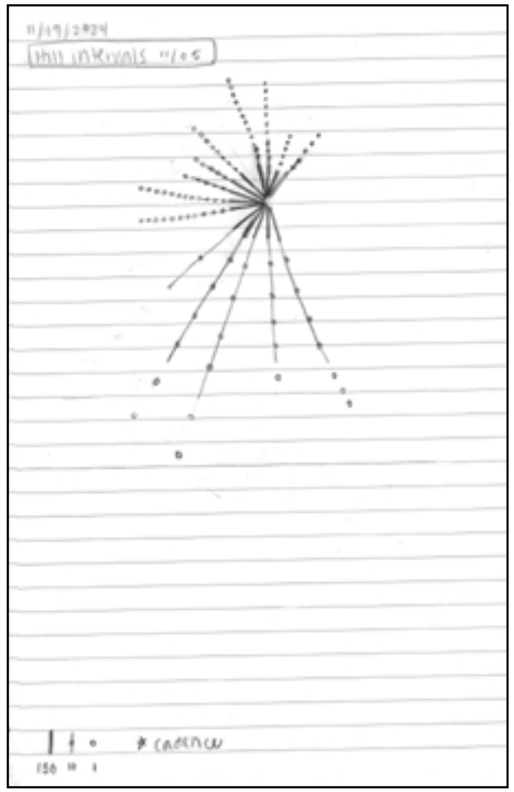
I was experimenting on how to layer data of several activities and several people.

Data Set: Average Heart Rate

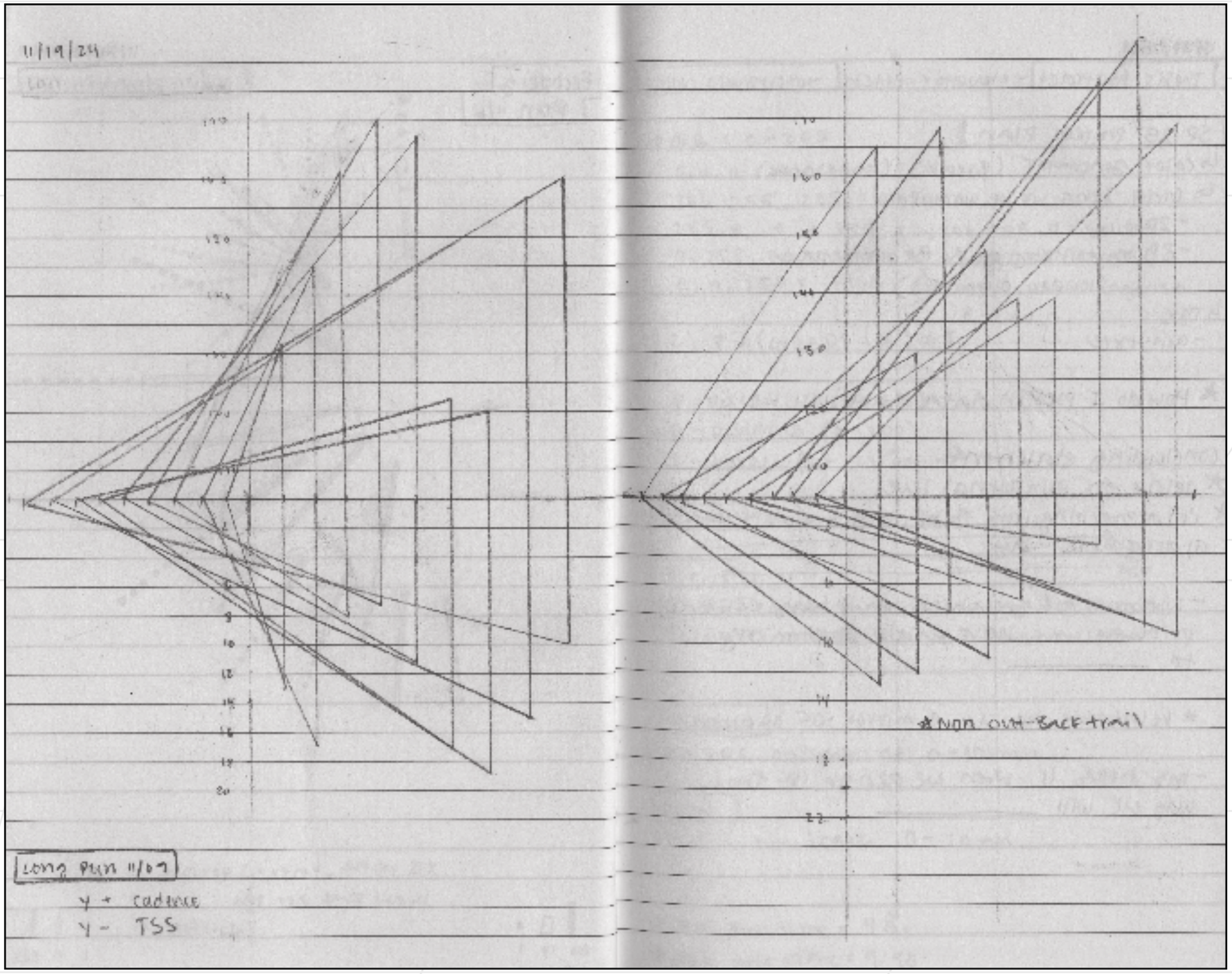


Average and max heart rate per lap segment.

Data Set: Cadence

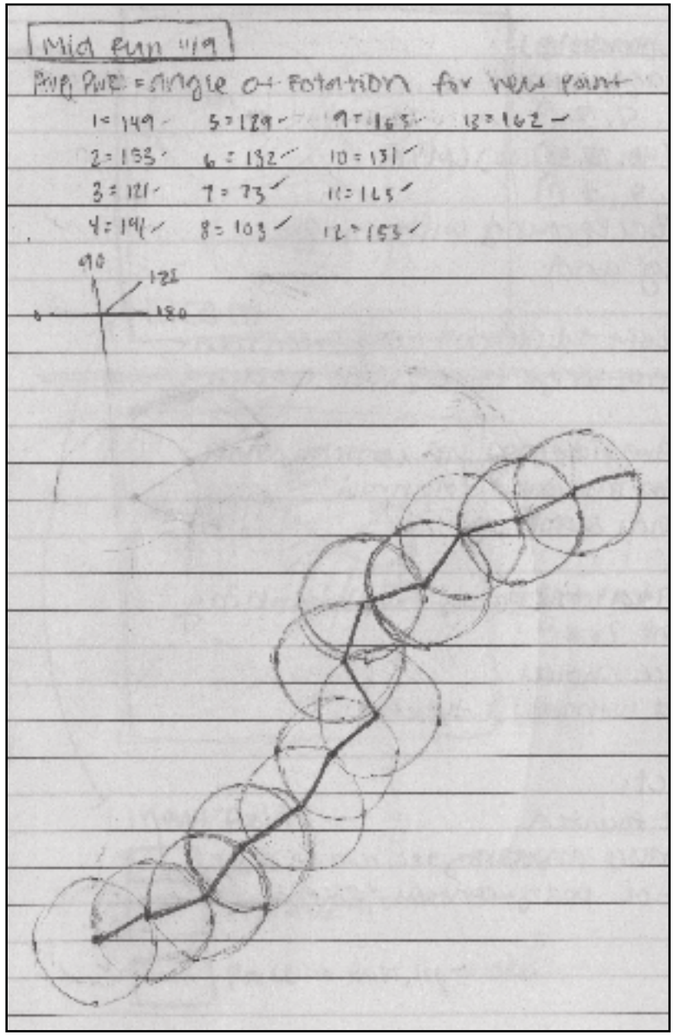


Cadence per lap segment in a randomly human-generated shape



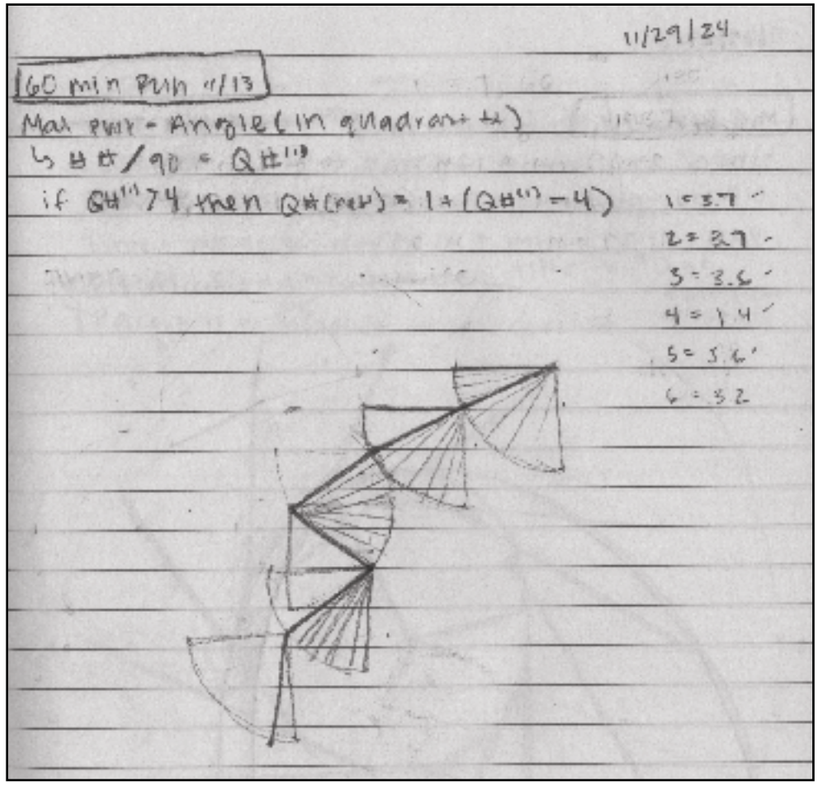
Data Set: Cadence and training stress

Data Set: Average Power



Average power determines the angle that the next point is placed in the line. These lines connected together demonstrate an overall steady pace. Sharp turns to the left indicate very low effort while any lines with a negative angle indicate a dangerously high effort.

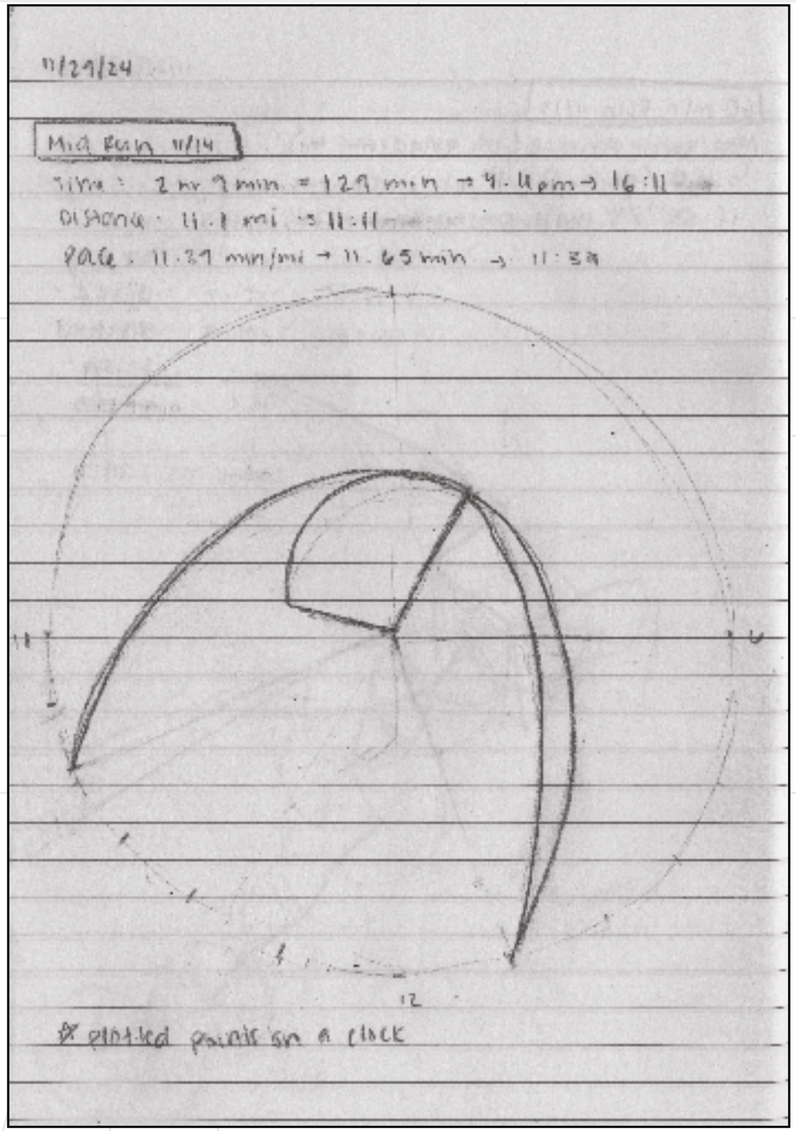
Data Set: Average Power



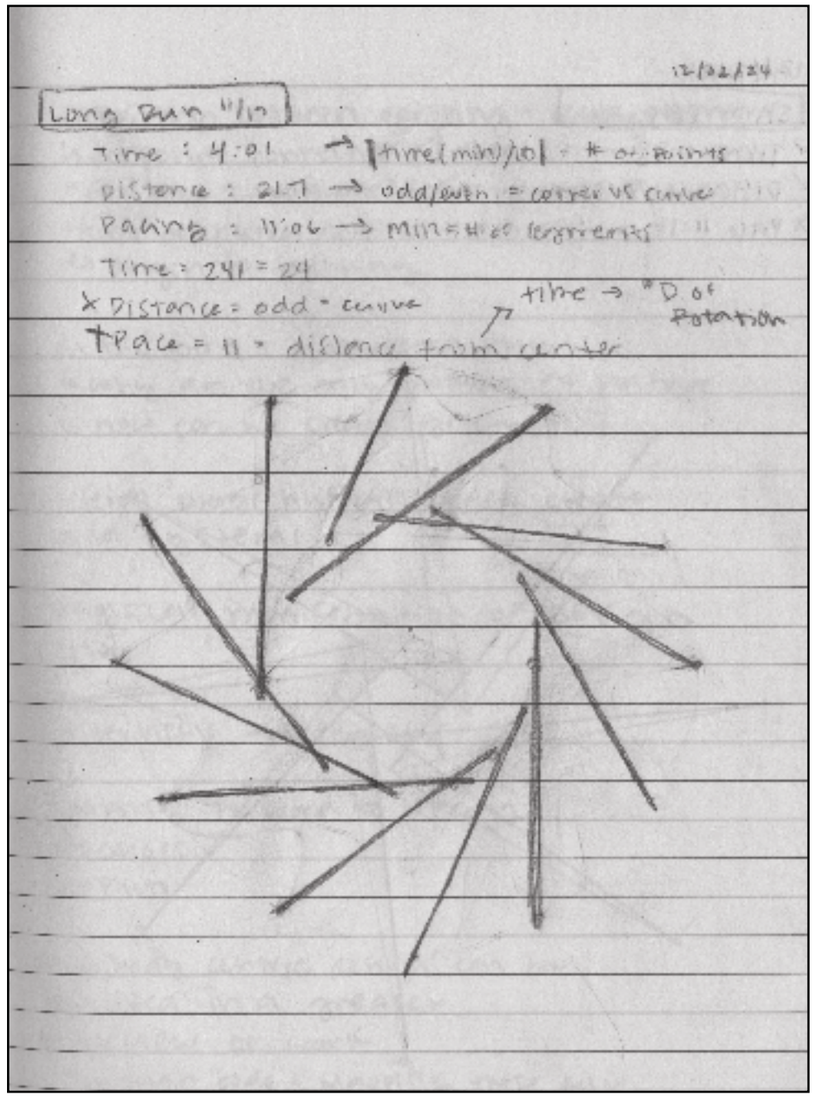
To increase the amount of variety, I created a mathematical equasion to determine quadrants and coordinates within for this visual.

For the next graphs I focused on creating visualizations based off three concrete data points for time, distance, and pace. This simulates the kind of data that is accessible enough to be collected for the final interface deliverable.

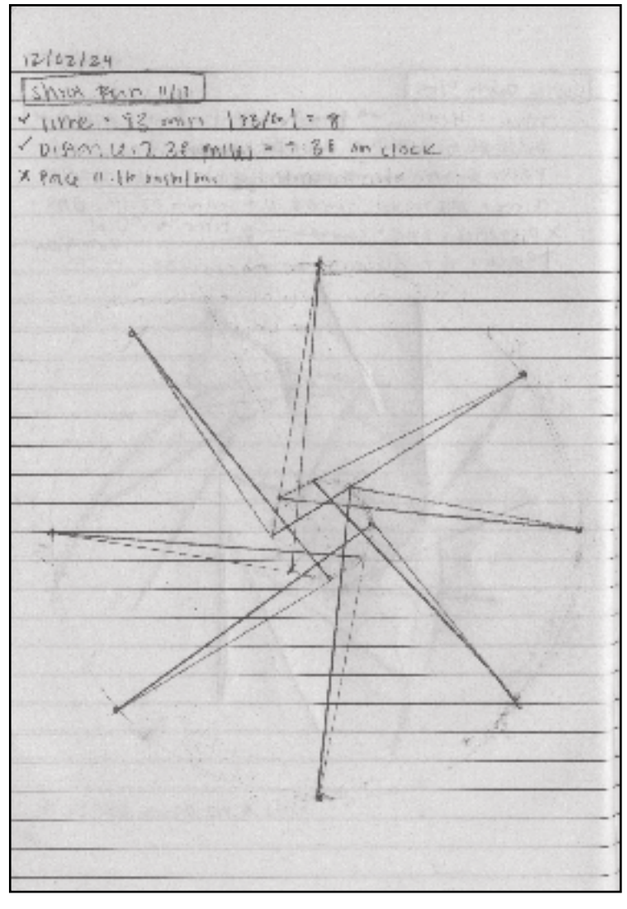
This graph takes the data points and maps them on a clock to create curved spirals.



Data Set: Time, Distance, Pace



Data Set: Time, Distance, Pace



Data Set: Time, Distance

I developed a mathmetical equasion based off of overall time, to determine the number of points on the inside and outside of the circle. The distance has been converted to an angle that determines what angle to rotate the inner circle at. These points are connected to make a spiral shape.

DIGITAL INTERFACE PROCESS

Building upon my daily and weekly analog explorations, I began developing a digital system to translate this new approach to visualizing running data into a scalable and accessible format. This transition from physical to digital allowed for greater flexibility and reach, while still preserving the essence of the original concept.

The system underwent multiple phases of construction, each stage refining its structure and functionality. A key objective was to ensure that its generative features were grounded in logical principles. I wanted the system to maintain a balance — offering a level of predictability while allowing for moments of randomness and variation. This semi-predictable nature mirrors the inherent unpredictability of human movement, capturing both the patterns and the deviations that make each motion unique.

Through iterative development and continuous testing, I worked to ensure the digital environment retained the organic, expressive qualities that first emerged through my analog experiments.

Number of Miles

Average Heart Rate

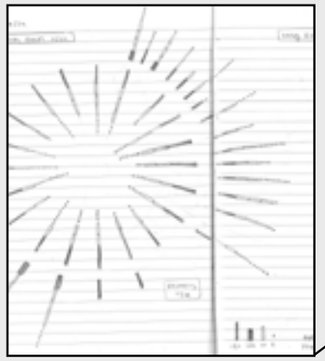
High Averate HR

Low Averate HR

First Marathon
March 8, 2020
26 Miles, HR 178

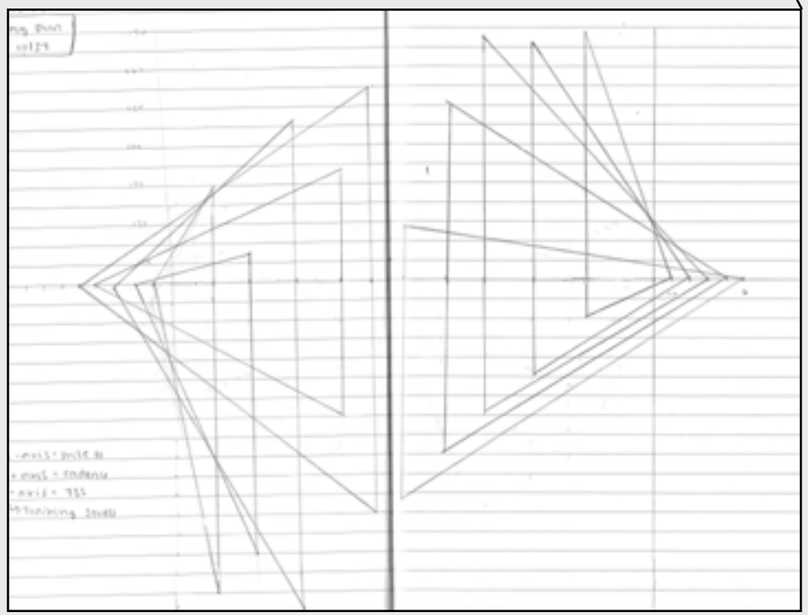
Last Marathon
March 16, 2025
26 Miles, HR 165

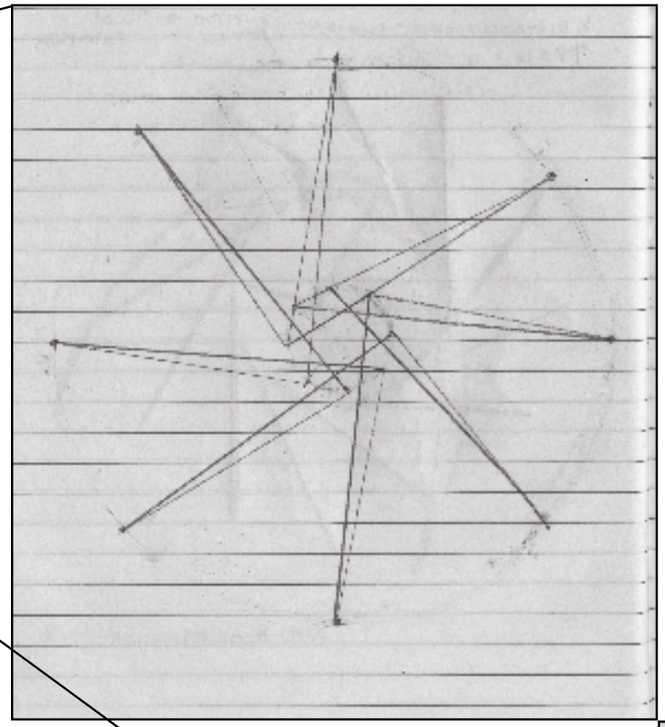
When designing the code for the primary interface, I drew inspiration from my most successful performance data visualization experiments. Through this process, I observed that arced forms and circular shapes closely mirrored the natural movement of joints within the human body.

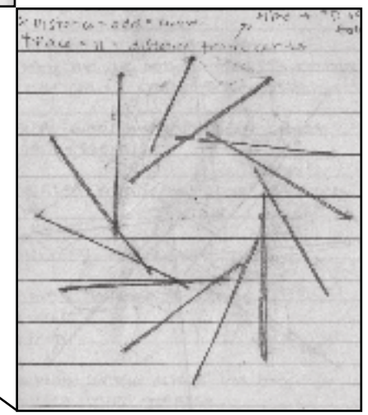


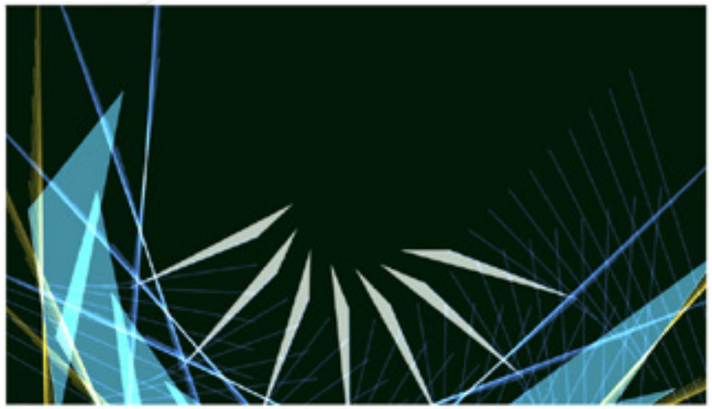
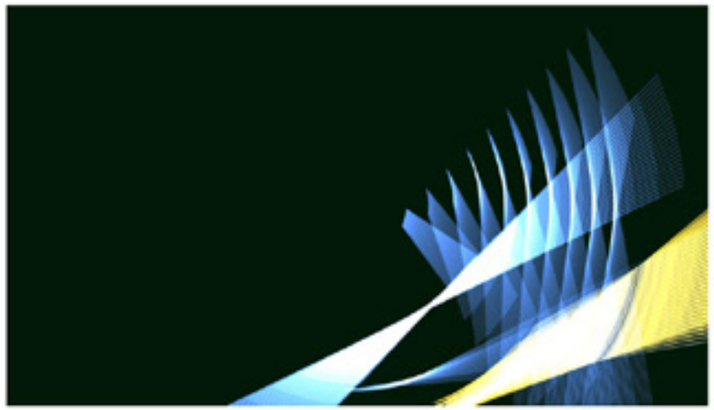
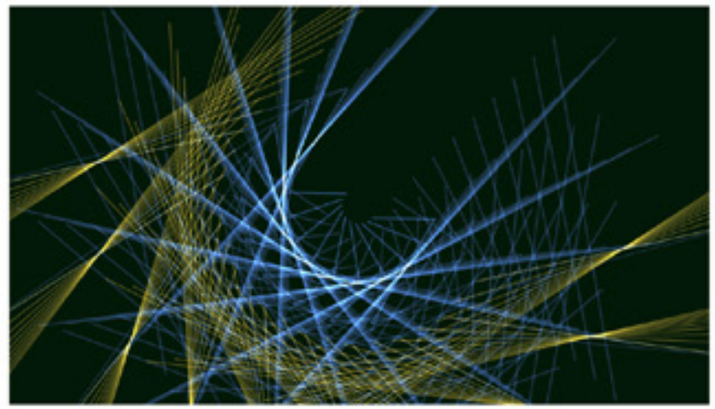
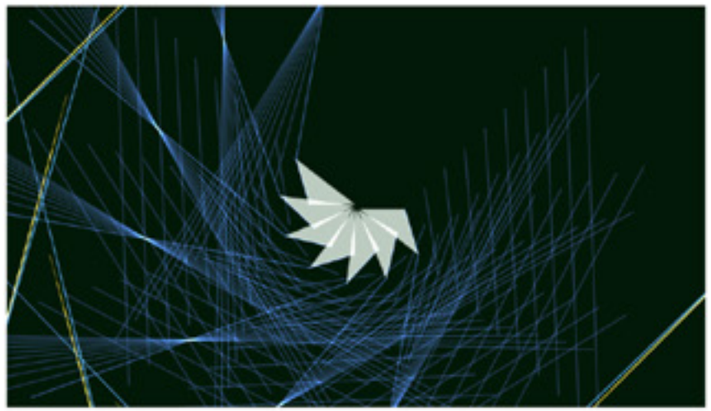
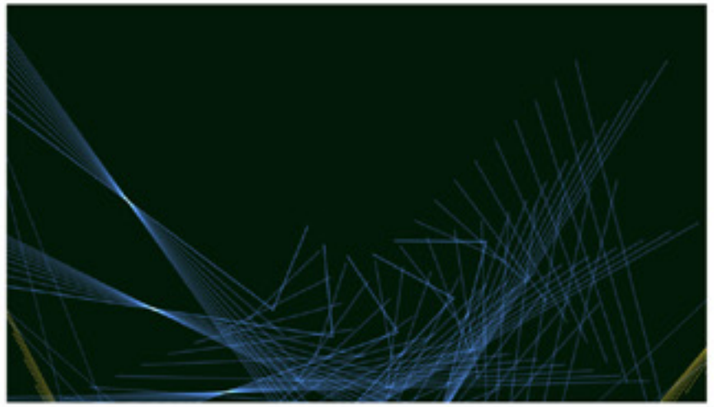
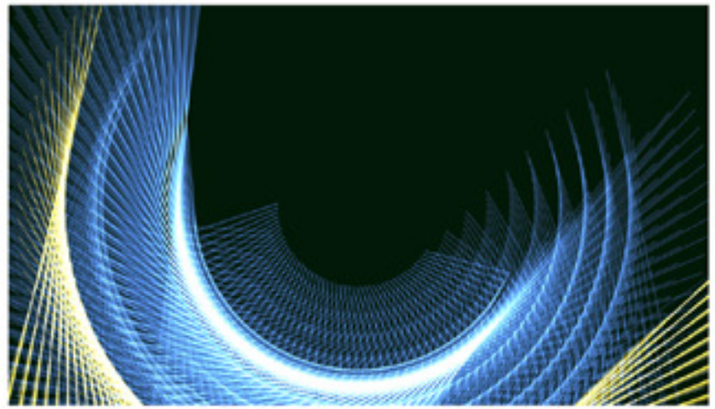
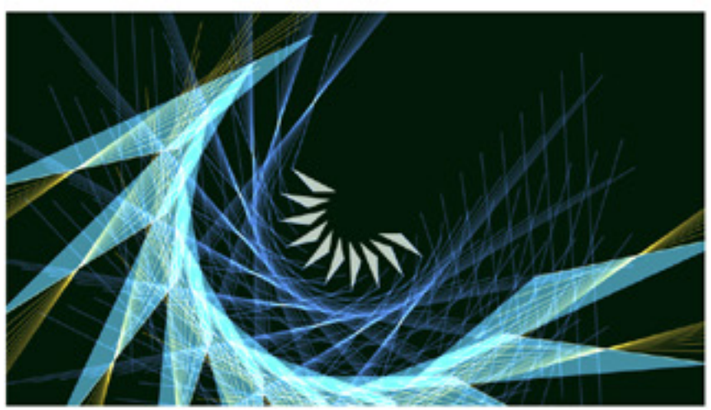
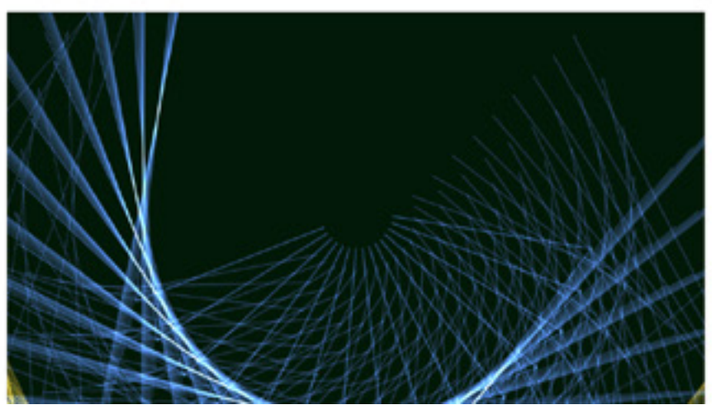
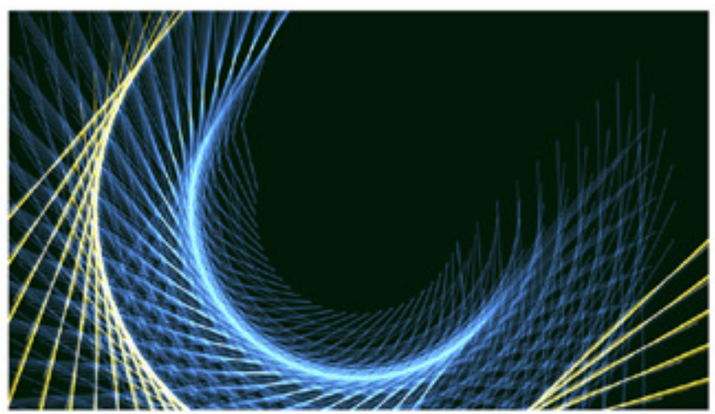
To further explore this concept, I developed a set of systematic rules governing the appearance and behavior of these shapes and lines. The design responds dynamically to input data points, with lines connecting to triangles whose forms evolve from a designated central axis. This adaptive visual language serves as a reflection of the underlying data, offering an intuitive representation of movement and performance metrics.

The interface was implemented using JavaScript within the P5.js framework. It underwent multiple phases of iterative refinement, each informed by continuous testing and analysis, leading to its current state.

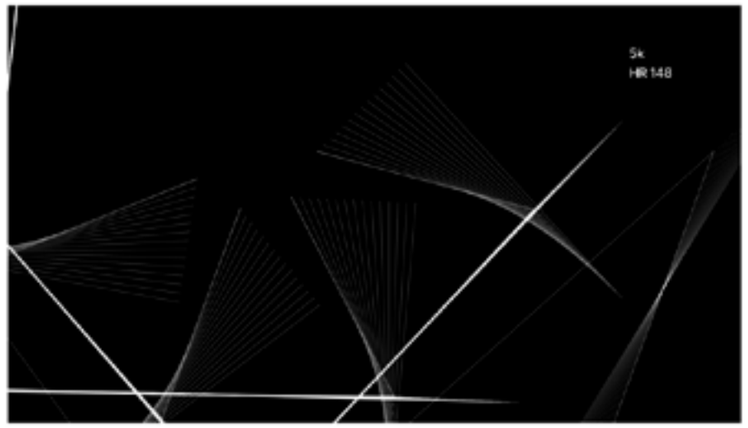


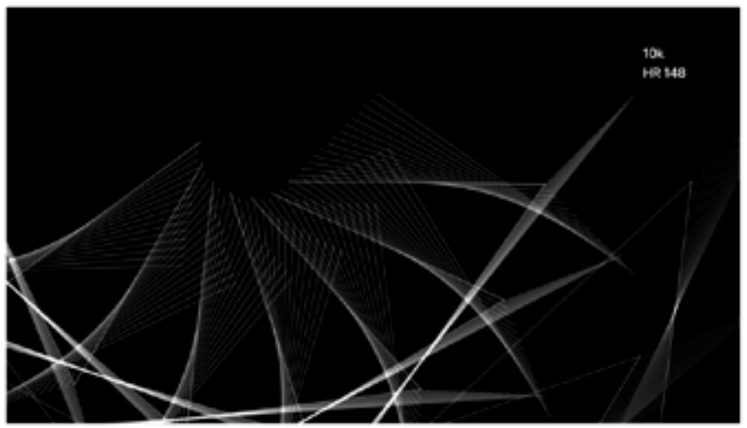




Phase 1


5k
HR 148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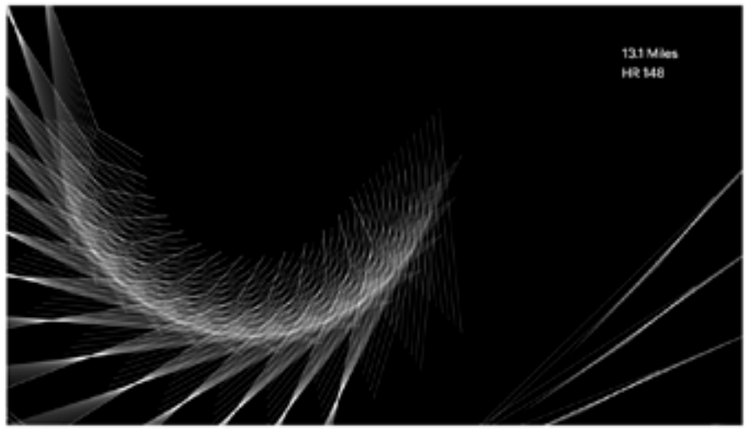
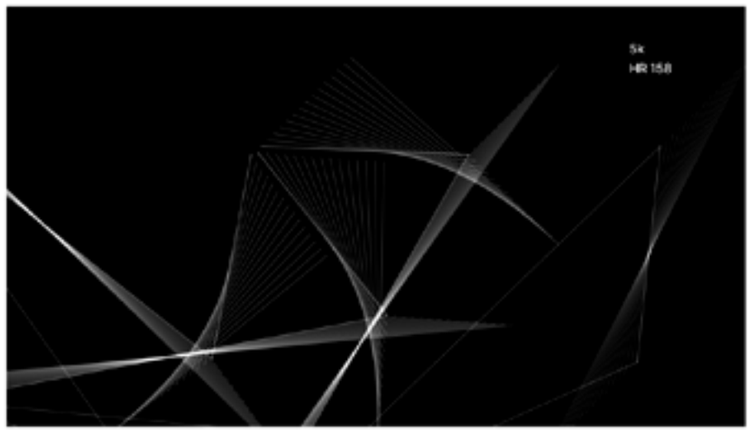
HR 148


13.1 Miles
HR 148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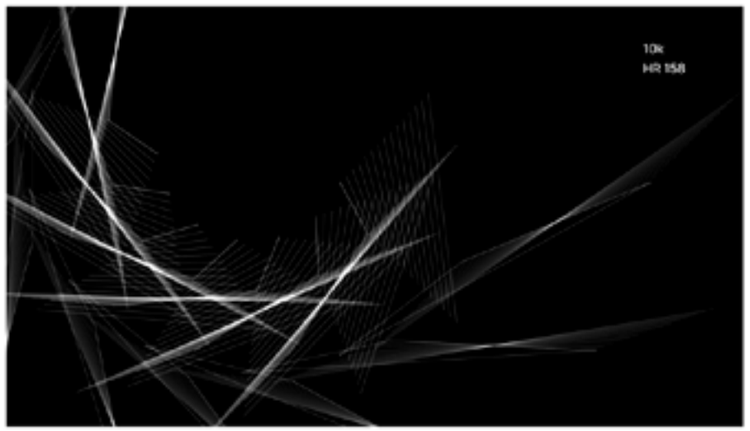
HR 158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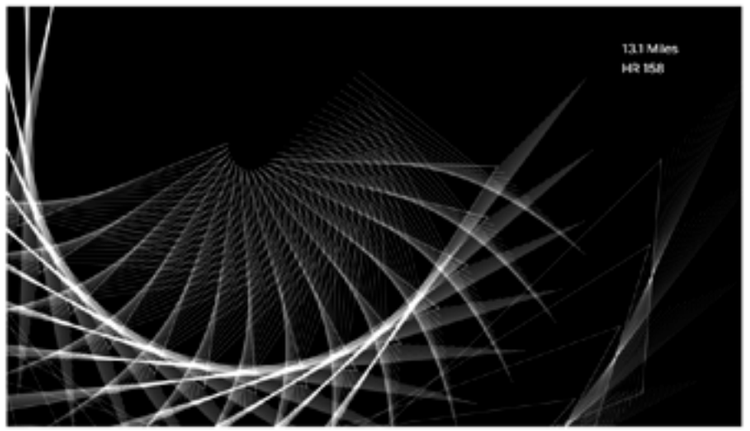
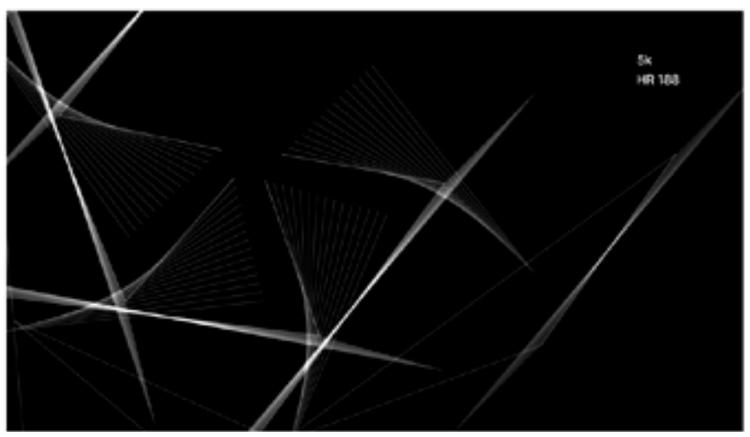
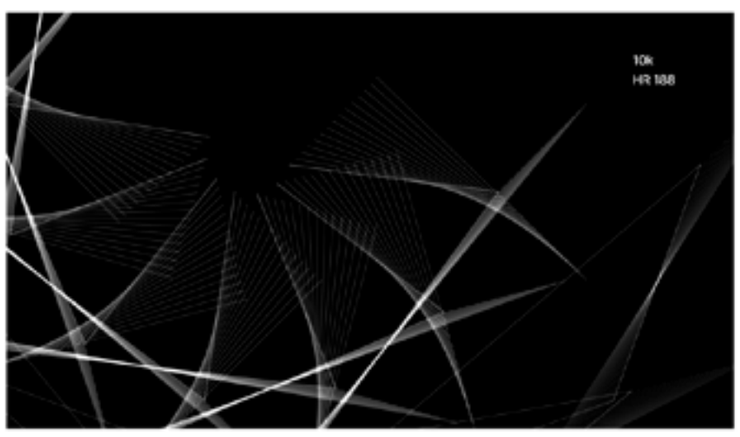
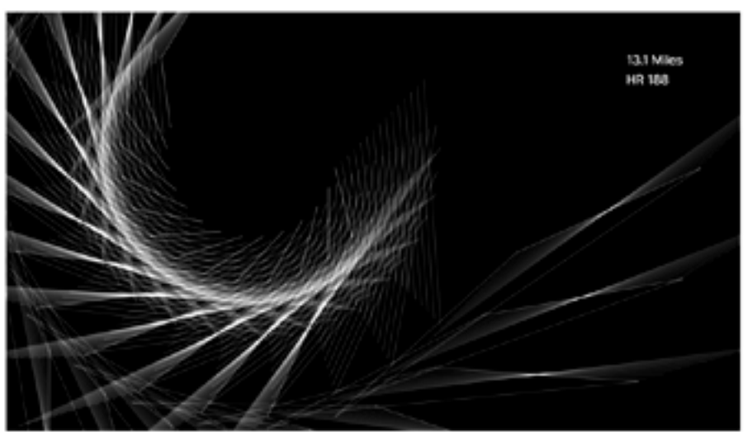
HR 158


13.1 Miles
HR 158

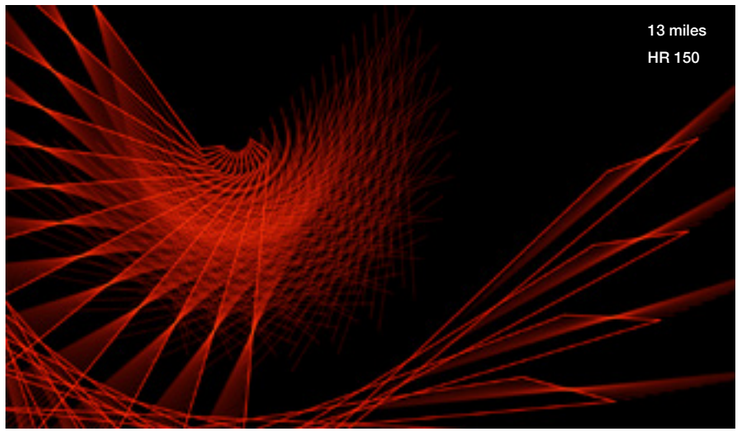

5k
HR 188

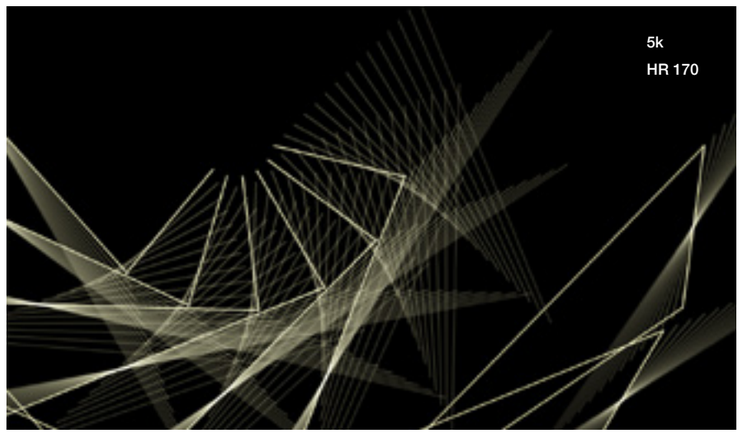

10k
HR 188

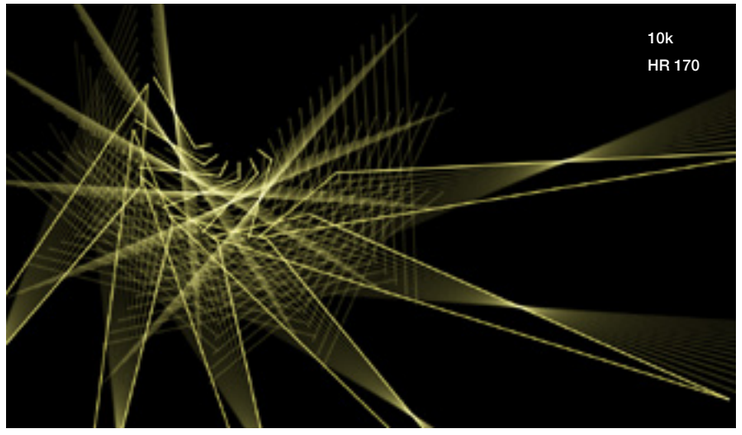

13.1 Miles
HR 188

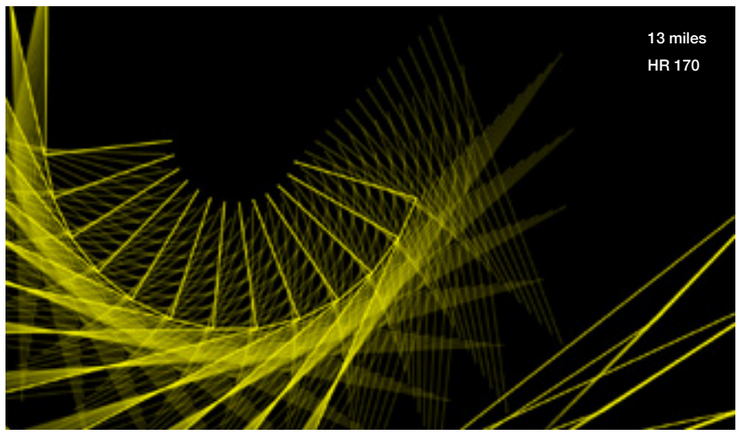

5k
HR 150

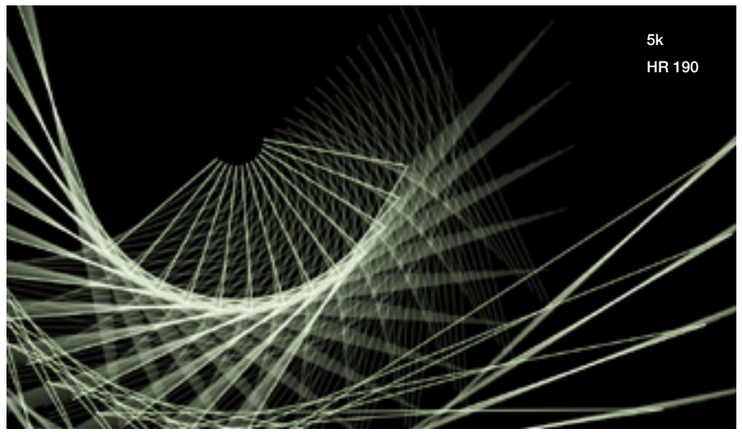

10k
HR 150

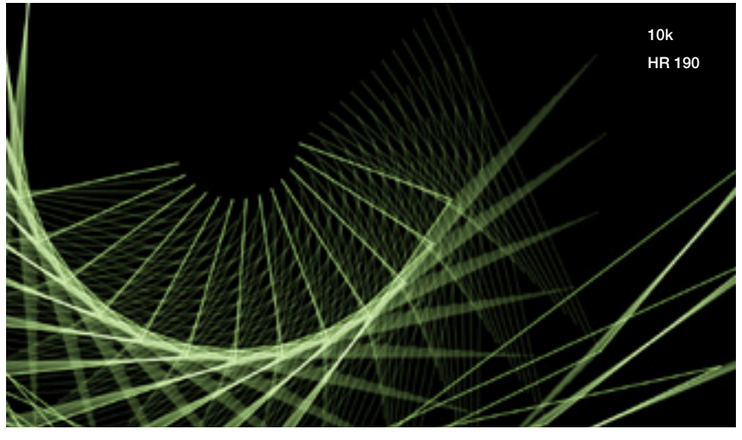

13 miles
HR 150

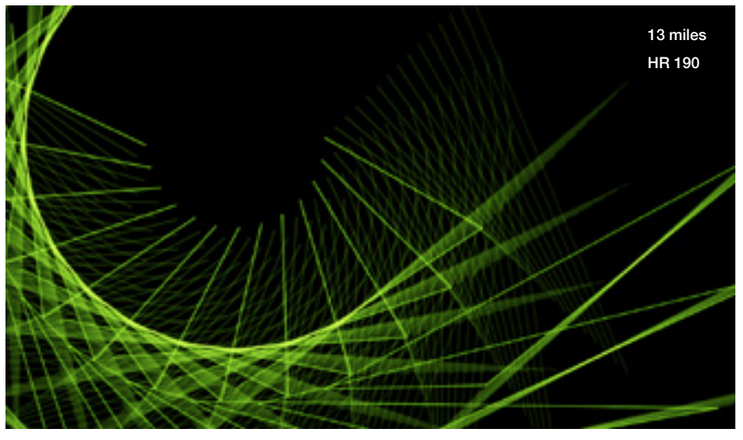

5k
HR 170

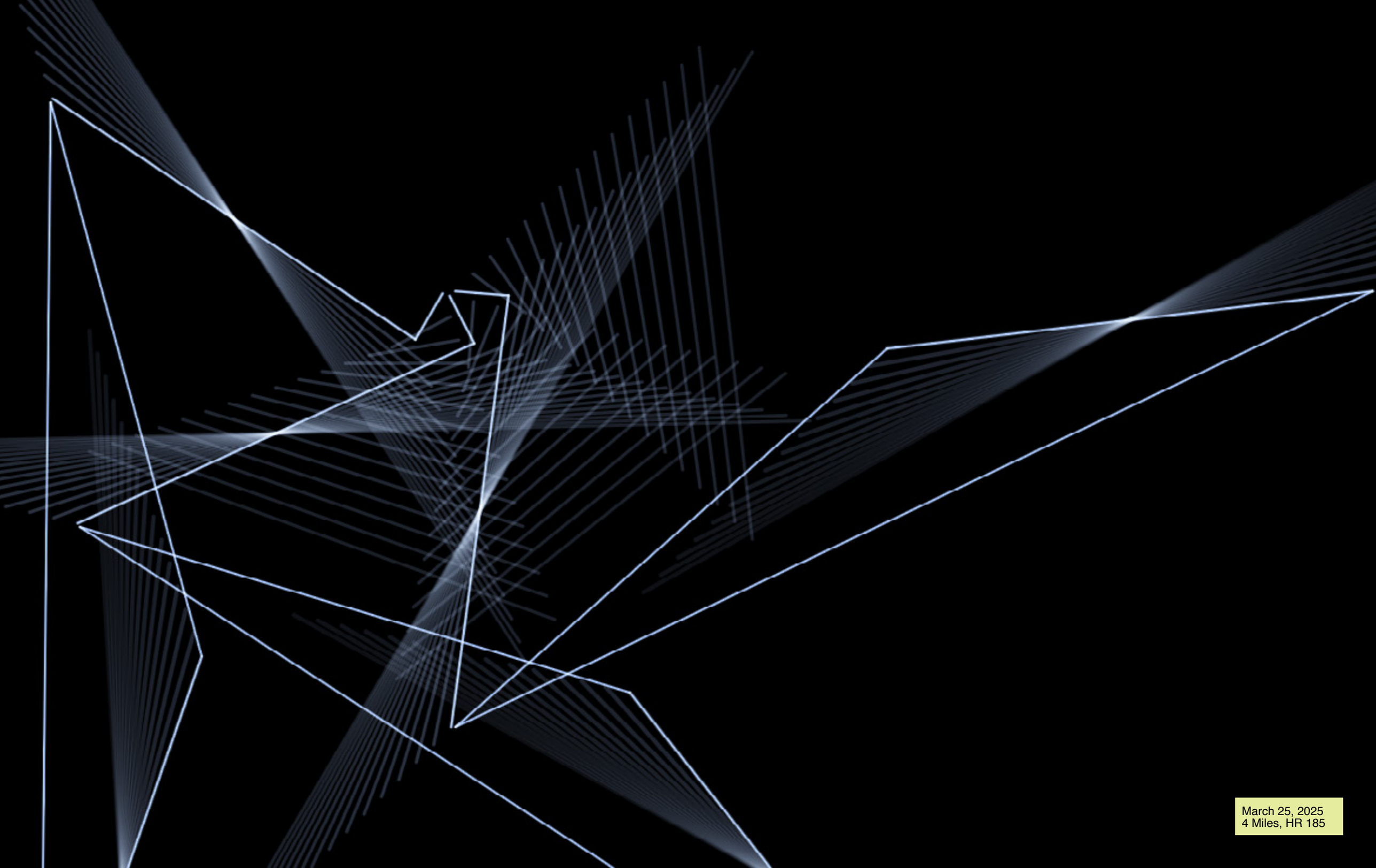

10k
HR 170


13 miles
HR 170


5k
HR 190


10k
HR 190


13 miles
HR 190



March 25, 2025
4 Miles, HR 185

MOVEMENT-GENERATED GRID

This method for creating a typographical grid was based on the geometric relationships within an athlete's motion. I began by selecting a still image of an athlete in action and identifying the major rotating joints, such as the shoulders, elbows, hips, and knees. I then drew circles centered at each joint, extending the radius to the furthest point of extension—typically the next joint unless the limb was fully extended, in which case the radius extended to the extremity (e.g., wrist or ankle).

Next, I determined the angles of action by drawing lines that followed the natural alignment of key body segments, including the shoulders, hips, thighs, shins, forearms, and upper arms. To structure the grid, I drew vertical lines where two or more rotation circles intersected, which sometimes resulted in diagonal alignments. I then created horizontal lines at points where different angles of action met, ensuring they remained parallel to each other.

This process established a structured yet dynamic grid system rooted in the organic movement of the human body, guiding the placement of typographical while literally activating them in motion of the body.

in the cloud...

103 rows
x 43 gigabytes
= 4515 gigabytes

4.5 terabytes
2.5 years of data

your data viewing and viewing

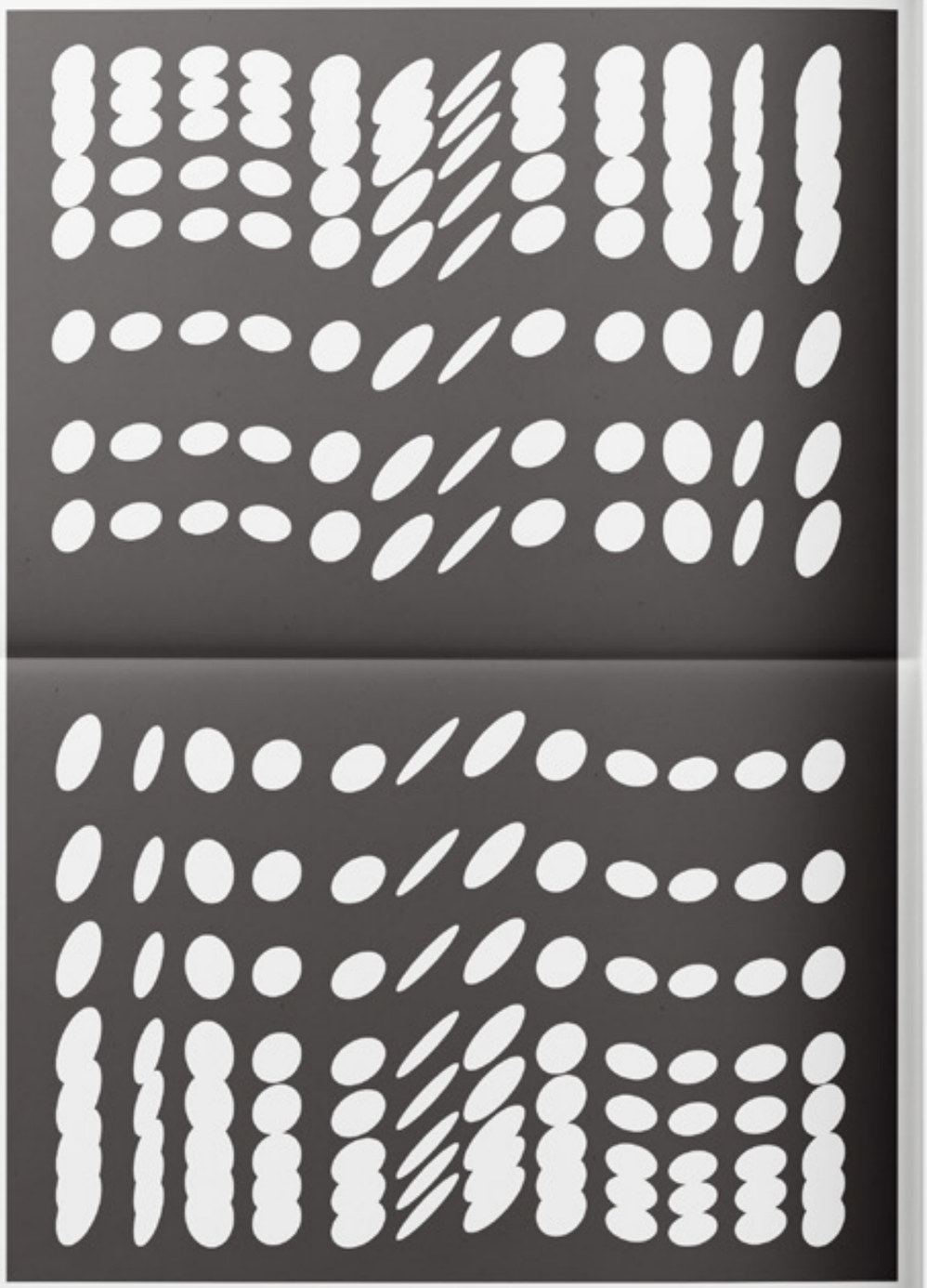
the data we generate is an extension of our identities, as personal as our DNA.

live stats

driving questions

5 GB / DAY
35 GB / WEEK
150 GB / MONTH
1.8 TB / YEAR

- how much of this data do we access?
- what can we learn from it?
- can we create from it?
- what is the DNA of graphic design?



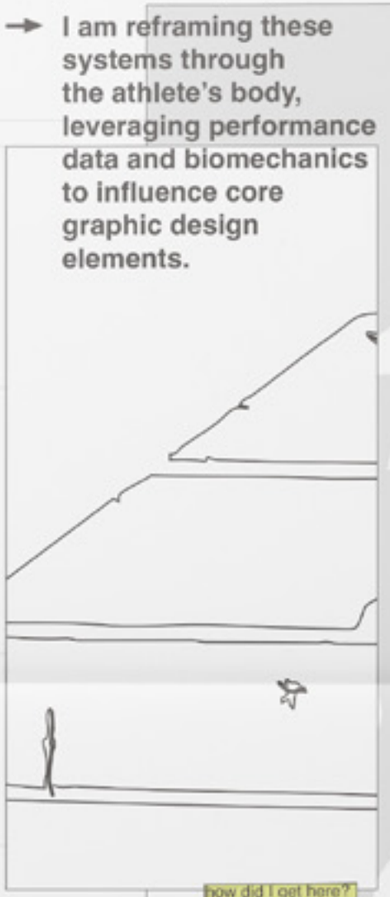
movement-made pattern, long jump

thesis:

As graphic design influences evolve from nature, comes the opportunity to embrace a human-focused framework through body-centric design.

→ I am reconstructing graphic design systems around the human body using "body-centric design" to create a deeper and more authentic connection between graphic design and the human experience.

→ **I am reframing these systems through the athlete's body, leveraging performance data and biomechanics to influence core graphic design elements.**



why?

I am an athlete (it is as core to my identity as being an artist).

athletes are very good at logging their activity data over time.

performance data metrics are challenging to understand as is.

a greater connection understanding our bodies can be created when connecting with data generated by the body.

activity tracking holds meaningful memories and events. let's give the data some life.

how did I get here?

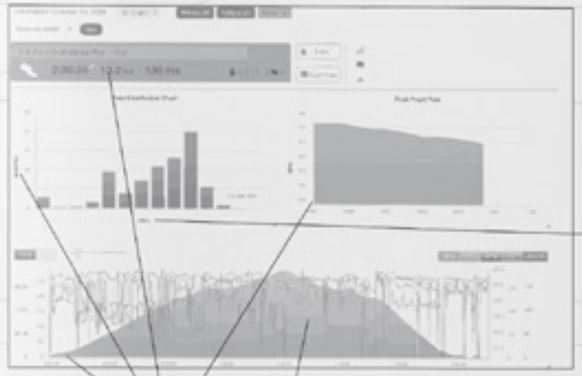
As a runner of 7 years, I have tracked my performance data since day one. This data has crafted my journey from running the 5k to 50 mile ultramarathons.

From 3 years on Strava, an activity tracking platform, I have logged over 800 activities. These activities not only track my fitness but a journal for life through the pandemic, navigating my undergraduate, and graduate degree.

Strava has over 120 million registered users. Multiply these numbers by the 5 daily gigabytes of data collected per person that wears smart wearables. That is 600,000 terabytes (600,000,00 gigabytes) of data collected per day by athletes.

Much of this becomes dead data as it piles up day by day, and activity after activity. For athletes, like myself, strides in performance often commemorate significant life accomplishments.

I am curious about how to bring life, and body, into this data that we generate and lose exponentially.



← all of these graphs are documenting the same run on different activity tracking platforms: training peaks, strava, and garmin connect

pace

distance

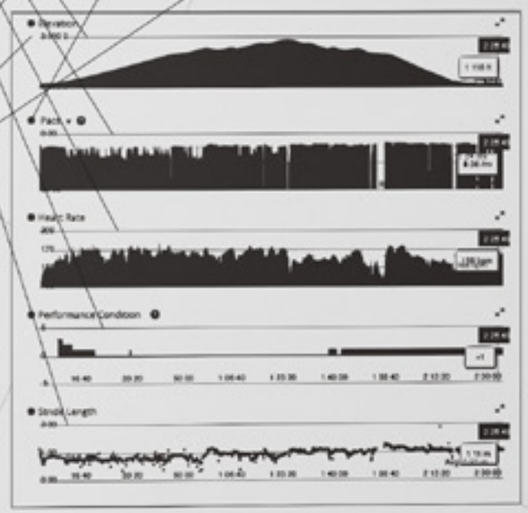
perfomance data visualizations fail to connect with athletes.

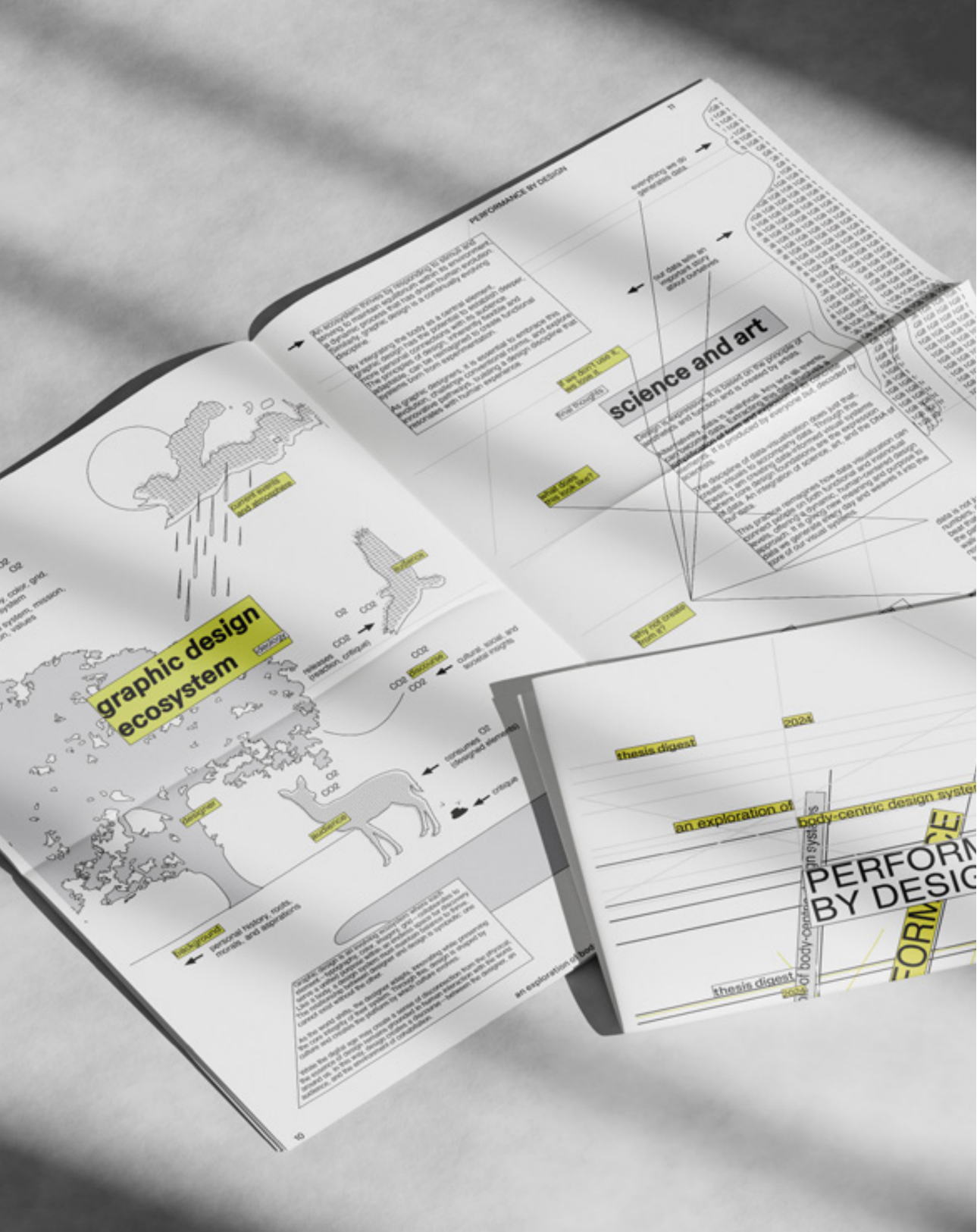
problem

vertical gain

insights:

- all graphs are horizontal →
- repetitive data, visually inefficient to understand. →
- different metrics take on similar graphs and forms. →
- data day after day, and person by person looks the same. It is impersonal and stale to read. →





[14] Eric H. Davidson, The Regulatory Genome: Gene Regulatory Networks in Development and Evolution (London: Academic Press, 2006), 2..

"Biology and art have often started with similar assumptions about what it means to be alive, what it means to preserve coherence through change, and why certain shapes might be privileged over others as change occurs. Understanding how forms relate in biology in science is important for understanding what it meant to be alive at different times in history"

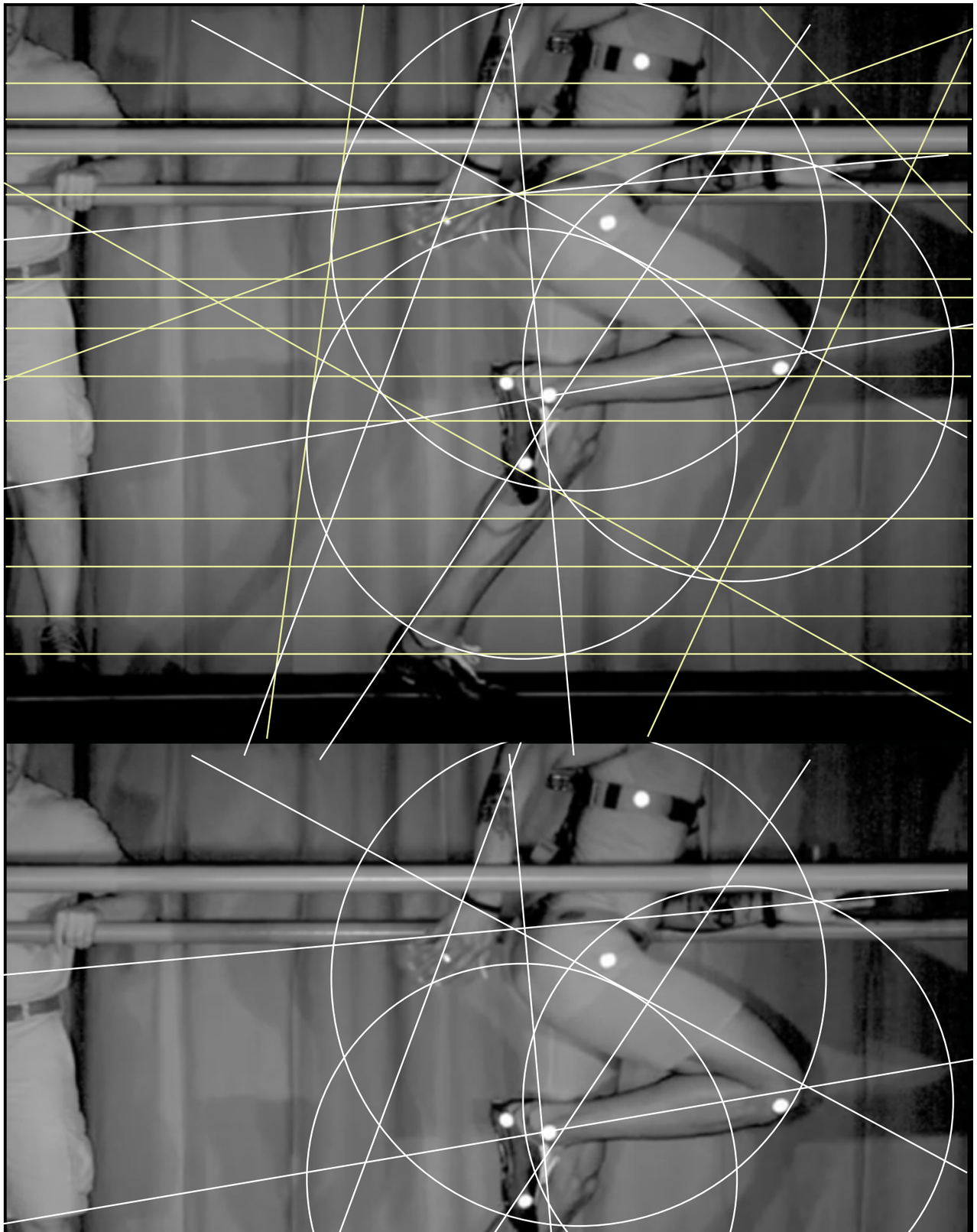
[14]

Over the course of the next chapters, I will outline what I think is one of the most important changes in how organisms were conceived in the history of biology. During the eighteenth and nineteenth centuries, organisms were thought to be collections of parts that fit together to form a whole. In the twentieth century, these formal strategies gave way to an abstract logic of regulation where questions about the relationship of the parts to the whole were suspended in favor of questions about how parts related to each other. Forms were emptied of their volumes, and parts were reduced to steps in abstract sequences. What emerged as important was not the teleological relationship of the parts to the whole, but how regulation functions to ensure that parts are assembled in the correct sequence. The idea of form was fundamentally changed. As we will see, this change is important as the idea of form was fundamentally changed. As we will see, this change is important as each of these ways of conceiving of organisms brings with it a different form of politics.

What this chapter and the next will argue is that Haeckel stood as a transitional figure in how life was conceived through images. Haeckel's formal strategies, indeed much of his philosophy of development, depended on a holism of forms. Yet there are times when his emphasis on the role of materials and in his adoption of grids for comparing developmental sequences challenged this holism in troubling ways. For instance, Haeckel's ability to demonstrate development through a series of images marks his legacy for contemporary evolutionary and developmental biology. As Michael Richardson and Gerhard Keuck argued in an article entitled, "Haeckel's ABC of Evolution and Development," "Despite his obvious flaws, Haeckel can be seen as the father of a sequence-based phylogenetic embryology."[14] This tension between form and sequence in Haeckel's arguments and illustrations is especially intriguing for me. To understand this tension, I will investigate how it wends its way through the pages of several of his publications, but most especially his masterpiece of visual forms, Kunst- Formen der Natur (Art Forms of Nature) and his popular science texts such as Natürliche Schöpfungsgeschichte (The History of Creation).

It is especially hard to overstate the importance of lines as compositional devices in the history of biological and medical illustrations. The line allows a surface to divide itself into greater complexity, creating two aligned spaces instead of the original single space. The addition of more lines to the surface can then bring even more complexity to it. On the addition of a line to paper can bring an energy or rhythm to an illustration by giving it a sense of direction and movement. If creating an image is important for studying living things, then studying how scientists and artists use lines can tell us how they visualize what it means to be alive. In the rest of the chapter I will take a look at how Haeckel uses

Over the course of a year developing and refining these dynamic, body-centric grids, my approach to typographic composition began to evolve. Rather than treating the grid as a neutral structure, I used it as an active tool to redefine hierarchy and guide the reader's experience. These grids highlighted unexpected entry points for 'first-read' content, shifting how hierarchy could be established across a page. I began manipulating the shape and flow of text boxes to align with the rhythm and motion embedded in the grid itself. This allowed me to take large volumes of academic writing—such as this thesis book—and present them within an experimental, yet highly readable framework. Through this process, I found new ways to balance legibility with expression, structure with spontaneity



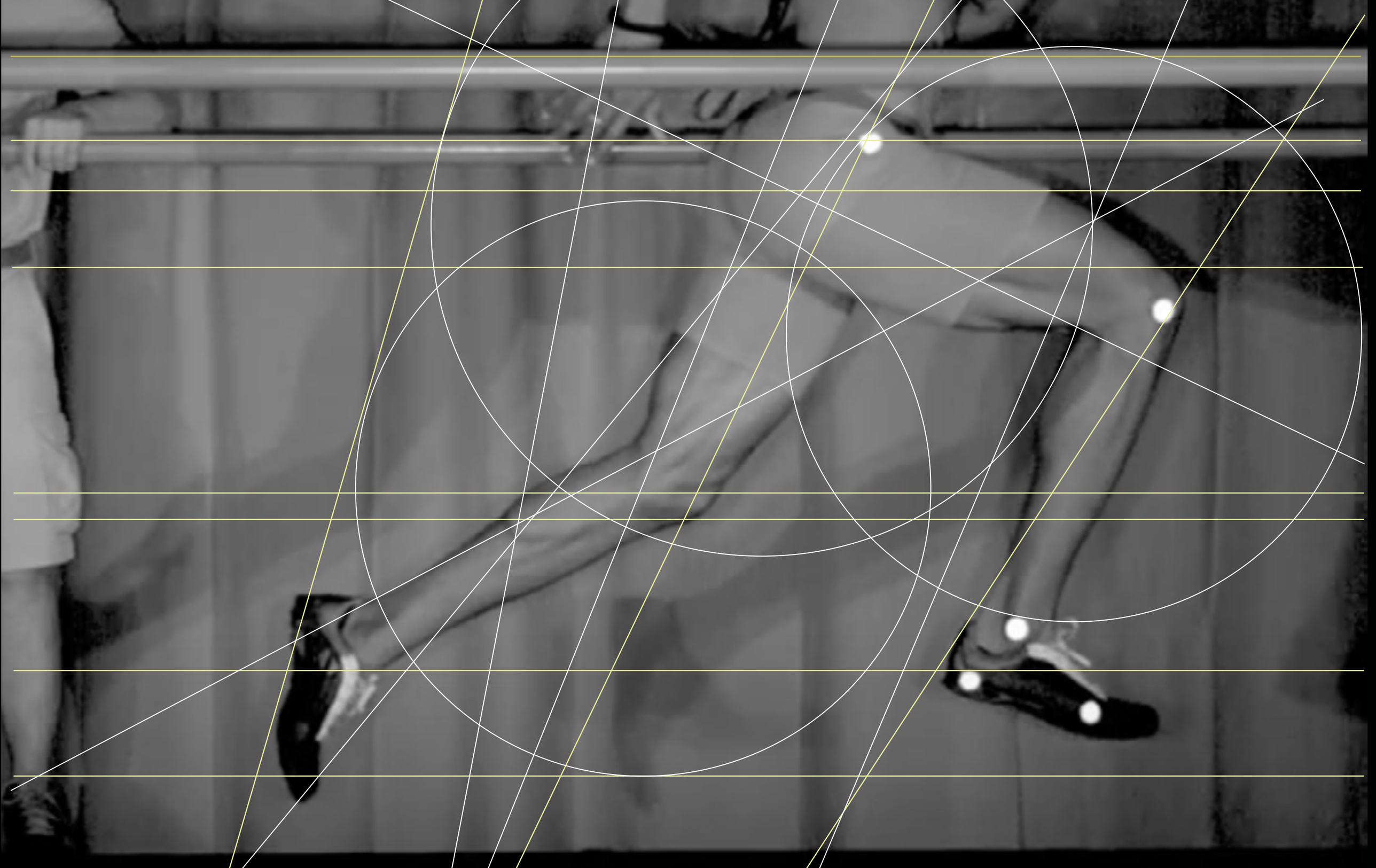
thesis digest

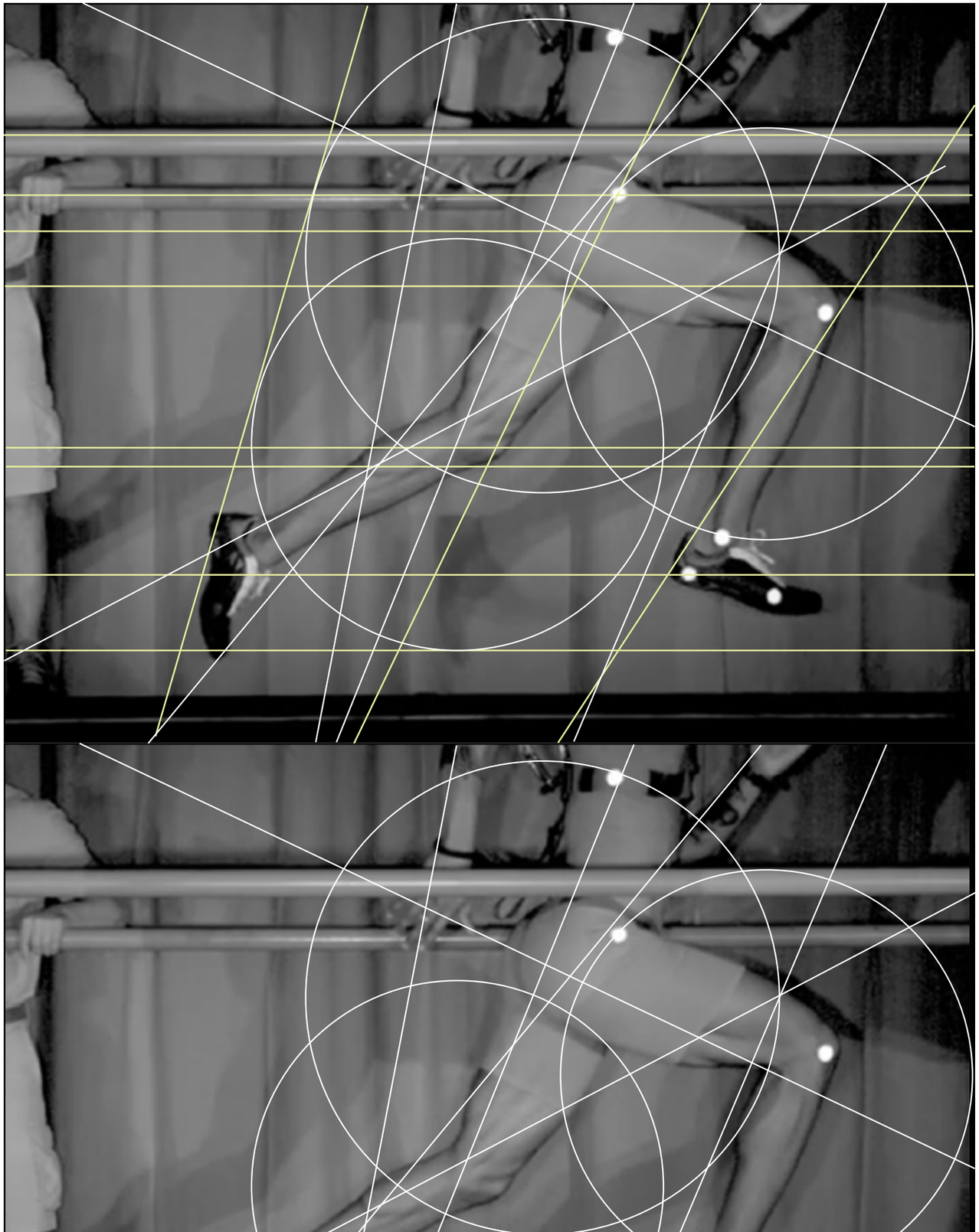
2024

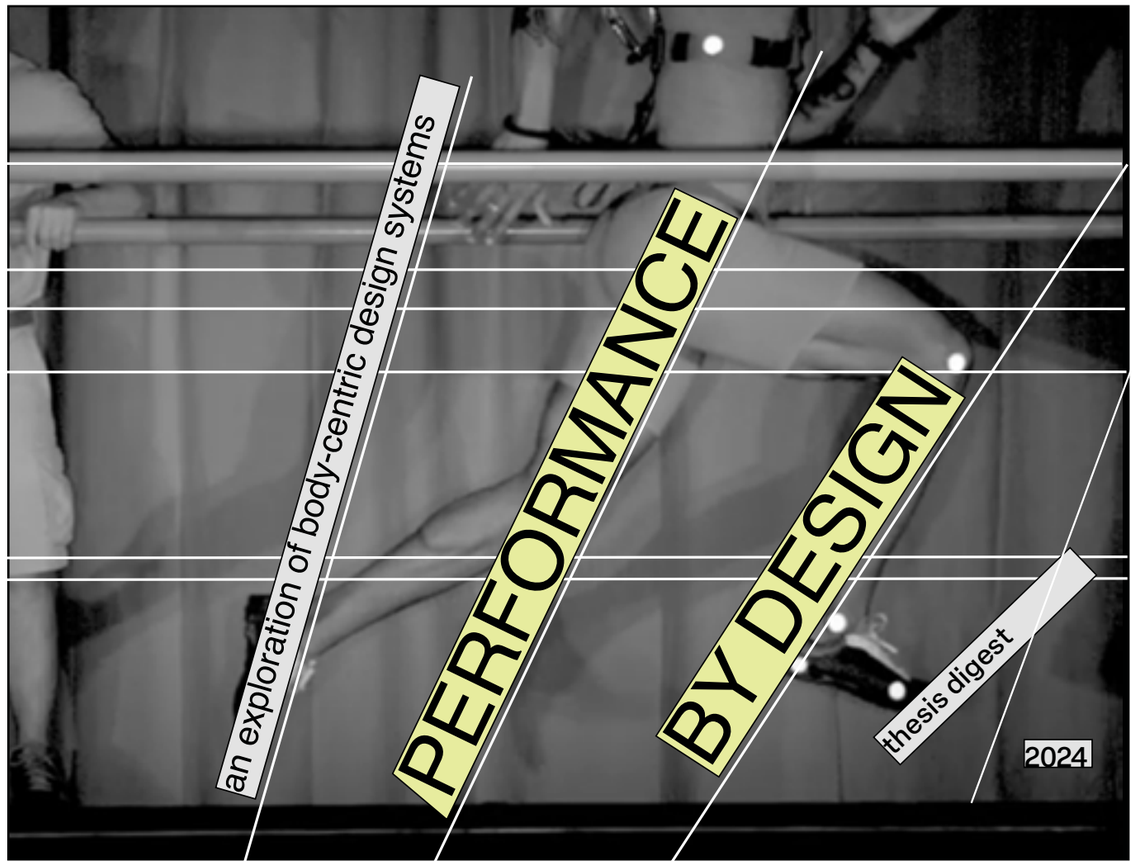
an exploration of

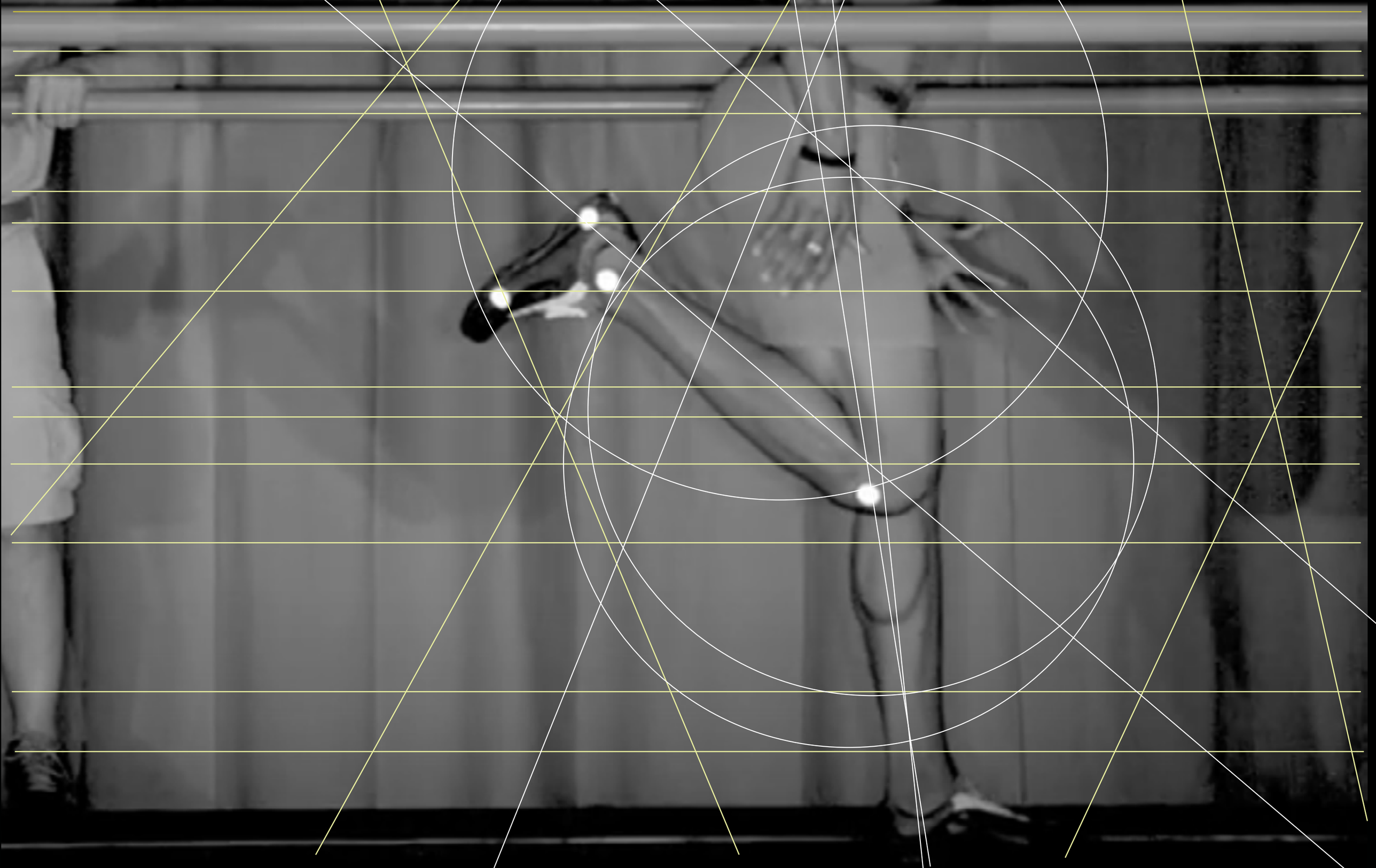
body-centric design systems

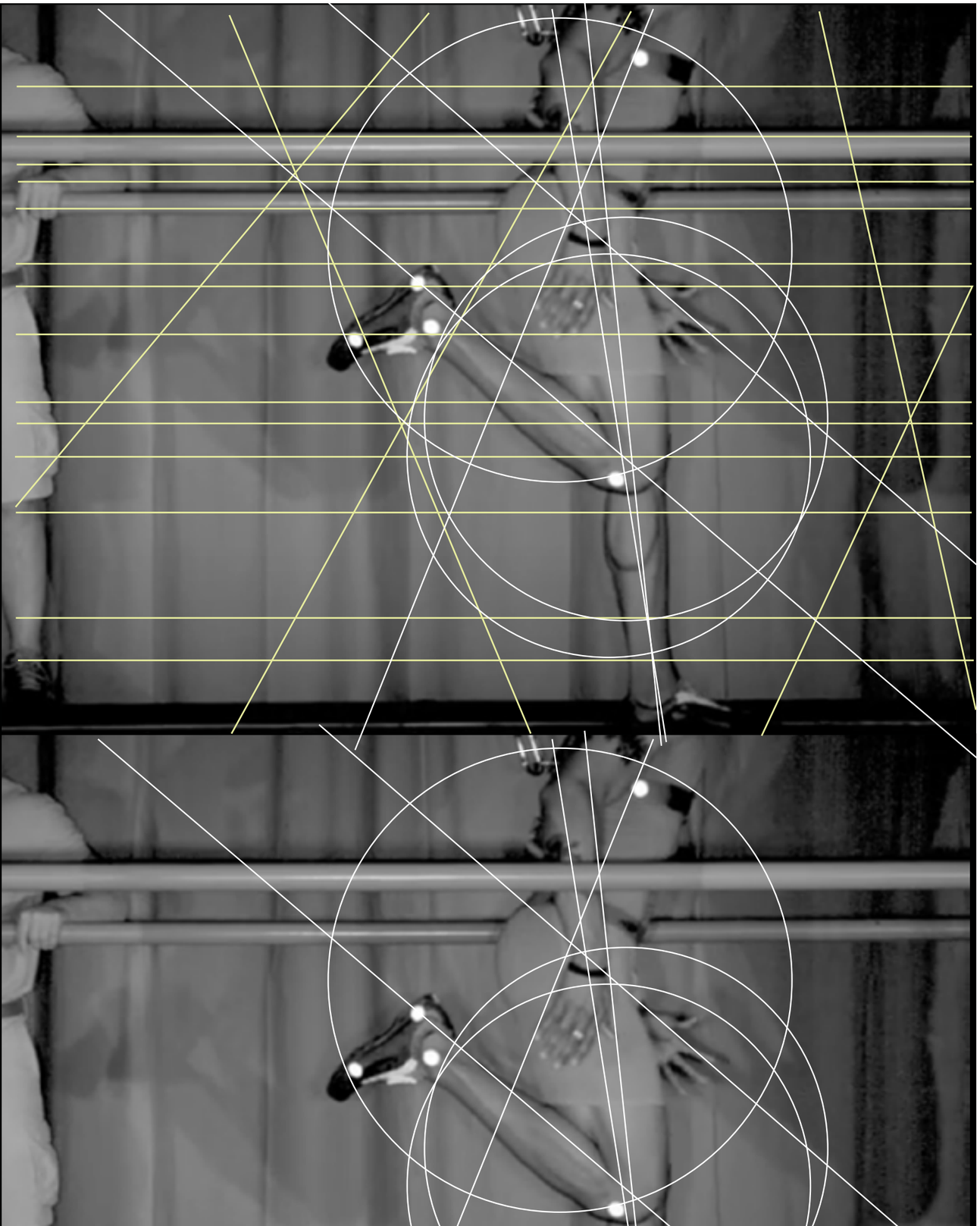
PERFORMANCE BY DESIGN

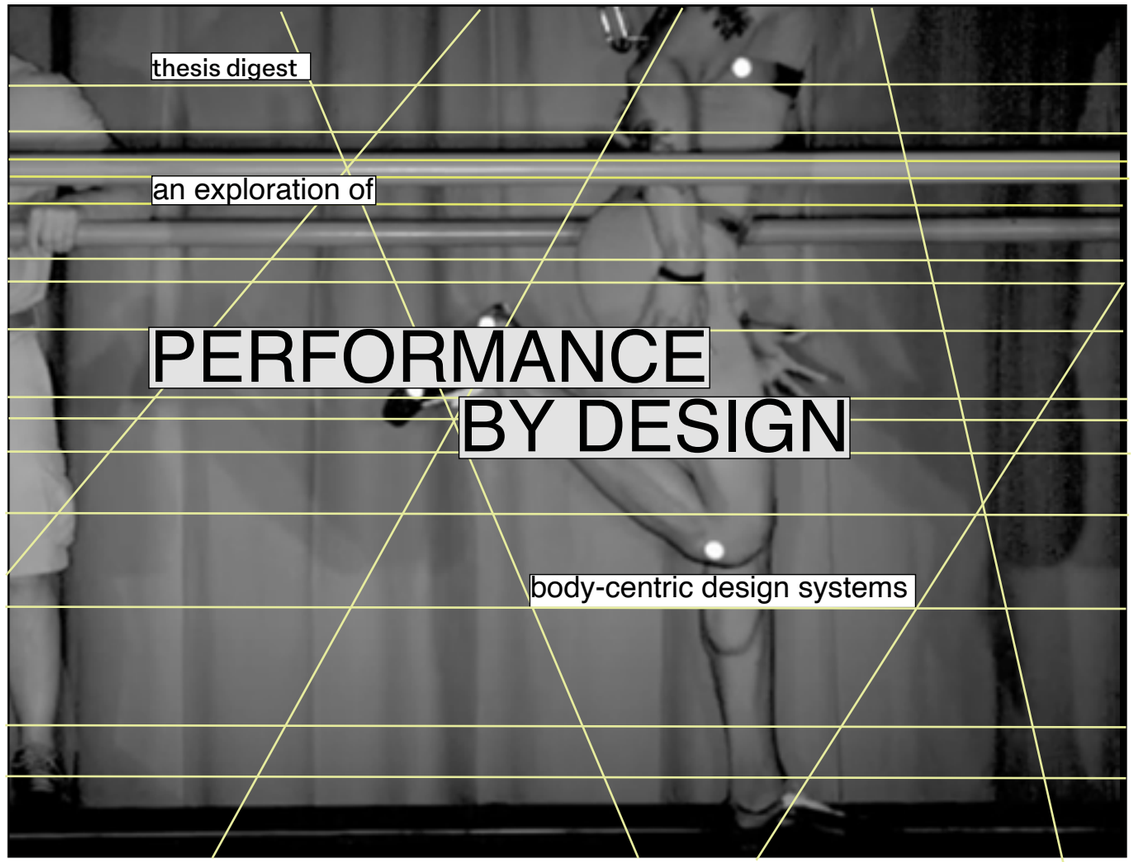





an exploration of body-centric design systems
PERFORMANCE
BY DESIGN
thesis digest
2024



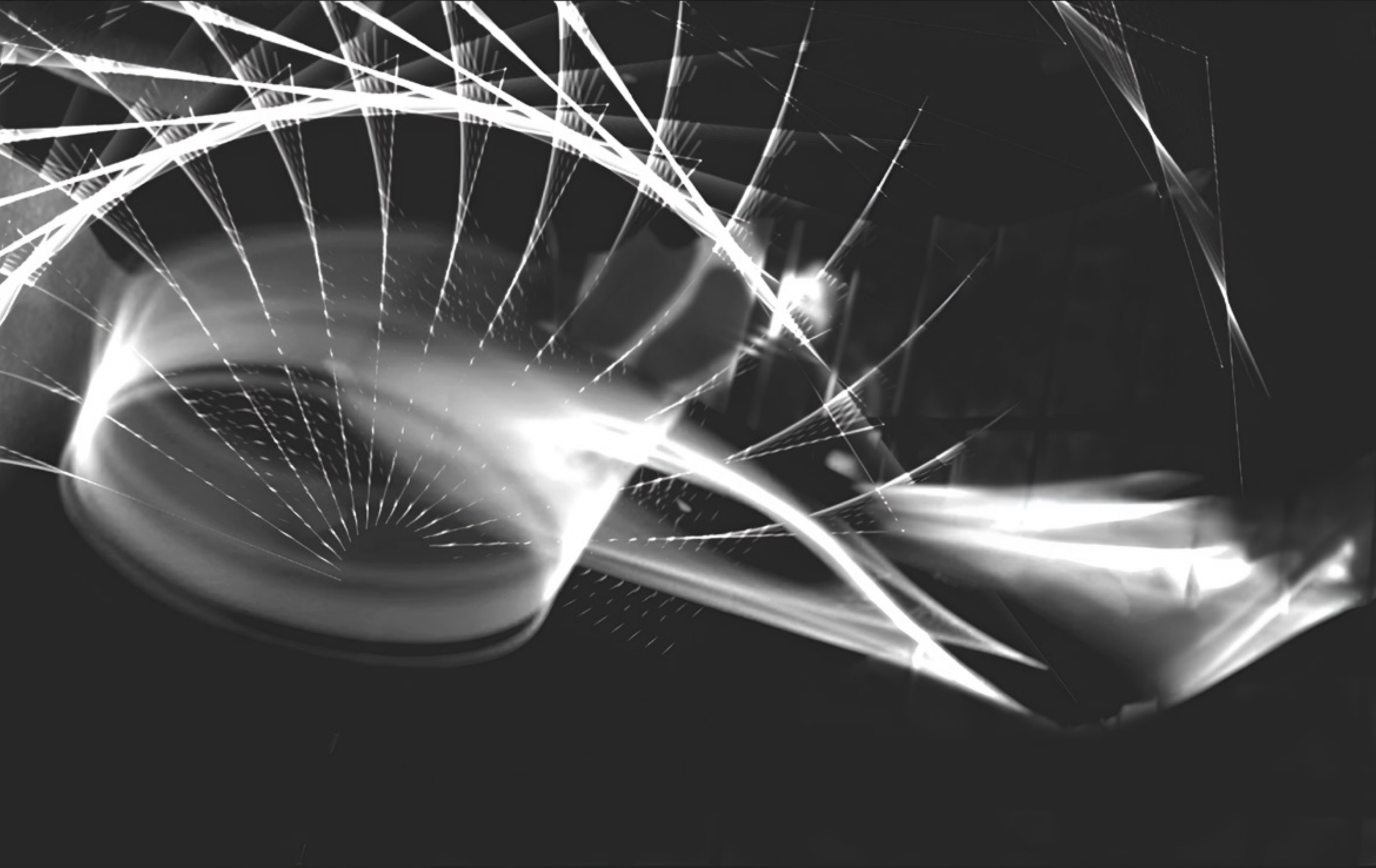


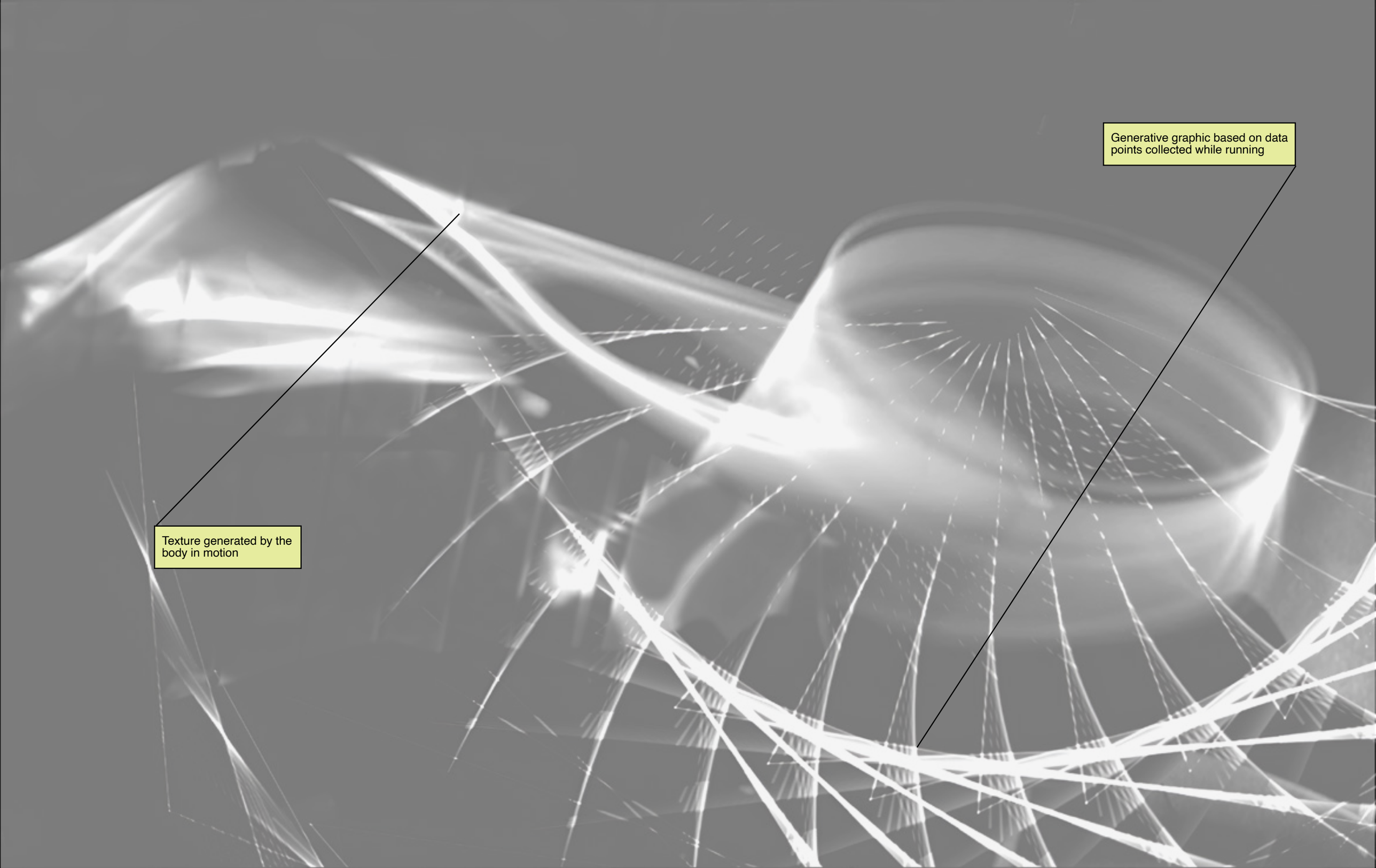

thesis digest
an exploration of
PERFORMANCE
BY DESIGN
body-centric design systems

PHOTOGRAPHY

Through photography, I aimed to explore the concept of movement tracking. Using simple materials such as glow sticks, tape, and a tripod, my photographer and I captured the semi-predictable yet variably dynamic patterns that emerge from repetitive motion. Even in highly controlled environments, such as on elliptical machines or stationary bikes, the movements of joints exhibited subtle, unpredictable variations.

This observation sparked my interest in examining the intersection between the fluidity of human movement and the mechanical data generated by these actions. By documenting and analyzing these visual patterns, I sought to better understand the relationship between organic motion and its digital representation.



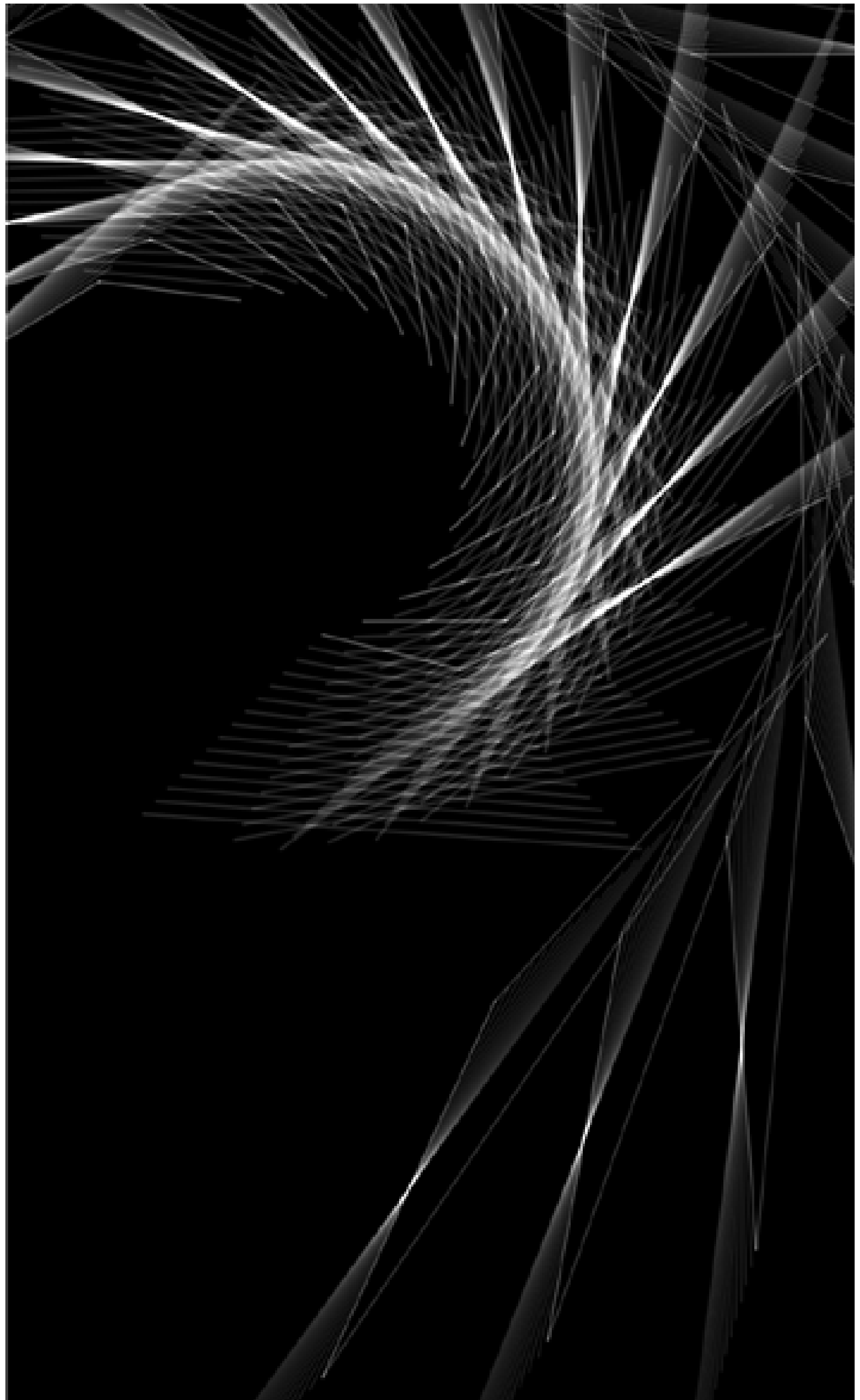

Generative graphic based on data points collected while running
Texture generated by the body in motion

Data:

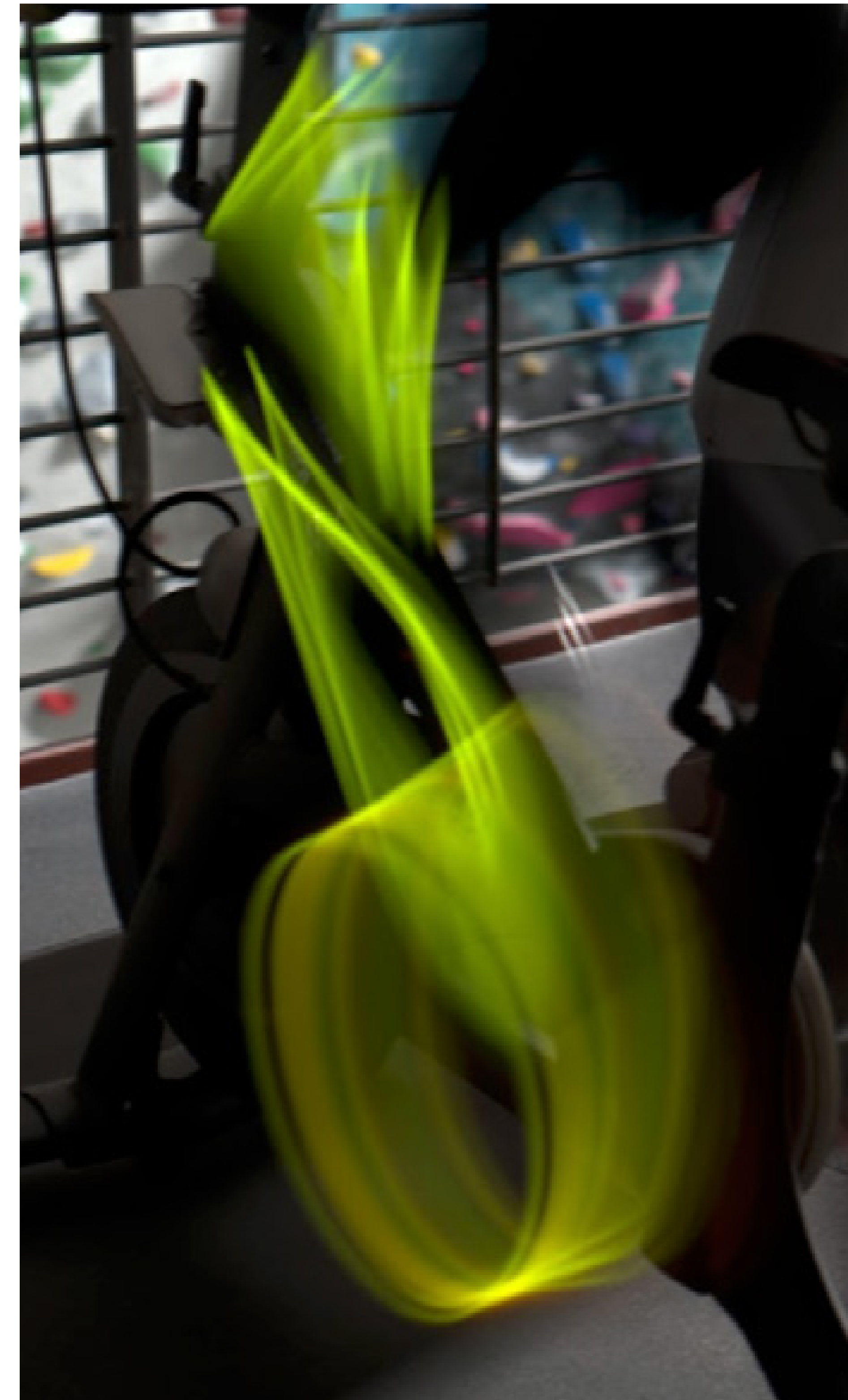
February 8, 2025
Mount Lukens

Miles: 14.75 miles
Average Heart Rate -151 bpm

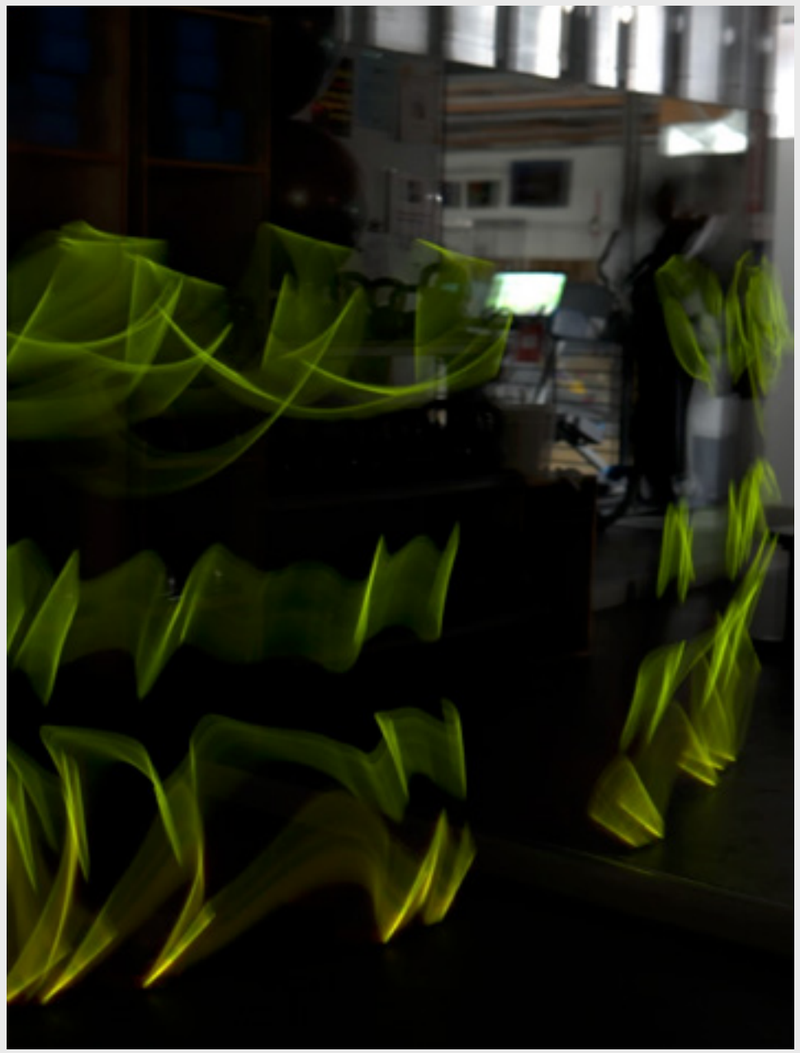
Layering of performance and body data



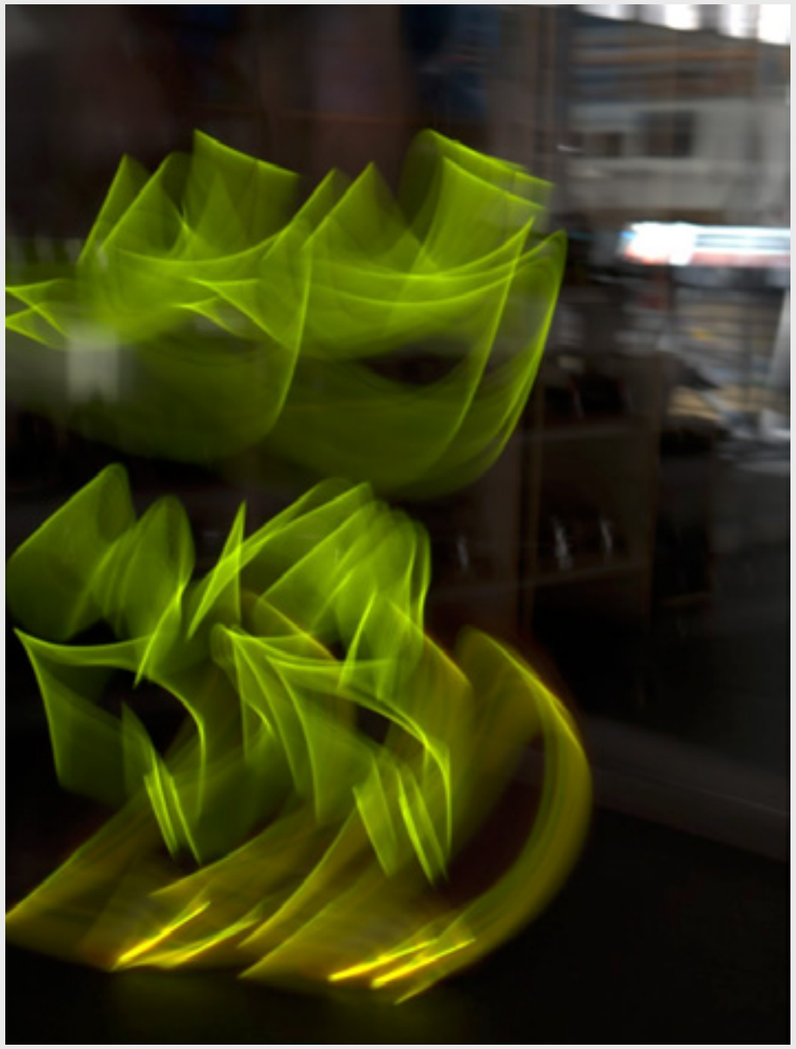
February 8, 2025
Mount Lukens
Miles: 14.75 miles
Average Heart Rate -151 bpm



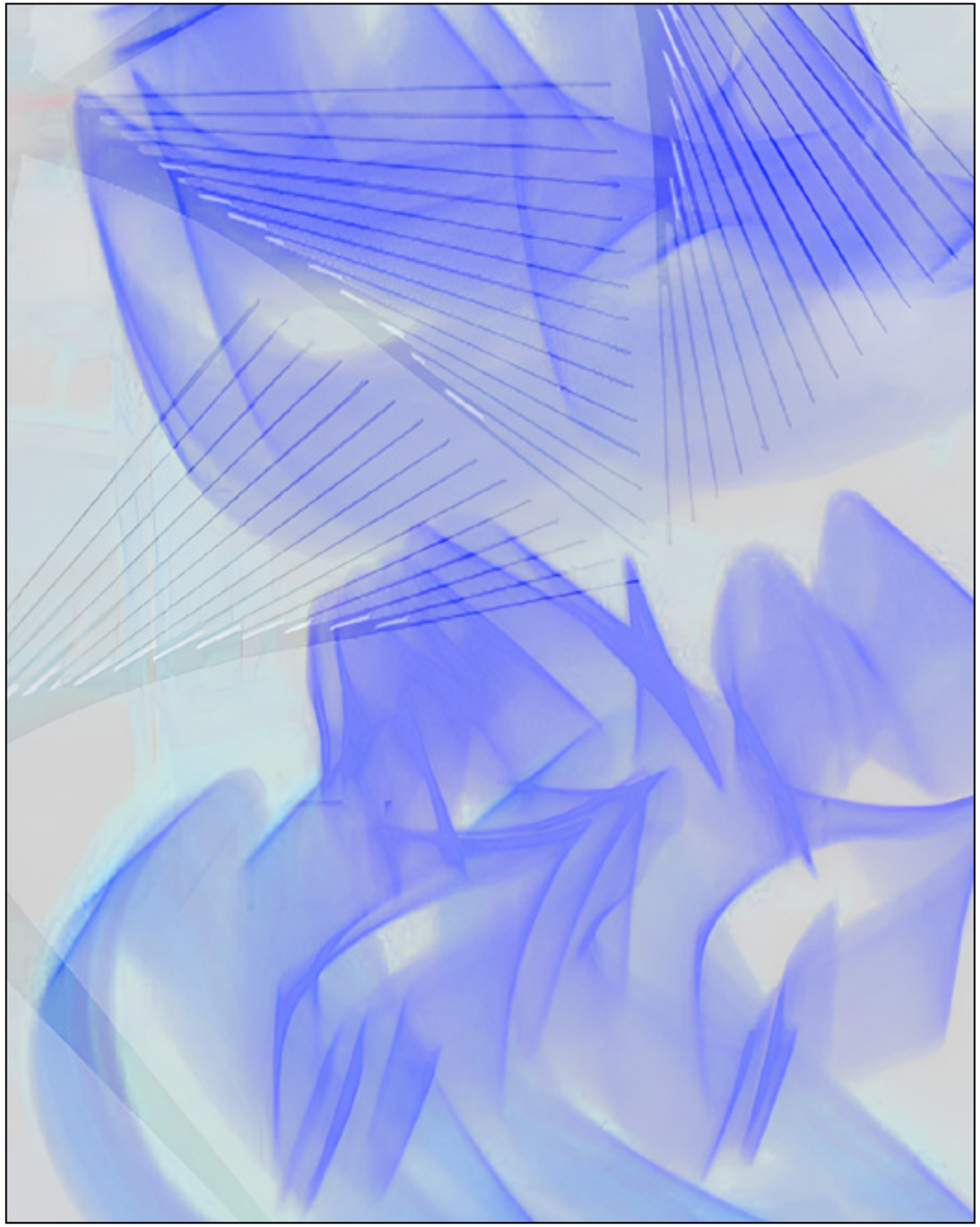
Movement tracing on a Stationery Bike



Movement tracking of running in place



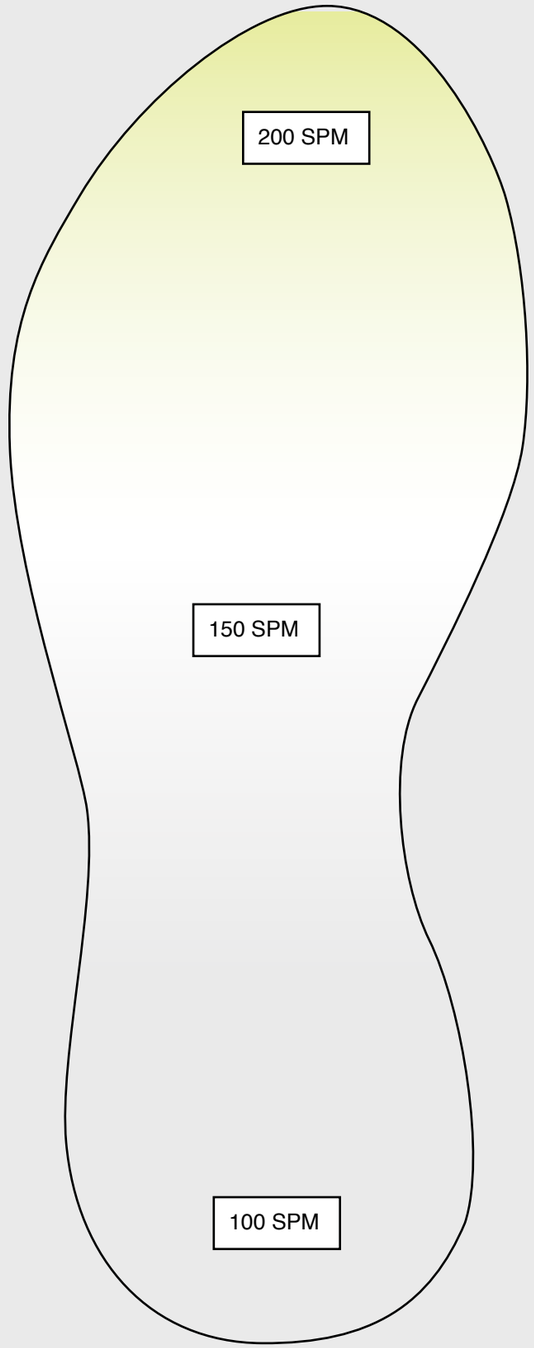
Movement tracking of running in place



CADENCE-DEFINED PATTERN

Cadence is a performance metric that measures the number of strides (steps) per minute. Alongside average pace, it offers valuable insights into running efficiency. Additionally, average cadence can indicate a runner's foot strike pattern — whether they land on their toes, heels, or midfoot. Foot strike refers to which part of the foot makes initial contact with the ground, influencing the need for traction and cushioning in that specific area.

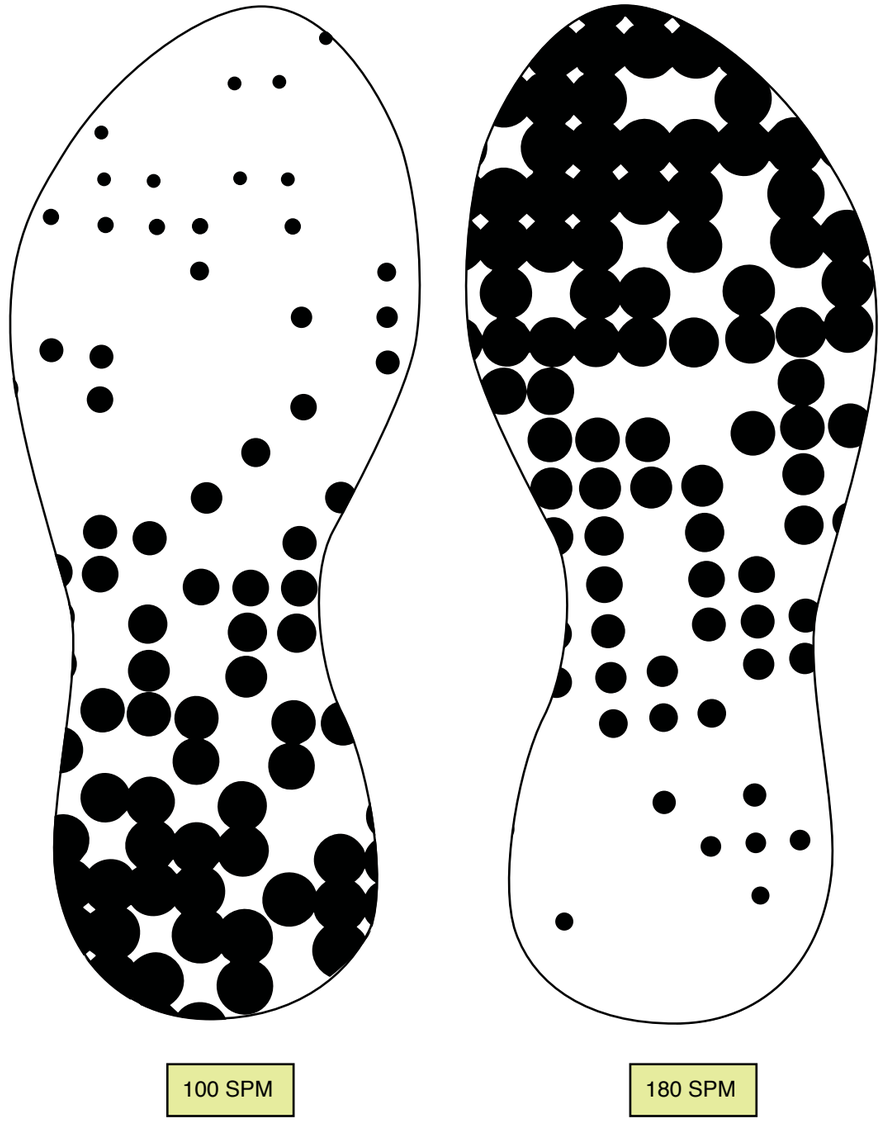
To visualize this relationship, I developed an algorithm that generates a unique pattern based on cadence input. This pattern can be applied to footwear tread, helping determine the optimal placement of traction for each runner's individual stride.

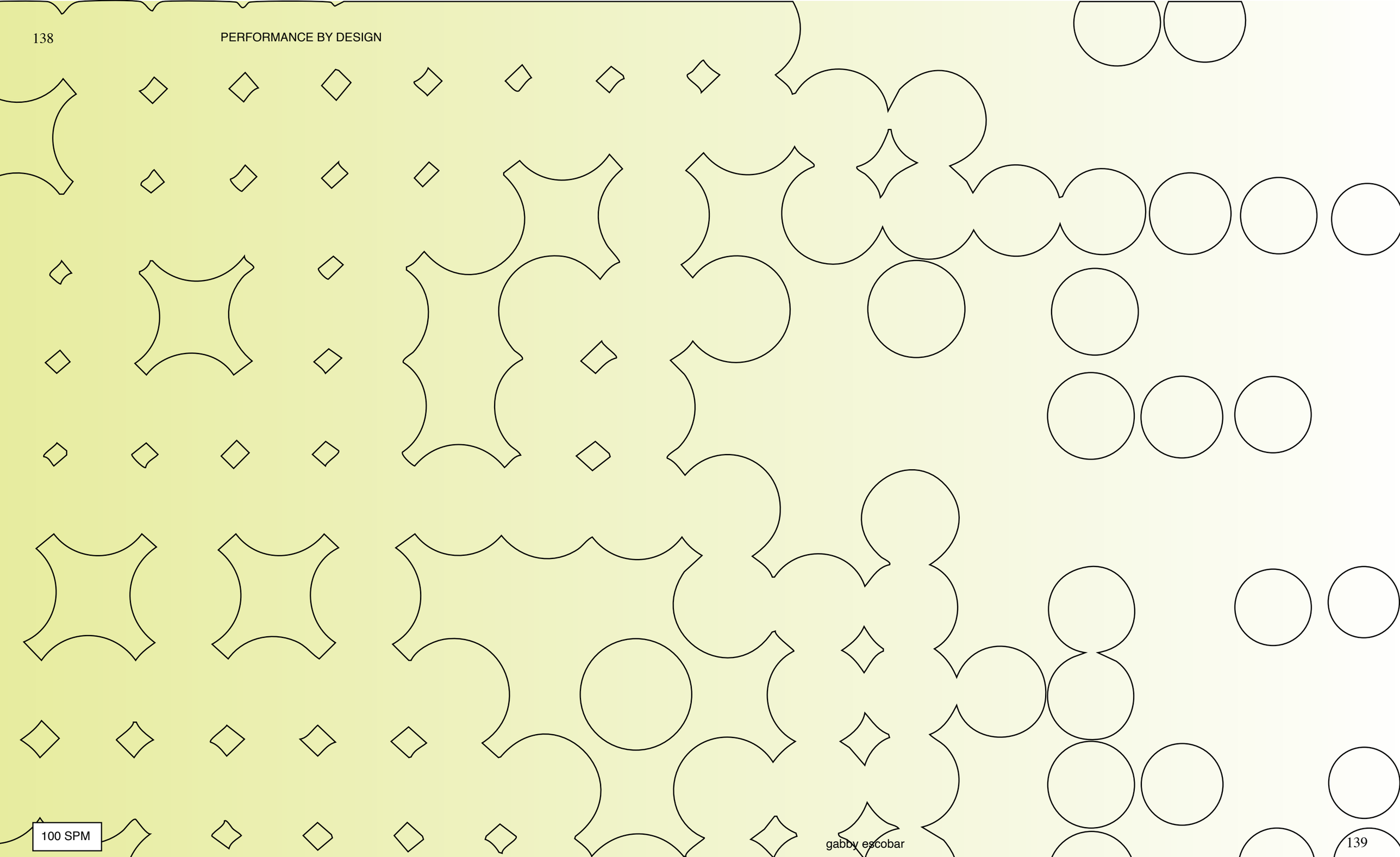


Toe-Strike Zone

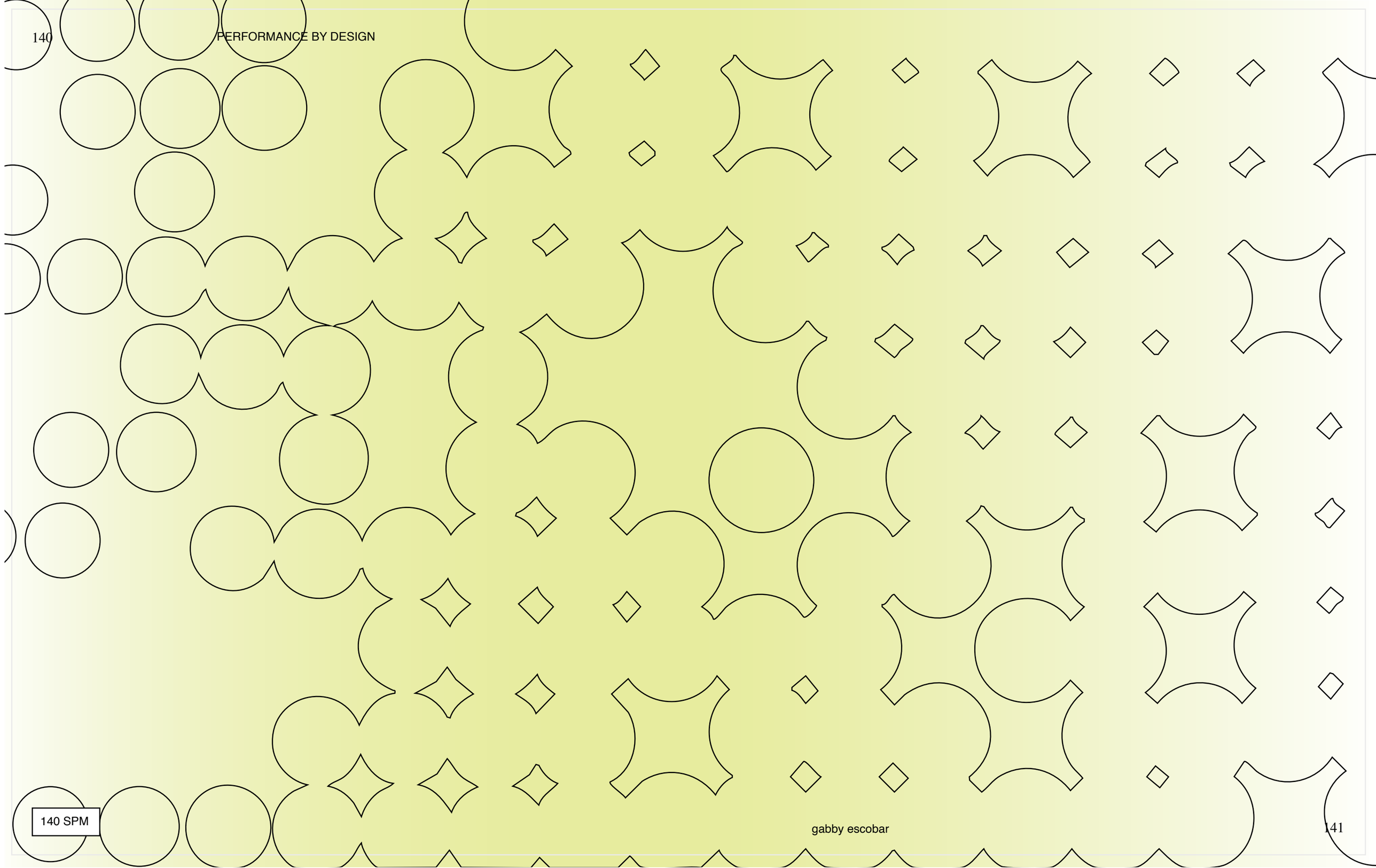
Midfoot Strike Zone

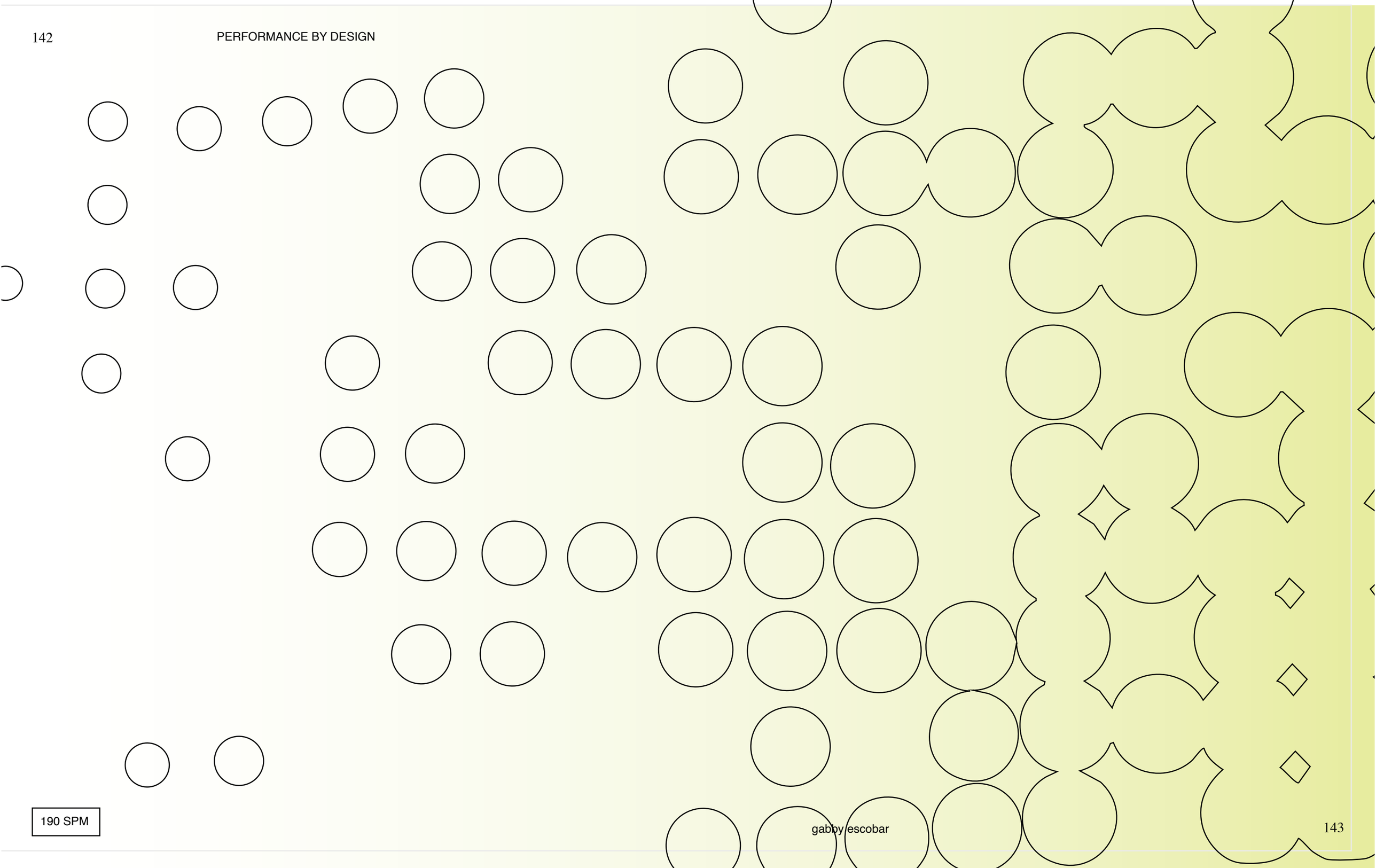
Heel Strike Zone



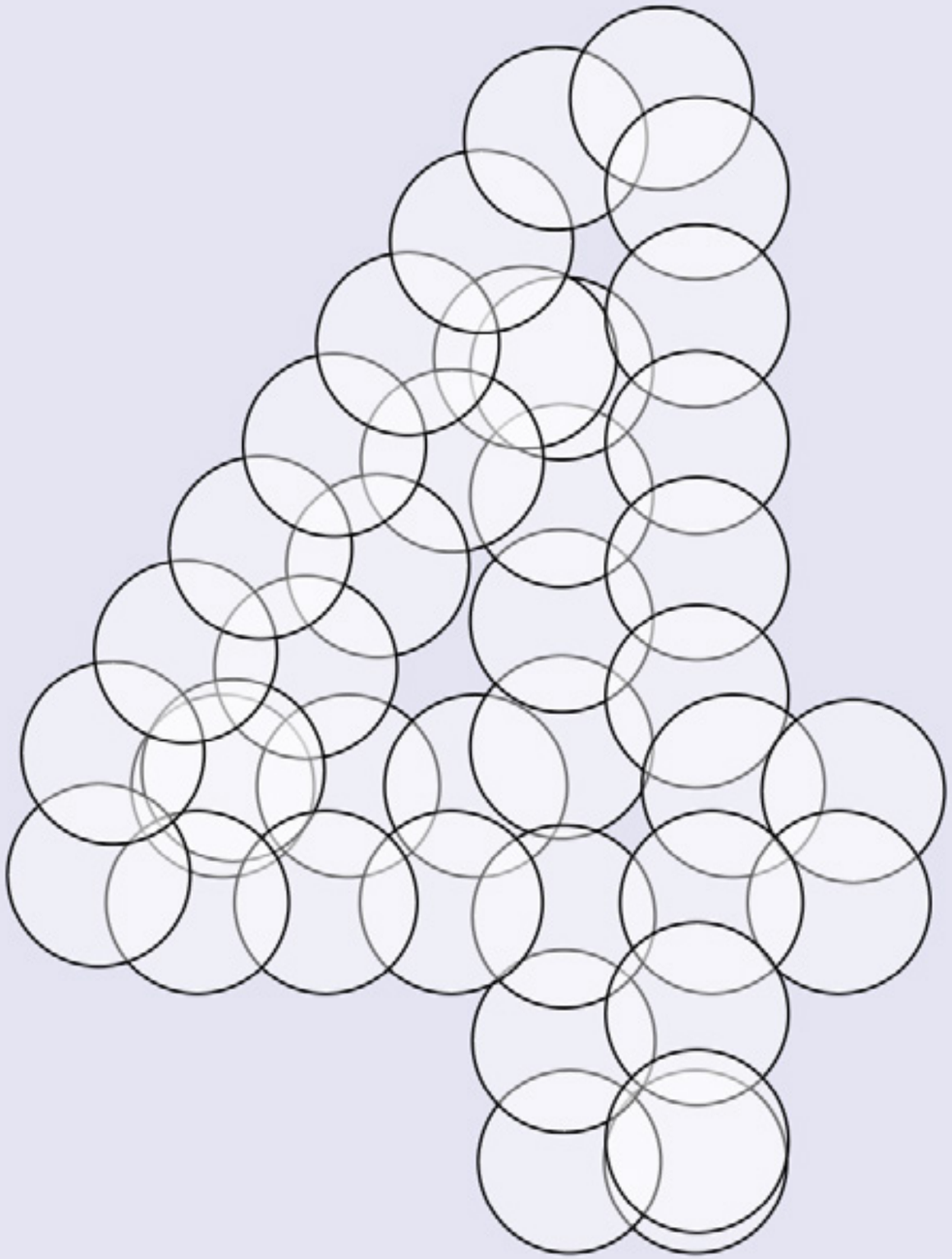


100 SPM





190 SPM



INNOVATION

gabby escobar

ONDA-RUN, IN RHYTHM WITH YOU

Onda Run is a hypothetical running event I have branded to contextualize and apply my design experiments. This conceptual framework allows the entire visual system to come to life through its messaging, race bibs, medals, and spatial applications. The name “Onda,” meaning “wave” in Spanish, evokes the fluid, dynamic motions of the human body — a theme that resonates throughout the design system I have created.

The logo and typography are intentionally minimalist, providing space for the body-centric principles to emerge. Rather than overpowering the visual narrative, the restrained design serves as a subtle backdrop, allowing the motion and presence of the runner to remain central. Just as the significance of performance data is inherently tied to the individual it represents, the visual elements are designed to reflect the personal context of each participant.

Color has been applied selectively to emphasize this relationship, offering moments of visual distinction without overwhelming the core concept. Reflective and transparent materials play a prominent role, further enhancing the individuality of the experience. No medal or race bib will appear the same across different participants — each one transforms depending on the person wearing it, the viewing angle, and the surrounding environment.

Through Onda Run, I explore how design can visualize and amplify the personal, ever-changing nature of human movement. This project invites consideration of how data, materiality, and context intersect to create a uniquely reflective visual language.

The Onda Run medal features a thermal-reactive neckband that transforms in response to the body's heat. While hanging, the band remains black, but upon contact with the skin, it shifts to a vibrant blue. This subtle yet striking transformation symbolizes the runner's role in activating the system — the body itself becomes the source of color and energy.

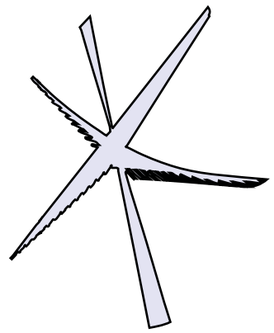
In keeping with this concept, the medal is crafted from a clear material, intentionally designed to interact with its surroundings. Rather than imposing a fixed visual identity, the transparency allows the medal to reflect and refract light, adapting to the wearer and the environment. Each photograph, viewing angle, and participant's movement results in a distinct visual expression.

The Onda Run medal features a reflective element on its interior, uniquely generated from each participant's running data. Applied after the race, this addition ensures no two medals are identical. Just as every race experience is unique, so is its visual representation.

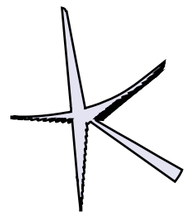
Random Casing

Symbolic Stars

each point = 10 BPM



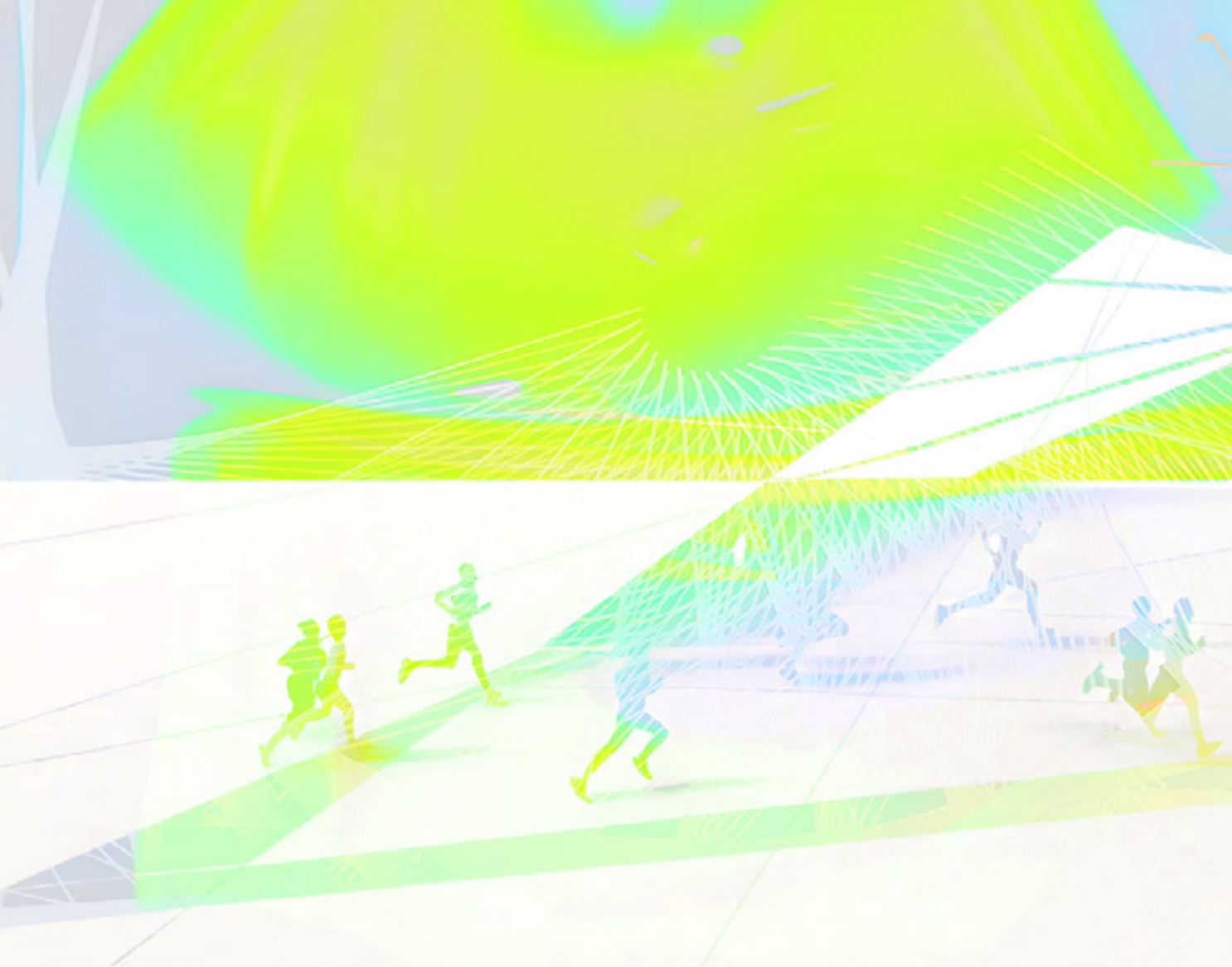
60 BPM



+ 50 BPM

= 110 BPM

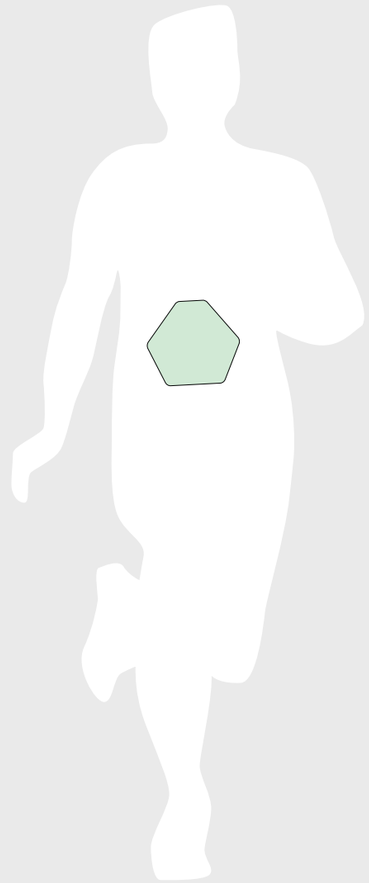
“This system uses BPM (beats per minute) as a central data point—an indicator that reflects effort differently depending on a person’s age and fitness level. It symbolizes exertion, and the medal honors the data generated through movement—specifically, an elevated heart rate. By combining a star-shaped element, whose form is generated from each participant’s average BPM, with a randomized outer casing, every medal becomes entirely unique—an individualized artifact of performance.”



The finish line structure is directly inspired by the visual language of the interface I developed, functioning more as a mobile art installation than a traditional race marker. Conceptually, it challenges the notion of a definitive ‘finish line’—because in the spirit of honoring movement, there is none.

I reimagined the line as a vertical, open structure that rises toward the sky, symbolizing the ongoing nature of physical practice and personal growth. Constructed from semi-transparent fabric, the structure becomes a canvas for dynamic, colorful projections derived from my body-centric design system. These projected visuals, rooted in movement-generated data, create a sense of continuous motion and energy.

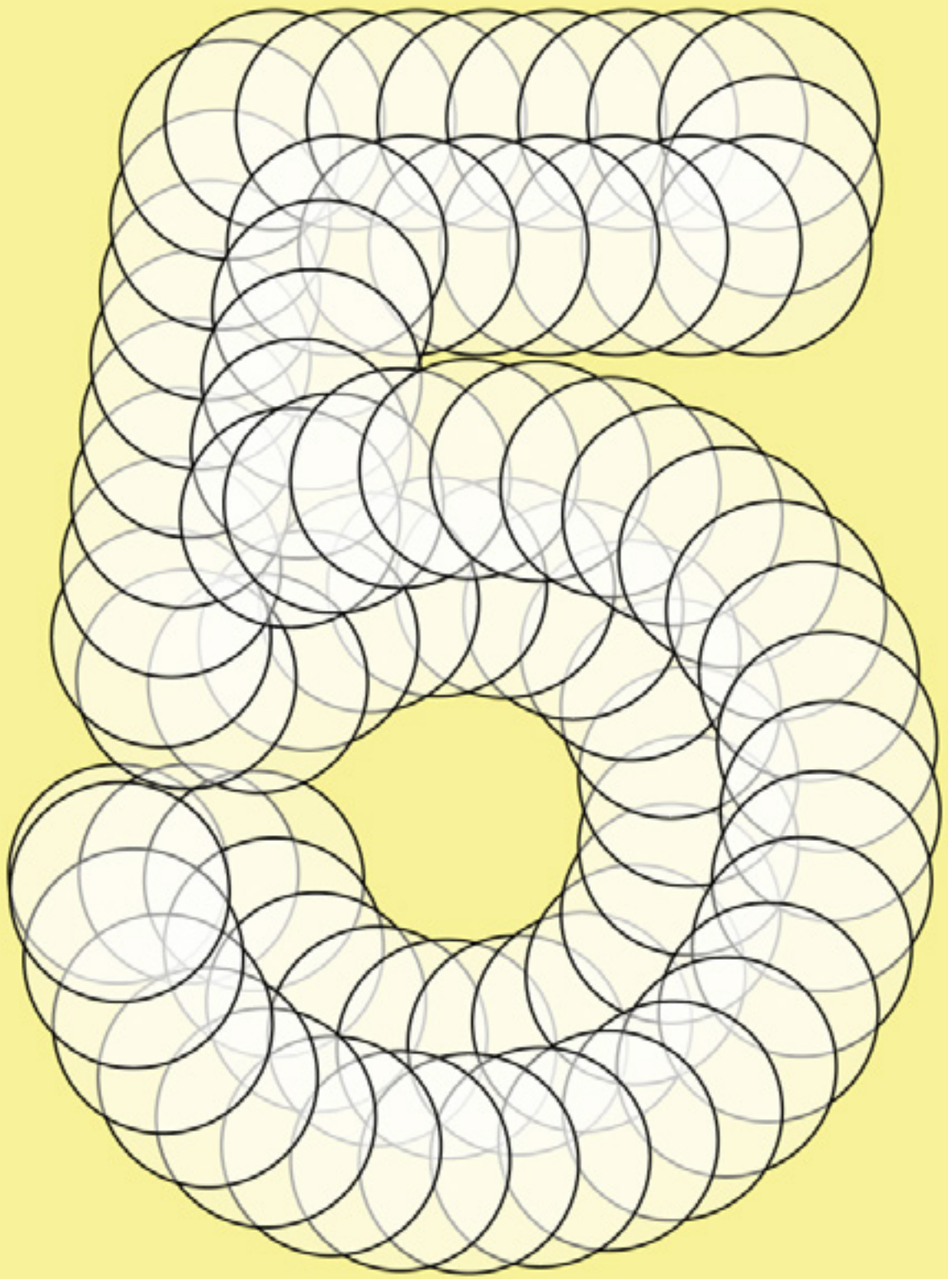
The use of lightweight, mobile materials ensures that Onda Run can function as a pop-up experience—adaptable to different locations around the world—reinforcing the idea that movement, and the celebration of it, is never bound to a single place or moment.



The race bib was designed with a number of body-centric concepts to embody athletes both formally and funcitonally.

The typography is arranged on a grid that is based off of the body of arunner. Each corrral features a different layout based off of different stages of the sprint.

A semi-transparent background allows the bib to integrate with the runner's appearance without obstructing key details. Its shape follows the natural curvature of the body in motion, providing a better fit and reducing interference during the race.



RESEARCH & STRATEGY

gabby escobar

LIFE ON THE LINE: ORGANIC FORM

Figure 1.1. Figures 1.1– 1.3 show three different conceptions of living figures. In Auguste Rodin's sculpture, Adam, notice how Rodin places Adam in an especially awkward pose that emphasizes the contraction of his body. This effect is sharpened through Adam's pointing to the ground and the incongruous placement of his legs in relationship to his upper body.

Figure 1.2. The title page of William Blake's, The Marriage of Heaven and Hell, copy D. An ascending diagonal movement suggests the energetics of life in many of Blake's relief etchings. See, for instance, how souls emanating from the marriage of heaven and hell move across the diagonal, from left to right, from the fires of hell to the growing flora of the earth.

Figure 1.3 Selection from Stan Lee and John Buscema, How to Draw the Marvel Way, reprint edition (New York:Touchstone, 1984). In this illustration from chapter 6, "The Name of the Game is – Action!" Lee and Buscema argue that drawing the body at its most extended possible point lends the figure energy and a sense of action. Copyright 1978 by Stan Lee and John Buscema. Reprinted with the permission of Fireside, a division of Simon & Schuster, Inc. All rights reserved.

Figure 1.1

Figure 1.2

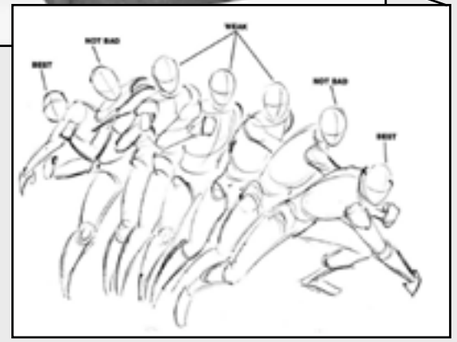


Figure 1.3

Although philosophers and scientists have always had difficulty describing life, artists have illustrated it with abandon.(1) From pictures in textbooks, sketches in natural history notebooks, or even a "life drawing" session at the community art center, drawing life just seems easier than explaining it. **When we draw a picture of an organism, however, how do we show that it is a living thing?** Are there special techniques that we use to bring an image on a page to life? If so, what are they and how do they operate? Do we condense an organism's motions into a physical form that appears to unfold in time, like a Rodin sculpture?(Figure 1.1) Or do we emphasize movement across a diagonal picture plane, like in a William Blake etching.(Figure 1.2)

Perhaps we choose moments where the curves and angles of the body are at their most extended, as Stan Lee and John Buscema proselytized in their book How to Draw Comics the Marvel Way.(Figure 1.3) What qualities of living things do we need to emphasize to suggest that something is alive? And what do these drawings tell us about how we think bodies are organized or how we think they operate? Perhaps it is the relative ease with which we draw life that has made biology one of the most visual of sciences. In fact, it is hard to imagine twenty-first-century biological practice without the use of images. They are used in collecting data and specimens, working out one's ideas, communicating results to other scientists, training young biologists, and disseminating scientific knowledge to audiences eager for new ways to see the world they inhabit. Because of this, the decisions one makes about how to illustrate living things hold specific consequences for how we think about life. These consequences could range from how one groups an organism with other organisms, how one demonstrates how organisms or species change over time, or how one organizes an organism according to how it is formed. **It is not just that a picture conveniently condenses a textual description (that a picture is worth a thousand words), but also that we use the tools of imaging, such as composition, form, color, and line, to picture what words have trouble articulating.** So how have these tools helped us explore the ways that living things are related to one another, and how have we used them to comprehend the ways that organisms develop and evolve?

Fortunately, the last forty years have seen a proliferation of analyses on the importance of images in science in general and biology in particular. Each of these publications enlarged a palette of approaches for thinking about how scientists and artists use images to depict living things. We now have excellent studies published by art historians,(3) philosophers and theoretical sociologists,(4) historians,(5) and journalists and scholars of visual culture.(6) We have studies of maps, atlases, models, guidebooks, films, bio-art, and diagrams. We have seen the role of science in art, art in science, aesthetics, and the power of images. You get the picture. **Scholars today are armed with many approaches for thinking about the role of images in scientific thought.**

Informed by the goals of these projects, if not always the specific approaches, this chapter will focus on the role of illustration in one of the key concepts in biology: the idea of the organic. When asked about what comprises a living thing, scientists may resort to the retort that life is something that is "organic." But this easy answer hides a deep philosophical ambiguity. On the one hand, the term "organic" refers to a property of form, as in the artisticmsense of how an image is organized or composed. On the other hand, the term "organic" also

[7] See Ash Amin, *Post-Fordism: A Reader* (Hoboken. N.J.: Blackwell Publishing, 1994) for key essays.

[8] Guy Debord, *The Society of the Spectacle* (New York: Zone Books, 1995).

[9] See Hannah Higgins's important monograph on the history of grids in art and design, *The Grid Book* (Cambridge. Mass.: MIT Press, 2009).

[10] See for instance the discussion of modularity in Gerhard Schlosser and Günter P. Wagner's, "The Modularity Concept in Developmental and Evolutionary Biology," found in *Modularity in Development and Evolution*, ed. Gerhard Schlosser and Günter P. Wagner (Chicago: University of Chicago Press, 2004).

[11] Michel Foucault, *Security, Territory, and Population: Lectures at the Collége de France,* 1977–1978, ed. Michel Senellart, trans. Graham Burchell (New York: Picador, 2004), 73.

[12] Foucault, 73.

[13] "I do not mean to say that the law fades into the background or that the institutions of justice tend to disappear, but rather that the law operates more and more as a norm, and that the judicial institution is increasingly incorporated into a continuum of apparatuses (medical, administrative, and so on) whose functions are for the most part regulatory." Michel Foucault, *The History of Sexuality Volume 1: An Introduction*, trans. Robert Hurley (New York: Random House, 2000), 144.

refers to a material quality, as in the chemical sense of objects being composed of carbon. Although these two notions sit in tension for much of the history of biology,[7] as we will see, they especially inflect the art and science of the nineteenth- century morphologist Ernst Haeckel. As a scientist who contemplated a career in art and concentrated on forms in nature, Haeckel used his theories and images to explore this tension between material and formal properties in late nineteenth- century biology.

Haeckel is a popular figure in recent histories of biological science, and I intend to draw on these studies in my discussion below. My use of his work, however, is very different from that of most historians. I am not interested in evaluating his contributions to biology, adjudicating on his scientific ethics, or even elaborating on the relationship of his personal history to the time period in which he lived. For me, Haeckel is an exemplar who, through his personal interests and his popularity, reveals interesting nineteenth- century assumptions for thinking about how forms are used to represent living things. In doing so, he proves to be an exceptional transitional figure in considering issues of form in biology. On one hand,Haeckel continues a tradition for thinking about biology as a science of form as related to aesthetic judgment. On the other hand, Haeckel's efforts to compare developmental sequences across species allow him to develop certain forms of representational practices used in twentieth-century developmental biology, such as the use of grids that we will study in chapter 2. Today these practices seem a bit at odds with each other as one evokes organic unity while the other industrial production. For Haeckel, they provided two different tools for contemplating how life productively channeled the tension between structure and change.

This tension between structure and change, however, is as prevalent in the history of ideas on aesthetics as it is in the history of ideas on biology. One reason for this similarity is that they share a homology of philosophical descent as inherited through the tradition of German idealism. The third critique of Immanuel Kant, The Critique of Judgment, for instance treats the appreciation of beauty and the appreciation of life as two related types of judgment. As is well known, this text was very influential for Johann Wolfgang von Goethe as he attempted to develop a

science, a "delicate empiricism" or morphology, of the study of the dynamic nature of plant and animal forms.[8]
Although Goethe's morphology was important for the development of biology it has also been an important touchstone for many thinkers wishing to rethink the role of forms in art. For example, writing in the 1930s, art historian Henri Focillon appealed to morphology in his attempt to understand some of the figural and formal complexities of art beyond a strictly narrow iconographic approach. As Focillon stressed in his influential text, The Life of Forms in Art, forms tended to follow their own logic, their own sense of rules for development, much like an organism. The most important method for studying forms in art then was not representational but developmental, not to its references to something outside itself but to the internal logic of how these forms changed when they related to one another. "Plastic forms are subjected to the principle of metamorphoses, by which they are perpetually renewed, as well as to the principle of styles, by which their relationship is, although by no means with any regularity or recurrence, first tested and then made fast and finally disrupted."9As Jean Molino writes in his commentary on Focillon, "Nothing explains the genesis of forms, nothing, that is except forms themselves and their encounters with other forms."[10] There is a logic to how images are composed that can't be reduced to representation.

Even somebody as canonic as Wilhelm Worringer recognized the relationship between biology and aesthetics when he argued for the important role of abstraction in the development of art.[11] Worringer appealed to the distinction between organic and inorganic matter to make his case: **"Just as the urge to empathy as a pre- assumption of aesthetic experience finds its gratifications in the beauty of the organic, so the urge to abstraction finds its beauty in the life- denying inorganic, in the crystalline, or, in general terms, in all abstract law and necessity."**[12] For Worringer, it was a sense of abstraction born from ornament, as opposed to the empathic copying of organic forms that provided the necessary impulse for the development of art.

I've come to view this tangled web between aesthetics and biology as a persistent and instructive mutual informing, as opposed to an anachronistic echo of a premodern conflation between art and science. When scholars focus on how science is a preeminent method for explaining the world (which it is), we've tended to cleave science from other forms of knowing. One of the main lessons of the entangled nature of biology and art then is that branches of both fields have been concerned with how forms change. As Molino insists, "[Focillon's thought] does not make form a living organism so much as life itself a form."[13] When considering the relationship of life to forms, I think it is important to appeal to scientists, philosophers, artists, and historians of art. They tell us that biology and art have often started with similar assumptions about what it means to be alive, what it means to preserve coherence through change, and why certain shapes might be privileged over others as change occurs. Understanding how forms relate in biology and science is important for understanding what it meant to be alive at different times in history. Over the next few chapters, I will outline what I think is one of the most important changes in how organisms were conceived in the history of biology. During the eighteenth and nineteenth centuries, organisms were thought to be collections of parts that fit together to form a whole. In the twentieth century, these formal strategies gave way to an abstract logic of regulation where questions about the relationship of the parts to the whole were suspended in favor of questions about how parts related to each other. Forms were emptied of their volumes, and parts were reduced to steps in abstract sequences. What emerged as important was not the teleological relationship of the parts to the whole, but how regulation functions to ensure that parts are assembled in the correct sequence. This did not mean that biology lost its emphasis on forms or aesthetics; it does mean that the idea of form was fundamentally changed. As we will see, this change is important as each of these ways of conceiving of organisms brings with it a different form of politics.

[14] Eric H. Davidson, The Regulatory Genome: Gene Regulatory Networks in Development and Evolution (London: Academic Press, 2006), 2..

“Biology and art have often started with similar assumptions about what it means to be alive, what it means to preserve coherence through change, and why certain shapes might be privileged over others as change occurs. Understanding how forms relate in biology in science is important for understanding what it meant to be alive at different times in history”

P. 31

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What this chapter and the next will argue is that Haeckel stood as a transitional figure in how life was conceived through images. Haeckel’s formal strategies, indeed much of his philosophy of development, depended on a holism of forms. Yet there are times when his emphasis on the role of materials and in his adoption of grids for comparing developmental sequences challenged this holism in troubling ways. For instance, Haeckel’s ability to demonstrate development through a series of images marks his legacy for contemporary evolutionary and developmental biology. As Michael Richardson and Gerhard Keuck argued in an article entitled, “Haeckel’s ABC of Evolution and Development,” “Despite his obvious flaws, Haeckel can be seen as the father of a sequence-based phylogenetic embryology.”[14] This tension between form and sequence in Haeckel’s arguments and illustrations is especially intriguing for me. To understand this tension, I will investigate how it wends its way through the pages of several of his publications, but most especially his masterpiece of visual forms, Kunst- Formen der Natur (Art Forms of Nature) and his popular science texts such as Natürliche Schöpfungsgeschichte (The History of Creation).

It is especially hard to overstate the importance of lines as compositional devices in the history of biological and medical illustrations. The line allows a surface to divide itself into greater complexity, creating two aligned spaces instead of the original single space. The addition of more lines to this surface can then build a sense of volume to suggest depth. Or the addition of a line to paper can bring an energy or rhythm to an illustration by giving it a sense of direction and movement. If creating an image is important for studying living things, then studying how scientists and artists use lines can tell us how they visualize what it means to be alive.

In the rest of the chapter that follows we will look at how Haeckel uses curved lines in his illustrations to suggest important aesthetic and biological qualities of life in general.

[8] Cooke, M. (2006). Design Methodologies: Toward a Systematic Approach to Design. In A. Bennett (Ed.), Design Studies : theory and research in graphic design (pp. 130–146). New York: Princeton Architectural Press.

[11] D'Ammasso Tarbox, J. (2006). Activity Theory: A Model for Design Research. In A. Bennett (Ed.), Design Studies : theory and research in graphic design (pp. 73–81). New York: Princeton Architectural Press.

[12] Givenchi, R., Groulx, I., & Woollard, M. (2006). Impact: Inspiring Graphic Design through Human Behaviours. In A. Bennett (Ed.), Design Studies : theory and research in graphic design (pp. 306–310). New York: Princeton Architectural Press.

[13] Harland, R. (2007). Redefining the plural domains of graphic design and orientating the subject towards a model that links practice, education and research. Paper presented at the International Association of Societies of Design Research 2007: Emerging Trends in Design Research, The Honk Kong Polytechnic University.

[17] Littlejohn, D. (2007). Yin and yan before talk and chalk. Eye Magazine, 16, 93–94.

[22] Nini, P. J. (2006). Sharpening One's Axe: Making a Case for a Comprehensive Approach to Research in Graphic Design Process. In A. Bennett (Ed.), Design Studies : theory and research in graphic design (pp. 117– 128). New York: Princeton Architectural Press.

[25] Soar, M. (2006). Encoding Advertisements: Ideology and Meaning in Advertising Production. In A. Bennett (Ed.), Design Studies : theory and research in graphic design (pp. 206–230). New York: Princeton Architectural Press.

[26] Storkerson, P. (2006). Communication research: Theory, Empirical Studies, and Results. In A. Bennett (Ed.), Design Studies : theory and research in graphic design (pp. 158–178). New York: Princeton Architectural Press.

THE DIMENSIONS OF GRAPHIC DESIGN: IN THEORY

Abstract:
Graphic design is more usually discussed through the material outcomes of the process of graphic designing, rather than process itself. This is common in visual studies of material culture, from Art to Architecture. Yet outcomes of graphic design tell us little about the design process that created them, or the relationships that exist in the field. In this paper we look beyond the artefacts and consider how graphic designers have attempted to represent the subject in terms of diagrams that explain complex relationships and ambiguous terminology. Examples are featured that explore 'intermediate dimensions' of the subject, examining earlier work by Bruce Brown and Katherine McCoy, as well as a wider framework of design and design education, developed by Bruce Archer in the 1970s. The outcome is a theoretical construct that incorporates common concerns attempting to locate graphic design in relation to design, science and humanities.

1. Introduction: It is typical to discuss the nature of graphic design using examples of graphic design—posters, brochures, signs, websites, to name a few outcomes of this ubiquitous design process. This paper avoids this approach. It attempts to present a framework that is free from the subjectivity and ambiguity often associated with outcomes in the field. But, then, how do we depict graphic design? What are the dimensions of the subject? How can the field organise itself, in order to further develop. In the past we have looked to the field's practitioners, historians, and more recently educators. A future may well see increased prominence of critics, researchers, and theorists. How will these important roles—practitioner, historian, educator, critic, researcher, theorist—be located in relation to each other, and the wider context?

Traditional definitions of the field are now recognised as limited at a time when graphic design must have professional as well as academic kudos. Some practitioners, historians and educators have realigned themselves to new descriptors that have emerged from within, and outside the subject. These embrace traditional and emerging fields, often referencing old or new technology and terminology. This has resulted in attempts to redraw perceived boundaries of the subject, whilst core values arguably remain the same. In this contested sphere we are confronted with the question of what the future landscape for graphic design will look like? It has been suggested by Jessica Helfland and William Drentell that to look ahead, we must look back [17].

This paper extends previous work based on this premise. It builds on research that explored how the traditional definitions from which the subject emerged, and has been represented in visual form, can link to the creation of a model that provides an opportunity to guide future progress. This is achieved by considering key spheres of influence in graphic design, recognizing that there are traditional, and emerging influences, that together can be modelled and mapped, helping to shape future planning and integrate p r a c t i c e , history, and education with the development of criticism, research, and theory in the field. This paper exposes an applied model that is best described as work in progress. It builds on the development of a basic model previously discussed at the International Association of Societies of Design Research conference in Hong Kong, 2007 (IASDR 2007) [13]. The applied model discussed here depicts what is described as the macro and micro dimensions of graphic design: in theory.

2. Using diagrams to depict aspects of graphic design Examples of diagrams used to depict theory and research relating to graphic design are now more accessible. In Bennett [8], we see the depiction of theory and research focused on methodology, design process, relationships and cognition. These span a range of approaches that include the development of design methodology [4], the usefulness of activity theory [11], IDEO's approach to human centred research methods [12], design process, audience and user research [22], Richard Johnson's circuit of culture [25], and various approaches depicting 'the cognitive process theory of communication' [26].

These examples can be said to depict aspects of theory in graphic design. However, using diagrams to depict graphic

Figure 1: Browns model of values in communication design. Source: Brown, 1979, pp. 133

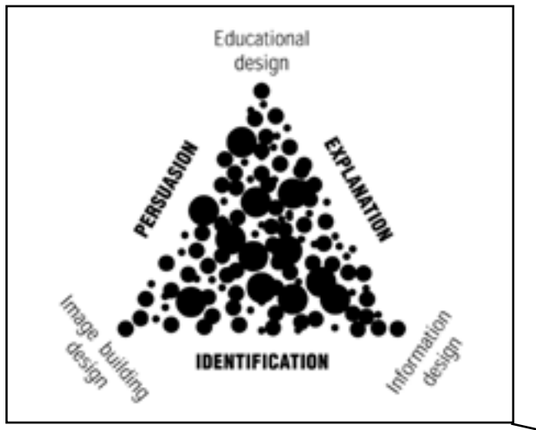


Figure 1

[2] Armstrong, H. (Ed.). (2009). Graphic design theory: readings from the field. New York: Princeton Architecural Press.

[15] Henwood, K., & Pidgeon, N. (2006). Grounded Theory. In G. M. Breakwell, S. Hammond, C. Fife-Schaw & J. A. Smith (Eds.), Research Methods in Psychology (3rd ed.). London: SAGE Publications Ltd.

design as a subject in its entirety is unusual, considering the visual nature of the subject. This is evident in Helen Armstrong's edited book Graphic design theory: readings from the field [2]. The book, split into three sections that deal with 'creating the field', 'building on success' and 'mapping the future' respectively, in the main follow the model used by design historians of showing examples of graphic design outcomes accompanying written text. Among the variety of outcomes on display – posters, publications, 'logo systems', and screen-based media, – some experimental work and the occasional use of schematic representation support the text. The content spans a century between 1909–2008 made up from contributions by familiar names such as Marinetti, Tschichold, Warde, Bayer, Rand, Weingart, McCoy; Scher, Heller, Helfland, Manovich and Lupton, to randomly select a few.

The third section of the book, Mapping the future, features nine contributions that stem mainly from the turn of the millennium, (with the exception of two from the 1990s). The title of this final section indicates a need to think about the future of the field, and 'map' it. This sentiment builds on what one of the contributors to the book, Jessica Helfland, had to say at a conference in America. During a joint presentation with William Drentell, they apparently commented that 'mapping the future of the profession will be difficult without looking back at our history to get a better idea of where we are going' [17].

In the early part of this millennium, this has been a preoccupation of the author of this paper and is part of a wider research investigation concerned with identifying the 'dimensions' of graphic design. Using the term 'dimension' developed from the use of metaphor to think about graphic design as some kind of 'nation state' [13]. The term is useful for two specific reasons. First, as a useful way to determine what Henwood & Pidgeon [15] describe as 'intersecting properties of core conceptual categories'. Secondly, it allows the opportunity to consider the idea that different core concerns may occupy similar territory, but differ in scale.

3. Depicting graphic design

As previously stated, there appears to have been few formal attempts to use diagrams to explain, or 'model' the field of graphic design, even though there is increasing amounts written about the field. In this paper we consider three attempts that are locatable in the research literature, books about graphic design, and design conference proceedings, that span the last thirty years. First, by Bruce Brown [6], second, Katherine McCoy [20], and more recently by the author of this paper [13].

3.1 The Graphics Triangle

Bruce Brown attempted to explain the three values of persuasion, explanation and identification in model form for the design of communications, referring to it as 'The Graphics Triangle'. This emerged from a need to discuss the communication values taken up when conveying either 'messages' or 'ideas'. The model demonstrates how three facets of graphic design – explanation, persuasion and identification – form a triangle, see Figure 1. Brown outlined each of the facets. In his view 'explanation' is concerned with health, safety and welfare. It is suggested that the outcome of designs in this category should result in one preferable solution, rather than a variety of possible options. This is the case with the second facet, 'persuasion', which is more open to alternative outcomes – seeking recognition is very important and a primary motivation here and the possible results are wide ranging. The third facet is 'identification'. This involves the need for distinction when anonymity prevails. Examples used by Brown to illustrate the three facets respectively include illustrations of putting on a life jacket, the design of a book cover, and a logotype.

It is argued that the nature of each of these facets is associated with either an active or a passive communication role, depending on the relationship to the audience. Brown argues that explanation and persuasion possess active values in addressing audiences. Consequently, persuasive values are associated more with trade and commerce, due to the potential emotional appeal, whereas explanatory values appeal to our sense of function, the need for rational decision-making and 'simplification'. However, identification is passive, relying on the audience to search out the communication value. Brown identifies three further facets that can be described as categories of design. These generic terms, associated with different kinds of material outcome, are labelled educational design, image building design, and information design. In Brown's model, these additional categories (or what are referred to here as 'angles') sit at the three points of the triangle, and emerge from the overlap between the two converging facets. It should be noted that it is not his intention to polarise these values but to acknowledge that the majority of design activity takes place in the space enclosed by these facets and angles.

Identifying these facets and angles, helps us to gain some understanding of some key values in graphic design and communication, and demonstrates equal levels of importance attached to each of them. This is useful, but also restrictive if the aim is to capture a more complete picture of graphic design. The model is limited in its ability cover the full spectrum of graphic design activity and influence, from conception to realisation.

To build his argument, Brown uses many examples of work that derive from the process of graphic design – logotypes, instructional diagrams, advertisements – but these come from what might now be considered a very limited range of two dimensional media, and are very much of their time. Other criticism is that the model does not fully engage with the potential influence and impact of changing technology, and how technology might act as a possible contributor to enhancing values of persuasion, explanation and identification

3.2 Typography as discourse

The second model we discuss emerged less so from a wider graphic design perspective taken by Brown—his approach did not show favour to any of the traditional activities associated with the subject such as illustration, photography, typography and print, from which graphic design emerged in the early twentieth century.

Figure 2: McCoys model of ‘Typography as Discourse’. Source: Lupton, 1996, p. 51

Figure 3: The dimensions of graphic design Source: Harland, 2007.

[3] Barnard, M. (2005). Graphic Design as Communication. London: Routledge.

[16] Lefebvre, H. (1991). The production of space / Henri Lefebvre; translated by Donald Nicholson Smith. Oxford: Blackwell Publishing.

[18] Lupton, E. (1996). Mixing messages: Graphic Design in Contemporary Culture. New York: Princeton Architectural Press.

[19] Margolin, V., & Buchanan, R. (Eds.). (1995). The idea of design. Cambridge: The MIT Press.

[20] McCoy, K. (2001). American Graphic Design Expression: The Evolution of American Typography. In S. Heller & G. Balance (Eds.), Graphic Design History (pp. 3–11).

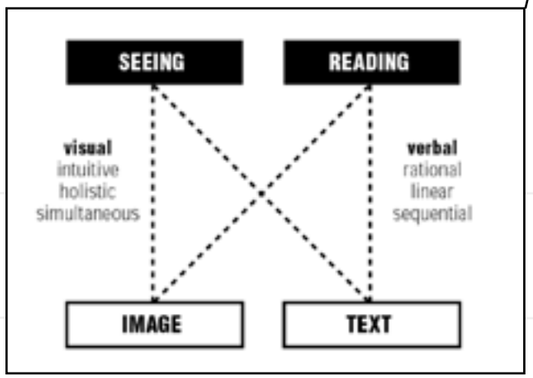
[23] Poyner, R. (2003). No More Rules: Graphic Design and Postmodernism. London: Laurence King Publishing.

[27] Swanson, G. (undated). Define Design. Retrieved 31 August, 2009, from http://www.gunnarswanson.com/definedesign/ New York: Allworth Press.

In the 1980s the phrase ‘typography as discourse’ surfaced from Cranbrook Academy of Art in Michigan to describe a model that had been developed in education by Katherine McCoy. This has been referred to as ‘expressive formalism’ [18]. This model appears to have emerged as a reaction to the rational problem solving approach in graphic design that had developed with the maturing of modernist principles, most revealed through graphic design work for large American corporations. Linguistic theories of semiotics provided the platform for this approach by McCoy that reflected the relationship between text and image with the processes of reading and seeing. See Figure 2. The model is underpinned by a series of dual terms adopted by McCoy from the French philosopher Derrida; art-science, mythology-technology, purist-pluralist, vernacular-classical, [23].

The background to this work, explained by McCoy [20] suggest that the roots of graphic design in America lie in book printing and type-cutting in Europe spanning the period since the early Renaissance. She explains that in the early twentieth century the artists and designers of modern movements such as cubism, futurism, Dada and surrealism, De Stijl, suprematism, constructivism and expressionism, experimented with typographic layout in expressive ways, introducing a visual quality to typographic design that contrasted with classical approaches. The ‘revolutionaries’ associated with these movements used typographic shape and overall layout as interpretation, adding further significance beyond the reliance on the meaning of words alone. McCoy states that ‘Typography finally became an expressive visual language as well as a verbal one’. Furthermore, she notes that ‘Seeing and reading are two modes through which we traditionally think of receiving messages. Image and text are two carriers of those messages.’ We can confirm from McCoy’s explanation is that the classical reliance on the power of the word (seeing and reading) had limitations. These limitations were exposed by more expressive (image and text) approaches to typographic design and layout that enabled the senders of such messages to reach wider audiences through combined artistic (expression) and scientific (legibility) approaches to graphic design.

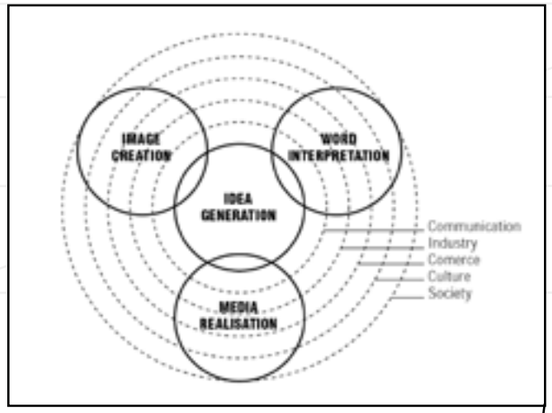
Figure 2



3.4 The dimensions of graphic design: Taking a wider perspective, we now reflect on the development of a model by the author of this paper first discussed at IASDR 2007. The stated intention for this work was to identify core values in graphic design in order to link practice, education and research in the subject around a common set of relationships.

The model proposed four active domains described as Idea Generation, Image Creation, Word Interpretation and Media Realisation. It attempted to demonstrate in visual terms the argument that idea generation is the central concern in graphic design, and this domain acts as a conduit for the creation, interpretation and realisation of graphic design products by utilising images, words and media. This activity is mediated by the communication needs of core contextual domains, listed as; Commerce, Industry, Culture and Society. Industry and Commerce are explicitly identified as important contexts (noteworthy because of the emergence and popularity of the graphic design in the twentieth century). These two contexts are discussed in the graphic design literature under the more generic term of ‘economic’ [3]. This depiction, shown in Figure 3, attempted to visualise relationships often discussed in the literature, but not ever appearing to be visualised in the form of a diagrammatic model. In this sense, the results of the inquiry were explained in visual terms that did not rely on examples of graphic design artefacts. For this reason, this basic model attempted to fill a gap, and serve an educational purpose.

Figure 3



Compared with the earlier discussion of models, by Brown and McCoy, this depiction incorporates media as a significant domain in its own right. But in making idea the central concern, we can discuss idea in relation to both graphic design activity as well as ideas that emerge from the wider context. Singling out idea in this way links the practice of graphic design to the context within which it happens. In this sense the diagram supports the philosophical view expressed by Lefebvre [16] that ‘...the (absolute) Idea produces the world’. This is what Margolin and Buchanan believe when they discuss the idea of Design: ‘the core of design thinking remains the ability to conceive, plan, and present ideas about products’ [19]. In the diagram shown here, it is argued that we can think of this domain in terms of ideas about how we create images, interpret words and realise material objects through media. Generating ideas is therefore closely associated with the Communication domain. Using a metaphor, the Idea dimension performs a ‘respiratory’ function, and facilitates the inhaling and exhaling of issues graphic design is concerned with, or the ‘messages’ and ‘ideas’ that Brown talks about. Communication might be thought of as the motive for converting ‘ideas’ into ‘messages’ and vice-versa. The intention behind the creation of this model was to identify key practical and theoretical domain. However, on reflection the balance between, and identification of, theory and practice is unclear. Which is which? How do we distinguish between the physical and the metaphysical? What is useful about the model is the opportunity to assign importance to the various domains, depending on personal preferences and abilities. For example, those who view graphic design as part of the wider subject of visual communication are able to highlight the communication domain. Similarly, those who wish to view the more practical concerns of media, (or theoretical issues associated with material culture), might see media representation as the most prominent. Illustrators or photographers might associate more with image creation, or typographers with word interpretation. In this sense the model attempts to identify basic dimensions from where we might begin to extract ‘core values’, ‘spheres of influence’, or what Swanson [27] prefers to refer to as ‘centres of gravity’. Whatever the focus, all of the dimensions are interwoven.

Figure 4: Proposed relationship between Humanities, Science and Design Source: Archer, Baynes and Roberts, (2005), p. 12.

Figure 5: The proposed relationship between design, science and humanities. Source: Harland, 2009.

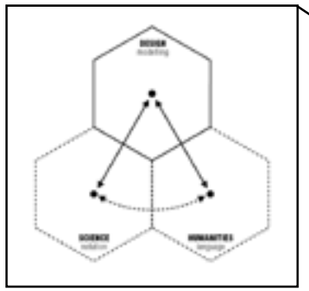


Figure 5

[1] Archer, B. (1976). The Three Rs. In B. Archer, K. Baynes & P. Roberts (Eds.), A framework for Design and Design Education: A reader containing key papers from the 1970s and 1980s (pp. 8–15). Wellesbourne: The Design and Technology Association.

[4] Bennett, A. (Ed.). (2006). Design Studies: theory and research in graphic design. New York: Princeton Architectural Press.

[21] McLean, R. (2000). How typography happens. London: The British Library and Oak Knoll Press.

[9] Cross, N. (2006). Designerly ways of knowing. London: Springer-Verlag.

[10] Crow, D. (2006). Left to Right / the cultural shift from words to pictures. Lausanne: AVA Publishing SA.

[11] D'Ammasso Tarbox, J. (2006). Activity Theory: A Model for Design Research. In A. Bennett (Ed.), Design Studies : theory and research in graphic design (pp. 73–81). New York: Princeton Architectural Press.

[14] Harland, R. (2009). The graphic design pendulum – the swing between information and affectation. Paper presented at the Information Design Conference 2009, 2–3 April 2009, London.

4. Art, science and design. McCoy asks '...is graphic design an art, science, business, craft, or language?' Similarly, the question pervades discussion in the closely associated field of typography. The back cover of Ruari McLean's [21] book How Typography Happens states 'Is typography an art or a science?' It seems that the answer to this question, according to Frascara [4], is to think of graphic design in terms of its 'basic duality', especially relating to the development of skills in an educational context.

Frascara states that 'Graphic Design is both a rational and an artistic activity', suggesting that two key spheres of influence on graphic design is the sciences and the humanities. But rather than assume that graphic design is merely a construct that emerges from an overlap between the two, in the same sense it has been suggested that design bridges a perceived gap between the sciences and the arts, and occupies an 'in-between realm' [5]. Are the material products of graphic design therefore revealed in some kind of space or overlap between the two? Or, do they exist in their own right? One answer to this question resides in the field of design research, where, building on the work of Bruce Archer in the 1970s, it has been argued by Cross [9] that design is a 'third area' or 'third culture'.

4.1 A 'third culture' and the work of Bruce Archer. When proposing an explanation of the relationship in general education between Humanities, Science and Design, Bruce Archer [1] used a triangle metaphor, and he traces the idea of a third domain back to Plato. Archer's depiction of the relationships, shown in Figure 4, positions Design at the bottom right corner of a triangle and Humanities at the top, acknowledging what he believed represented its dominance in general education since the fourteenth century. Science is located bottom left. The diagram attempts to identify as 'Design' the subjects that Science and Humanities 'leaves out', such as performing arts or physical education. Furthermore, Archer argues that the 'doing and making' relating to 'material culture' is not a concern of Science and Humanities, but is a central feature in Design. Describing the 'essential language' of each of these cultures, Archer refers to Science as 'notation', Humanities as 'natural language' and Design as 'modelling'.

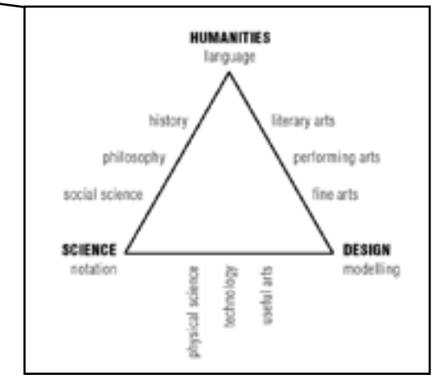
5.0 Synthesising theories of graphic design with design: Comparing Archer's depiction of the Science and Humanities with McCoy's focus of verbal-visual activities, it is possible to superimpose one on another. The 'verbal' qualities of rational, linear and sequential map onto those qualities associated with Science, whereas visual aspects link directly to Humanities. Similarly, Brown's suggestion of explanation and persuasion can be respectively mapped onto Science and Humanities respectively. And the terminology 'word interpretation' and 'image creation' used by Harland can also be aligned.

It's worth mentioning that this use of language is a simplification. The use of 'word' and 'image' when trying to define 'signs' makes use of familiar language to describe important ingredients that graphic designers work with. However, the suitability of 'word' and 'image' as terms of reference has also been noted as being too 'simplistic' [10]. The alternative use of 'alphabetical' and 'pictorial' has been used by Adrian Frutiger [10]. Concern about using the terms word and image, according to James Elkins, cited by Crow [10] suggests opposing and incompatible terms that do not capture the intricacy and sophistication of reading. Nevertheless, Crow uses the terms to represent the left and right side of the brain.

If we consider a reorientation of Archer's triangular model, the left/right, word/image, verbal/visual, explanation/persuasion dualities can be overlayed onto Science and Humanities. This allows the opportunity to align the different approaches taken by McCoy, Brown and Harland, with the work of Archer. In doing so we are able to elevate Design to a position of prominence more in keeping with the notion that Design is a bridge between the Science and the Arts. This reorientation has been described and depicted as Design being at the fulcrum of a pendulum that swings between Science and Art, shown in Figure 5 [14]. This is demonstrated using three hexagons. In constructing the diagram, Science, and its association with left-brain activity [7], is positioned accordingly on the left. Humanities is on the right, with Design helping to form a triangle of 'human knowledge and ability' [9].
Within this visual framework, we can begin locate key domains that make up graphic design. It is logical that the core values associated with the subject should align with human knowledge and ability. We might therefore make the simple assumption that graphic design is located predominantly as part of Design, and the importance attached to the question about whether graphic design is a science or an art is less relevant. This still raises questions relating to the respective influence of the sciences, and the humanities, in graphic design (the same can be said in reverse). Is one or the other more dominant? Or is this now a futile question that is better answered from the perspective of the context within which graphic design is situated.

Graphic design, at times, must draw on the values associated with the sciences, and the humanities. Often both. In this sense, Figure 5 depicts the physical, material culture dimension of design, and graphic design, located at fulcrum of the pendulum that is constantly swinging between the dual metaphysical domains of Science and the Humanities. The characteristics associated with these dimensions – left and right, verbal and visual, explanation and persuasion, objectivity and subjectivity, orderly to disorderly thinking – are important to designing. But it has been argued that at the outset, graphic design does not necessarily assume the values associated with one or the other [14]. Whereas Cross [9] suggests that design is concerned with 'appropriateness', the same can be said of graphic design. In this sense, we might place more emphasis on the differences between graphic science, graphic design, and graphic art, but this is not space here to explore this more fully.

Figure 4



KEY TREND: INTUITIVE INTERFACES

Figure 1: Netherlands-based Modem and Swiss design agency Panter&Tourron developed an open-source LLM device called TERRA. The pocket-sized AI offers a minimal interface approach for users seeking fewer distractions from their smartphones

Figure 2: Iyo's (US) personal computing enables users to learn, work, shop and curate audio surroundings, eliminating unwanted sounds

Figure 3: The Rewind Pendant by Limitless (US) lets you record and retrieve conversations. It comes with permission-based data protection

Figure 3

Figure 1

Figure 2

Natural User Interfaces (NUI) allow intuitive and easy interaction with systems and products. NUI design draws inspiration from real-world interactions, using human abilities to optimise synergy between physical and digital devices.

Aiming for convenience, voice assistants can boost productivity on the go.

Opportunity

As user interface vocabulary and innate gestures change, designers must be aware of cultural factors, future scenarios and behavioural contexts to create sustainable and immersive experiences. Leverage learned user behaviour to create personalised experiences with AI systems by collecting patterns based on users' interactions and preferences with an interface.

Desirability is an essential element of UX design that attracts users to interact with a product over its competitors. Consider user sentiment and feelings toward NUI designs in CMF direction and ergonomics in product development to cater to diverse consumer preferences and needs.

Need to know:

1) The global voice recognition market size is expected to reach $50bn by 2029
2) By 2032, the global gesture recognition market will reach approximately $116bn
3) In the US, 62% of people age 18+ use a voice assistant on any device
4) 53% of US consumers are more likely to make a purchase from voice ads
5) The global biosensor market size is projected to be worth around $58bn by 2033

Key themes:

1) Sleek assistance: design hardware applications for portable AI voice assistants
2) Environmental context: predict user needs to design better interactions
3) Disguised UI: minimise users' cognitive load through their learning path
4) Empathic tech: address the limitations of tech for emotional state recognition
5) Naturally inclusive: prioritise accessibility to help more users easily interact with devices

Sleek assistance

Design aesthetically pleasing wearable and portable AI-powered assistant devices that enable intuitive interactions.

The balance between aesthetics, functionality and usability is paramount. Brands must tackle technical issues like battery life and sensitive data collection when designing natural user interface gadgets.

With a global projection of over $265bn by 2026, the wearables and AI devices market faces challenges and opportunities for innovation.

Figure 4: Shapeshifting stickers by Northwestern University and Washington University School of Medicine (US) can be placed in human organs to monitor post-surgery complications by identifying the body's pH levels

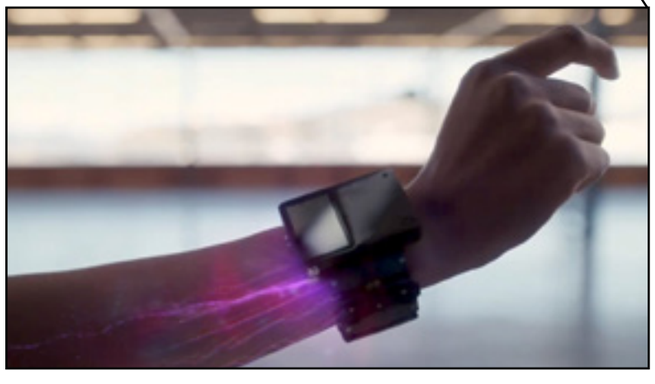
Figure 5: Meta Labs' (US) wrist-based gadget has limited contextualised AI to adapt to the user's environment through gesture control

Environmental context
Enhance usability by anticipating user needs based on past behaviour and preferences.

To be considered a natural interface, specific skills need to match the use context. Since we cannot design for every person in the world, creating with the use context in mind will differentiate and add value to companies that seamlessly integrate their products and services into users' environments.
Businesses will implement AI-powered solutions to use behavioural data to provide a more context-aware and tailored user experience, resulting in greater user engagement. Text-to-video AI avatars will count for 70% of digital and marketing communications by 2025. NUI solutions can provide users with complete digital support by offering a multimodal experience.

Improving user adoption is paramount in building brand trust for new product interfaces. Develop standardised UI for NUI tech to meet users' expectations from their accustomed traditional interfaces.

Figure 5



KEY TREND: INTUITIVE INTERFACES, ARIANNE ANABUKI

Figure 4

Figure 6: Invisibility Shield Co (UK) can render people and objects invisible in broad daylight using optical technologies

Figure 7: Concept View by LAYER (UK) for Deutsche Telekom is an AI-powered 3D holographic hub that seamlessly blends into surrounding decor and can be activated by a virtual assistant

Figure 8: Canada-based Naqi Logix's earbuds enable wearers to navigate the invisible user interface via a command input of jaw-clenching or eyebrow-lifting

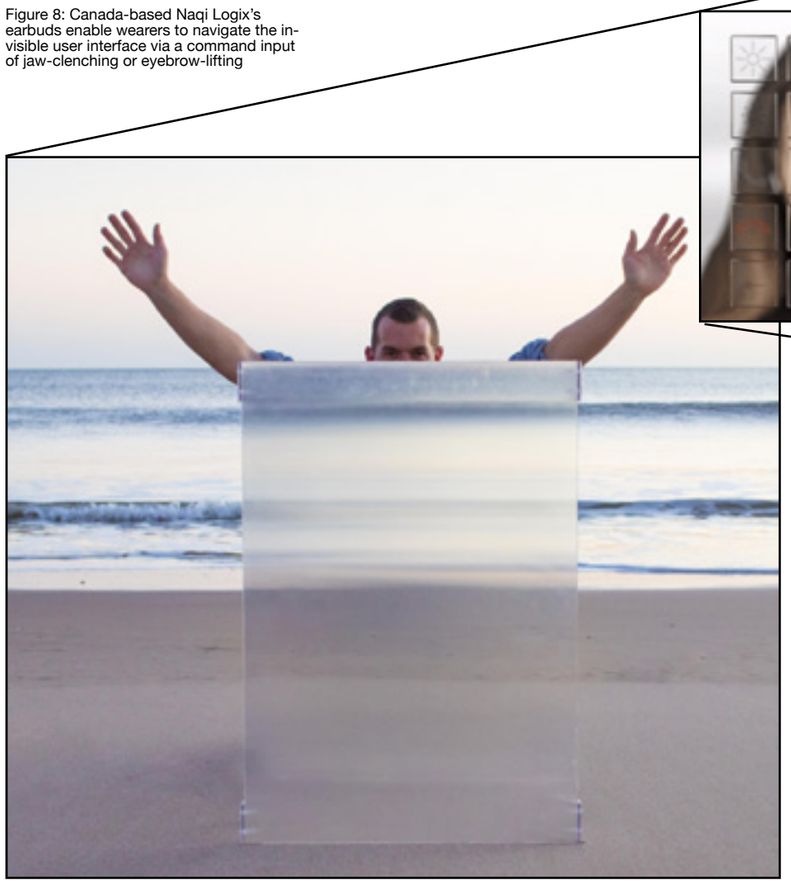


Figure 9

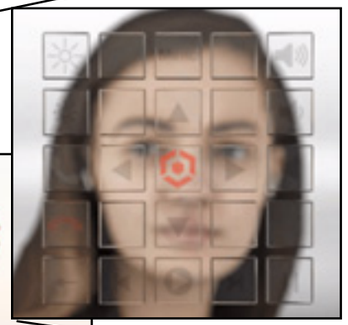


Figure 11

Disguised UI
Develop successive learned interactions to help transition users from novice to expert.

A well-designed user interface must maintain aesthetic appeal while providing excellent usability. It should integrate smoothly with the surroundings and be activated when needed. When the interface and interactions are simplified and seamless, users can focus on their tasks and goals. Minimising users' cognitive load requires NUI designs to transfer real-world skills to apply to new modes of interaction.

Novice users will require a more significant learning path to improve their experience than advanced users. Leverage progressive learning to allow users to perform basic tasks while supporting more complex interactions with veteran users.

Empathic tech
NUI can create human-like interaction between a user and a device, but brands should be aware of relying on affective computing technology.

NUI designs are great for understanding contextual information, anticipating user needs and delivering personalised experiences. Identifying patterns of product usage behaviour is crucial in informing design decisions and product development.

Using inputs such as facial expressions and physiological data to recognise, process and interpret human emotions is still up for debate. Cultural and local criteria can influence how we infer meaning from someone's emotional state. Localised data is essential to deeply understand users' motivations and needs rather than designing for the average.

Data collection raises concerns about user privacy, data misuse and data colonialism, converting human life aspects for value generation. Invest in R&D and strive to demonstrate your understanding of the technical, scientific, social and ethical implications of inferring emotions into technology using AI.

Figure 10

Naturally inclusive
Incorporate multimodal input-output modalities to generate natural user interaction by harnessing profound observation of human behaviour and attitudes towards technology.

Brands must strive to deepen their understanding of diverse user needs. Advocate for accessible and inclusive technology to reach a broader range of users, reduce frustration and increase satisfaction.
Multiple input methods enable more flexible and comfortable interaction. Craft output modalities to make UX more enjoyable and immersive, ensuring effective feedback communication through auditory, visual and sensory cues. Pursue feedback loops to ensure each interaction provides immediate and consistent responses to users.
Follow established guidelines such as WCAG to meet accessibility criteria. Involve diverse groups in the user research and testing stages of product development to identify accessibility issues and gather feedback on usability.

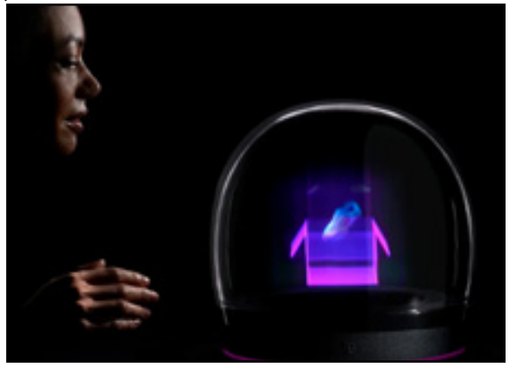


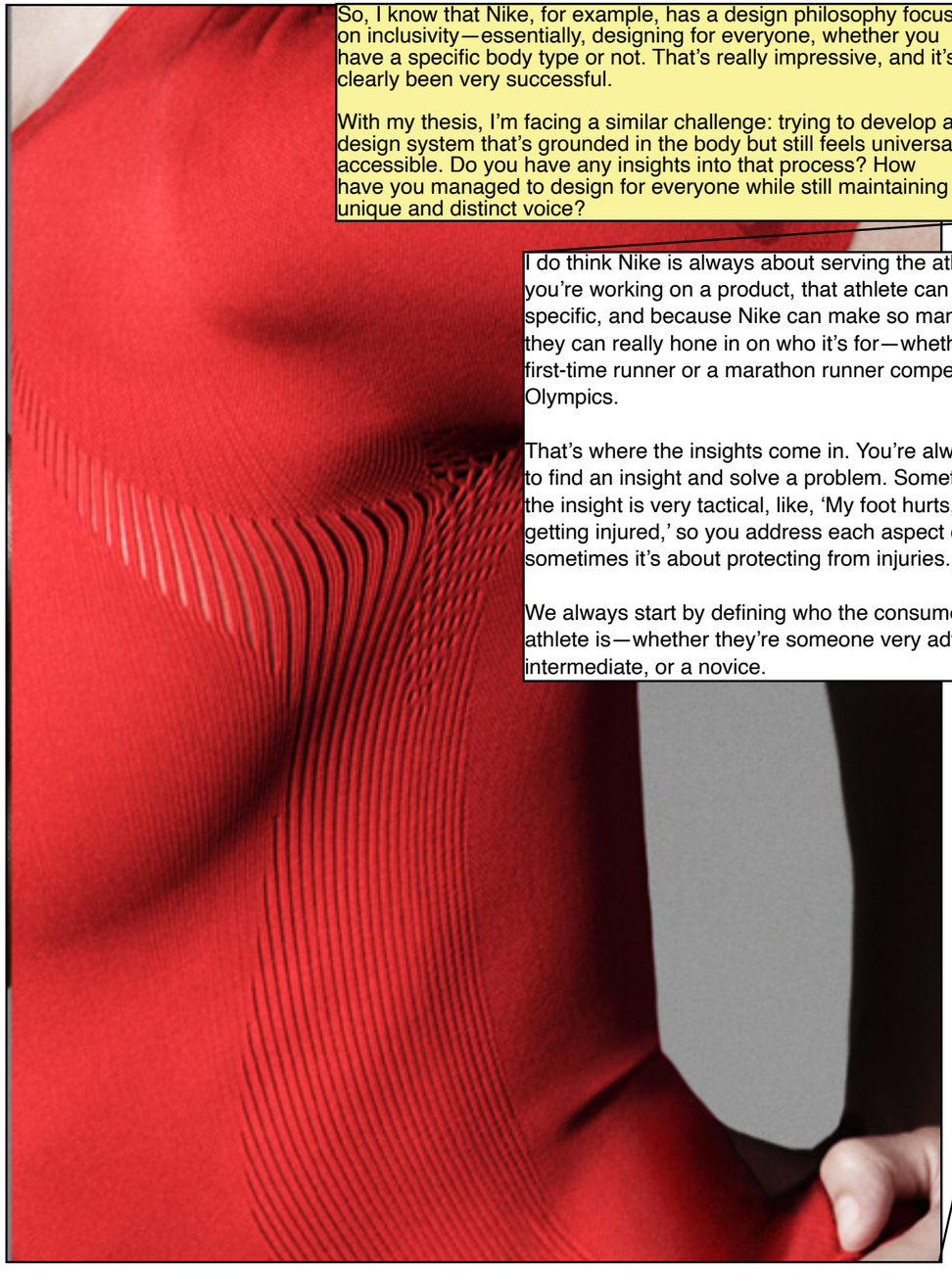
Photo Credit: Harley Weir, for Future Sport* Exchange

THE BODY AND BIOMIMMICRY: AN INTERVIEW WITH LINDA MAI LOTTI

Linda Mai-Lotti is a pioneering creative leader whose multi-disciplinary expertise spans product design, branding, retail, and marketing. Over her career, she has shaped innovative consumer experiences for globally renowned brands, with a significant impact at Nike. Known for integrating biomimicry and sustainability into design, she contributed to groundbreaking projects such as Nike's patented active illumination running jacket and sustainable retail concepts like Nike Well Collective and Nike Style. Her work aligns with her commitment to sustainability, as seen in events like the Future Sport* Exchange, where she collaborated with global leaders to address climate change and inspire meaningful design

At Nike, Linda's work encompassed diverse initiatives, from launching Jordan Women's business to creating brand-defining Olympic moments. Her human-centered, insights-driven approach ensures strategic alignment while fostering innovation. By simplifying complex concepts, she unites stakeholders, whether elite athletes, collaborators, or executive leaders, to achieve shared goals. Her global perspective, shaped by an international background and experience with institutions like NASA and IDEO, enriches her creative vision

Linda is also a passionate advocate for diversity and inclusion, building cultures where innovation thrives. Her leadership amplifies collaboration and creativity, creating environments where teams excel. With expertise in storytelling and future-forward strategies, she continues to redefine how design and sustainability intersect. As a thought leader in biomimicry and innovation, Linda's work exemplifies the power of creativity to connect, inspire, and drive positive change



So, I know that Nike, for example, has a design philosophy focused on inclusivity—essentially, designing for everyone, whether you have a specific body type or not. That's really impressive, and it's clearly been very successful.

With my thesis, I'm facing a similar challenge: trying to develop a design system that's grounded in the body but still feels universally accessible. Do you have any insights into that process? How have you managed to design for everyone while still maintaining a unique and distinct voice?

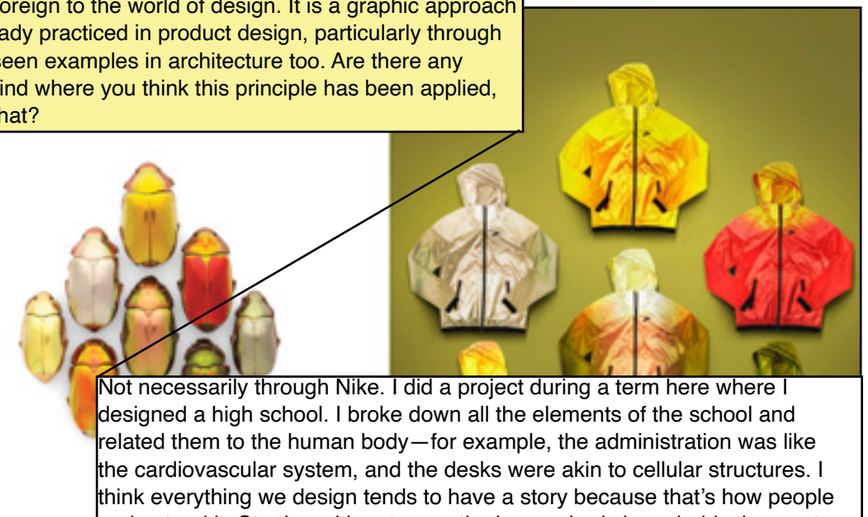
I do think Nike is always about serving the athlete. When you're working on a product, that athlete can be very specific, and because Nike can make so many products, they can really hone in on who it's for—whether it's a first-time runner or a marathon runner competing in the Olympics.

That's where the insights come in. You're always trying to find an insight and solve a problem. Sometimes the insight is very tactical, like, 'My foot hurts,' or, 'I'm getting injured,' so you address each aspect of it. And sometimes it's about protecting from injuries.

We always start by defining who the consumer or athlete is—whether they're someone very advanced, intermediate, or a novice.

Okay, so within each product line, you identify very specific athletes to cater to, right? And then the way you design for everybody—or, as you say, everybody with a body is an athlete—is by creating different collections to highlight various groups of people.

In my thesis, I'm exploring the concept of body-centric design. I don't believe this concept is entirely foreign to the world of design. It is a graphic approach to something that's already practiced in product design, particularly through ergonomics. I've even seen examples in architecture too. Are there any projects that come to mind where you think this principle has been applied, even if it wasn't called that?



Not necessarily through Nike. I did a project during a term here where I designed a high school. I broke down all the elements of the school and related them to the human body—for example, the administration was like the cardiovascular system, and the desks were akin to cellular structures. I think everything we design tends to have a story because that's how people understand it. Starting with nature or the human body is probably the most intuitive and central—maybe not instinctual, but intuitive.

If you look at nature—which includes the human body—it's all about survival, longevity, and growth. Nature designs for survival, so it's inherently efficient. There's so much to learn from that efficiency—every leaf changing color or the behavior of a bug is either about attracting a mate for reproduction or scaring away predators. I find designing inspired by nature endlessly fascinating.

At Nike, we've often looked at biomimicry. For example, you can be inspired by nature in terms of colors, patterns, or visibility. For running gear, visibility is critical, like ensuring a car sees you on the road. We've created a jacket inspired by the reflectivity and iridescence of a beetle. We've even worked with bioluminescence. I helped develop a running jacket that lights up at night using bio-luminescent ink. It charges and flashes without requiring a constant battery, which makes the battery last longer.

What's interesting is how the flashing was designed—it mimics the rhythm of a human breath. When a car sees it, the subconscious registers it as a living form rather than just a mechanical light, like from an ambulance. It's not just ON-OFF; the pauses give it a more natural, almost human quality.

Nike Lunar Epic,
www://mai-lotti.com

Nike Winged Goddess sculpture
by Kendall Buster, www://mai-lotti.com

Nike Epic Backpack, 2004
www://mai-lotti.com

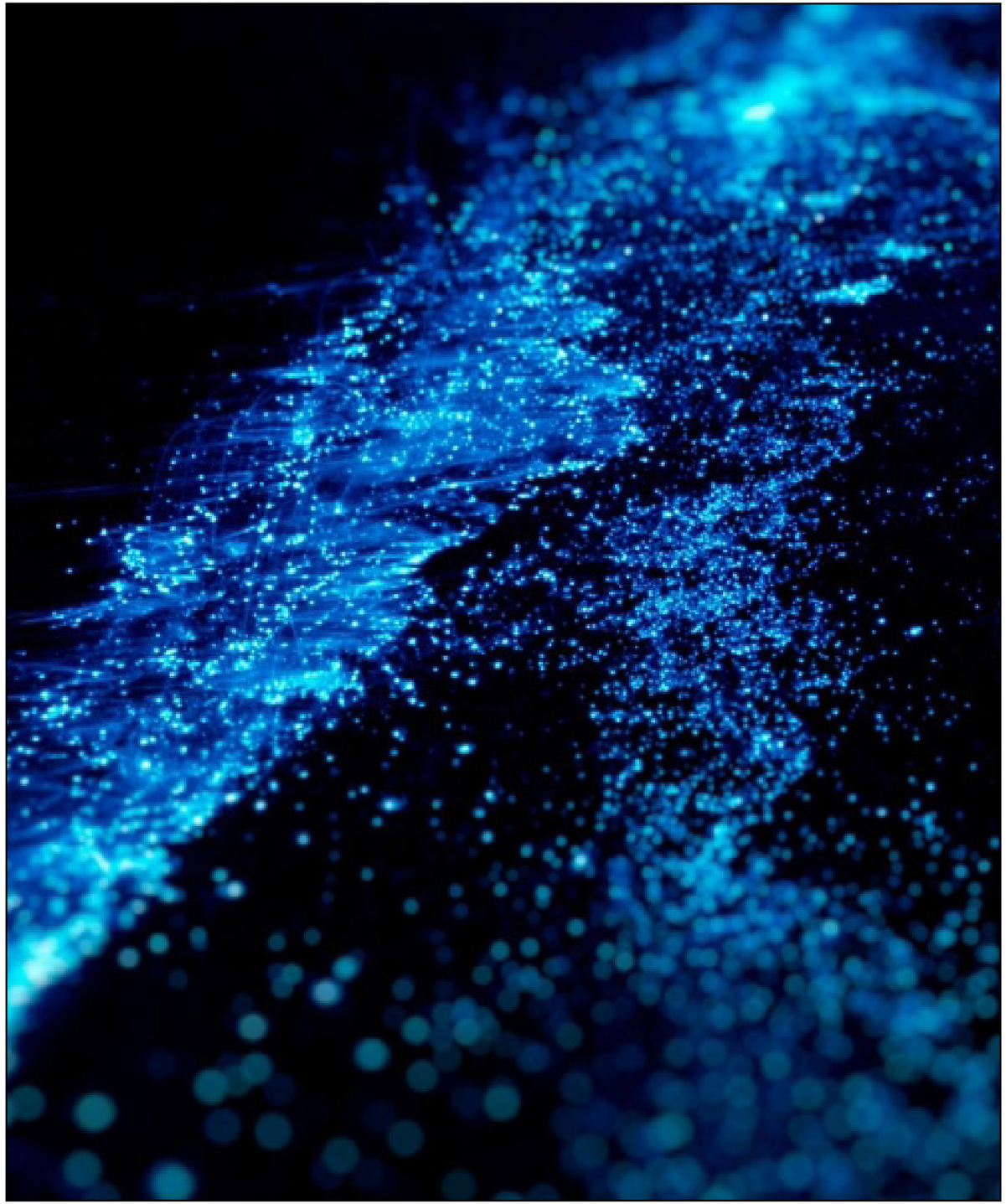
That running jacket is so fascinating to me. It sounds like you've combined the science of bioluminescence with an appeal to human nature by creating a flashing design that signals life—like to cars and others on the road. Is that right?

Ultimately, right? It always goes back to solving a problem. You're talking about people running at night, yeah, to be visible, and, yeah, and, and the insight is, runners like to run on the row versus on the sidewalk. I think, well, they just run on the sidewalk, but actually the sidewalk is concrete, which is very hard on the joints. That's why people run on the asphalt. It's a little bit more forgiving. So I'm like, Oh, okay. Then they just need, even need to be even more careful.

Do you feel that through these projects that combine these two concepts you like connected more like with your body through the research

Ultimately, right? It always goes back to solving a problem. You're talking about people running at night, yeah, to be visible, and, yeah, and, and the insight is, runners like to run on the row versus on the sidewalk. I think, well, they just run on the sidewalk, but actually the sidewalk is concrete, which is very hard on the joints. That's why people run on the asphalt. It's a little bit more forgiving. So I'm like, Oh, okay. Then they just need, even need to be even more careful.

The discovery, I think, is that it matches the rhythm of your pulse when you're running. You know how sometimes you can feel or even hear your heartbeat in your chest? It feels more connected that way.



gabby escobar

Figure 1: Model of flow of Generative Design References

[1] Robert E. Franken: Human Motivtion, 3rd ed, California State University Scripts.

[3] T. Jones, “Sample Journal Article,” Jour. Imaging Sci. and Technol., vol. 53, no. 1, pp. 1-5, 2009.2/2020

GENERATIVE DESIGN FOR CREATORS - THE IMPACT OF DATA DRIVEN VISUALIZATION AND PROCESSING IN THE FIELD OF CREATIVE BUSINESS

GENERATIVE DESIGN FOR CREATORS JULIA SCHNITZER

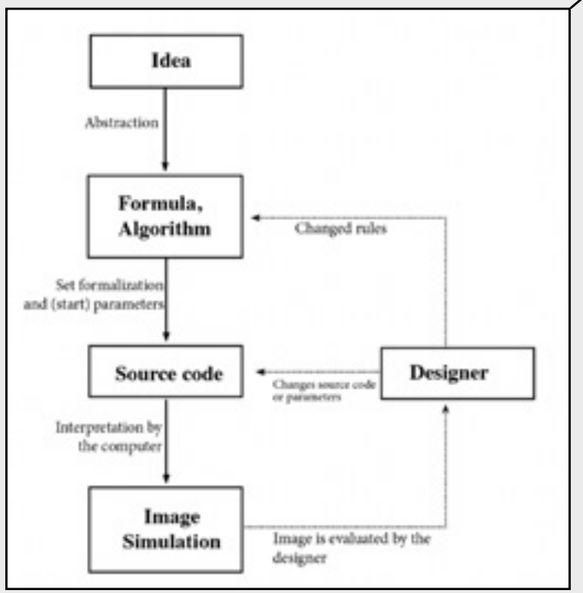


Figure 1

Abstract:

In how far can algorithms take care of your creative work?

Generative design is currently changing our conventional understanding of design in its basic principles. For decades, design was a handmade issue and postproduction a job for highly specialized professionals. Generative Design nowadays has become a popular instrument for creating artwork, models and animations with programmed algorithms. By using simple languages such as JavaScript’s p5.js and Processing based on Java, artists and makers can create everything from interactive typography and textiles to 3D-printed products to complex infographics. Computers are not only able to provide images, but also generate variations and templates in a professional quality. Pictures are being pre-optimized, processed and issued by algorithms. The profession of a designers will become more and more that of a director or conductor at the human-computer-interface. What effects does generative design have on the future creative field of designers? To find an answer to this complex field we analyze several examples of projects from a range of international designers and fine arts as well as commercial projects. In an exercise I will guide you step-by-step through a tutorial for creating your own visual experiments that explore possibilities in color, form and images. The present work deals with three different fields of application of algorithms in the field of creative business. There are a variety of definitions of what generative design is. Originally the term refers to a design method especially in the field of Industrial Design where certain parameters (stress, material, humidity etc.) create variations of a single draft. Nowadays, Generative Design is a technology in which 2D- or 3D models are created and optimized by an algorithm. A user sets up requirements for the model, such as manufacturing processes, loads, and constraints, and then the software offers designs that meet those requirements.

This paper addresses the question of the extent in how far can algorithms create better results as an artist / designer / architect and in how far can an algorithm meet a designer’s and client’s high expectations? The current situation can be divided into four sections:

1. Algorithm as a co-creator. This chapter deals with the question about the definition of human creativity and wants to find out in how far an algorithm can support daily challenges of a creative job examining several examples.

To understand the sense of creativity we first have to look at typical human skills to be able to get a deeper understanding of the complexity of creativity. Which human skills are needed for creativity and will not be replaced by Artificial Intelligence in Future? What characteristics differentiate humans from other forms of life and in addition to artificial intelligence? Besides that, human ideas are not only generated by electric nerve activity but with a combination of several body activity it is clear that creativity cannot only be substituted by mathematical issues.

Human skills needed for creativity for example are:

- Empathy
- Responsibility
- Experience
- Ethics
- Systematic thinking
- Believe

[2] J. Doe, Sample Book,
Springfield VA: IS&T, 1999.

Creativity is defined as the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others.”

[2]

First, we have to consider, that the term intelligence is a collective term for cognitive or mental performance. Creativity describes the ability to create something that is new or original while being useful or usable. Or as described by Prof. Robert E. Franken: Creativity is defined as the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others.” [1] Intelligence is kind of a superordinate, neutral term whereby in comparison creativity is performance.

Artificial Intelligence can be categorized into strong and weak KI and there are four types to be named [2]:

1. Reactive machines (f. e. a chess computer program). They were developed for limited purposes and cannot be easily applied to another situation.

2. Limited memory (f.e. in autonomous driving cars). Observations that happen in the not-too-distant future, for example, a car changing lanes. These observations are not stored permanently.

3. Native theory. In this category, AI systems have selfawareness or consciousness. Machines with selfawareness understand their current state and can use the information to infer what others are feeling. This type of AI does not yet exist.

4. Self-Awareness. In this category, AI systems have selfawareness or consciousness. Machines with selfawareness understand their current state and can use the information to infer what others are feeling. This type of AI does not yet exist.

Creativity would be a mixture of all four types. So let’s consider as a first raw conclusion: **Artificial intelligence is able to substitute human creativity in some fields. What makes it so special?**

Let us next have a look at a convenient creative workflow to achieve more insights: Clients expect from creative people (artist, designer, architect) to be unique, artistically (measured in winning competitions), trendsetting (get articles in relevant newspapers) and technically firm. It mostly starts with a client’s briefing and a request for a price offer. The client expects us to develop a viable and sustainable idea. We create drafts and if we like what we see, bring it to a professional level by vectorizing and finalizing it to a professional level. A feedback from the client mostly lets us draw variations in form, color, structure, layout position, shape and so on. We have a test-run and final draft / production going. But a lot of the time budget we spend for variations and finding the best / suitable design from a basic idea.

Figure 2: Flowchart of a convenient creative workflow

Figure 4: Optimization result of the Airbus A320 partition wall. [4]

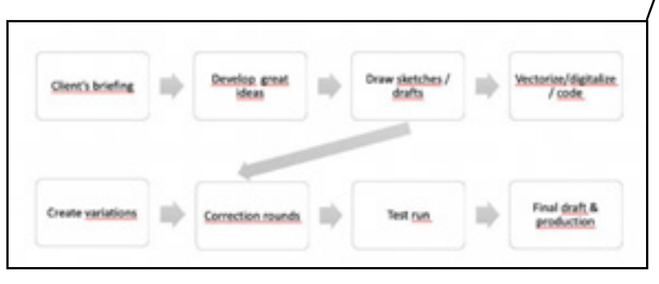
Figure 5: Assembling construction view Bionic Partition Wall Airbus A320 [4]

[4] Airbus Newsletter 03/16, Pioneering bionic 3D printing, https://www.airbus.com/newsroom/news/en/2016/03/Pioneeringbionic-3D-printing.html

The following image shows how conventional workflow is structured and where there is a lot of time investigation necessary for a successful result. As can be seen from the figure, the algorithm in this example can be particularly helpful where variants and design options are involved.

Let's have a look at an illustrating example: The aircraft manufacturer Airbus relies on generative design in the further development of the A320. The Bionic Partition Wall, developed in collaboration with US software company Autodesk and created using the 3D-printing process, weights 30 kg and is therefore 45% lighter than previous components. 4

Figure 2



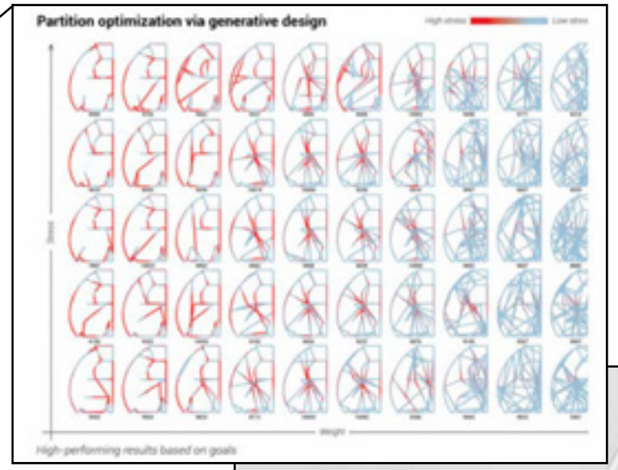


Figure 4

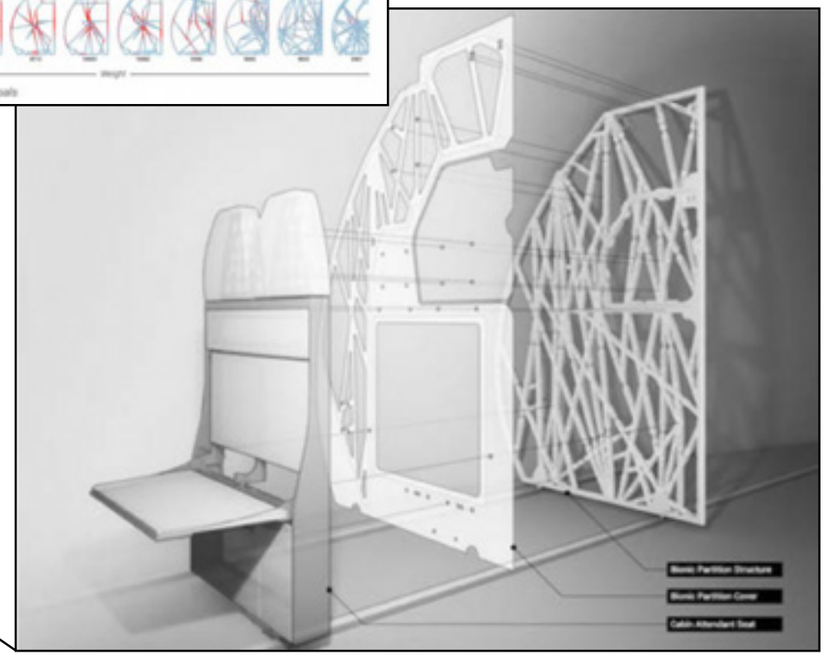


Figure 5

Interim summary:

An algorithm supports a creative process in the following fields as listed:

- Large range of parameter-driven variations of optimized design-drafts with little effort
- Shortens design and production process
- Creates better performing results (in the shown example lighter or more stress-resistant samples)
- Lower material costs
- Less model building (clay models) or less assembling or welding work (also thanks 3Dprinting possibilities)

Figure 6: Andy Warhol Campbell Soup Cans 1962 [5]

Figure 7: Campbell Soup Can for $ 3,89 in MyAmerican Market Online-Shop [6]

Figure 8: Bosporus Data Scupture by Refik Anadol, Istanbul, 2019 [9]

[5] Singulart Magazine, Kunstwerke unter der Lupe, Campbells Soup Cans from Andy Warhol: https://blog.singulart.com/de/2018/08/14/campbells-soup-cans-vonandy-warhol/

[6] https://www.myamericanmarket.com

[7] Arthur Danto, What Art Is, Yale University Press, 2014

[8] Art vs. Life vs. Pop: A review of Andy Warhol (Icons of America series) by Arthur C. Danto cont. by Gary Comenas/London/2009

[9] https://refikanadol.com/works/bosphorus/

Figure 8

2. Algorithm as a creator

This chapter deals with the question about the impact of Generative Design in the field of art and how an algorithm can create art. Example 01: The example shows the very famous series of “Campbell soup cans” 1962 by of Andy Warhol at Ferous Gallery in New York.

There are a lot of existing namely articles about the fact that Andy Warhol’s Campbell Soup Can Serie, also as a pile-up artwork of originals, is art but it’s sisters and brothers sold in a simple supermarket are not. One of the most important definitions and the explanation about why Andy Warhol’s soup cans are considered art, but also a common definition is made by Arthur Danto in “What art is”[7]. He explains as follows: **“What in the end makes the difference between a Campbell’s soup can and a work of art consisting of a Campbell soup can is a certain theory of art... without the theory, one is unlikely to see it as art, and in order to see it as part of the artworld, one must have mastered a good deal of artistic theory as well as a considerable amount of the history of recent New York painting. It could not have been art fifty years ago.” 8** Both intention and perception, then are integral to Danto’s definition of art. If somebody creates something as art and that thing is perceived as art, then it is art. The importance of Danto’s definition of art is that its basis is philosophical or conceptual rather than a question of the aesthetics of a piece. The reason that the Campbell’s Soup Cans could not have been art 50 years previous to Danto’s essay is because definitions of art in the early twentieth century still concentrated on the aesthetics of a piece rather than the idea behind it. Danto’s definition does, however, present its own set of problems. Could art exist in a vacuum? But Art generated by a computer would still be considered art because it’s about a concept.

The question exposed here, however, is not what art is, but to what extent an algorithm can generate art. To illustrate this, I would like to give two further examples.

Example 02: Bosporus Data Sculpture. Refik Anadol is acontemporary media artist based in Los Angeles. His artwork is special for that the artist is creating the idea of his artwork but the illustration itself is generated by an algorithm. This example shows that the act of art doesn’t compulsory mean be bound to its result. It is enough to create a vision, the main idea and to construct an engine.
The output is generated by the computer and image quality meets the audience’s high expectations. The result shows that an algorithm as can be a creator as long as it is built by an artist.

Figure 7

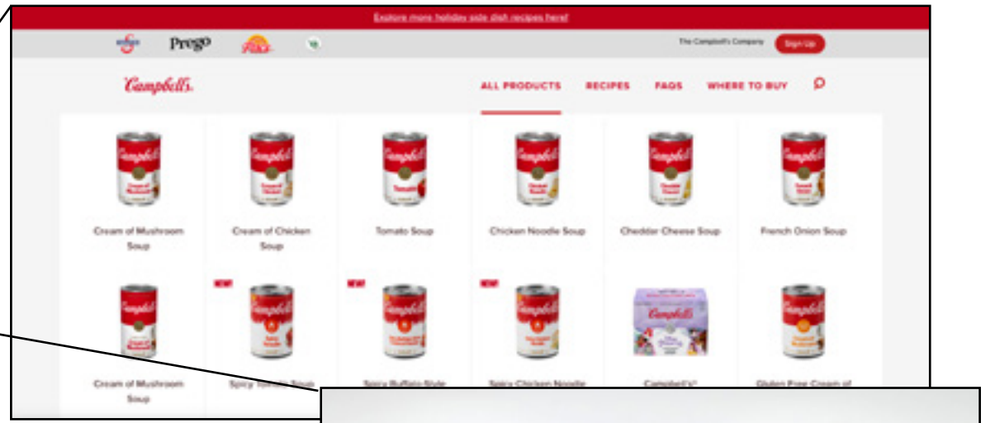


Figure 6

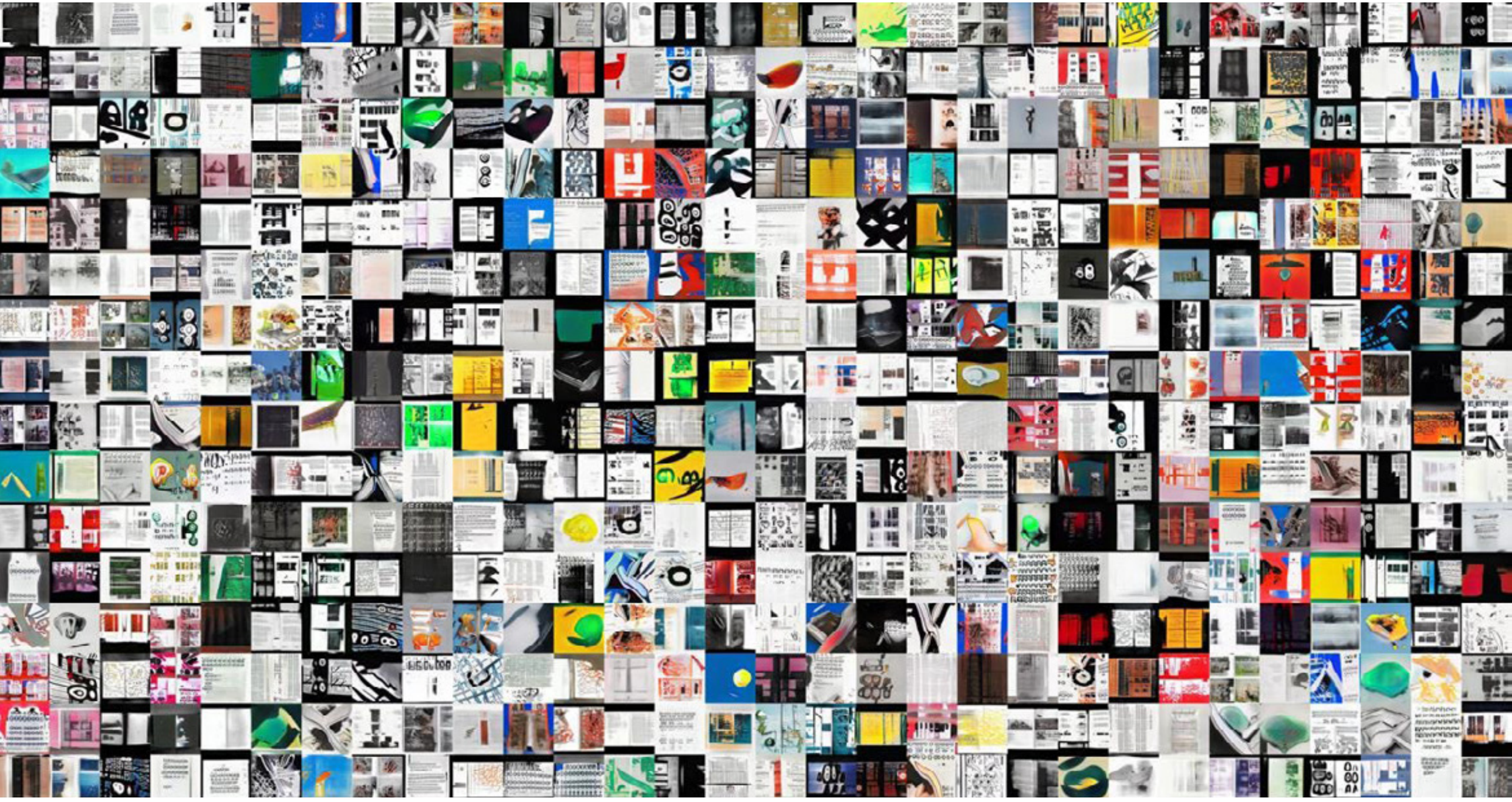


Figure 9: Images from Element of Disruption – the noise inside learning machines [11]

Figure 10: Artwork from Sougwen Chung, “when I draw with robots”, co-active drawings with AI-robots. [12]

[10] Friedrich Kittler, born in 1943, is considered one of the most influential media theorists in Europe. Professor of Aesthetics and History at the Humboldt University of Berlin. https://archive.transmediale.de/content/friedrich-kittler

[11] Runway Flash Residency. https://medium.com/runwayml/elementsof-disruption-the-noise-inside-learning-machines-cd0b42f655a8

[12] “Sougwen Chung – Art Gallery”. nips4creativity.com. Retrieved 2018-03-04.

Figure 9

Example 03: „Elements of disruption – the noise inside learning machines“ by Runway Flash Residency. Runway ML is a software that promises to create digital art by Machin Learning, and you do not need any coding skills to use it. The company gives scholarships within the Runway Flash Residency. This project called “Elements of disruption – the noise inside learning machines” was written by a runway scholarship holder. Since Friedrich Kittler [10] we know that noise is not only disturbing our messages, rather it is the message itself — that wants to be decrypted. “Let’s tell a little more about the concept behind because it is really challenging and forward-looking: noise is not only disturbing our messages, rather it is the message itself that wants to be decrypted. When looking at images of machine learning, one common pattern is noise. Instead of suppressing this noise, I want to take a close look in this visual exploration. When you look at these machines generated images, what you commonly see, are very distinct artefacts. Moments of distortion, that so many engineers are probably trying to fight right now. But instead of fighting it, I want to take a closer look at the noise produced by these machines learning algorithms”[11]

These examples show that the question “what is art?” depends on the artists idea, who is executing it is unimportant, it can be a team of people or a machine. But yet the spark cannot be given by an algorithm. They only execute and generate. The output result is remarkable aesthetic.

Example 04: Artwork from Sougwen Chung, “when I draw with robots”, co-active drawings with AI-robots. Soungwen’s work is an exploration into machine learning of the drawing style of the artist’s hand. The robotic arm’s behavior is generated from neural nets trained on the artist’s drawing gestures. In a sense, the robotic arm has learned from the visual style of the artists previous drawings and
outputs a machine interpretation during the human / robot drawing duet.

Interim summary

An algorithm supports an artistic process as:

- The (digital)artist creates the concept
- Artist / coder writes an algorithm which is fed by data (input)
- The visual output (animation, graphics etc.) is created by the algorithm / robot
- Algorithms change from passive to active / co-active production
- Not only reaction but also decisions are made by the algorithms.

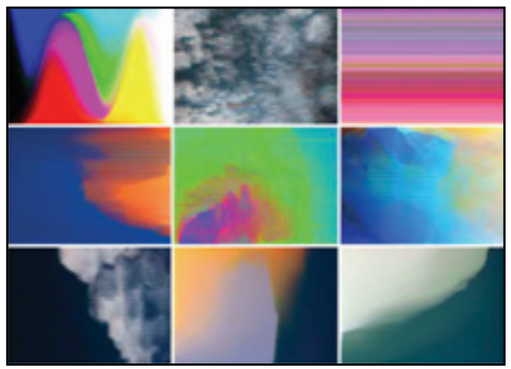


Figure 8

Figure 11: Heinz H. Landes, Solid, Beton-Freischwinger 1986

Figure 12: Corporate- and Packaging Design BRUTÉ Wine. [15]

[13] Louis Sullivan; „The tall office building artistically considered“, 1896

[14] Heinz H. Landes, Abbildung aus „Kunstforum“ Thema Design, 1996

[15] http://www.brute-wine.com

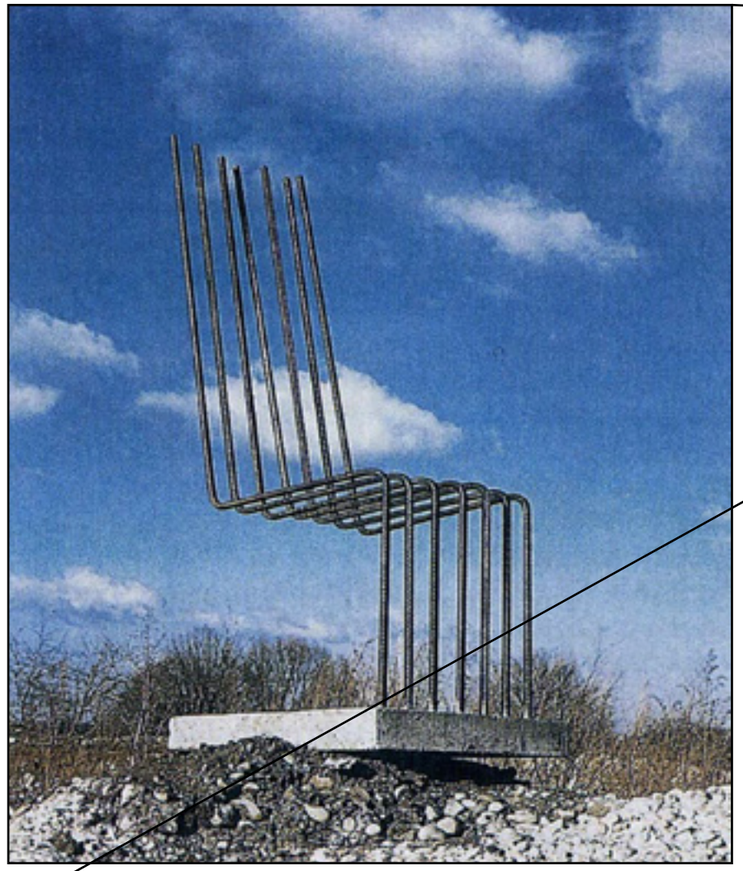


Figure 11

Figure 12

3. Algorithm generating brand identity

In contrast to art, design defines itself as linked to function. “Form follows function” is the most common and easy to understand definition of Design by Louis Sullivan [13]. This guiding principle also works for Generative Design, as demonstrated later. But let us start with a convenient example showing that also this definition is interpreted broadly:

Example 02: Corporate Design for Hamburg-based wine yard “Brut Wine”. The idea behind using Generative Design for the product packaging and label design of their wine and sparkling wine products is that the character of every vintage is generated by weather conditions like rain, wind, sunshine and temperature. The algorithm is fed by daily weather data. if there is a lot of rain, the design becomes more tighter, using stripes and larger dots. If there is wind, there is more dynamic in the picture. At the end of the season a unique pattern is generated and printed for each single collection.

Interim summary

An algorithm supports a corporate design as:

- Suitable for corporate designs which ahave movement, progress or change within their brand values
- Algorithm creates variations, creator can choose
- Basic design has to be drawn by creative person
- High quality aesthetics

4. Final conclusion

Code and design are increasingly intertwined and interdependent. Meanwhile it’s outdated to think that artists work with paint only or create a design by making sketches of furniture or drawing book-cover illustration only. Art universities offer more and more digital skills and media classes, because creators become code engineers of their own work. This changes the conventional education of artists and designers fundamentally. The Job description of creative people has changed rapidly. Away from the cliché of who is primarily responsible for the beautiful shell / optics, towards an interdisciplinary team player who is involved in the development process from the start.

Generative design leverages artificial intelligence and machine learning to turn tedious engineering design processes into a sophisticated yet natural interaction between computer and engineer. The main part of the topology optimization and simulation is automatically conducted by the computing unit.

And yes it has a phantastic impact on our creative jobs whether we use it to complement traditional techniques or to head on for a totally different understanding of art and design: Generative design therefore helps us to find the most efficient form in the production of three-dimensional objects and it helps us to conserve resources. In contrast to generative design as it exists in art, generative design pursues very specific intentions geared towards economic goals. In this environment, the designer is no longer necessarily the one responsible for creation. Rather, with thecomputer, the designer gets a “co-creator” who puts him in the role of curator himself. **As such, the designer can draw on the full and in close coordination and on an equal footing with engineers, developers and other decision-makers, make the selection of the ideal design.** There is no need to push through and “defend” your own design, because ultimately all designs were created using algorithms.

3. Michelle A. Borkin, Azalea A Vo, Zoya Bylinskii, Phillip Isola, Shashank Sunkavalli, Aude Oliva, and Hanspeter Pfister. 2013. What Makes a Visualization Memorable? IEEE Transactions on Visualization and Computer Graphics 19, 12 (Dec 2013), 2306–2315. DOI:http://dx.doi.org/10.1109/TVCG.2013.234

22. Nam Wook Kim, Zoya Bylinskii, Michelle A. Borkin, Krzysztof Z. Gajos, Aude Oliva, Frédo Durand, and Hanspeter Pfister. 2017. BubbleView: an interface for crowdsourcing image importance maps and tracking visual attention. TOCHI (2017). DOI: http://dx.doi.org/10.1145/3131275

33. Peter O'Donovan, Aseem Agarwala, and Aaron Hertzmann. 2014. Learning Layouts for Single-PageGraphic Designs. IEEE Transactions on Visualization and Computer Graphics 20, 8 (Aug 2014), 1200–1213. DOI: http://dx.doi.org/10.1109/TVCG.2014.48

39. Ronald A Rensink. 2011. The management of visual attention in graphic displays. Cambridge University Press, Cambridge, England.

40. Ruth Rosenholtz, Amal Dorai, and Rosalind Freeman. 2011. Do Predictions of Visual Perception Aid Design? ACM Trans. Appl. Percept. 8, 2, Article 12 (Feb. 2011), 20 pages. DOI: http://dx.doi.org/10.1145/1870076.1870080

LEARNING VISUAL IMPORTANCE FOR GRAPHIC DESIGNS AND DATA VISUALIZATIONS

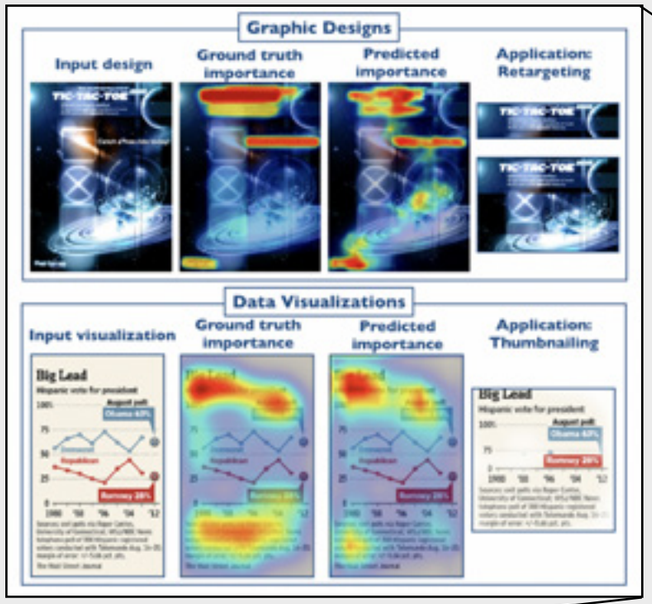


Figure 1. We present two neural network models trained on crowdsourced importance. We trained the graphic design model using a dataset of 1K graphic designs with GDI annotations [33]. For training the data visualization model, we collected mouse clicks using the Bubble-View methodology [22] on 1.4K MASSVIS data visualizations [3]. Both networks successfully predict ground truth importance and can be used for applications such as retargeting, thumbnailing, and interactive designtools. Warmer colors in our heatmaps indicate higher importance.

Abstract:

Knowing where people look and click on visual designs can provide clues about how the designs are perceived, and where the most important or relevant content lies. The most important content of a visual design can be used for effective summarization or to facilitate retrieval from a database. We present automated models that predict the relative importance of different elements in data visualizations and graphic designs. Our models are neural networks trained on human clicks and importance annotations on hundreds of designs. We collected a new dataset of crowdsourced importance, and analyzed the predictions of our models with respect to ground truth importance and human eye movements. We demonstrate how such predictions of importance can be used for automatic design retargeting and thumbnailing. User studies with hundreds of MTurk participants validate that, with limited post-processing, our importance-driven applications are on par with, or outperform, current state-of-the-art methods, including natural image saliency. We also provide a demonstration of how our importance predictions can be built into interactive design tools to offer immediate feedback during the design process.

Introduction:

A crucial goal of any graphic design or data visualization is to communicate the relative importance of different design elements, so that the viewer knows where to focus attention and how to interpret the design In other words, the design should provide an effective management of attention [39]. Understanding how viewers perceive a design could be useful for many stages of the design process; for instance, to provide feedback [40]. Automatic understanding can help build tools to search, retarget, and summarize information in designs and visualizations. Though saliency prediction in natural images has recently become quite effective, there is little work in importance prediction for either graphic designs or data visualizations.

We use "importance" as a generic term to describe the perceived relative weighting of design elements. Image saliency, which has been studied extensively, is a form of importance. However, whereas traditional notions of saliency refer to bottom-up, pop-out effects, our notion of importance can also depend on higher-level factors such as the semantic categories of design elements (e.g., title text, axis text, data points). This paper presents a new importance prediction method for graphic designs and data visualizations. We use a state-ofthe-art deep learning architecture, and train models on two types of crowd sourced importance data: graphic design importance (GDI) annotations [33] and a dataset of BubbleView clicks [22] we collected on data visualizations.

Our importance models take input designs in bitmap form. The original vector data is not required. As a result, the models are agnostic to the encoding format of the image and can be applied to existing libraries of bitmap designs **Our models pick up on some of the higher-level trends in ground truth human annotations.** For instance, across a diverse collection of visualizations and designs, our models learn to localize the titles and correctly weight the relative importance of different design elements (Fig. 1).

We show how the predicted importance maps can be used as a common building block for a number of different applications, including retargeting and thumbnailing. Our predictions become inputs to cropping and seam carving with almost no additional post-processing. Despite the simplicity of the

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approach, our retargeting and thumbnailing results are on par with, or outperform, related methods, as validated by a set of user studies launched on Amazon's Mechanical Turk (MTurk). Moreover, an advantage of the fast test-time performance of neural networks makes it feasible for our predictions to be integrated into interactive design tools (Fig. 2). With another set of user studies, we validate that our model generalizes to fine-grained design variations and correctly predicts how importance is affected by changes in element size and location on a design.

Related Work

Designers and researchers have long studied eye movements as a clue to understanding the perception of interfaces [9, 16]. There have also been several recent studies of eye movements and the perception of designs [2, 12]. However, measuring eye movements is an expensive and time-consuming process, and is rarely feasible for practical applications.

Few researchers have attempted to automatically predict importance in graphic designs. The DesignEye system [40] uses hand-crafted saliency methods, demonstrating that saliency methods can provide valuable feedback in the context of a designapplication. O'Donovan et al. [33] gather crowdsourced importance annotations, where participants are asked to mask out the most important design regions. They train a predictor from these annotations. However, their method requires knowledge of the location of design elements to run on a new design. Haass et al. [11] test three natural image saliency models on the MASSVIS data visualizations [3], concluding that, across most saliency metrics, these models perform significantly worse on visualizations than on natural images. Several models also exist for web page saliency. However, most methods use programmatic elements (e.g., the DOM) as input to saliency estimation rather than allowing bitmap images as input [4, 47]. Pang et al. predict the order in which people will look at components on a webpage [36] by making use of the DOM and manual segmentations. Other works use the web page image itself as input to predict saliency [43, 45]. Most of these methods use older saliency architectures based on hand-crafted features that are inferior to the state-of-the-art neural networks we use in our approach. Our work also relates to the general program of applying computer vision and machine learning in the service of graphic design tools [27,28, 42].

Figure 2. We show an interactive graphic design application using our model that lets users change and visualize the importance values of elements. Users can move and resize elements, as well as change color, font, and opacity, and see the updated realtime importance predictions. For instance, a user changes the color of the text to the left of the runner to increase its importance (middle panel). The right-most panel includes a few additional changes to the size, font, and placement of the text elements to modify their relative importance scores. A demo is available at visimportance.csail.mit.edu.

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Predicting eye movements for natural images is a classic topic in human and computer vision. The earliest natural image saliency methods relied on hand-coded features (e.g., [15]). Recently, deep learning methods, trained on large datasets, have produced a substantial jump in performance on standard saliency benchmarks [7, 8, 14, 29, 35, 49]. However, these methods have been developed exclusively for analyzing natural images, and are not trained or tested on graphic designs. Our work is the first to apply neural network importance predictors to both graphic designs and data visualizations.

Data Collection

To train our models we collected BubbleView data [22, 23] for data visualizations, and used the Graphic Design Importance (GDI) dataset by O'Donovan et al. [33] for graphic designs. We compared different measurements of importance: BubbleView clicks to eye movements on data visualizations, and BubbleView clicks to GDI annotations on graphic designs.

Ground truth importance for data visualizations

Large datasets are one of the prerequisites to train neural network models. Unfortunately, collecting human eye movements for even hundreds of images is extremely expensive and timeconsuming. Instead, we use the BubbleView interface by Kim et al. [22, 23] to record human "attention" that is correlated with eye fixations. Unlike eye tracking, which requires expensive equipment and a controlled lab study, BubbleView can be used to to collect large datasets with online crowdsourcing.

In BubbleView, a participant is shown a blurry image and can click on different parts of the image to reveal small regions, or bubbles, of the image at full resolution. Initial experiments by Kim et al. [23] showed a high correlation between eye fixations collected in the lab and crowdsourced BubbleView click data. In this paper, we confirm this relationship. Concurrent work in the computer vision community has applied a similar methodology to natural images. SALICON [18] is a crowdsourced dataset of mouse movements on natural images that has been shown to approximate free-viewing eye fixations. Current state-of-the-art models on saliency benchmarks have all been trained on the SALICON data [8, 14, 29, 35, 49]. BubbleView was concurrently developed [23] to approximate eye fixations on data visualizations with a description task. Some advantages of BubbleView over SALICON are discussed in [22]. Using Amazon's Mechanical Turk (MTurk), we collected BubbleView data on a set of 1,411 data visualizations from the MASSVIS dataset [3], spanning a diverse collection of sources (news media, government publications, etc.) and encoding types (bar graphs, treemaps, node-link diagrams, etc.). We manually filtered out visualizations containing illegible and non-English text, as well as scientific and technical visualizations

containing too little context. Images were scaled to have a maximum dimension of 600 pixels to a side while maintaining their aspect-ratios to fit inside the MTurk task window. We blurred the visualizations using a Gaussian filter with a radius of 40 pixels and used a bubble size with a radius of 32 pixels as in [22]. MTurk participants were additionally required to provide descriptions for the visualizations to ensure that they meaningfully explored each image. Each visualization was shown to an average of 15 participants. We aggregated the clicks of all participants on each visualization and blurred the click locations with a Gaussian filter with a radius of 32 pixels, to match the format of the eye movement data.

We used the MASSVIS eye movement data for testing our importance predictions. Fixation maps were created by aggregating eye fixation locations of an average of 16 participants viewing each visualization for 10 seconds Fixation locations were Gaussian filtered with a blur radius of 32 pixels. Fig. 3a includes a comparison of the BubbleView click maps to eye fixation maps from the MASSVIS dataset. Ground truth importance for graphic designs We used the Graphic Design Importance (GDI) dataset [33] which comes with importance annotations for 1,078 graphic designs from Flickr. Thirty-five MTurk participants were asked to label important regions in a design using binary masks, and their annotations were averaged. Participants were not given any instruction as to the meaning of "importance.".To determine how BubbleView clicks relate to explicit importance annotations, we ran the BubbleView study on these graphic designs and collected data from an average of 15 participants per design. Fig. 3b shows comparisons between the GDI annotations and BubbleView click maps. In both data similar elements and regions of designs emerge as important. Each representation has potential advantages. The GDI annotations assign a more uniform importance score to whole elements. This can serve as a soft segmentation to facilitate design applications like retargeting. BubbleView maps may be more appropriate for directly modeling human attention.

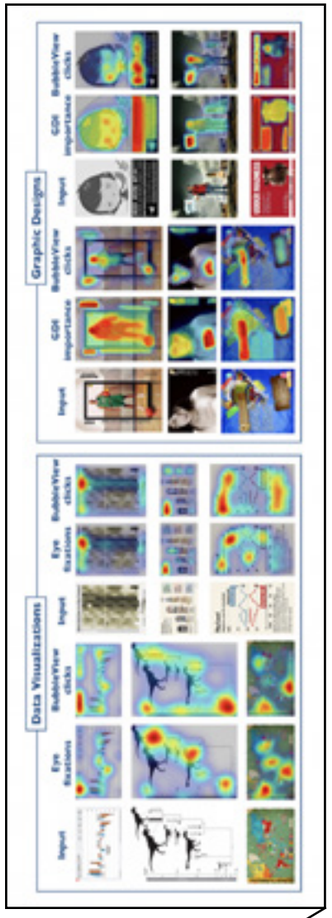
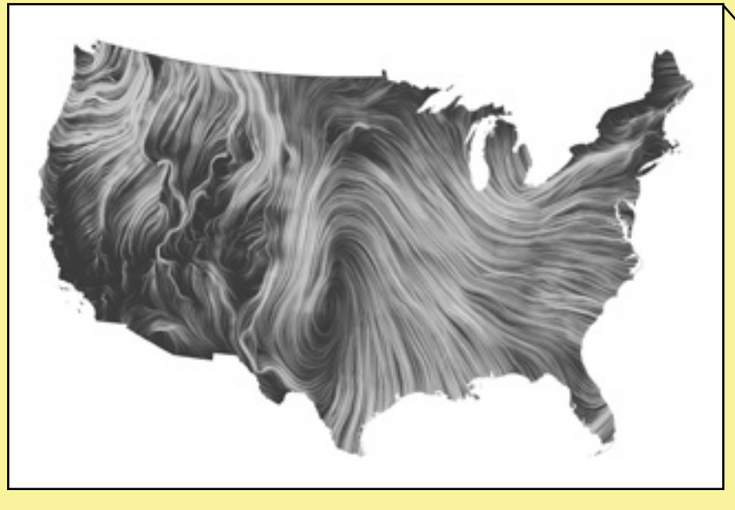


Figure 3. Left: Comparison of eye movements collected in a controlled lab setting [2], and clicks that we crowdsourced using the BubbleView interface [22, 23]. Right: Comparison of importance annotations from the GDI dataset, and clicks that we crowdsourced using the BubbleView interface. These examples were chosen to demonstrate some of the similarities and differences between the modalities. For instance, compared to eye fixations, clicks are sometimes more concentrated around text. Compared to the GDI annotations, clicks do not assign uniform importance to whole design elements. Despite these differences, BubbleView data leads to similar importance rankings of visual elements (Evaluation).

Artists in the Exhibition:
Refik Anadol
Laurie Frick
Hyojung Seo
George Legrady
Rafael Lozano Hemmer
Giorgia Lupi and Ehren Shorday
Iñigo Manglano-Ovalle
Sarah Morris
Data to Discovery: Santiago Lombeyda and Hillary Mushkin
Mimi Ọnụọha
Semiconductor: Ruth Jarman and Joe Gerhardt
Linnéa Gabriella Spransy
Mika Tajima
Fernanda Viégas and Martin Wattenberg
Peggy Weil

SEEING THE UNSEEABLE: DATA, DESIGN, AND ART EXHIBITION

We live in the age of Big Data: extremely large data sets collected from multiple sources by scientists, businesses, nonprofit organizations, government agencies, and others. Data visualization—the practice of representing data—is one of the primary tools used to make these massive amounts of data understandable, transforming them into knowledge. Within the sciences, data visualization conveys information in a compelling manner; in art, it transforms information into a canvas for creative expression. Over the past 20 years, artists and designers have incorporated data visualization into their work, both as a way of critiquing it and as a new form of storytelling. Seeing the Unseeable explores how art, science, and design have become integrated in the work of both scientists and contemporary artists.



"Wind map," visualization of wind patterns in the us on November 2, 2013, Fernanda Viégas and Martin Wattenberg. Courtesy of Fernanda Viégas and Martin Wattenberg. ©Fernanda Viégas and Martin Wattenberg.

"Storm Prototype No.4," 2006, Iñigo Manglano-Ovalle. Fiberglass and aluminum alloy foil.

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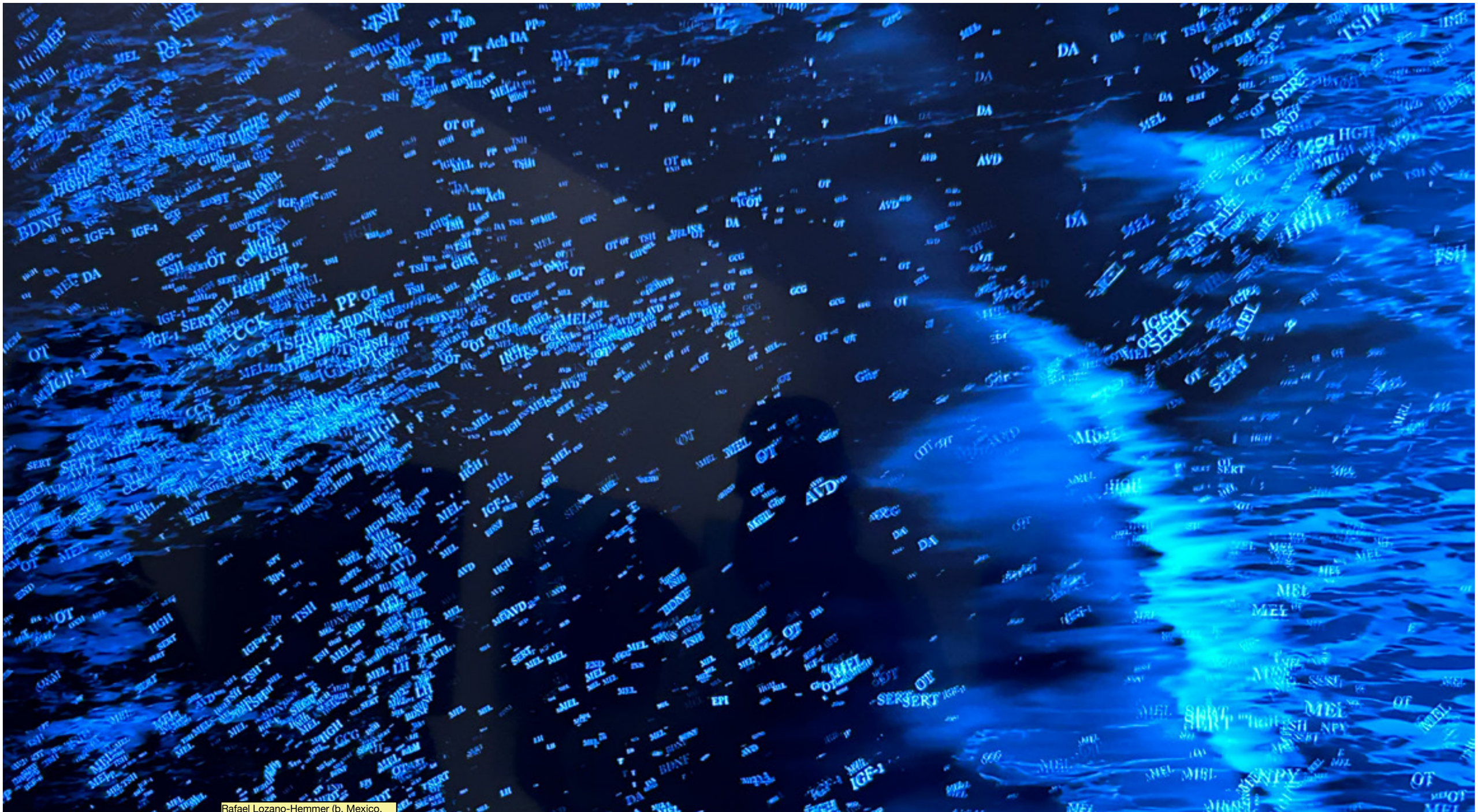
What does It Mean To Live In The Age Of Big Data? How Has It Permeated Into Our Cultural Moment? Does Your Data Generate A Story? What Can Data Visually Look Like? How Would Seeing Data Beyond Numbers And Charts Change Or Alter The Way We Understand This Medium?

SEEING THE UNSEEABLE: DATA, DESIGN, AND ART

Linnéa Spransy, Prime Mover, 84" x 132", acrylic on canvas, 2023.

gabby escobar



Rafael Lozano-Hemmer (b. Mexico, 1967), Hormonium, 2022 Custom-generative code, computer, 4K display. Collection of Arkive.

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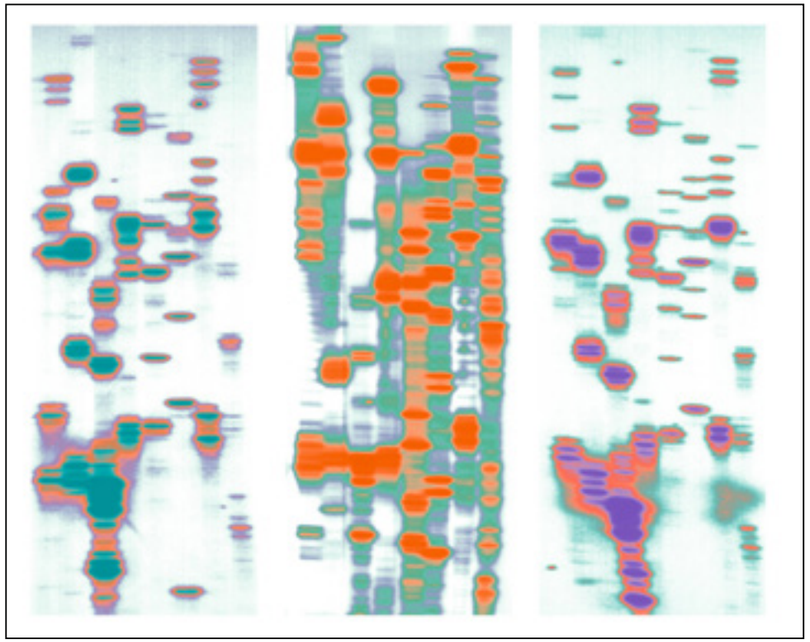
Iñigo Manglano-Ovalle, Lu, Jack and Carrie (from the Garden of Delights), 1998.



Works in the exhibition's Data Environments category express concern for Earth's current state and climate. Included in this section are Spanish-born American artist Manglano-Ovalle's 2006 works Storm Prototype: Cloud Prototype No. 2 and Cloud Prototype No. 4, and his 1998 work Lu, Jack and Carrie (from the Garden of Delights).

Known for his sculptures, photography and video pieces formed over years of research, and achieved in collaboration with scientific experts, Manglano-Ovalle's work examines ecosystems, natural and man-made systems, ethical challenges presented by modern technologies, and inequalities related to race, ethnicity and class.

Lu, Jack and Carrie (from the Garden of Delights) combines three colorful digital prints that are images of DNA samples used in genomic mapping. The Garden of Delights, the series the piece is from, features DNA samples from 48 participants. Manglano-Ovalle chose 16 individuals, who each invited two other people to form a series of triptychs that include Lu, Jack and Carrie. Inspired by late 18th century Spanish casta paintings that illustrate hierarchy based on race and class, the series also draws its title from Hieronymus Bosch's famous triptych The Garden of Earthly Delights.

Storm Prototype: Cloud Prototype No. 2 and Cloud Prototype No. 4 are large-scale cloud-like sculptures made of fiberglass and titanium alloy foil and formed by the study of weather systems and compilations of numerical data from thunderclouds. The works are aesthetic objects that resonate with what science tells us about Earth's changing climate, says co-curator Nowlin.

"Just as the working principles of science demand that knowledge is formed as an outcome of following evidence, Iñigo Manglano Ovalle's Storm Prototype is sculpture formed as an outcome of following data," says Nowlin. "His work becomes a metaphor for how science can generate not only information, but also sublime transformative sensations. The aesthetic that blossoms from his process is as much of science and of nature as it is of art."

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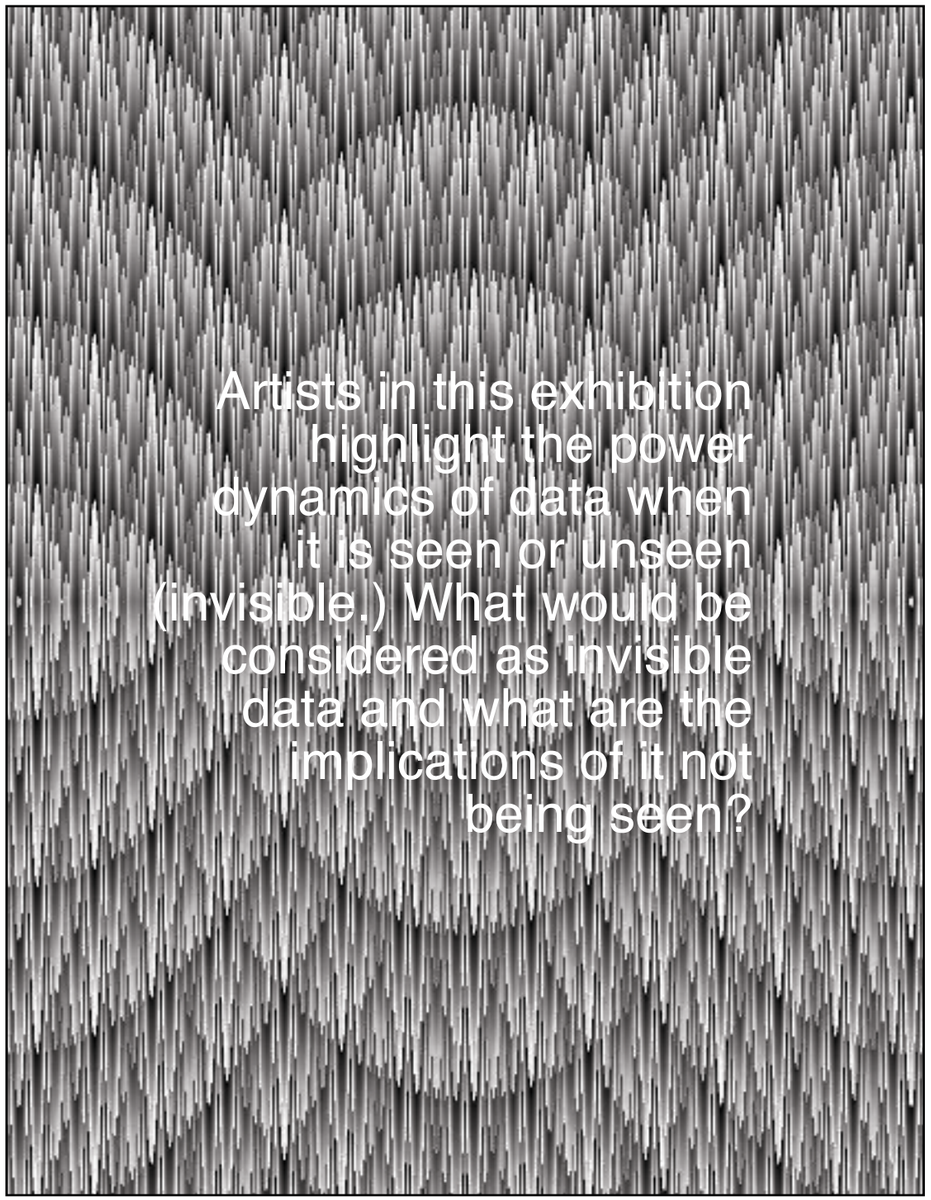
Artists in this exhibition highlight the power dynamics of data when it is seen or unseen (invisible.) What would be considered as invisible data and what are the implications of it not being seen?



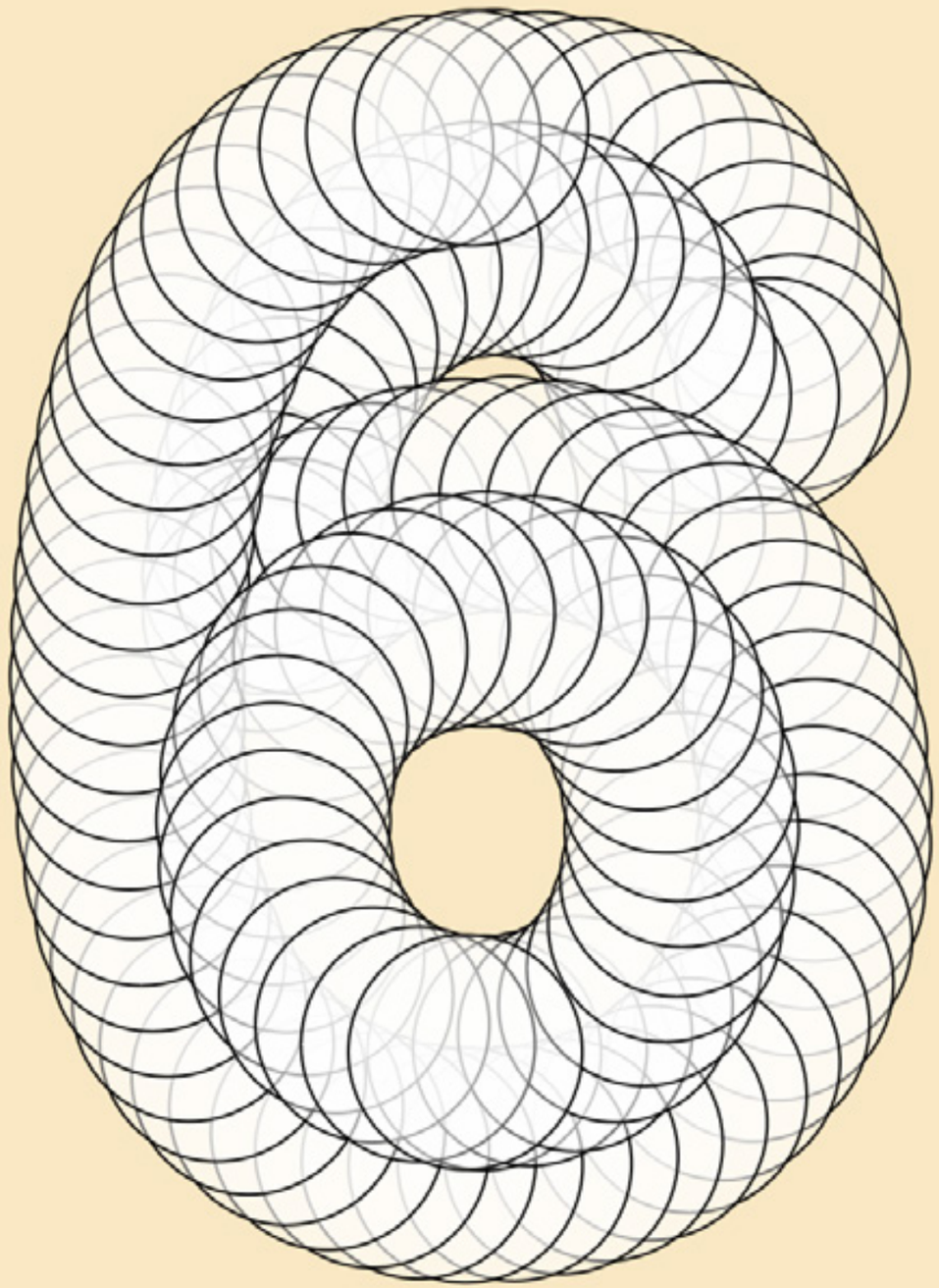
George Legrady, Phantom Waves, 2020-2021

Detail of The Library of Missing Data Sets, 2016, by Mimi Ọnụọha.

The Library of Missing Data Sets features three filing cabinets filled with empty file folders, with each folder titled with labels and subjects such as “Cause of June 2015 Black church fires.” These subjects examine the implications of data collection, says Seeing the Unseeable co-curator Valentine. They bring awareness to the ramifications of suppressed and purposefully untracked information.

Incroci, 2022, by Giorgia Lupi created in collaboration with Ehren Shorday.

For Incroci, Lupi and Shorday created a data set—conducted during the COVID-19 pandemic—by asking strangers, and their social media circles, to share five dates (day, month, year) that they saw as significant life moments, from the day of their birth to the present, in 2022. Each canvas painting features rising and falling black lines, signifying a marker of an individual’s important moments, and the entire series—installed in a grid—represents a network of intersected lines as overlapping days among strangers and friends.



CONCLUSIONS & BIOGRAPHY

gabby escobar

2025
MFA Graphic Design,
ArtCenter College of Design

2023
BA Speculative Design,
University of California, San Diego

GABBY ESCOBAR

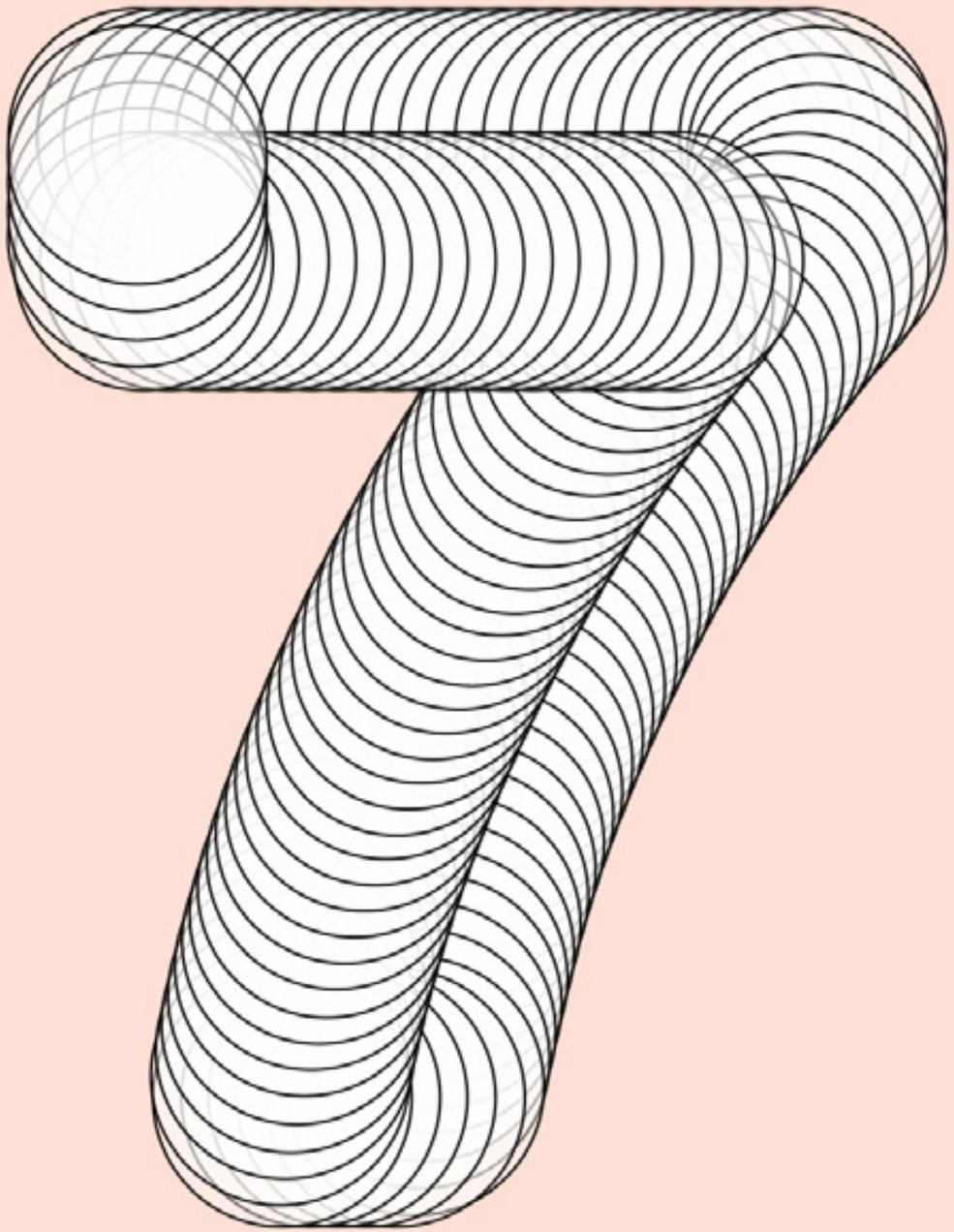
I am an interdisciplinary designer driven by a curiosity to push the boundaries of design. My background as an ultramarathoner has deeply influenced my design practice, where pacing, strategy, and research form the foundation of my work. This mindset has shaped my approach to projects feeling capable of taking on any new skill with the right approach to the brief.

Throughout the course of my thesis, I have developed a passion for data visualization. Engaging with my own running data allowed me to gain a deeper understanding of my body, uncover patterns, and experiment with methods to optimize my performance. This experience led me to explore the concept of biohacking — using data as a tool to access untapped potential. I believe we are capable of far more than we often realize; the key is knowing how to interpret and apply the information available to us.

I earned my BA in Speculative Design from the University of California, San Diego, where I explored the practice of envisioning possible futures through design. What captivated me most about speculative design was its ability to provoke strong reactions — both positive and negative — and its power to spark dialogue and critique. This perspective continues to inform my work, encouraging critical engagement with contemporary issues.

My thesis serves as a critique and celebration of personal data, exploring the meaningful insights that can emerge from publicly accessible information. Now, as I conclude my MFA in Graphic Design at ArtCenter, I have become a firm believer in the importance of specificity within design. I've learned that genuine intention is what drives successful brands and meaningful experiences. Every design choice should be justified by its relevance to the audience, transforming design from a purely visual practice into a way of understanding and navigating the world.

Designers have the power to speak a universal visual language — one that can inform, challenge, and connect. Graphic design, at its best, serves others by making ideas visible and accessible, amplifying voices, and fostering understanding. Through this thesis, I hope to contribute to that ongoing dialogue.



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gabby escobar

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Onda Run Product Photography by Logan Monroe