Media Lab Portfolio
December 2014

Caroline Jaffe
www.cajaffe.com

I am fascinated by the way humans conceptualize and navigate cities. I want to use technology to better understand mobility patterns to develop efficient and innovative ways for people to move around urban spaces. The projects and research presented in this portfolio have helped me discover and develop this interest through a variety of channels including hardware engineering, software development, data visualization, architectural modeling, writing, and historical research. This collection of experiences reflects my strong belief that the most successful way to build human-friendly technology is to hone technical expertise while developing a deep understanding of humans themselves.

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CAROLINE JAFFE

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EDUCATION

Yale University - B.S. in Computer Science & Electrical Engineering May 2013
Graduated Cum Laude, with Distinction in the Major
GPA: 3.89 / 4.00 (within major); 3.85 / 4.00 (overall)

Technical classes: *Data Mining and Machine Learning, Circuits and Systems Design, Data Structures and Programming Techniques, Linear Algebra with Applications, Systems Programming and Computer Architecture, Design and Analysis of Algorithms, Intelligent Robotics, Digital Systems, Artificial Intelligence*

TECHNICAL EXPERIENCE

Fitbit - Software Engineer August 2014 - present
Boston, MA
As part of Fitbit's E-Commerce team, which is responsible for processing and handling shipments to millions of customers, I am completely refactoring and automating the messaging protocols we use to communicate with warehouses and track inventory in our internal ERP system.

The Fulbright Program - Research Fellow September 2013 - June 2014
Delft, Netherlands
Collaborated with researchers at Delft University of Technology on a self-designed, data-driven research project where I applied machine learning techniques to social media data to understand what motivates cycling behavior.

Google - Software Engineering Intern May 2012 - August 2012
Mountain View, CA
Designed and developed a consistent, intuitive end-to-end implementation of Basemap styling for Maps Engine, a Google Maps web application that allows users to display, analyze and share geographical data.

Yale Social Robotics Lab - Research Assistant January 2012 - May 2013
New Haven, CT
Worked with Professor Brian Scassellati to develop algorithms for social hierarchical learning; designed, implemented and carried out a study to test perceptions of an out-group member in increasingly large group sizes.

Microsoft - Explore Intern May 2011 - August 2011
Redmond, WA
Worked closely with two other interns to design, implement and test features for Windows MultiPoint Server.

Reed Electrical Engineering Lab - Research Assistant June 2010 - August 2010
New Haven, CT
Worked with Professor Mark Reed to develop microfluidic nanosensor devices to detect biomarker particles.

Yale Student Technology - Residential Student Tech January 2010 - January 2013
New Haven, CT
Provided individualized hardware and software support; educated students about safe Internet practices.

LEADERSHIP

Women's Salon - Founder October 2014 - present
Cambridge, MA
I currently coordinate and host a women's group that meets biweekly to explore selected readings, listen to presentations, and discuss pertinent professional and social issues.

Force Elektro Women's Ultimate Frisbee - Captain October 2013 - June 2014
Delft, Netherlands
Oversaw the creation of and guided the competitive, athletic and social development of the first ever Women's Ultimate Frisbee team in Delft.

Yale Women's Ultimate Frisbee - Captain May 2012 - May 2013
New Haven, CT
Oversaw the competitive, athletic and social development and well-being of the team. Previous roles held: Webmaster, Alumni Coordinator, and Recruitment Chair (2009 - 2012).

Yale Bootstrap - Co-Founder & Events Director September 2011 - January 2013
New Haven, CT
Helped foster campus interest in technology, start-ups and programming by organizing speakers, hackathons, hack nights, and workshops on practical programming; acted as liaison for tech companies who recruit on campus.

Yale Historical Society - Treasurer May 2010 - September 2011
New Haven, CT
Spearheaded fundraising efforts, organized funds and oversaw reimbursements.

AWARDS & HONORS

Usability Award November 2014
Generation Citizen Civic Tech Challenge
My team and I built a web application to empower teenagers to engage in politics and civic activity; we won the Civic Tech Challenge Usability Award for ease of use, intuitiveness, and appeal to a young generation of users.

Dutch National Women's Ultimate Frisbee Team December 2013 - June 2014
Netherlands National Frisbee Association
During my time in the Netherlands, I was selected for the Dutch National Women's Ultimate Frisbee Team; I participated in a months-long training regimen and attended several international tournaments with the team.

Fulbright Research Fellowship September 2013 - June 2014
Fulbright U.S. Student Program
Highly competitive national grant awarded for carrying out year-long, independently designed research project on bicycle commuting in the Netherlands.

Perspectives on Science and Engineering September 2009 - August 2010
Yale College
Competitive academic program for freshman at Yale that consisted of weekly research talks, discussion groups and funding to carry out supervised research in a Yale engineering lab.

Selected Awards:
Presidential Scholar Semi-Finalist (2009), National Merit Finalist and Scholarship Winner (2009), National AP Scholar Award (2009), Cum Laude Society (2009), NCWIT Award for Aspirations in Computing (2009)

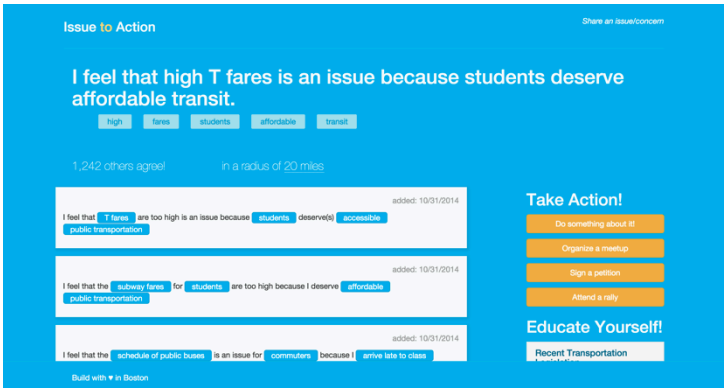
SKILLS & INTERESTS

Software	Java, JavaScript, R, Python, C, GIS, HTML, CSS, Unix
Hardware	Arduino, ARDrone Parrot quadcopter, PIC microcontroller, basic woodworking and welding
Interests	Ultimate Frisbee, bicycling, backpacking, farmer's markets, international education

DATA, SOFTWARE & ACTIVITY TRACKING

Issue to Action
Generation Citizen Civic Tech Challenge
Cambridge, MA – November 2014

In November, I attended Generation Citizen's Civic Tech Challenge. Generation Citizen is a nationwide non-profit group that empowers teenagers to engage in politics and civic activity. During the 8-hour Civic Tech Challenge hackathon, we built a tool to help young activists decide how and where to allocate their problem-solving energy. Our team prototyped a web application that would connect participants with similarly minded people, educational material, and actionable opportunities to get involved. Screenshots of the basic flow can be seen below.



On the first page, users are prompted to enter a statement about their concern or issue. On the second page, users see other statements related to the issue. We extracted keywords from each user's statement and used these to tag and categorize the statements. Users can filter results using different keywords or find other users in a certain area. On the right-hand side, users can discover relevant action items or educational material about the issue they've entered. Our project won the hackathon's Usability Award for ease of use, intuitiveness, and appeal to a young generation of users. Though we just completed a prototype at the hackathon, we are planning to continue work on this project at Code for Boston hack nights.

Social Media Analysis as a Method of Exploring Cyclists' Attitudes
Fulbright Research Fellowship
Delft, The Netherlands – September 2013 - June 2014

After graduating from Yale, I spent a year researching urban cycling behavior as a Fulbright Fellow at Delft University of Technology (TU Delft) in the Netherlands. I used computational data analysis to learn about urban bicycling, a successful form of mobility in the Netherlands – 27% of all trips are made by bicycle! – but one that faces growing pains in the U.S., where cycling comprises less than 1% of trips.

Building upon work done by my Dutch colleagues, I investigated the attitudes, emotions and motivations that surround an individual's decision to cycle or not. Environmental factors are important, but research suggests that less tangible factors, like the way a community perceives cyclists or a person's habits, can have equal impact. To study these factors, I collected Twitter data and analyzed it using Naive Bayes sentiment analysis and Latent Dirichlet Allocation topic modeling. My investigation was aimed at both deciphering the way people feel about bicycling and evaluating social media analysis as a research method for understanding transit habits. I found that cycling sentiment is highly bimodal. Discussion centers around high-profile issues, both positive (e.g. new bike lanes) and negative (e.g. dangerous cycling behavior), that capture the attention of cycling advocates and detractors. While I faced challenges in establishing the reliability and representativeness of Twitter data, social media analysis proved an exciting technique that offered real-time access to opinions richer and more direct than those collected in traditional transportation research. My findings, which reflected on the possibilities and challenges of using social media analysis to better understand cycling motivations, were gathered in a paper that I am preparing to submit to the international journal *Transportation*. The full manuscript can be accessed at www.cajaffe.com/portfolio/bicycle-social-media-analysis.pdf.

Recognizing and Rewarding Intentionality in Personal Fitness Tracker Usage
Yale College Senior Thesis
New Haven, CT – Spring 2013

I have been working as a software engineer for three months at Fitbit, a company that makes wearable devices that enable users to track step, calorie and stair counts, as well as map exercise routes and measure heart rate. Fitbit's work relates closely to my interest in analyzing human dynamics and tackles public health issues by encouraging users to exercise more and make healthy choices.

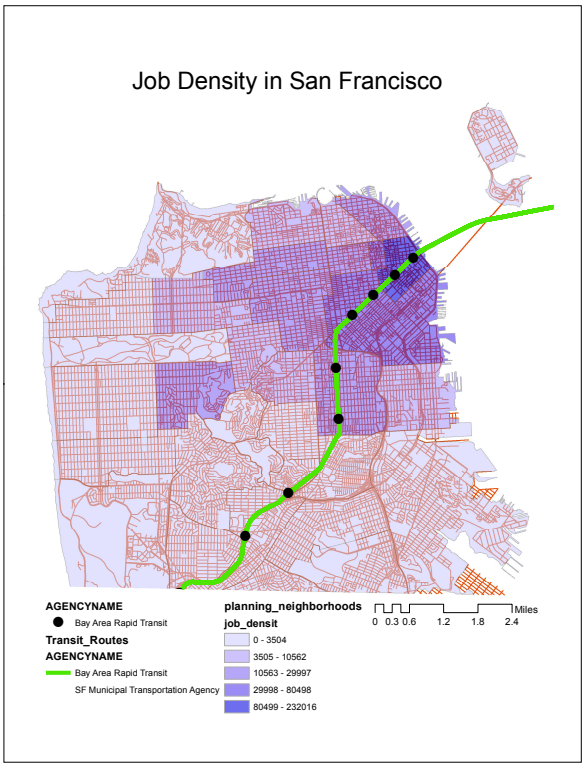
In addition to being a Fitbit employee and a long-time Fitbit user myself, Fitbit devices were a key component of my senior thesis in college. For this project, which I designed and executed independently, I collected annotated activity data from several friends, and used it to train a Random Forests classifier to understand when a user was intentionally exercising (e.g. by going on a run) or merely increasing their step count incidentally (e.g. by walking to class). Using this model of user behavior, I programmed an Aldebaran Nao humanoid robot to communicate and coach the user, with the idea that an embodied presence can give rise to more significant changes in a user's behavior. Through these interactions, I sought to present the robot as a social presence who understood the context of a user's life and exercise habits. One of the greatest barriers to successful personal fitness tracker usage has been durable engagement; usage diminishes as the excitement of the new product wears off. With the embodied presence of a social robot, I hoped that the insights available from the fitness tracker data would continue to seem relevant and that users would stay engaged with the system. A write-up of this project can be found at www.cajaffe.com/portfolio/fitbit-robotic-coach.pdf and videos of the robot interactions can be found at www.cajaffe.com/portfolio/robot-videos.html.

Where Does BART Belong? Optimizing the Placement of Additions to the Bay Area's Transit System
New Haven, CT – Fall 2012

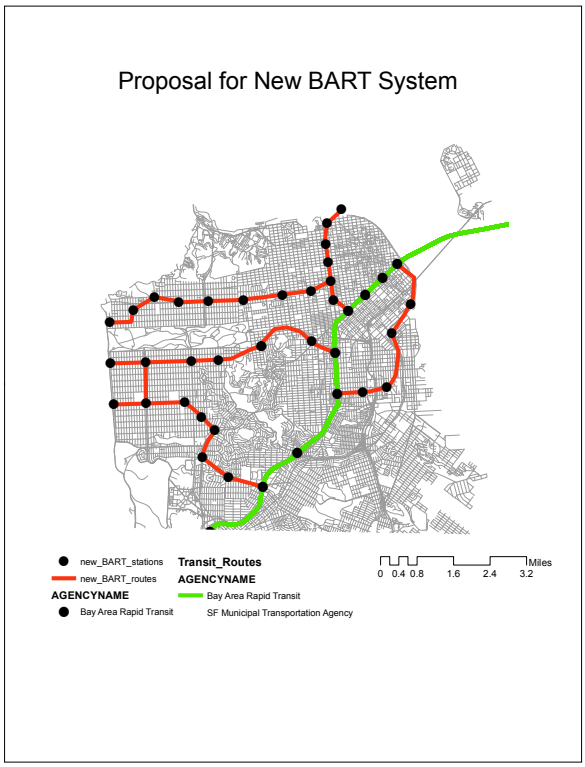
After spending a summer commuting in the Bay Area and experiencing first-hand the shortcomings of the area's public transportation systems, I was interested in learning about the area's transit history and thinking about how these systems could be made more accessible and useful. I used the final project of a GIS class as an opportunity to explore possibilities for expansion. I learned that when the Bay Area Rapid Transit (BART) was originally conceived in the 1950s, planners visualized a transit system that would encircle the Bay. For various reasons, only a fraction of the system was implemented and today, BART connects a wide swath of the East Bay with just a sliver of Southeastern San Francisco and parts of the peninsula. While the system itself is relatively reliable, fast and cheap, it is weakened by its minimal coverage in San Francisco and bulky interface with other transit systems.

For my analysis, I collected data on population, traffic and job density, city topography, and existing public transportation systems, and integrated this information using GIS map algebra to optimize the placement of new branches of the BART system in San Francisco.

The full report can be found at www.cajaffe.com/portfolio/where-does-bart-belong.pdf.



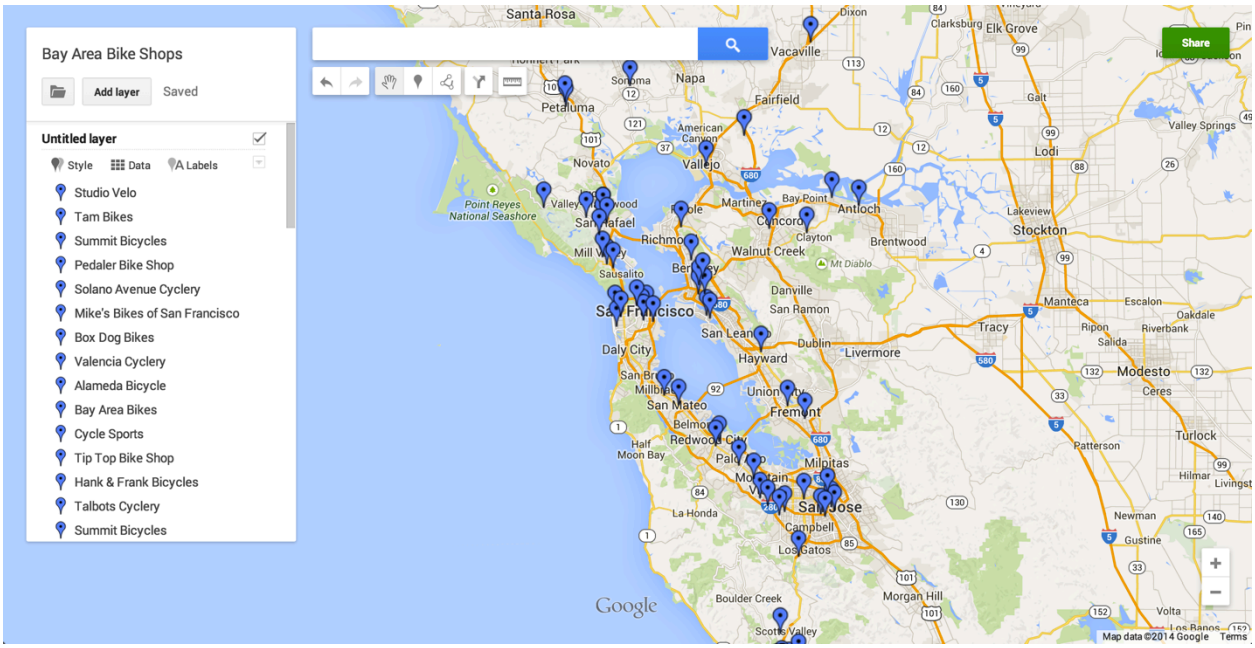
Map of job density in San Francisco



Final proposal for BART additions

Google Maps Engine Front End Development
Mountain View, CA – Summer 2012

After my junior year of college, I spent the summer as a software engineering intern at Google. I worked on Maps Engine, a program that allows users to create collaborative custom maps showing favorite places, routes or areas. For example, a map could visualize a system of bus routes or the locations of medical clinics. I worked primarily on the front-end user interface that permits the user to choose different custom map styles, but also touched the back-end database that held geographical data. The internship taught me to work effectively on a ten-person engineering team where I had to deliver high quality results on deadline and was exposed to engineering best practices. My time at Google also offered me another opportunity to see how technology can impact human activity in a meaningful and productive way. Google Maps Engine was launched in 2013 and can be viewed at https://mapsengine.google.com/map/.

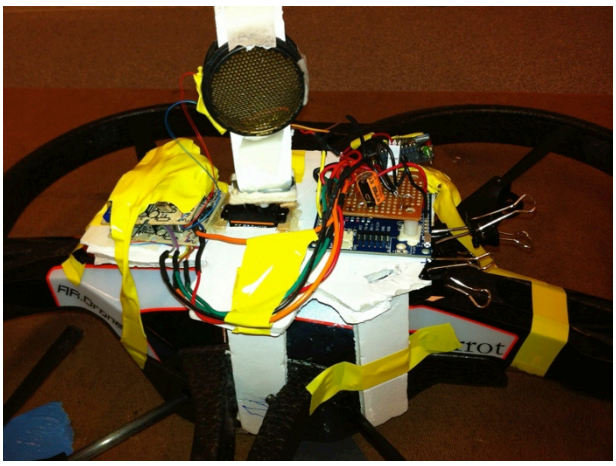


Example of map made using Google Maps Engine

HARDWARE

Using a Sonar Ranging System to Develop Autonomous Wall-Following for a Quadcopter
Independent Research (Electrical Engineering)
New Haven, CT – Fall 2012

For an independent engineering project, a classmate and I developed a custom sonar ranging system for a quadcopter drone. Our goal was to build a system that would allow the drone to follow and avoid a wall, with the idea that we could eventually extend this behavior for tasks like searching, following, transporting, monitoring or leading. This project required the integration of several disciplines and techniques, including hardware for the sensing system and wireless communication, and software for writing the drone's control algorithms. The sensing system consisted of two sonar sensing modules mounted on a rotating servo motor that produced a distance reading. Based on this reading, we used our control algorithm to set the pitch, roll and yaw values to allow the drone to maintain constant distance from a wall. These values were communicated wirelessly to the Linux system controlling the drone and sent to the drone using its built-in SDK.



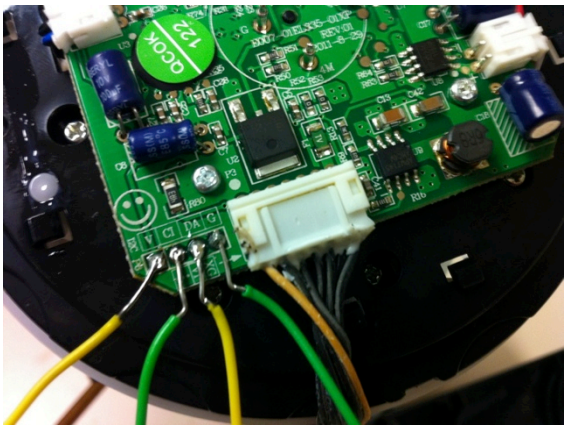
Custom sonar ranging system

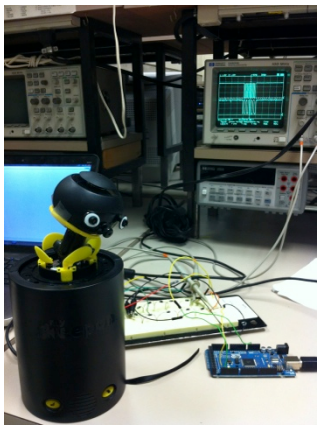
Drone with sensing setup

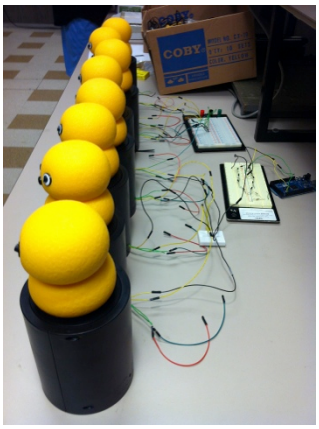
Through our calibrations and testing, we produced a set of parameters for our control algorithm that allowed the drone to successfully follow and avoid a wall, staying within 0.5 to 2m. This project laid important groundwork for other useful projects involving quadcopters and was an instructive opportunity for hands-on hardware work. A full write-up of the project can be found at www.cajaffe.com/portfolio/quadcopter.pdf.

The Odd Keepon Out: Using Robots to Examine How Group Size Affects Perceptions of an Outgroup Member
New Haven, CT – Spring 2012

During my junior year of college, I took a human-robot interaction course that culminated in a month-long robotics research project and final presentation. Two classmates and I wanted to understand how group size impacts perceptions of "outgroup" members. We wanted to model these groups with robots, because robot behavior can be controlled and replicated across many trials, but faced a major challenge in cost. Instead, we reverse-engineered a toy robot – a $20 version of a research-grade robot – so that we could easily scale group size. To gain control of the robot's servo motors, we used an oscilloscope to monitor the signals passed to motors. We were able to decipher the digital messaging protocol and program the robot with customized actions. With control over the robot's motors, we conducted an experiment where we asked participants to rate the skill and likeability of a robot with unique actions in groups of different size. We found that perceptions of the individual robot's talent grew stronger as group size increased; this result has important implications about dynamics in the classroom, on athletic teams, and in professional settings.


Tapping into the I2C Protocol

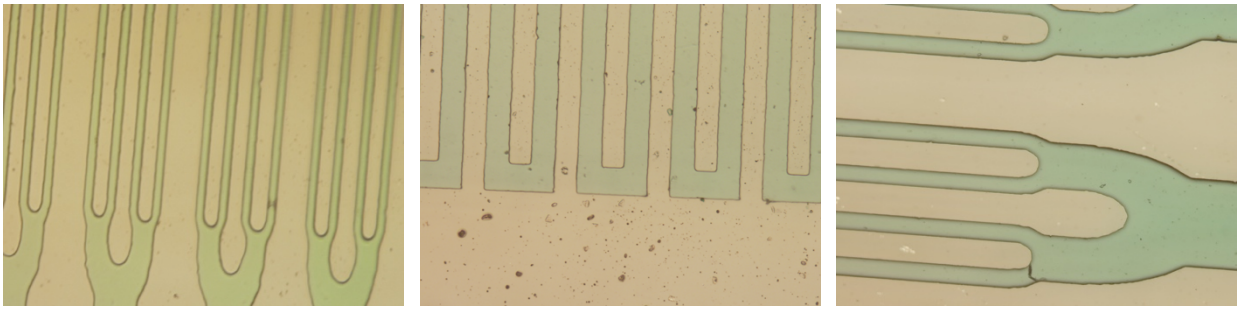

Working setup


8 Hacked Robots

This project set an example of overcoming cost constraints in robotics research by reverse-engineering toy robots. Our work has evolved into a cheap, open-source robotics platform with accompanying tutorials. Versions of these "hacked" robots have been presented at the World Science Fair in New York City and exhibited at AAAI and CogSci, flagship research conferences in artificial intelligence and cognitive science. This project encouraged me to think deeply about how scientific research can be used to understand human behavior and was a course-related opportunity to apply technology to human issues. A more detailed description of the project can be found at www.cajaffe.com/portfolio/odd-keepon-out.pdf.

Investigating PDMS Bonding Methods for Microfluidic Nanosensors
New Haven, CT – Summer 2010

During a summer research experience supported by Yale's Perspectives on Science program, I worked in an Electrical Engineering and Materials Science lab. Working independently, and with a graduate student, I developed bonding methods to help construct nanosensors that can quickly detect biomarkers – specific proteins that may indicate the presence of disease – in small blood samples. These sensors used tiny microchannels to sort and filter proteins. My work consisted of testing different channel construction methods and designs to discover the strongest and most effective microchannel device design. These nanosensor devices are now the basis of an award-winning biomedical startup that has raised thousands of dollars in venture capital funding.

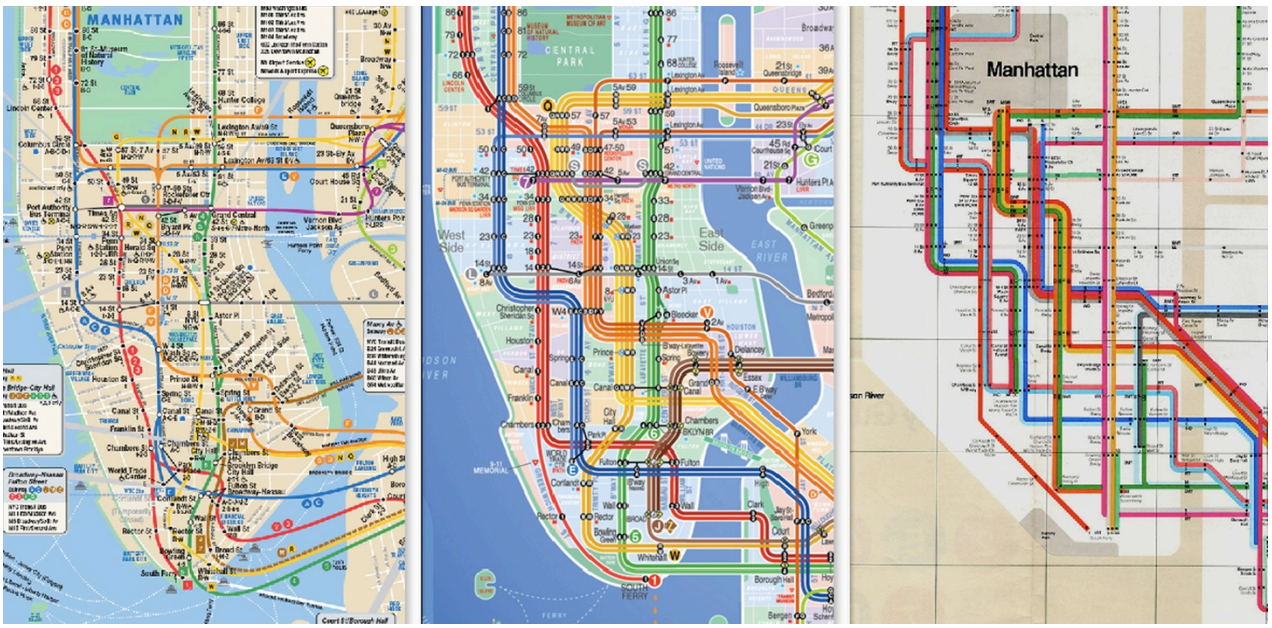


Different microchannel designs visualized with colored water (under microscope)

WRITING

The Great Transit Mapping Debate
New Haven, CT – Fall 2012

For my final paper in a seminar on cartography, I delved into the world of transit map design. I focused specifically on Harry Beck's 1931 schematic map of the London Underground and Massimo Vignelli's 1972 map of the New York City Subway. While Beck's map was generally accepted and has set the standard for transit map design throughout the world, Vignelli's schematic map – which incorporated Beck's design principles – drew widespread criticism for its geographic distortions and was soon replaced by a more geographically accurate map. In my paper, I discuss factors that impact transit map usability and argue that Vignelli's map was unsuccessful because it challenged New Yorkers' unique mental relationship with the geography of their city. Because of New York's alphanumeric grid system, New Yorkers have a specific mental idea of the space-time relationship between two points in the city based on their grid coordinates; introducing a map, such as Vignelli's, with such obvious geographic distortions betrayed that mental map. In cities with non-orthogonal street systems, the cognitive link between locations is less precise; in these settings, diagrammatic, geographically distorted maps may have greater utility.



Comparison of current NYC Subway Map, hybrid "KickMap" and Vignelli Map
(from http://www.kickmap.com/ by Eddie Jabbour)

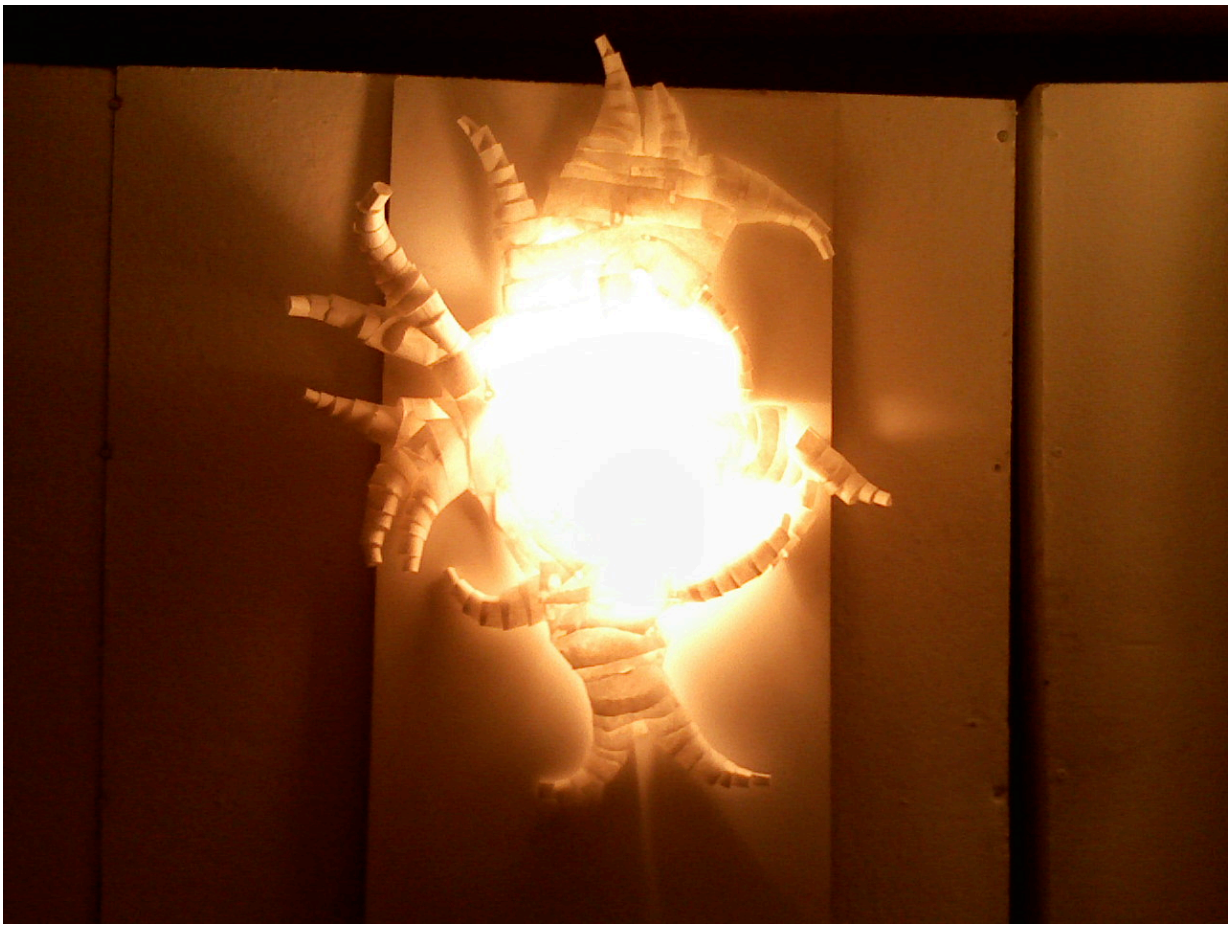
The research for this paper made me think deeply about humans' mental relationship to maps, how information and design affect usability, and how people think about navigating cities.

My full paper can be found at www.cajaffe.com/portfolio/transit-map-debate.pdf.

DESIGN

Sea Creature Lamp Shade
New Haven, CT – December 2010

For the final project of my sophomore year architecture class, we were instructed to make a lampshade using one type of white paper and one type of adhesive. I chose to use strips of white butcher paper and super-glue, because they were flexible and cheap materials. I thought building with strips of paper, instead of larger pieces, would allow my design to evolve more naturally. In my design, I was intrigued by organic, tessellating shapes, where the same pattern would build upon itself, but at different scales and with different orientations. The construction of my lampshade ended up being an almost meditative process; working from my original concept, I let the lampshade take shape naturally, adding strips of paper where needed, until the piece took on a life of its own.



Sea creature lamp shade

Quiet Space
New Haven, CT – October 2010

During an introductory architecture class my sophomore year of college, we were asked to build a model of a space or place using a specified list of materials. Inspired by the Vaillancourt Fountain in San Francisco, I wanted to create a natural space that incorporated both indoor and outdoor areas and hard and soft materials. My piece sought to emulate that fountain, by using the specified materials in asymmetrical, organic ways. I envisioned it as an open space or pavilion that explored the interplay between different spaces and materials. This project encouraged me to think critically about which characteristics contribute to successful, multi-functional and accessible public spaces.

Full view of model

Detail view of roof