Senseable City Lab :: Massachusetts Institute of Technology

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Welcome to the Senseable City Lab – a cutting-edge multidisciplinary research group that studies the interface between cities, people, and technologies and investigates how the ubiquity of digital devices and the various telecommunication networks that augment our cities, are impacting urban living. With an overall goal of anticipating future trends, we bring together researchers from over a dozen academic disciplines to work on groundbreaking ideas and innovative real-world demonstrations.

Each academic year, the Senseable City Lab invites students at the Massachusetts Institute of Technology to participate in the Digital City Design Workshop. The workshop seeks to provide pragmatic, technological solutions that address a key concern of urban living. The Senseable City Guide series showcases this research which is undertaken in partnership with cities from across the world.
Amsterdam
Senseable City Guide

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SENSEABLE CITY LAB, MIT
Amsterdam, the “Venice of the North”. A city whose history and genius loci are inexorably linked to the magnificent network of canals that form the backbone of a transportation system that historically has been “the most efficient and popular way to deliver and dispatch goods” and which shapes much of the city’s concentric urban form.

These canals, whose construction began in the 17th century during the Dutch Golden Age, today encompass more than 100 km of waterways and over 1,500 bridges. More than 1,500 historic buildings are located alongside such iconic canals like the Prinsengracht, Keizersgracht, Herengracht and Jordaan, effectively anchoring the cultural gravitas of the city and rightfully earning them a place for the canals in UNESCO World Heritage Site list.

The Amsterdam canals are also at the center of a deep relationship that the Dutch people have with water. Every day, hundreds of boats of various sizes and lengths crisscross the canals for all sorts of activities; from transporting tourists who simply want to enjoy the sights of the city from a privileged viewpoint, to delivering flowers to the city’s flower market. From the many boat houses that serve as a permanent place of residence to Amsterdammers who don’t want to be too far from water, to platforms on the canals serving as temporary parking space for bicycles, yet another emblematic and ubiquitous fixture in the city.

Researchers at the Senseable City Lab, together with researchers from the Advanced Metropolitan Solutions lab in Amsterdam have been working for the last year in developing an autonomous robotic water vehicle system named “Roboat”, which could be deployed in the canals of Amsterdam and used for a wide variety of functions, such as transport for goods and people, or assembled into temporary on-demand structures for example. For the Senseable City Lab’s 2017 Digital City Design workshop, we decided to support this effort by focusing our design efforts on speculative uses for autonomous boat technologies in conjunction with other digital platforms towards the creation of new services and experiences in the city.

The projects presented in this book are the result of multiple exploration processes of this challenge, where each participant in the workshop tackled it by looking at the opportunities and possibilities through their own specific lens of interest. For some such as Daniel Marshall and Sera Tolgay, that lens was the interrelation of food production and markets. Meanwhile Waishan Qiu tackled the relevant question of the interface between the street. For Rida Qadri and Lauren Kennedy, their creative perspective shifted to social activation of space through public art on the canals. Finally Jonathan Hasolan, Yan Liu, and Ignacio Cardona looked at new experiences and amenities that could enhance the quality of life in the city in order to make it more attractive to locals and tourists alike.

I hope you enjoy reading through their projects, whose goals are not only to propose new design scenarios for an exciting technology such as autonomous vehicles, but ultimately to challenge the possibilities for future Amsterdam in reimagining its canals as a central public space in the city and their relationship with Amsterdammers in the 21st century.
Growboat
by Sera Tolgay
SENSEABLE CITY LAB, MIT
PROJECT DESCRIPTION

As urban food systems are becoming more globalized and consolidated, increasingly centralized networks involving fewer individual actors are supplying a growing proportion of the world’s food. The challenge of providing a sustainable urban food system requires addressing the divergent local and global development pathways in the way food is produced and consumed. Recognizing that family farmers, smallholder food producers, restaurateurs and even food enthusiasts or ordinary citizens play a key role in feeding cities, the Growboat system intends to help maintain resilient and equitable local food systems.

Using autonomous boat and sensing technologies, Growboat provides a connective tissue for Amsterdam’s urban food network. It uses the canal system to provide connectivity between food production, distribution centers and restaurants. Re-orienting food systems and value chains for sustainable diets can be a means to reconnect consumers with both local producers and the agro-food sector.

The Growboat System

To simultaneously address water quality and growing food demand, the 3D-farming approach of the Growboat modular system works in 3 different on-demand capacities: i) remediate, ii) farm, iii) harvest and ship. The system combines biological (aquaponics, filter feeders, seaweeds) and digital (water quality sensing, GPS monitoring, SONAR) technologies to autonomously clean and feed the city.

A new model for feeding the city can take advantage of positive feedback loops, shorter supply chains and new logistic concepts utilizing the canals for urban food production and distribution. The span of the Growboat is not only limited to the city center but also its surroundings. Consistency in the use of the canals and connection to the hinterland can contribute to urban food supply and health while also supporting its local economy.

Growboat is a connective tissue for Amsterdam’s urban food network.
The idea of farming small plots of land is not new to the Netherlands—the first allotment gardens were distributed to families in 1838 to foster a culture of growing one’s own vegetables. Although Amsterdam is a crowded city, in between the canal houses and parked bikes it is possible to site an occasional tomato pot or roof garden. According to researcher Jan-Eelco Jansma of Wageningen University, consumers started to become more and more interested in where their food came from 10 years ago. Farmers, meanwhile, began to realize that selling their produce locally reduced transportation costs and was thus more economically attractive. As concerns grew about climate change and food security, more and more residents in Amsterdam began to grow their own food. Growboat builds on this dynamic of urban farming already present in Amsterdam by providing modular pods that can be incorporated to residential buildings, public spaces and gardens, urban farms needing more space, fresh produce markets and restaurants adjacent to the ubiquitous canals in the city. When their produce is ready, users are notified through the mobile system on the next page. The system allows users to personally tend to the plants and the CNC systems functions as a personal assistant, keeping track of the growth of users’ produce through the mobile application system. Users can also choose to sell the products they grow to markets or restaurants on demand, enabling an opportunity to support livelihoods of Amsterdam residents.
Despite limited space, agriculture in the city is thriving, with more than 188 registered city gardens and 13 school gardens in the city, ranging from small community herb gardens to a football pitch full of pigs. Amsterdam also has many vibrant outdoor markets adjacent to canals as well as larger food distribution centers that do not take advantage of the canals as transportation networks. Using autonomous boat and sensing technologies, Growboat uses the canal system to provide connectivity between food production, distribution centers and restaurants. Mapping allotments, commercial urban gardens, community gardens, school gardens that supply food on the one hand and markets and restaurants that demand food on the other reveals a multitude of possibilities to integrate the Growboat into the urban context. Re-orienting food systems and value chains for sustainable diets can be a means to reconnect consumers with local, rural and urban, producers. With up to 23,000 cargo vehicles delivering packages in Amsterdam everyday, using the canals to produce and deliver fresh produce is one way to offset congestion and bring a unique way to engage with the city’s culture of growing. A continuing issue in Amsterdam’s canals is water quality, owing to the fact that industrial activity over the centuries has altered soil and water quality. Areas around shipyards, petrol service stations and gasworks are still heavily polluted. One of them is the Petroleumhaven site, one of the biggest oil ports in the world in terms of tonnage stored. Using a biological system of underwater plants and microbes, in this context, the Growboat functions as a remediation agent. In the winter season when the Growboats will not be used intensively for farming, the idle pods can be parked in polluted areas like Petroleumhaven to gradually remediate these areas. The overwater function of the Growboat is to provide dynamic, on-demand farming systems. These pods can serve as educational and recreational gardens in areas where there is demand and interest in community farming but no available greenspace for this function. The pods can also serve markets and restaurants that want to increase their local supply of fresh produce and be able to grow desired produce from an extensive list that is available on demand. The network map below shows how these systems are connected through the canal network to dynamically meet the needs of aspiring farmers and local food enthusiasts.
The autonomous Growboat system combines biological (hydroponics, bioremediation agents) and digital (water quality sensing, GPS monitoring, SONAR) technologies to autonomously clean and feed the city. The growboat also consists of a three-dimensional system combining overwater and underwater vegetation systems that function together.

Nutrient bioextraction is an environmental management strategy by which nutrients are removed from an aquatic ecosystem through the harvest of enhanced biological production. The underwater system of the Growboat consists of algae and large seaweeds called kelp, which can absorb nitrogen and phosphorus. This underwater farm has the potential of removing excess inputs of nutrients (eutrophication), low dissolved oxygen, reduced light availability in Amsterdam’s canals.

Kelp has a high rate of growth and its decay is quite efficient in yielding methane, as well as sugars that can be converted to ethanol. Kelp ash can be used in soap and glass production. Alginate, a kelp-derived carbohydrate, is used to thicken products such as ice cream, jelly, salad dressing, and toothpaste. Provide fresh seafood for markets and restaurants.

The biological systems of the Growboat are coupled with digital systems that include GPS Monitoring, a global navigation satellite system that provides geolocation and time information to a GPS receiver anywhere through telephonic or internet reception that also allows for users to recall a Growboat through geofencing. The pods also include water quality sensing technology to track properties such as salinity, temperature, and current velocity and nutrient measurements are used to monitor processes that affect biogeochemistry. When water quality levels are safe enough for produce production, the Growboat alerts users. Lastly, SONAR technology allows for underwater scanning to detect schools of fish and other organisms by using reflected sound to monitor aquatic life in the canals.

The CNC farming system can produce a range of crops including broccoli, spinach and strawberries and can track the growth of produce through image recognition algorithms. Vegetables grown with Farmbot technology connected to the grid, for example, emit 25-30% less CO2 than vegetables bought at the store. This number is close to zero if the system is powered by renewable energy. Similarly, the hydroponic system of the Growboat can help reduce water use in agriculture by 90% but may need to be connected to the grid to keep pumping water when power is low. The greenhouse structure is made from light polycarbonate panels, which helps protect the valuable equipment and produce.

The Growboat system above water consists of an octagonal greenhouse that combines CNC farming and aquaponics. These floating systems use waste produced by aquatic animals that supply nutrients for plants grown hydroponically, which in turn purify the water.

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The cocentric form the Growboat enables the pods to assemble modularly to reduce blockage of the canals while also allowing for large scale remediation to occur over large areas.

Growboat combines digital and biological systems to grow food and remediate water.
Algae and large seaweeds called kelp can also absorb nitrogen and phosphorus. This underwater farm has the potential of removing excess inputs of nutrients (eutrophication), low dissolved oxygen, reduced light availability in Amsterdam’s canals.
SERA TOLGAY

Sera is a dual degree candidate in the Master of City Planning and Master of Science in Architecture Studies, originally from Istanbul, Turkey. Prior to MIT, she worked on various urban development projects at UNDP, EMBARQ and Studio-X Istanbul. In 2014, she co-founded Muhit, an award-winning crowdsourcing and urban data analytics platform that is working towards making the planning process in Turkey more transparent and inclusive. At MIT, she has worked as a data analyst for the Civic Data Design Lab. She received her B.A. from Yale University where she also worked for the Yale Sustainable Food Project.
The culture of selling food is today a globalized industry, with supermarkets importing food from across the planet by air, sea, and rail. Yet new technologies in urban farming may begin to challenge this model of supply.

Supermarkets now dominate food sales in developed countries and are rapidly expanding their global presence. At the same time, international mergers and acquisitions, and aggressive pricing strategies have concentrated market power in the hands of a few major retailers. Improved transport systems and increased capital mobility have globalized supermarket supply chains. For example, the cost of sea freight fell almost 70% between the early 1980s and the mid 1990s. As a consequence, the supermarkets and their importers have become ‘global sourcing companies’. Amsterdam itself has 60 Albert Heijn Stores, a large conglomerate of 2134 stores, distribution facilities, and transportation infrastructure.

Hydroponics uses much less water than conventional farming approaches, it also requires less transportation energy as it can be grown close to the location of sale. Amsterdam is at the center of this new trend in growing your own food. The city of Almere is a nearby example of a city, which is attempting to grow its food within and nearby.

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This ambition to grow food closer to home has multiple motivations; reducing CO₂ from transportation and improving the social interactions between people. Amsterdam has Europe’s largest rooftop garden, located in the Zuidpark, it grows food for office workers and reveals this new trend of utilizing space in the city for food production. Equally Amsterdam’s Sunday farmers markets reveal a group of people in the city committed to selling products, but...
infrastructure unique to Amsterdam that can both take produce from people and deliver it to others. With this model you are able to provide economic opportunities to new areas of Amsterdam - you don’t need a shop to sell your products in the center of the city, and you don’t need to be in the center all day to sell your things. Rather you just provide the valuable item, and let the market system sell it for you.

Amsterdam already has a vibrant culture of urban farms, with 217 noted by the municipal government (shown in the map opposite). To connect with these producers, the Roboat market network could position several hub buildings in the city. In this case an optimization has been run to locate the hub buildings close to existing nodes of urban farming.

These hub buildings would provide a space for the urban farmers to deposit their products, and for the Roboat to collect them (see left).
The goods are moved around the market inside a glass box; the principal interaction is between the glass box and the buyer. The first interaction is visual: you look at the box and browse for something desirable. Therefore the first significant interaction is in the display of products, and the design takes inspiration from supermarket shelving which tilts back to allow a better view. The Roboat acts as a display cabinet for products on the rivers and canals.

Once your interest has spiked, the buyer then needs to get close to the Roboat. A Roboat can be caught by a person already on the water. The roboat can be requested by an iPhone application, or the Roboat can be accessed at the Roboat market.

Once in proximity to the Roboat, the person then surveys the products, moving up and down the Roboat. When they find products they want, they can swipe a card on the card reader, which then opens the box. The box is sensitive to what you take out. You take out products that you like, and it charges you based on the difference once you’ve closed the box again.

This interaction can occur on the water, between Roboats and other boats. It can also occur between Roboats and the canal side; however the canal side is harder, as the height difference is around one meter. This encourages a Roboat which is taller.
The fluid market could theoretically deploy on any canal in the city. It could be deployed based on an average location of potential buyers, or it could be positioned based on a predetermined schedule dictated by the city.

In the mapping exploration opposite, two location methodologies are explored. The mapping shows locations of markets that sell local products in the city. Method one would locate the roboat market close to existing food retail, with the logic that there are already buyers here and the market could participate in their trade. A second approach would be to take the inverse, to go to the food deserts and provide a shopping experience for people who are otherwise far from a market.

One principal problem for a floating market is the prospect of blocking the river from other traffic. The market needs to allow movement through it, yet also allow for trade to continue between boats. The canals of Amsterdam can be hectic at times, with people on the water enjoying in a range of different sized vessels, from small to large. Rather than implementing a fixed geometry on the river, the market would benefit from having flexible joints, allowing it to maintain a connection between boats whilst changing shape to allow for other boats to pass.

To create this flexible joint, a magnetic ball bearing is used. The ball bearing can move around a groove embedded into the boats hull. Allowing for the magnetic connection to be rotated all the way around the boat.

To allow for other boats to pass, the market would need to do one of two things. Either behave like a massive bumper car system where boats “push” their way through. Or the boats in the market would need to be aware of other boats so that they can autonomously adapt the global shape to allow a boat to pass.

Furthermore whilst all of these complex movements are taking place, the market must maintain the capacity for people to move between pontoons. People can comfortably transition between two moving surfaces so long as the speed is never greater than 26 cm per second. This is the constraint on the speed between the point of contact between pontoons, and the pontoons on the bank. However the pontoons could move faster so long as the point of contact does not.

The curved geometry allows for this motion to be assisted. A square shape will make for awkward motions whereas a curved geometries allows for a point of contact to be maintained whilst slipping and rotating.
One principal problem for a floating market is the prospect of blocking the river from other traffic. The Roboat Market needs to allow movement through it, yet also allow for trade to continue between boats. The canals of Amsterdam can be hectic at times, with people on the water enjoying a range of different sized vessels, from small to large. Rather than implementing a fixed geometry on the river, the market would benefit from having flexible joints, allowing it to maintain a connection between boats whilst changing shape to allow for other boats to pass.

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The second significant urban interaction is the drop off point. The market is intended as being a place for food makers and growers in Amsterdam to sell their produce. The market would therefore have a few drop of nodes where Amsterdamers could deposit their products for the Roboats to pick up and take to market. These stations will be located throughout the city, close to areas of high residential population with fewer economic opportunities. The fluid market attempts to provide new economic opportunities to people who have no opportunity to sell products in their neighborhood.
Daniel J. M. Marshall

Daniel is currently studying for a Masters of Architecture degree. He was born and raised in Lewes, a small town nestled in the South Downs national park of southern England. He completed his undergraduate studies in Architecture at the University of Cambridge, graduating with a starred first in 2014. Daniel spent the subsequent year working for Niall McLaughlin architects in London, primarily working on the conversion of the historic (Grade I listed) Radcliffe Infirmary Outpatients Building for the University of Oxford. Daniel started at MIT in 2015, and since has developed a specific interest in computational fabrication, in particular working as a research assistant in the MIT Digital Structures group to robotically print structurally optimized lattices.

ROLL DECK
by Waishan Qiu

SENSEABLE CITY LAB, MIT
Amsterdam is a city that thrives on multi-scale interactions between the land and water. The tradition of creating land on water and the human scale of the waterways once made canals an essential part of life for citizens. However, the recent history of Amsterdam has seen the city disengage with the water. With the advent of the car and rail, water commuting and logistics are no longer competitive to those on road. As a result, urban activities shifted to become land oriented. Space on land became more contested, and dozens of the city’s canals were filled to alleviate congestion. This increasing lack of reliance upon the canals has arguably led to a citywide disengagement with the water network. The autonomous boat project ‘ROBOAT’ provides a great opportunity to pull the urban life and the urban space back, becoming reliant upon the canals again. It will also provide opportunities to re-engage with the citywide asset of waterfront lands and spaces. This project takes advantage of the opportunity to envision the future of Amsterdam’s historic canals with autonomous boat systems and urban sensors. The ROBOAT program is ambitious. It is a fleet of autonomous boats in Amsterdam’s canals, monitoring the environment, providing transportation and enabling self-assembling bridges and other urban infrastructures. However, there is a missing piece of the perfect puzzle in the blueprint of ROBOAT. That is the transition between the canals and the banks. The relationship between land and water, or the interface is actually suffering from barriers of many scales in Amsterdam. There are physical and non-physical obstacle that block residents’ access to canals. The first kind of obstacle is physical: the elevation difference in bank and water. As the canal side has an important role of flood protection, in the condensed city center, it is difficult to access and enjoy the water. The discrepancy in elevation between street level and water surface varies mostly from 0.5 meter to 1.5 meters in the dense historic area of Amsterdam. How to design a flexible and feasible solution that can meet the dynamic requirements of landing or loading people, cargo or even the ROBOAT itself, is a crucial task. The other tough barrier is the inconsistency between the relative static land use regulation and zoning, and the more dynamic demand of human activities. Compared with other ‘water cities’ such as Barcelona, Copenhagen, and Stockholm, Amsterdam was very proud that it boasted plenty of public quaisides and waterfronts. These should be places where residents and visitors can stroll and meet each other, and they would be able to provide space for markets, terraces, and rows of benches sheltered by trees, serving as promenades where metropolitan life is played out. However, one condition necessary to unfold the waterfront public space is that these quaisides and waterfronts are actually accessible, which is currently not the case. The access to canals are impeded by parked cars and bicycles or is obscured by waterside obstacles or houseboats. In particular, it is difficult for people in the central area in Amsterdam to engage with the water because cars are often parked along the water’s edge, and houseboats parked on the riverside.

**Bridge the Elevation Gap**

**Offer Adaptive Interfaces**

**OBJECTIVE**

Nevertheless, these obstacles also present opportunities for the city to re-organize the waterfront land use programs and renovate the public urban spaces. The first urgent goal is to develop a seamless interface to flexibly bridge the gap between water and land. It is in response to Right: Typology of current interfaces and their accessibility to water.
the first challenge— the difference in elevation between water and ground. How can residents, commuters, business owners and visitors across the city easily access the fleet of autonomous boats? If the access to ROBOAT relies on fixed or heavy infrastructure such as harbors, decks, jetties or piers, then the advanced novelty and mobility of autonomous boat is negated. Because the future of Amsterdam is believed to be highly autonomous and dynamic, it is crucial that this kind of flexible system should have the capacity to evolve to either become a larger and more permanent infrastructure or it diminish and exit the space accordingly. By doing this, the flexible system can meet the ultimate dynamic demand of providing a connective interface between boat and land for large amounts of people and logistics in the long run.

STRATEGY

To tackle the challenge of elevation gap and to meet the objective of seamless transition between land and water, RODECK proposes a smart and adaptive machinery system. It is a flexible, light, and integrated infrastructure. The design will envision an adaptive and affordable structural interface that is flexible enough to meet the challenges of bridging the elevation gap, offering portable platforms and helping to incentivize water oriented activities. Design solutions proposed by the RODECK will be framed by the following strategies. First of all, it offers feasible and adaptive interface for the regional water transport system. Digital technology, sensors and urban information are highly involved in this system. Specifically it is an architectural solution implemented to bridge the physical gaps in elevation. It detects the surrounding information as well as provides feedback information to the regional system of ROBOAT. Secondly, it has the potential to work as a portable platform to densify the urban space, to help with the land scarcity problem in Amsterdam. Thirdly, its machinery and engineering design is capable of transforming into various and multiple uses such as Pop-up Café, Gallery and Airbnb so as to react to urban changes. Lastly, it is attractive to incentivize the recreational use of water. The interaction with this system is a lot of fun. It improves the usage of the waterway and pull human beings closer to the water again.
The personal interaction with RollDECK system contains two parts to integrate both physical and digital experiences. First of all, the system design enables a digital and information-based interaction between different personal users, and between individual user and the system itself. By crowdsourcing technology, residents, visitors, business owners of Airbnbs, Water Farms, Water Cafes and other ROBOAT service based businesses can monitor the movement, availability, condition of DECKs and then request a RollDECK to connect. Besides the request, other information on accessibility, flooding, traffic congestion situations near the users’ geolocation are also conveyed to the application users in real time. For the consideration of physical interface of personal interactions, the RollDECK proposes to use LED pixelated panels as the surface of the decks. With the information from motion sensor and cameras, the movement of passengers and people nearby can be translated into pixel paintings that are an abstract representation. Meanwhile the interface becomes an information input device. Passengers can plan their route and select information they want to see by interacting with the interface using their body’s motion and physical touch. The physical interaction demonstrates a novel, tangible and straightforward approach of information communication between individual passengers and the DECK system. It is also a two-direction interaction. The physical interface is an integrated device of cybernetic system. It is the input end as visitors’ motion and touching movements and actions are inputting orders. It is the output and display end as the urban information are visualized via the pixelated panels.
Top: Potential Elevations
The RollDECK has the potentials to transform and connect different elevation gaps by the movement activated by two linear actuators.

Down: Modular Units
Various sizes and scales of platforms based on the combination of different modular units.

First of all, it is a deck, no matter its shape, appearance, or the fundamental function. When there is no demand for loading or landing people and cargo, it is a piece of stable deck that plugs into the canal bank. However, when there is a request for landing or loading, the autonomous and cybernetic feedback loop is activated. Secondly, it is a basement of possibilities. According to the data it collects, such as numbers of passengers, type of transportation, purpose of trips, it can be gradually expanded to a permanent tourist pier or a kiosk offering information. It can become a permanent storage tower for ROBOATS. It can be a pop-up art gallery, a cafe or a shelter for homeless. Thirdly, it is an extension of the bank. When area on land is scarce, the deck expands and becomes a temporary public spaces. Secondly, RollDECK proposes a smart and adaptive machinery system that is embedded with urban information systems. It is a flexible, light, and integrated infrastructure as well as a social computing and crowd source platform. The platform design envisions a two-way interactive feedback system that is capable of integrating information collected around the city at any time. It is not only a data collector, but can also perform network analysis and return feedback about the trends and patterns of ROBOAT usage. It also encourages social interaction by embedding social media functions with the trip plan and partner finding. Its machinery and engineering design is capable of transforming into various and multiple uses such as Pop-up Cafe, Gallery and Airbnb in order to react to urban changes.

Elevation Difference
The elevation gaps between canals and streets ranges from 0 to 2 meters for the most of the cases in Amsterdam.
To create a seamless transition between elevation gaps of canal water level and street ground level, as well as to provide new adaptive and light infrastructure embedded with urban information services including mobility on water and livability in city, the RollDECK project proposes a smart and adaptive machinery system. It is a flexible and light infrastructure as well as a media device that is integrated with urban information sensors and interfaces. First of all, it is a deck actuated by electronic linear actuators that can expand perpendicular to the canal bank. It then senses the gap in elevation and subtract the height of the coming ROBOAT considering different weight loads. It then calculates the degree of slope and actuates its rotation. Meanwhile, it has the ability to adjust to the fluctuations caused by waves. Its transformation is realized by electronic linear actuator. With a laser sensor, load sensor, motion sensor and others, it also collects surrounding information. Its machinery and engineering design is capable of transforming into various and multiple uses such as a Pop-up Cafe, Gallery, or Airbnb so as to react to urban changes. Lastly, it is attractive in order to incentivize the recreational use of water. The interaction with this system is a lot of fun. It improves the usage of the waterway and pull human beings closer to the water again.

The five axon drawings on the right show the evolution and development of RollDECK system into different purpose and usages based on the same standard unit design.

1. Suspension Rope
   The rope connects Rotatable Holders. It is powered by motor, which realizes the function of unfolding and folding the holders.
2. Rotatable Holder I & II
   The holders connected with ropes are uplifted when the deck extension is activated.
3. The Deck Extension
   Wood board with metal framework. It is hidden within Deck Part I when there is no needed to extend to touch the water level.
4. The Deck Part I
   Wood board with metal framework. It is the basic deck and there is DECK Extension hidden in it.
5. Anchor & Motor Sector
   The sector anchored to the vertical bank and there is motor and electronic wires in it.
6. Laser Sensor
   Sense the distance to water.
7. Linear Electronic Actuator I
   Realizes the extension or retraction of the deck.
8. Linear Electronic Actuator II
   Realizes the rotation function of the deck.
9. Connection Board
   Wood board with framework that is horizontally anchored to the bank.

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TECHNOLOGY
DESCRIPTION

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In the long term, RollDECK can fully justify its function of re-organizing the urban spaces with more timely and responsive strategies on the demands side with corresponding land uses adjustment by crowd sourcing, dynamic requests and other data sources.
To tackle the challenges of seamlessly transitioning between the elevation gap of canal water level and street ground, the RollDECK project proposes a smart and adaptive machinery system. It is a flexible and light infrastructure as well as a media device that is integrated with urban information sensors and interfaces. The system is designed to be adaptable in different conditions.
Waishan Qiu

Waishan is a candidate of Master in City Planning at MIT. He holds a M.ARCH Urban Design degree with Distinction from Bartlett School of Architecture at University College London and a B.E. degree in Urban Planning from Tongji University, China. He is currently the research assistant at MIT STL Lab, Center for Advanced Urbanism and Evidence for Policy Design at Harvard Kennedy School. Has been studied and researched in China, UK and USA, he see himself as an interdisciplinary designer across scales. His previous researches vary from as small as a 3D print ring, to as large as the urban systems of a territory. Being skilled at computation tools such as Rhino, Grasshopper, ArcGIS, Python, he is very interested in Cybernetics theory, sensing technology and data visualization. He wishes to explore how information and sensing technology would interact with architecture and urban spaces. More detailed information and work samples can be found at www.qiuwaishan.com.
Amsterdam is known for its vibrant canals— they are the site of national events, colorful festivals and even private celebrations. Despite the fact that most of this interaction happens on the water, the canal otherwise serves simply as a vessel for transportation. Perhaps this is why when conditions such as weather or inhospitable banks do not permit such uses, interaction levels fall drastically, leaving the canals empty and desolate.

**SOLUTION**

I propose shifting the canals from simply a vessel for activity to the object of activity. By designing water itself, my project allows Amsterdam to interact WITH the water not as a spectator to participant, but all of them. I envision for these a myriad of uses: sculpting water into temporary pieces of art, enhancing water quality, and also creating playful interactions through water games. These interactions range from passive to active, spectator to participator, but all of them encourage a less functional relationship with the canals than exists currently. “Huppelen” means to skip with joy in Dutch, and this word captures the levity I hope the project brings to the canals of Amsterdam.

The fountains can be an addition to existing events like the light festival, but also be used as an anchor for place making, attracting crowds to isolated locations and drawing people away from the center. The fact that they’re autonomous and dynamic means they can be used for multiple interactions in different places. Unlike regular water fountains they are not limited by nozzle placement or location. They can also move away if there is traffic that needs to pass.

An additional use of these fountains, which would merge function with the current performance-centered design, would be water filtration or water oxygenation. Given that the fountains would be pumping out water from the canals and recirculating them, there is a good opportunity to either clean the water or add more oxygen to it before returning it to the canal.

The huppelen fountains are multi-use crafts and thus, each function allows for a different kind of interaction on a spectrum from passive to active. Passive interactions include viewing the dancing fountains as they traverse the city, enhancing the ambience of each place they stop in. The play functionality allows for more active participation through two mediums: digital through a mobile app and physical through a touch screen, which will be located along a few banks.

Physical screens dotted along key locations in Amsterdam are a dynamic means they can also move away if there is traffic that needs to pass. The mobile app would include location information about the spectacular fountains, real time water quality, and aeration statistics. The app would also allow users to play games with the fountains.

To encourage the use of huppelen as a social activity, the app will aggregate and feature a running feed of social media activity where people are interacting with the fountains. These can be videos, photos or tweets which can be directly submitted to the app or can be aggregated through hashtags.

Once the system matures, interactions with the fountains can be deepened by allowing users to create their own games and fountain shows through the app. The mobile app would also display the location and statistics of all playful fountains on a map and users can choose to get alerts whenever they are walking past an area where a playful fountain is available.

Through the app, users connect to the fountain, if there are a lot of people playing users get into a virtual waiting line with the app alerting them whenever their turn comes. There are a variety of games users can play, and these can be added upon as time goes by. From basic shooting games, to more complex races, obstacle courses or even gesture controlled fountains. These games allow the translation of play with water from the street to the canal.

**PERSONAL INTERACTIONS**

**Mobile Art**

Information on fountain shows, including location, timings and patterns.

**Water Quality**

Information on water aeration activities of the crafts, including location and statistics.

**Urban Play**

Social media feed, vote for your favourite fountains.

**Check locations of nearby playful fountains, and if found pair with them.**

**Non-Passive Interactions**

**Passive Interactions**
One of the primary purposes of this project is placemaking, stimulating the transformation of spaces into something more than they already are. The crafts will be designed to encourage two primary placemaking activities:

1) Enriching Public Space
2) Creating Spaces of Social Engagement

The need for placemaking is not the same everywhere, something this project recognizes. Each area in Amsterdam has its own dynamic and design, which requires individual attention.

To ensure tailored services, each area will be categorized in a central database, depending on its activity level and its interaction potentials. Each category would come with its own set of instructions: which function to perform, when to visit and what inputs to wait for. The crafts can move through the city taking into account these categories. As the crafts move along the canals, they will continually be sensing water quality and alerting the city to where an intervention may be needed.

The city can then act on this information and ask a craft to go to particular places to aerate the water. Special events like weekly markets, parades and festivals can be added to the ‘schedule’ of the crafts, ensuring maximum visibility for the fountains, and an extra attraction feature to these events. Amsterdam has numerous grand public spaces which attract visitors from all over the world. These are generally high activity areas but with low interaction potential, since few people would want to interrupt their visits to monuments with games. Examples include Amsterdam Centraal, the symbolic entry point to Amsterdam, the Royal Palace, Dam Square, and Rijksmuseum with its open spaces which are currently unused.
Spaces of Social Engagement

The bridges, markets and squares of Amsterdam see many different people come and go, yet they rarely stop to have a chat and actually meet each other. Urban play has the potential to overcome barriers between people and to entice interaction and engagement.

Spaces of intense pedestrian activity like the ones mentioned will be tagged as ‘social engagement’ spaces where the ‘playful’ crafts would be positioned. Bridges like those on the Reguliersgracht would be an ideal place — all seven bridges can have strangers playing games with each other, adding levity but also forming momentary bonds.

Enriching Public Space

There is another category of places which requires activation. These are low activity areas usually far away from the city centre where there are fewer visitors or residents or smaller streets in the city center which do not have as many attractions to offer. These areas, however, have high interaction potential.

While in the former category performances will add grandeur to the places and ornament them with color and joy.

There can be fixed repeat performances of dancing fountains on different days, depending on crowd levels.

In the latter category, the fountains can be used as an attraction to encourage people to visit lesser trodden paths in Amsterdam. Prime examples include Veemkade in the Eastern Docklands which have so much history and open spaces, but few visitors. Another candidate might be the canal near Nes Street while an average tourist passes Dam Square four times, they never pass its neighbor Nes Street. Through play and pomp the fountains can make places into destinations.
The Huppelen fleet needs three kinds of technology support:
1) The design of the craft and fountain system itself
2) The dynamic placement algorithm
3) The sensors and actuators that would allow it to perform

The technological needs of each use can be built on each other, allowing one roboat craft to be used for multiple interactions. This flexibility makes any investment in these fountain crafts practical.

**Fountain System:**

- **Exterior:** The crafts need to have a rugged exterior to ensure bumps and accidents in the canal do not impact the internal circuits.
- **Variable Frequency drive water pump:** The fountain pump pressurizes the water which requires anywhere between 0.5-5HP of energy. It will be responsible for sucking up the water from the canal and circulating it. Because it is going to be a VFD Pump, it will save energy consumption by only using the energy required for a given operating scenario.
- **Gyrating nozzle:** Nozzles are responsible for creating definite shapes and movements. By installing nozzles off-axis and mounted on a rotating bearing cup, the water can be made to look like it is dancing.
- **LED Lights:** The roboat will be surrounded by a ring of LED Lights which can be powered at will. They are all independently functioning, providing flexibility to develop a light language for communication and display.
- **Suction filter:** The suction filter mounted at the inlet of the suction pipe prevents the ingress of dirt in to the pump.

**Performance and Sensing:**

- **CPU and control panel:** Each roboat will be fitted with a CPU which will be able to run through the various choreographed nozzle formations and dance routines. This will be responsible for positioning the nozzle in the X-Y axis and adjusting water flow rate for just the right stream height. It will also direct the positioning of the roboat around the city.
- **RTK/GPS:** To detect minute changes in position.
- **Mesh network:** All the roboats will be connected through a wireless mesh network to allow communication.
- **Battery and solar panel:** Since roboats are dynamic boats, each boat only need have enough battery charge for one show.
- **Blu etooth:** Allows pairing with app.
- **Water quality sensor:** To detect the quality of the water to report back to the city.
- **Anemometers (or wind sensors):** To dial the vertical jets up or down depending on the wind speed.

**Dynamic placement algorithm:**

This algorithm will prioritize enriching public space and social engagement following the place based categorisation as described in the previous section. Demands from the city or the crowd (through the app), any ongoing special events, or activity patterns around the city can be used as special inputs for idle crafts. The algorithm can then decide the optimum strategy for deployment depending on time of day. Once the battery is low, the crafts can park on the side of canals to charge.

**Water Remediation**

Apart from information on fountain shows, users can get real time access to water quality statistics of the canals the crafts float through. Since fountains are natural aerators, each fountain use adds oxygen to the canals by breaking the surface of the water. Users can access data on how much oxygen was added to the water by each fountain show. If there are crafts that are idle, the app also gives users an opportunity to demand ‘aerating’ fountains in desired locations allowing Amsterdam’s residents a to play a part in their canals being reclaimed for flora and fauna.
Dynamic Placement

The crafts can strategically place themselves around the city, responding to needs of places and crowds. While their primary tasks are placemaking and encouraging social engagement, they can also be moved to specific places to aerate the water.

As an example, at 8 AM on a weekday, crafts could be greeting commuters on their way to work through performances. By noon, they could be entertaining crowds at lunch places and public spaces like museums. On a weekend, in contrast, they could be focusing on building social interaction in spaces of intense pedestrian activity like markets. They could also be encouraging adventures and explorations to little visited spaces and places around Amsterdam. At night, they would still be focusing on social engagement and activating places, but instead they would be showing people new places to experience Amsterdam’s nightlife.

When the day is over, the craft can park itself in a safe corner and charge itself so it is ready to take on another day.

While the algorithm’s priorities would be to aerate only through other uses, if there is an idle craft it can be sent solely on an aeration mission.
Interacting with the canal not just on it.

Huppelen combines autonomous technology with beautiful design to create moments of joy for all. Imagine dynamic, multi-use crafts spread around the city in a network of smart, energy efficient fountains — at once, pieces of art, playful gestures and water quality enhancers.
Rida Qadri is a current PhD Student in Urban Information Systems at MIT. Her work uses spatial data analytics to inform more inclusive design and governance practices for the informal economy. She has previously worked on projects which have integrated various data sources in novel ways to investigate the functioning of low-income street retail in places like New York, Durban and Singapore.

Kooikerhondje
by Lauren Kennedy

SENSEABLE CITY LAB, MIT

Photo by Lauren Kennedy
Could the dark voids of the canals become canvases for light and interaction?

**CONTEXT**

The canals of Amsterdam are synonymous with the city, and the concentric waterways are a prominent element that delineates the urban layout. One could accurately claim that the canals are perhaps the best known feature of the city; the human-scale of the waterways make them an essential part of life for citizens in the city. During the day the canals bustle with life from pleasure boaters, tourists, and locals. Private boats line the edges of the canals, on-call for their owners, and visitors can rent a variety of boats, or join one of the numerous canal tours that continuously run. Roadways next to the canals are congested with bikes, delivery trucks, cars, and pedestrians, all trying to commute alongside the picturesque waterways. The canals provide the perfect ambiance for a daytime break, and both picnickers and diners at cafes lining the water add to the dense clusters of activities. During the day, the canals are a magnet drawing people in. Canal nightlife is dramatically different. While the city thrums with clubs and activity, the canals are silent. The street congestion fades away, the boats are docked, and all of the people disappear. While a rare tour boat might meander along, for the most part the canals become deserted after sun goes down. This is especially true in the city center where there are lots of people out at night, but little canal activity. How is it that this city, this place that is defined by water, abandons it at night? Could these dark voids become canvases for light and interaction, luring people back to the canals in the evenings?

**ENGAGING CANALS AT NIGHT**

Kooikerhondje, named after a spunky breed of Dutch spaniels, proposes a new engagement with the canals of Amsterdam at night. Visitors can connect to a Kooikerhundje to become its owner, and then engage and play with their new found pet. When the owner walks along the canal, the disc follows along, just like a pet puppy. Kooikerhundje can be used as a placemaking tool to engage with the imagination and playfulness of the Amsterdam public. As more people discover the playful lights, they will engage both with each other and the waterways. The installation is designed to facilitate both one-to-one and one-to-many interaction, encapsulating a wide range of uses. By creating a new connection between the pedestrians and the canals at night, the city can maximize the shared value of the water by extending the hours in which they can be enjoyed.

**LIGHT FESTIVAL**

Kooikerhundje is an installation design that could be adapted for use during the Amsterdam Light Festival, an annual event that takes place in December and January. The festival features Water Colors, light art in the canals, and Illuminade, a walking tour of light installations. As the Light Festival is a well-attended event, the Kooikerhundje disc programming would be permanently set to interact with crowds of people. Kooikerhundje would be available for interaction, as well be programmed to perform mini light shows conducted by the viewers. During the Festival, the puppies would be located in points accessible by those touring the show.
Kooikerhundje engages the Amsterdam canals at night through playful illumination and light interactions. For this installation to fully succeed with the public, there is a three-part process to the interaction: (1) drawing in participants and pedestrians to the canals; (2) providing a meaningful and fun experience at the canals at night; (3) continued engagements on various occasions, creating a sustainable connection. With these three phases of interaction, Kooikerhundje could become a permanent installation in the canals of Amsterdam.

**DRAWING IN PARTICIPANTS**
Currently the Amsterdam canals are dark and quiet at night. Rather than begin the interactions with bright lights moving about the canals, a more subtle approach will be used to draw attention to the installation. Using submersible LEDs mounted under the Kooikerhunje discs, canals will softly glow, signaling to potential playmates that something is happening down in the water. Clusters of the discs (packs) will be stationed around the designated areas of engagement, awaiting interaction.

Once an owner on shore is connected, the Kooikerhundje disc will ‘wake’ up, ready to play. A ring of light will flicker on, signaling to the user that they can begin playing. As more people come to the canal shores, more Kooikerhunjes will appear. Using a cloud-based wireless server, the discs will be able to signal to the larger pack where more Kooikerhunjes are needed. Using the autonomous boat technology, the discs can move about the canals unti, and distribute themselves to denser collections of people, lighting up once they are in the correct position.

**PLAYFUL DISCOVERY**
Once a participant has been assigned a disc, they will have a new pet to play with. A range of motions can be measured by the user’s phone, which becomes the digital leash for the Kooikerhunje. As the owner walks along the canal, the Kooikerhunje will automatically heel, floating and illuminating the canal as it moves. If the owner stops, the Kooikerhunje will also stop, waiting further instruction from the shore.

This is where the owner can start experimenting with their new pet. Owners can set the app to ‘Command’ where they can directly move the Kooikerhunje through a range of motions including spinning, jumping, dancing, and a variety of arm motions. All cause new and different reactions from the discs including rotating, blinking, and color changes. Users can also set the app to “Offleash” which allows owners to influence the motions and behaviors of their disc, but does not dictate each specific move. New colors and motions can be unlocked with more interaction.

When more than one user is on the shore, the Kooikerhunje may get distracted and play with each other, returning back to their owners after moving about together. Once owners are finished playing, they can walk along the canal, accompanied by the Kooikerhunje to their next destination. If they hit the end range of the designated ‘puppy park’, the Kooikerhunje will return to its pack.
CONTINUED ENGAGEMENT

For this to be a successful installation, it needs longevity and continued use. In evaluating potential users of the Kooikerhunje, one must recognize that there are two categories of users: visitors and residents. Visitors and tourists will engage with the lights because they are a novelty. Seeing the lights in the canals and interacting with them will become part of the tourist to-do list when visiting Amsterdam. Because the city has a large tourist industry, it is likely that the Kooikerhunje will be engaged on a nightly basis.

To attract the citizens of Amsterdam requires a bit more ingenuity. A one-time pet may not be enough to lure someone back to the canal after the first interaction. However, could creating a relationship with a light pet lead to continued engagement? Using information stored in the app, owners would not only capture a pet, but they could begin teaching their pet different tricks. More interaction and engagement with the pet and the app could unlock new features of the Kooikerhunje. If you take your Kooikerhundje for a one-mile walk, then you unlock the orange light; if your pet participates in a dance show with a large pack, then it 'remembers' some of the dance moves and periodically starts to dance; if you visit every night for a week, you have the ability to add blinking and fades to your lights. Every time an owner captures a disc, they are able to continue building on the repertoire of the Kooikerhunje’s abilities—the interaction becomes more of a relationship than a one-time fling.
CROWDS
When the canal banks become more crowded, or perhaps during public events such as the Amsterdam Light Festival where large groups are expected, packs of the Kooikerhundje can combine to create personalized light shows for their owners. Using the smartphone app, viewers will be offered sliding scales that can be used to select their preference for colors, movement, and speed. Input from the crowd will direct the light and movement show that the Kooikerhundje will perform. If the crowd all move their sliders to the monochrome side, the Kooikerhundje show would be understated and delicate; the multi-color choice would create a Kooikerhundje party, with bright colorful lights.

TIMING OF INTERACTION
Whether the interactions are occurring through an organic crowd, or a crowd from the Amsterdam Light Festival, the timing of the play | dance cycle would follow the same structure. On the right, the timing and flow of the crowd interactions is described: from play-based interactions, to show selections, durations, and the eventual reset of the system.

0:00 - 2:00
Viewers connect to the Kooikerhundje and they are given options to change the color and influence the behavior and direction of the discs. The autonomous nature of the discs will not allow people to crash them into each other, and interesting interactions will occur as they steer through the canals.

2:00 - 2:30
After an opportunity to connect directly to a Kooikerhundje and play, a new screen will pop up on the users’ app. Sliders appear with a countdown timer of 20 seconds for participants to make their selections. At the end of the voting phase, the discs begin a light show based on the crowd inputs.

2:30 - 4:30
Following the voting phase, the Kooikerhundje will line up and perform a light dance based on the crowd inputs.

4:30 - 5:00
As the light show comes to a conclusion, viewers will have the opportunity to connect with a Kooikerhundje and interact with it, beginning and new cycle. If a Kooikerhundje is not connected to an owner, it will interact, play, and maybe even distract Kooikerhundjes that are paired up—just like a puppy at a dog park!
As Kooikerhunje are intended to engage the canals at night, selecting appropriate locations is essential. Not only will the placement influence who the audience will be, it could also provide useful data about the spaces and how participants interact in them.

To determine the location(s) for this installation, a variety of factors were evaluated: high traffic pedestrian areas in the evening such as bars, night clubs, and venues, accessibility of the canals (are cars or other obstacles going to block pedestrians from getting to the canal edge?), high density tourist areas, such as the red light district, and tour boat routes.

With these four metrics, four areas (indicated by the white lines in the map on the left) were selected as suitable sections of the canal to place the installation. Each location offers a unique space which can be compared against each other. The criteria that all have in common is that there is a side of the canal is accessible and not overly crowded with cars or other obstacles.

**WATER COLORS**

If Kooikerhunje were to be implemented during public events, a smaller, more concentrated area for interaction would be established. The best location for the installation during the Amsterdam Light Festival would be in the Hortus Botanicus. This park is both part of the Water Colors boat tour, and the Illuminade walking tour. Here visitors could interact with the Kooikerhunje discs from the land, viewing the light show from the shore. As the boat tours passed by, the discs would move out of the way (as illustrated on the previous page).

**DATA COLLECTION**

Captured through the smartphone interactions, data will be collected throughout this installation which could provide useful insight to how the installation engages the canals — and if that engagement changes throughout the course of the installation. Kooikerhunje will be able to record the number of unique users they interact with, how long the interactions last, and how many people return. Site comparisons can be made to see what locations were the most successful at drawing people in for prolonged, continued engagement. Data analysts will also be able to determine whether the installation is more successful with locals or tourists.

During the Amsterdam Light Festival, the crowd preferences will be recorded. It is likely that with larger crowds, the meters will average towards the middle for many shows. It will be an interesting social experiment to see if the crowd can coordinate to all move the sliders towards one side of the other so that they can collectively experience a show where they can view the extremes of formation, color, or movement.

**TECHNOLOGY**

A user’s smartphone connects to the cloud server via a smartphone app. Through this connection, the user’s GPS coordinates are shared. The server then communicates to a Kooikerhunje disc the location of the interested user. The disc moves to that location to connect. The smartphone app establishes a geofence perimeter. Once the disc is within the range of the user’s geofence, a Bluetooth connection can be established. At this point the user and the disc communicate via a local connection.

Crowds can use their smartphone app to influence light performances. Individual preferences are sent to the cloud server via the app. These ‘votes’ are aggregated, pre-designed instructions (i.e. choreographed behaviors) are then sent to the control board on the Kooikerhunje. A wide variety of motions and behaviors will be choreographed, providing a large catalog of lights shows that can be performed.
Kooikerhunje discs are essentially autonomous boats in the shape of light discs. For the discs to connect to users and each other, a cloud based server will be used. Users will connect to the cloud via an application on their smartphone, which will record their location through the phone’s GPS coordinates. The cloud based server will then wirelessly alert a Kooikerhunje to move to the location of the user. Using autonomous boat technology, including a GPS and control board, the disc will arrive to the location it was called.

Once the disc is near enough to the user, the disc will pair directly to the phone through geofencing. This technology will allow the disc to follow the new owner up and down the canals.

Using the phone’s IMU capabilities, movements such as shaking, rotating, and moving up and down (and combinations of all three) will be detected by the phone and interpreted by the disc to perform preprogrammed movements.

The cloud based server will allow the Kooikerhunje to communicate to each other, which enables the Kooikerhunje to perform light shows and parades for large crowds. And if one Kooikerhunje senses a boat coming down the canal, all nearby Kooikerhunje will be alerted to move the water’s edge. Object detection will also prevent the Kooikerhunje from bumping into each other if their owner is a tad over zealous.

The cloud based server will allow the Kooikerhunje to communicate to each other, which enables the Kooikerhunje to perform light shows and parades for large crowds. And if one Kooikerhunje senses a boat coming down the canal, all nearby Kooikerhunje will be alerted to move the water’s edge. Object detection will also prevent the Kooikerhunje from bumping into each other if their owner is a tad over zealous.

Users will connect to the Kooikerhunje discs through their smartphone. Geofencing, utilizing the GPS function of the phone, will tether the Kooikerhunje to the user for the length of the installation. This way the Kooikerhunje can follow the ‘owner’ down the canal.

Motion sensors on the Kooikerhunje will detect boats and other movement in the canals. When sensed, the discs will move out of the way, allowing the boat to pass. When the boat has passed, the Kooikerhunje will return to the center of the canal.
LAUREN KENNEDY

Lauren earned her BFA from the University of Hartford in Visual Communication Design, and a Master's Degree in Museum Studies at the Harvard Extension School. She is currently a graduate student at MIT in the Department of Urban Studies and Planning working towards a Master's Degree in City Planning. Lauren specializes in information design and identifying opportunities to introduce and apply data visualization solutions that emphasize exploration and discovery while engaging users.

Floating Parklet

by Yan Liu

SENSEABLE CITY LAB, MIT
Floating Parklet: new space to meet and exercise.

Amsterdam, the capital of the Netherlands, has more than one hundred kilometers of canals, about 90 islands and 1,500 bridges. Its name is derived from the dam of the Amstel river, which now connects to the complex system of canals. The three main canals, Herengracht, Prinsengracht, and Keizersgracht, that were dug in the 17th century during the Dutch Golden Age, formed concentric belts around the city, which are perhaps the best known features of the city. Amsterdam thrives on the multi-scale interactions between land and water as well as the human-scale waterways, which have become essential parts of citizens’ lives in the city.

However, recent urban development has gradually separated the land and water: automobiles and bicycles occupy the edges of the canal banks and houseboats occupy the riverside. It has become more difficult for people to engage with the water now so more and more urban activities have been shifted from water to land. Free space on land has become increasingly sparse and this lack of public space is causing a negative impact on the quality of people’s lives. Moreover, the existing canal tour cruises are primarily intended for tourists instead of locals, and can only offer limited opportunities for people to enjoy the water.

This project envisions the future of Amsterdam’s historic canals with the design possibilities of autonomous boat technologies. Such autonomy will allow boats to operate more dynamically and potentially reduce traffic congestion and accidents greatly. How will the city react to such changes? Will such technology drastically alter the existing relationship of how people use land and water? While the main group utilizing canal and public spaces is currently young adults, it is necessary to take other demographics (children, elderly, disabled) into consideration. With an emphasis on bringing people more accessible public spaces that they can use in daily life, a new type of autonomous boat in future Amsterdam is proposed. It is based on the concept of the parklet, which is a sidewalk extension that provides more spaces and amenities for people using the streets. Usually parklets are installed in parking spaces offering places for people to stop, sit, and rest while conducting the activities on the street. Here, the parklet design is being used on the autonomous boat by proposing a new type of “floating parklet” on the canals of Amsterdam.

There are two functions of the floating parklets: Meet and Move. The floating parklets provide great opportunities for people to meet up with their friends, families, colleagues and even strangers. Just imagine lying on a comfortable sofa reading an interesting book or chatting with your friends with all of the breathtakingly gorgeous Amsterdam surrounding you or having a meeting with your teammates or colleagues in the fresh air and glorious sunshine!

Meet: There are two modes in the Meet system: Relax and Work. The floating parklets provide great opportunities for people to meet up with their friends, families, colleagues and even strangers. Just imagine lying on a comfortable sofa reading an interesting book or chatting with your friends with all of the breathtakingly gorgeous Amsterdam surrounding you or having a meeting with your teammates or colleagues in the fresh air and glorious sunshine!

Move: There are two modes in the Move system: Bicycling and Yoga. Since nowadays people are too busy to exercise, the floating parklet provides them with feasible and convenient opportunities to exercise on their way home or to work, saving the time to go to gym. They will find that keep daily exercising is entirely within their grasp.
Whether you're a first-time visitor or permanent resident, everything in Amsterdam seems a bit more magical when viewed from a boat. Imagine floating on the boat with open air and public facilities: the new floating parklet system will provide new experiences to both visitors and local residents to gather and relax. The entire network of the canals becomes the new public space system in the city accessible to everyone.

With the constraints of the size and weight of the autonomous boats, a modular platform of autonomous parklets is proposed. A parklet of 10m (length) x 2.5m (width) can provide flexible uses of the space. Unlike regular parks on the ground, they move along the river, passing by the fantastic city with diverse activities on the boat. That could be the most important motivation for people to jump on the floating parklets.
MEET
New experience to get together, relax, read and work

Relax Space
The Relax mode of the Meet autonomous boat is intended to provide new spaces and experiences for people to meet others, regardless if they’re family, friends, colleagues, or even strangers. It provides a cozy environment for people to escape from their daily routine and have a good time on the water. It features comfortable bean sofas and digital kiosks where users can simply tap their phones to get access to thousands of resources including e-books and maps. Another feature of the boat is the specially-designed bike rack where people can easily park their bikes.

Work Space
The Work mode of the Meet autonomous boat is designed for office workers and students to escape from lackluster meeting and study rooms and enjoy the city in a new way. With two long tables in the center, it can accommodate two groups of six people or smaller groups of two to three people. Through the phone application, you can reserve a spot and request a pickup for you and your teammates. After getting on the boat you can enjoy the working space and then write a review of your experience as a reference for future users.
**Bicycling Space**

Want to work up a sweat while cruising down a river? If so, you will love the Bicycling mode of the Move boat.

The Bicycling space would be a fun escape for exercise enthusiasts who are tired of stuffy and boring gyms as well as busy office workers who don't have much time for exercise. Now they can exercise while enjoying the fascinating scenery even on their way to work or back home!

The sensors built into the vessel can track people's output and real-time data as well as the environmental conditions of the river.

**Yoga Space**

Have you ever thought of doing yoga on a boat? The Yoga mode of the Move boat is your new choice to keep fit while exploring fabulous Amsterdam!

Yoga helps to reduce perceived stress and anxiety, increase people’s flexibility and balance. It also offers people self-reflection, the practice of kindness and self-compassion, and continued growth and self-awareness. You can also adapt the practices to your own speed and level of comfort. No matter which yoga exercises you choose, the practice will always be part of a great workout routine.
In order to create diverse experiences for users, different itineraries are proposed to meet people’s different demands and uses. The “Move” autonomous boat is primarily intended for local residents who might be too busy to exercise daily. Therefore, it mainly passes through residential and work areas to provide more flexibility for office workers and students. There are two different routes based on different time frames: one hour and two hours.

Since both bicycling and yoga can take a while to finish, the route is perfectly designed for people to utilize either exercise with enough time available.

The “Meet” autonomous boat is more intended for tourists who come to visit Amsterdam. Therefore, the routes mainly pass through commercial areas and tourist attractions. The 0.5 hour and 1 hour time frames are designed to meet different demands.
YAN LIU

Yan is currently a first year student in the MDes (Master in Design Studies) program specializing in Risk & Resilience at Graduate School of Design, Harvard. She holds a master degree from University of Southern California majoring in Landscape Architecture. Before that, she worked in several Landscape and Urban Design consulting firms including Atelier Dreiseitl, Hargreaves and AECOM in Singapore, Boston, Paris and Hong Kong for almost two years. She has a strong design background and experience in different types and scales of design including architecture, landscape, urban, product, lighting, fashion, AR/VR and so on. She is now working as a Teaching Assistant at the VR/AR Lab at Harvard Innovation Lab.

Socioboat

by Jonathan Hasoloan
To leverage access and increase engagement with canals and water in Amsterdam

The canal system is a powerful urban fabric embedded in the historic city of Amsterdam. Ideally the canals serve both as infrastructure as well as public space, accommodating movement and urban life. Currently, the locals, particularly those who own boat(s), have the ability to explore and enjoy the canals more than just as a background for urban life – but as a platform of activities. Such privilege relies heavily on boat ownership and thus we can observe many boats are parked and unfortunately neglected during the off-season. But for most part, urban life happens adjacent to the canal because of the limited access to the water itself. The existing canal tour boat is one of the simple alternatives that allows boat-less people, especially tourists, to experience the canal. The municipality is concerned about increasing traffic on the water so they are encouraging more shared or rental boats. These conditions raise the question of whether the emerging autonomous boat system can leverage access and increase engagement with this significant urban fabric of canals and water in Amsterdam.

The autonomous technology allows us to redefine the concept of owning a boat to be able to experience the canal. The technology can also elevate tourist attractions in Amsterdam into a more compelling experience and allow visitors to simply enjoy the canal as urban fabric or to create customized private tours around the city. A platform that accommodates a more intimate experience for a smaller group of people, compared to the larger, impersonal experience of the existing canal tour boat groups, is apt to offer optimum flexibility and accessibility. That is what Socioboat offers. Generally, Socioboat is an autonomous boat boasting a modular surface that can be retracted and moved by hand in order to form configurations of benches and tables. This flexibility is key to providing a versatile platform for both personal and urban scale uses. The operation relies on an on-demand phone application so it can be requested anywhere in the city. On a larger scale, the autonomous boats are designed to be able to interact with each other and be combined into a larger platform. This larger platform can be useful for organizing larger group gatherings or community events. During the off-season when canal activities decline or some canals are frozen, Socioboats can be stored or used for other purposes. Another important feature, in addition to the Socioboat itself, is the logistic or service unit. The potential to combine Socioboats with such units can enrich user experiences and complement the function as a social platform. For example by having food delivery, trash collection, or entertainment options served by the logistic unit, users can improvise their needs while being on the water.
The main users of Socioboat are local people and tourists who are looking for authentic urban experiences. Socioboats can be requested through an on-demand application—similar to existing e-taxi systems. A significant limiting factor is the difference in elevation between water surface and the river banks so specific hop-on/off points may have to be deployed throughout the city, unless where the difference is identified as insignificant. A minimal deck structure that connects river banks and the boat can be attached to the river bank in several strategic locations.

But because Socioboat focuses more on creating experience, the on-demand application will involve selecting several factors beyond just origin and destination points. Users can choose the duration of their journey as well as any stops they’d like to make along the way. Destination and route options can be customized, but are suggested based on the idea of creating experience. These options are built around existing city attractions, views, vibrant districts, water spaces, etc. Suggestions will appear on the initial interface of the application.

Through the application users determine how they want to explore the canal. Users can select suggested routes based on several themes, which offers a private tour around the city. Information about the tour can also be provided through the dashboard on the ship so the boat acts as a tour guide as well.

Another option is for the users to create their own route and determine the duration of usage. Users can stop by different spots on the canal and hop off onto the street whenever possible, either to take a photo or to grab a beer. Furthermore, if paired with a logistic unit, users can order food or other amenities through the same application and have them delivered in the middle of the trip. A Socioboat unit is, by default, a flat barge with retractable modular panels forming the platform. Those panels can be elevated manually to be used as seating or as a table to allow flexibility of uses in different capacities.

By using the system, the users contribute to the mapping of places in Amsterdam where local people enjoy the city from the canal and how tourists may use it differently. Such data can be processed and fed back to the system and users to improve knowledge of various interesting places and routes in Amsterdam.

A private group tour on the canal

Flexible configuration on the Socioboat surface
Explore Popular Trip
Citadel Tour (60 min)
Amsterdam has several magnificent castles and citadels spread throughout the city!
Socioboats increase people’s interaction with the canal and provide new experiences with the water. It provides a new social platform in Amsterdam.

The system will allow a single unit to combine with other Socioboats in the middle of a trip. Imagine two families in different Socioboats have a similar interest in going on a museums route. They can, through the application, connect to each other and join the boats to create a more cheerful trip. Or a student with historical knowledge can open his boat for public integration so interested people can simply find him. This kind of interaction may leverage social interaction between people—though it will be set as optional.

In a larger scale application, the Socioboat can be assembled within a designated space to create a more spacious platform. For example, the water around the NEMO Science Museum, which has an existing deck for ship parking, can be transformed into a large platform for special occasions—maybe tied to a museum event or simply as a public space that offers a breathtaking city view.

Such urban-scale functions will need support from city regulations to determine the hierarchy of the canals and the allowed uses, especially those that occupy a significant amount of water area.

New physical infrastructure will also be required to support Socioboat operations such as deck stations along the river banks to bridge the various elevation gaps between water and ground level. These decks will be accompanied with a digital machine to request the Socioboat. Several hub stations will be located strategically to also serve as charging stations. These locations can be determined by considering the placement of existing attractions in the city, public transportation, and renewable energy sources, among other factors.

It is possible to integrate with the existing solar panel and charging stations, which can be very useful for electric vehicles such as this Socioboat. Currently, a significant number of privately-owned solar panels can be found throughout Amsterdam. Several charging stations can also be found along the river banks, which could be further improved and modified to accommodate boat charging as well.

These new infrastructures and activities may also push the municipality and community to rethink more interactive designs along the canal that could be integrated with the stations.

Additional regulation regarding water activities

Redefining programmatic space along the canal

New supporting infrastructure

Hub with Charging Station

Decks station

1 km

0

Hub with Charging Station Deck station

New considerations Socioboat brings to the design and organization of the shore and waters of the canals.
An autonomous system relies heavily on highly accurate positioning systems and object sensing technology like LiDAR or ultrasonic sensors. This enables the boat to map the physical realm into the digital realm and also allows for the boat itself to be mapped on the water, interacting with the surrounding objects, both dynamic and static.

The Socioboats and the stations are identifiable using geofencing technology. That data is then shown to users through the software application which also allows interaction with other parts of the system (boat-user, boat-boat, and boat-deck).

The positioning system will create a map of usage data, thus providing new insights into how people explore the canals within the city of Amsterdam. This data will be owned by the operator of Socioboat, either the municipality or a private company. Waternet, who manage the canals, have created a mobile application (vaarWater App) that provides information regarding canal traffic as well as several suggestions of thematic tour routes. The Socioboat can integrate its data system with the Waternet application data.

Such information can also help the municipality to provide possible improvement or complementing infrastructure in areas that are desirable for water activities.

The Socioboat will be equipped with a dashboard and an on-board manual control to steer the boat when necessary. The dashboard will have a screen displaying the application interface and providing information regarding the tour and boat performance. The Socioboat also features retractable modular surfaces that can be pulled manually into benches and a table on the boat. This flexible platform allows users to form the space according to both personal and urban scale uses. The surface is covered in a robust, lightweight, 3D-printed structure and hydrophobic rubber flooring to provide traction as well as comfort for sitting and to endure weather exposure.

The Socioboat will also need the ability to align itself with the decks or river banks and to other boats. Therefore a sensor is placed on each of the four sides. A locking system is placed on each of the four corners to allow firm connections when Socioboats are assembled into a larger platform. This locking system will not only connect Socioboats physically but also will connect a system that synchronizes their data and energy sources — similar to a USB plug where you connect both physically and systemically.

On the four sides, it is equipped with a retractable railing (which slides up and down) covered with transparent fiberglass. The sliding function is important in order to accommodate a flexibility of uses when boats are being combined to create a larger platform.

Exploded isometric of a Socioboat

Dashboard + Boat Lights

Transparent Fiberglass Railing
(Slides Up/Down)

Modular Retractable Surface
(Extending Structure)

Electric Water Jet Unit

LED Light

Battery + Processing Unit

Object Sensor

Water Jet Outlet

Locked System

Dashboard + Boat Lights

Transparent Fiberglass Railing
(Slides Up/Down)

Modular Retractable Surface
(Extending Structure)

Electric Water Jet Unit

LED Light

Battery + Processing Unit

Object Sensor

Water Jet Outlet

Locked System

The connection made if four Socioboats are assembled into a larger platform
New Urban Realm

The Socioboat will enhance interactions between people and the canals in Amsterdam. It offers flexibility of uses and accommodates the dynamism of water activities through a dynamic platform. It appeals to the local who seeks for the social buzz of Amsterdam on a different ground or on the contrary serenity of quiet water. It attracts the tourist who seeks to explore the city and experience the significant culture of being on a boat passing through the canals.
Jonathan Hasoloan is a 2018 candidate for Master in City Planning at DUSP MIT. He finished his undergraduate study at Bandung Institute of Technology with a Bachelor degree in Architecture (2012). Prior to attending MIT, Jonathan has worked at an urban design firm in Indonesia and involved in various urban design projects.
Generally, there are two types of tourists in Amsterdam: The corporate one, that usually stays in the Five-Star hotels located at the periphery of the Old City. And, the young tourists that stay within the Old City’s traditional houses to enjoy its nightlife experience. But, there is a more diverse third group that wants to stay close to the Old City but wants an experience different from partying all night.

H2OSTEL is a tourist accommodation within the water. A possibility to navigate from one of city’s multiple tourist attractions to another. Amsterdam is known for its many tourist attractions. Its artistic heritage and narrow houses with gabled facades, legacies of the city’s 17th century Golden Age. Its Museum District, with amazing Rembrandt, Vermeer, and Van Gogh paintings, its wonderful cheeses and good beers, its proximity to appealing tulip fields irrigated by the beautiful complexity of the windmills, and an elaborate canal system that allows a singular connection between these attractions.

According to the Tourism in the Amsterdam Metropolitan Area Report (Amsterdam Municipality, 2016), Europe is the world’s most popular holiday destination, and Amsterdam is one of its main destinations. In 2014, there were 40 million hotel bookings registered in the Netherlands, 17 million of which were in the Amsterdam Metropolitan Area (42%). In recent years, the number of nights spent in the area grew more quickly than the national figures. People want to visit Amsterdam.

In general terms, Amsterdam has two types of tourist accommodations: Five-star hotels located in the periphery of the Old City, and numerous traditional houses in the city center that have been transformed into hotels and hostels.

While the canal system forms a complex and efficient ecological network, there are underutilized areas in urban and tourist terms. Places that have been without a specific use for many years, and sometimes with moored damaged boats, whose reinvention would allow the canals to further contribute to the development of tourism in Amsterdam and the region. At the same time, the tourists have an imperative need to have a close relationship with the beauty of this canal system.
In order to receive diverse groups of guests that sometimes want to navigate within the Old City Center but also enjoy the quietness of other spaces of Amsterdam's surroundings, there are two specific characteristics that the project must fulfill.

The first characteristic is the flexibility to accommodate different guest groups. Sometimes the H2OSTEL has to host a person with a one-room module, but the module should also increase for a family. Also, it could incorporate additional attachments to provide - for example - a terrace as an extension of the rooms or a place for a pet.

The second characteristic is the mobility to different tourist attractions. With the H2OSTEL, the guest will move across the canals to visit some of the tourist attractions of the City. In addition, the room will be able to autonomously move during the night while the guests sleep to allow them to enjoy another part of Amsterdam when they wake up. And since the movement is part of the tourist experience, we will be able to go not only to any attraction of the City Center and its immediate surroundings, but also to many other beautiful locations such as the countryside, villages, farms, and other distant attractions that are difficult to visit with traditional resources.

Flexibility and mobility will work together through the H2OSTEL app. While each guest can control the sensors to manage the room's internal environment, one of the smartphones will function as an Administrator to communicate to the Service Center the movement that the room will do to reach tourist attractions. The Service Center also will host the management of the room Maintenance.

Top: H2OSTEL room facades.
Right: Interaction Process of the H2OSTEL system.
H2OSTEL app will allow a flexible interaction between guests and rooms, for a movable tourist experience across Amsterdam. After the creation of an account, the guest requests the number of rooms he needs (one to three rooms to fit the modules within Amsterdam canals dimensions). The system also will permit the incorporation of small pieces that provide additional services to the rooms, like breakfast or special tourist services.

After boarding, one of the guest will control the system with the app as the Administrator. To manage the movement of the room, always controlled by the Service Center. In the process, the guest will control flexibly of the destinations and types of navigation: the guest could choose a specific place to go, or can request a random navigation where the tourist destination is a surprise. Other guests will also be able to control aspects of the internal environment, like glass opacity, light and heating, through the H2OSTEL app.

The Service Center will control the room remotely, enabling visits to a maintenance center at any moment while the guest is visiting a specific tourist attraction. Additionally, because the Service Center has the overall control of the rooms in the territory, it will be able to manage the docks of destinations whose cost could vary dynamically on demand. But also, the guest will be able to avoid costs of docks by moving to other destinations while resting.

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Top: H2OSTEL app interface
Right: Personal Interaction Flowchart
Besides the control of the system through H2OSTEL app, **personal interaction** will involve a physical connection with the Canals through room arrival / attachment, and then navigation from within the room.

The diagram below represents how the dock costs will be controlled dynamically depending on proximity to tourist attractions. The closer the client requests a space to dock, the more expensive the space will be. A dynamic control of dock costs will depend on closeness and availability. However, the guest will also be able to avoid dock costs if they use the time spent navigating to rest within the room.

**Itinerary:**
- **Day 1:**
  - 10 am: Pick up.
  - 11 am: Anne Frank House.
  - 12 pm: Lunch.
  - 2 pm: Magere Brug.
  - 4 pm: Museumplein.
  - 6 pm: Bike ride.
  - 7 pm: Stroopwafel time.
  - 9 pm: If guests are tired, instead of return to their room by walk, the room navigates to pick them up.
  - 10 pm: Rest + Movement.

- **Day 2:**
  - 10 am: Old City Canals.
  - 12 pm: Lunch.
  - 2 pm: Magere Brug.
  - 4 pm: Museumplein.
  - 6 pm: Rest + Movement.

- **Day 3:**
  - 10 am: Countryside tour - tulips fields / windmills / cheese factories.

Left-top: Arrival-Attachment of H2OSTEL rooms.
Left-bottom: Dock-space management diagram.
Top: Physical navigation in the canals.
With H2OSTEL, the tourist experience could be extremely intense in Amsterdam. Guests will be able to request a room in any canal across the territory, and move to any place in the city and its surroundings. From Rijksmuseum to IJ Brewery, the door of your H2OSTEL will open in front of the place of your choosing, even the most beautiful tulip fields and windmills, the autochthonous cheese or wooden clog-making factories.

The Amsterdam tourist experience will extend further than what we traditionally refer to as city attractions.

Sample Itinerary
1. Anne Frank House
2. Traditional Begijnhof Courtyard
3. Rijksmuseum + Van Gogh Museum
4. Red Light District
5. Magere Brug (Old Bridge)
6. IJ Brewery
7. Zaanse-Schans Windmills
8. Local Cheese Producers
9. Molen van Sloten Museum
10. Ajax Amsterdam Arena
11. Volendam Village
12. Marken Village
First, the external sensors are related to the autonomous navigation (a), devices such as GPS, camera, LiDAR, gyroscope, radar, and magnetometer to facilitate the safety room’s movement and actions. The H2OSTEL app will also be able to control the internal environment of the room: glass (b) transparency, allowing the guest full exposure or total privacy. Also light (c), heating (d), and control, among other aspects. Finally, connectivity (e) will enable the Service Center to be the owner of the data generated by H2OSTEL, which will allow for an efficient management of the traffic/dock system. There are also sensors to control the physical technology (f). Likewise, the data can be analyzed to improve new tourist development.
Amsterdam is well known for its intense relationship with the water, with more than one hundred kilometers of canals, about 90 islands and 1,500 bridges. Amsterdam is also known as one of the most attractive cities for tourists in Europe, the world’s most popular holiday destination.

The H2OSTEL seeks to combine these two characteristics into a groundbreaking project that permits a tourist accommodation within the water, giving the guest a unique way to experience the Amsterdam canals. By merging the experience of traveling the water and the tourist’s pleasures, the project seeks a combination between physical and digital technology, between personal experience and digital management, to have a compact but comfortable room-module, connected to an app, where you can request a room and program different tours across Amsterdam and its surroundings.

The project uses the advantages of the autonomy of the MIT Roboat to build a flexible, mobile, and also modular, H2OSTEL.
“I am a wandering herdsman. Sometimes my goats and I have to pass through cities, but we are unable to distinguish them. Ask me the names of the grazing lands: I know them all, the Meadow between the Cliffs, the Green Slope, the Shadowed Grass. Cities have no name for me: they are places without leaves, separating one pasture from another, and where the goats are frightened at street corners and scatter.”

Italo Calvino (1972). Invisible Cities
IGNACIO CARDONA focuses his studies on creative methodologies of design research to weave together fragmented urban city fabric in order to promote social equity while foster economic and environmental sustainability.

He is a Doctoral Student at Harvard Graduate School of Design, Architect (Universidad Simón Bolívar/1998), cum-laude Magister of Urban Design (Universidad Metropolitana/2003), and Founder of "AREPA: ARQUITECTURA ECOLOGÍA Y PAISAJE" (www.arepa.info), an important Venezuelan think-tank that has become a reference on urban phenomena in Latin-America, that has developed several projects and has won many international awards with the philosophy to articulate the technical knowledge of design with felt needs of communities.