SENSEable CITY GUIDE TO COPENHAGEN
COPENHAGEN
SENSEable City Guide

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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.

SENSEable CITY LAB - MIT - BOSTON

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COPENHAGEN
Introduction

by David Lee

The modern city of Copenhagen is a role model for quality of life and environmental sustainability. Its dense form and widespread biking culture allow citizens to move easily and comfortably throughout the city without relying on cars. Large investments in infrastructure have brought light rail to underdeveloped parts of the city and centralized heating to municipal buildings, and wind power harvested from the open sea will soon power a fleet of electric vehicles. These strong initiatives were taken by joint efforts by the government and industry partners, who have come together to advance a “green growth” agenda that will improve the performance of the city while creating 21st century jobs.

The city developed previously underutilized land on Amager Island (once known primarily as a litter dump) to house high-tech industries, cultural venues, a new light rail line, and the Bella Center, a large exhibition and conference space. The success of this region, now known as Ørestad, has encouraged the city to look east towards the sea for new sustainable development opportunities close to the urban core, rather than westward to sprawling suburban growth. Nordhavnen, an industrial harbor northeast of the city center, is slated as the next site for major urban development, with reliance on renewable energy and public transit accessibility.

One important directive of the green growth strategy is to attract worldwide attention to Copenhagen’s sustainability efforts, through events like the United Nations Climate Change Conference (COP 15). Ørestad and the Bella Center provide important platforms for these high-visibility conferences, which allow green industries in Copenhagen to develop and export their technology worldwide. When the opportunity arose to potentially host the World Expo in 2020, the city asked the SENSEable City Lab’s Workshop to design new platforms that would both support the exposition’s activities and contribute to the green growth of Copenhagen.

The Copenhagen team, composed of Ann Woods, Homero Flores, Julie W. Gawendo, and Christian Lehmkuhl, had to consider the historical challenges facing World Expos of the past. Such expositions have had to serve many roles, facilitating the exchange of goods and culture, providing iconic structures to the city (e.g. Eiffel tower in Paris 1889), and branding the nation (Brisbane 1988, Hannover 2000). Yet, they also manifest great economic risk, both in the expense of constructing temporary structures and subsequent underutilization of land. Without prior planning, the pavilions are by their nature unsustainable; in most cases they are demolished or fall into disrepair. There are few examples of entire Expo sites being reused and converted back to productive urban fabric.

Thus, the team focused their brief on creating a “floating exposition,” a complex of platforms and pathways that would quite literally float in the harbor and house the international pavilions. These structures would move and reconfigure themselves according to the performance of the urban fabric, infrastructure needs like water and power, and the programmed flow of events in the World Expo. They would link up with the shores of newly developed neighborhoods in Nordhavnen, according to feedback from the residents themselves. Finally, once the exposition concluded, these platforms would become cultural and recreational facilities for the whole city, maneuvering to serve multiple neighborhoods beyond Nordhavnen as needed. Dynamic reuse of the floating pavilions to serve residents of Copenhagen would make them a truly sustainable addition to the city.

Each member of the team created various designs, some complementary, some competing, for this brief. Ann envisioned a modular system of barges that would join and shift to respond to needs of residents and communities. Barges providing infrastructure, amenities, and mobility would form networks conveying energy, information, and people to and from each neighborhood. Homero proposed seven floating islands, representing the seven continents of the world, composed of smaller block units that could detach and join other elements.
parts of the city. Each block would be optimized for mobility and human-scaled public space. Julie designed folding pathways to connect the city, Nordhavnen, and interactive “blocks” floating in the harbor. These paths could also travel to other parts of the city or even depart for other countries. Finally, Christian considered how citizens could influence the movement of floating platforms within an aggregated demand system, and technological systems for stabilizing platforms and harvesting wave energy.

These projects share the same vision of an urban fabric that responds closely to the short-term and long-term needs of the city. In the short-term the World Expo needs spaces for exhibition, infrastructure for energy and information, and platforms for events and cultural mixing; likewise citizens need places to work and play close to their homes. In the long run the city must provide sustainable, well-performing spaces for its growing population, but might not know where demand might be greatest; similarly, communities also need to easily relay their needs and aspirations to those who can provide infrastructure. Water provides the ideal “low-friction surface” for such platforms to move along the edges of the city, while wireless communication becomes the “low-friction medium” for their negotiation and organization. Copenhagen could thus become the birthplace of dynamic floating architecture, and propagate this vision to cities around the world.
The Floating City

by Ann Woods
PROJECT DESCRIPTION / BACKGROUND

Responding to the mandate for an expo site to integrate with the city post-expo, rather than becoming part of its waste cycle, this project envisions a dynamic floating infrastructure that first hosts and defines the expo in 2022 and then becomes the new building blocks for the City of Copenhagen as it expands northward into Nordhavnen. The purpose of a world expo is to express a certain zeitgeist which embodies a spirit of innovation and cultural, economic, and social exchange. The most successful expos have leveraged that spirit of innovation in physical ways which have superseded the moment of the expo and transformed the cities in which they are hosted (London: 1851, Paris: 1889, Chicago 1893, New York: 1939, Brussels: 1958, Montreal: 1967). If an expo should express a zeitgeist, the floating expo does so not only by integrating new technology and addressing environmental problems like climate change, but also in its dynamic reconfiguration, the project becomes a physical manifestation of that zeitgeist. The reconfigurability of the floating expo also gives the expo an iconic presence within the context of other expos and beyond.

As an urban proposition, the floating city becomes a realization of the idea of a responsive city envisioned by architects of the twentieth century such as Archigram, Cedric Price, and Constant, by utilizing soft technology of crowd sampling paired with hard technology of marine propulsion in order to reconfigure the city in a new dynamic form. The project takes on the ecological crisis of rising seas caused by climate change and envisions a future civilization occurring on the water, taking cues from the research being done by artists, architects and scientists working with Open Sailing and Mary Mattingly’s Waterpod.

In a traditional city, a citizen can decide to go to a grocery store, pharmacy, laundry, restaurant, etc. and navigate the city using landmarks, monuments, and major public spaces usually connected by a form of public transportation. In the dynamic city, monuments, public spaces, and landmarks or “watermarks” are reshuffled with city blocks based on behavior, thus creating new paths to navigate and new discoveries to make along the way.

The project is physically composed of three elements which combine in various quantities to form the city. These three elements: the non-propelled infrastructure barge, the self-propelled “city block” barge, and the smaller more dynamic “water taxi” barge are essentially vessels of different capacities that allow the city to move at different speeds to achieve a dynamic city. Using the metaphor of the router and its local area network, the city organizes its parts in small groups which communicate among each other to create new configurations. The non-propelled infrastructural barges act as hubs within the city and are the conduit through which information and other resources such as water and power would flow. The self propelled “city block” barges physically attach to the router barges as a way of connecting to resources and information. Acting together with other connected city blocks, they form a district or local network structured from one router barge. The router thus becomes a point of exchange as well as a way to “sample” the city’s population to derive demographics and shared interests.

In the context of the expo, based on the sampling data, the routers could accept or reject barges from different countries based on the interests and behavior of the city block. This may also be based on availability of resources, e.g. power, water, information. The barges would thus be able to be self propelled, but only self-reliant for a limited time. This could produce interesting socio-political adjacencies such as...
“Monuments to skilled hackers rather than fallen war heros would punctuate the dynamic city.”

politically unfriendly nations forced to share water and power in one block, or new partnerships between countries, people, and ideas. In the context of the city district or neighborhood, this type of shuffling would incentivize certain ways of life and behaviors. If the population does not use a resource like a grocery store, restaurant or even school, the resource would be relocated to another part of a city more in need of that resource. The city would also theoretically become a place of socio-economic diversity, creating a new type of city that is not segregated based on economic status.

A NEW TYPE OF HISTORY AND MEMORY

The shared history and memory of a city are critical to the formation of identity and sense of ownership. A central question that this project examines is in a constantly changing city, how do we create memory and history? What form does history take, how is memory created?

In the dynamic floating city, a new type of history will emerge as events normally relegated to the intangible world of the digital are physicalized. The great crash of 2047 for example may not be a stock market crash but rather a server crash whereby all routers and sampling were offline and the citizens were forced to the find their way using traditional means. New landmarks like the traditional church steeple would emerge from such an event, creating history and memory for the citizen in his/her floating district.

NEW PARADIGMS FOR POWER AND SUBVERSION

This type of social programming will develop new forms of innovation and power by which citizens can have agency over the sampling methods. In this way citizens will learn how to shape their own social, political and economic environments, even as the city’s code tries to organize the city based on a set of values. Monuments to skilled hackers rather than fallen war heros would punctuate the city. This new type of subversion may begin to influence the traditional city in new and unexpected ways making the traditional city more dynamic and more akin to the floating city rather than vice versa.
EXPO

The expo is organized across six different sites within the city and region (including Malmo Harbor) with the Nordhavnen site as the primary location of the expo. As the expo occurs countries move to scheduled locations with their barges in order to refuel and touch other parts of the city, however, each country is not programmed for every day of the expo, thus giving them the opportunity to migrate to other parts of the city and connect with other countries of the expo. Such reconfiguration would produce potentially volatile socio-political adjacencies whereby politically unfriendly nations forced to share water and power in one block, mandating a sense of cooperation and sharing of resources. Barges can also meet on the open water which has always been a place of unique opportunity for unconventional economic, social or political relationships to occur.

POST-EXPO: THE DYNAMIC CITY

As the barges transition from expo host to city grid, reshuffling occurs to a lesser magnitude but involves the institutions and services of the city to move from place to place, thereby leaving the residential mainly free to configure their own unique neighborhood arrangements and adjacencies. As these relationships stabilize, the dynamic city begins to build a sense of history and memory.
Expo Sites
As Elements of the Floating Expo migrate around from block to block chance meetings occur.
PERSONAL INTERACTIONS

INCENTIVIZING A WAY OF LIFE

As the city takes over the expo sites and people move onto the barges, the kind of high intensity reshuffling of the expo would diminish and be based more directly on the behaviors of the city's inhabitants. The movements of the city would still be choreographed according to a schedule, as during the expo, however the schedule in this case would merely indicate a time at which to evaluate the sampled data and reconfigure based on such data. This scheduled movement thus begins to incentivize certain ways of life. For example, if one's neighborhood has an organic grocery store, but everyone eats out, then this store may move across town, where many people cook and may use the store. This would also happen for city services such as schools, libraries and museums. The movement of the city's institutions becomes an interesting proposition when we again consider the adjacencies being made. For example, a school next to a library is a very different proposition than a school next to a zoo or cinema. These new adjacencies can lead to a new way of learning about the city not just in the school, but also across the city as one must determine updated navigation routes in order to reach his/her destination.

“In civilizations without boats, dreams dry up, espionage takes the place of adventure, and the police take the place of pirates.”

Michel Foucault
Of Other Spaces
Different adjacencies and pathways provide a new way to learn about the city.

As elements of the city move away or to your neighborhood, it reinforces certain behaviors or ways of life that either maintain the services in place or redistribute them to areas more in need.

Block A has a grocery store but everyone eats out.

Block ZZ has no grocery store but many people who want one.

Grocery store moves, Incentives Shopping Local, Improves Local Economy.
The dynamic floating city requires a diversity of vessels that can operate at different speeds in order to accommodate the diversity of speeds which occur in a traditional city.

Vessels:
- Wind Powered or Towed; record 48 knots per hour
- Traditional Barge Fuel Powered or Towed; 410 knots per hour
- Water Taxi Fuel Powered; up to 35 knots per hour
- Cruise Ship Fuel & Steam Powered; up to 20 knots per hour

The dynamic floating city uses the metaphor of the router and Local area network in order to organize the city.
Aqua-thermal Heating (Exhaust from Steam Engine)
Structural Slab and DataTie-In
Rechargeable Battery
BioFuel Tank for Steam Engine
Influent/Effluent Water Tanks
Steam Powered Engine

New Ground

Barge Body and Data, Water, and Electric Hookups

Soft Connection Barges
Self Propelled Barge Attachment
Storage Battery/Grid Connection
Wastewater Tanks
Fresh Water Tanks
1050 gallon tank Per capita daily water use: 69.3 ga/avg.

Hard Connection to Land

Algae Harvesting for Biofuel from Below
ANN WOODS

Ann Woods is a 2012 candidate for a Master of Architecture from MIT. While at MIT, she has developed a strong interest in digital infrastructure at an urban scale and the hybridization of low and high technology. Prior to attending MIT, Ann worked at an architecture firm in Boston. Ann is a graduate of Williams College where she earned a Bachelor of Arts in Comparative Politics and French.
Moving Landscapes

by Homero Flores
Dynamic landscapes will host the Copenhagen EXPO. These will be seven floating islands, each representing a continent, with a dynamic surface in the vertical and horizontal directions. After the EXPO, these islands will form part of a new urban development of the city, Nordhavnen. Blocks of different sizes will form each island. These blocks and their combinations will provide various services, for example, space for walking, playing sports, dining, attending concerts, pavilions, or parks. The theme of the EXPO will be “a world with no borders”, that will focus on the physical planet, its natural wonders, and the culture, arts and technology of the human race. The dynamic landscapes represent the changing physical world in which we live.

The various blocks that form this space are floating in the harbor, and can move and shift their location simply by detaching from each other or from the land. This allows reconfiguration of the floating landscape, spontaneity in its form, and adaptability of its functions. This also allows the islands to visit other parts of the city and thus engage Copenhagen as a whole, not just Nordhavnen and downtown neighborhoods. Each island will be smart by automatically configuring their locations, both horizontally and vertically. Wirelessly it will communicate with each of its elements, and sensors will track the social interactions taking place, weather, and proximity to the land and harbor. The elements will slide along each other using frictionless edges. They will connect with hooks. These conforming blocks will propel with small jets located on each of their sides, very much like space ships. They will be powered by internal batteries that are charged wirelessly. The width of the smallest blocks will be ten by ten meters, and the largest blocks, a couple of hundreds of meters long, and less than one hundred meters wide. The structure of these blocks will be made of concrete and steel as some marine platforms are built, but their surface will covered with wood similar to that seen in existing shore parks in the region. The flexible form of the islands will allow them to mold to water edges within the city. This will create a cozy European city like feeling for the EXPO, in contrast to past expositions where the EXPO site is far from the city center.
“A floating public space that can be transformed, grow and shrink by connecting blocks of different sizes”
**EXPO THEME**

The theme of the EXPO will be the physical Earth, and the culture and arts of its people. The idea is to forget about branding, be it a commercial brand or a nation. Each island will represent a continent that will showcase its natural treasures and why they are relevant to the human race. As well as its culture and arts, including ancient and modern technology and science. There will be seven islands: Asia, Africa, North America, South America, Antarctica, Europe and Australia. Each island will configure to the shape of the continent it represents during the EXPO. The size of each of them will be proportional to the size of the continent it represents.

**COLLABORATION AMONG NATIONS**

The countries belonging to each continent will need to collaborate with each other to set up the EXPO. This will provide an experimental set up of international collaboration (like John Lennon's Imagine ‘Imagine there's no countries. ’) that can later be extrapolated outside of the EXPO.
Renderings of these landscapes, some of them within Nordhavnen and Copenhagen for scale.
Visitors to the EXPO will have a new experience as Land and Sea merge through the moving landscapes. The way the EXPO site looks will change with every new day. The surface of the smaller cubes will be wood and will be painted of different colors to create a more vivid image of the represented continent. The elevation field will showcase one pavilion/building or will hide it. The range of elevation changes will be at most 4 meters. Paths will form among the elements so that people can walk through it (i.e., they won’t be able to climb a 2 m difference in elevation, but paths will allow people to go there (or not, some elements could be put off the access to the public on some days).

The coziness of the EXPO next to the city center will foster the use of public spaces and interaction among its dwellers. The fact that it is attached to the land permits citizens to bike or walk to it, without the need of more complex modes of transportation such as boats or cars. Climate: it will provide for warmth during cold weather, and beach during warm weather.

With this project we aim to make the space attractive so people want to be in it. The means to do so are identified in “New City Life” (Gehl et al., 2006). This interaction is beneficial for the EXPO and Nordhavnen because it stimulates a sense of community, safety, and economic development. Places within the city that this space will try to emulate in terms of social impact are those with a vibrant confluence of people, such as Nyhavn (busy restaurant/bar street by next to fishing boats), Kongenshave (large park where people sunbathe in the summer), and the Harbour Park at Islands Brygge (a long strip next to the harbour where skating parks, swimming pools, and sunbathing green patches lie busy with people during the summer).
GHEL’s MEASUREMENTS

Ghel et al., 2006 have identified twelve measures of public space quality that should be addressed. These are divided into three categories: protection, comfort and enjoyment. Protection includes measures of safety, crime rates, and protection against weather/pollution.

The Comfort measures include easiness to walk (into and within), stand/stay, sit, see, talk/listen, play/excursion. The Enjoyment category includes measures of scale (that is, that buildings are not huge), climate, and ‘sensory’ (meaning that the space has things that excite our senses). The proposed project has the potential to score high in all these measurements.
Setting the EXPO right in downtown Copenhagen will allow the visitors to experience the city and the EXPO immediately, in contrast to past expositions where the EXPO site was far from downtown. At the same time, the islands can provide lodging and services to the visitor, thus reducing the strain on the city services. After the expo, the moving landscapes will migrate to Nordhavnen, and form part of the new development. International resources will have created the infrastructure of the city.
Below: Rendering of various of the moving landscapes surrounding Nordhavnen and connected to the downtown of the City of Copenhagen.
The elements of the island will have a similar structure to barges. They will have tanks that fill with water to sink in, and with air to float, similar to submarines. The blocks forming the moving landscapes will slide along the non-friction edges. A combination of bearings will reduce the friction. To link the elements, articulated magnetic connections will form at their edges at the water surface level. The articulations will allow a degree of freedom in their movement as water waves move through the landscape. Each block forming the island will be able to move by its own power with propellers installed on them. The energy requirements for movement will be small given that these elements will move slowly and therefore it is possible to power them wirelessly. The island should be controlled automatically and be intelligent. It should send the climatological conditions, and know how to protect the space from the cold wind, or connect the city to the water edge on a warm day. This ‘intelligence’, aided by sensor of depth, proximity of other vessels, etc, from each of its elements, and the function of the buildings and spaces it hosts, will steer the moving landscape.

Swimming platform that is only used in the summer. During the rest of the year it could have other uses if it were dynamic, and transformed itself into a small plaza, close to the shore, protected from the wind and the rain.
Seattle, WA
This wooden structure seems able to move in the vertical direction when water floods the zone, by buoyancy. The granite column looks like a guide for the movement.

Image is courtesy of Ann Woods
SENSE AND SUSTAINABILITY

The buildings in the Copenhagen EXPO will not be wasted. They will form part of a new development: Nordhavnen.
HOMERO FLORES

I was born and raised in Mexico City and its surroundings. I have been struck since an early age by the speed at which the city and its surroundings changed with very little concern of the government or society on the impact of these changes. I think such changes should be better planned, and I hope one day to have a chance to do just that. I obtained a C. E. degree to improve my chances (UNAM, 2001). Then I specialized in Hydrology (M. S. MIT 2004, and PhD MIT 2010). Now I study how the landscape evolves over hundreds or thousands of years as water fluxes erode and sculpt it. But I also enjoy understanding what happens within minutes and days. For example, the tight link between energy and water fluxes in the biosphere. The interconnectedness between water and energy fluxes has a significant control on the patterns of climate we experience in the world. I find this fascinating. And I think that this interconnectedness can be greatly exploited in the design of the built environment.

In engineering aesthetics usually are not important but they are to me. For the past ten years I have been drawn to photography, drawing, and dance. I think that these arts feed my aesthetic sensitivity. I would like to get more involved with these activities. I think this is possible within the context the intersection of engineering and architecture/design. I love living abroad and traveling. I learn from the experience and the people I meet, from a cultural and technological perspective.
Connecting a Dynamic Landscape

by Julie W. Gawendo

SENSEable CITY LAB, MIT
Project Description

Today, sidewalks, streets, waterways, bike paths, and many other designated and undesignated paths carry the citizens of Copenhagen. Can Expo Copenhagen begin to inform a new form of movement within the city? Can this event begin to dictate an alternative form of inhabitation with new processes and systems, which can inform both the expo and Copenhagen’s future urbanization? The expo and Nordhaven development will begin to experiment with growth that reaches beyond land boundaries, and into the sea. Currently, the Nordhaven masterplan proposes to inhabit the water’s surface through landfill, an application that does not truly activate the water to great extents. This proposal counteracts this movement by activating the water’s surface through the creation of new dynamic paths to be used during Expo Copenhagen and in the future.

Today, much of Copenhagen’s harbor is difficult to reach, and access is at a minimum. With the urban development of Nordhaven, as well as the development surrounding Expo Copenhagen, there are new possibilities to heighten these connections, and begin to explore landscape and urbanization, which truly embraces the water. These new connections propose dynamic intersections, rather than formalist interventions, which are dependent on the expo’s existing model of objects in a field. Here, an opportunity arises to reprogram the city, with a focus on flexibility, access and interactions. Most cities construct infrastructure before activities, the expo presents an opportunity to develop facilities in conjunction with an activity, which will dictate and contribute to future development within the city.

Proposed new pathways, both digital and physical, will begin to lead the citizens of the world during the expo, and potentially expand to the urban scale, post-expo. Issues surrounding innovation, crowds and waste will be addressed not only on the site scale during the expo, but have the potential to be adopted by the city of Copenhagen post expo. This proposal suggests a new expo, one where the expo is the path. While rethinking the expo, the paths become the pavilions, a model where the experience of the individual exposition is not limited to the static pavilion, but to movement along a path. During the expo, paths become generators for interaction. Our world is comprised of boundaries and thresholds, which are often linked to topics surrounding national identity, information gathering and sharing, as well as eternal issues of ownership and territory. If the expo design is generated as a result of the behavior of the path, the design has the opportunity to employ new relationships between participants, as well as countries and the world at large. Overall, pathways present an interesting opportunity because they intersect. These crossroads and overlaps are contrary to the idea of the isolated bubble, inherent in the existing expo model.

Currently, the expo in Shanghai is largely detached from the city and each country’s exhibition space is entirely disconnected from the next. This is not a new pattern. Expo Copenhagen has the opportunity to utilize these edges and boundaries to enhance an ease of mobility but also move beyond the traditional realm. The path helps to create a more coherent story amongst the individual exposition, helping tie things together and provoke ideas. Participation is an important factor in the experience of the expo. During the expo, the paths exist as accordion-like structures, which can turn, pivot, fold and unfold as needed.

The path themselves are dynamic, but also move connect and distribute themselves within the fluvial landscape based on personal and collective needs. As stated, the expo becomes path, but after the expo the paths can develop into new infrastructure for the city. This new infrastructure can be transformed into docking structures for cruise ships that will still enter Nordhaven, events around the city and new outdoor recreational space. Re-imagining movement in Copenhagen leads way for new technologies, and an engagement beyond the body. One that begins to embrace the physical and intellectual inquires of human beings. Can these new adjusting and dynamic systems begin to harness energy, instigate new human and nature interactions, all while connecting the dynamic landscapes needed for the expo and beyond? Will the surreality of movement and temporal change create and ignite a dreamlike state while using these paths? Investigations of presence and disappearance will also be introduced within the proposal. For instance, information is transferred digitally to the visitors, but visitors are also able to leave information in the space while collecting previously left information. Paths not only prompt dynamic physical movement, but an important new exchange of information. Along the path one can also find interactive blocks; these are points of interest along the path, which are comprised of smaller blocks. These boxes will be also used during the expo dynamically, and can be de-assembled, reconfigured and reassembled for various needs. The units, or blocks can be used for seating, stages or audio and visual displays as an individual unit or a collective. Post-expo these blocks could be placed around Copenhagen or be redistributed globally as a commemoration and icon of Expo Copenhagen.
Can these new ecological and energy efficient configurations also lead to greater emotional reactions? Copenhagen’s theme for the expo involves not only physical movement, but also movement of the mind. This concept has been investigated throughout the ages, but particularly throughout the 1950s and 1970s. The Situationists, Archigram and the Japanese Metabolists all envisioned urban space as an experimental arena for human interaction, self-realization and most importantly self-organization. Their hyper-realized cities were living organisms, both mobile and expandable. Constant, part of the Situationists had some of the most radical projections surrounding movement in a city. Constant envisaged a society where automation had realized the liberation of man from the hardships of industrial work, and its replacement by a nomadic life of creative play, outside of the economic domain and in disregard of any considerations of functionality.

‘Contrary to what the functionalists think, culture is situated at the point where usefulness ends’, was one of Constant’s more provocative statements (Simon Sadler, “The Situationist City”). Although it is important to note that Constant’s labyrinth removes itself from the city, where this proposal for new paths aggregates a secondary landscape, extending the physical landscape. Can Expo Copenhagen create ‘the New New Babylon’?

More recently, Rebecca Solnit, the author of “A Field Guide to Getting Lost” concentrates on the act of walking as anarchic and shares the view that it provides a means of loosing yourself more than just physically. The act of losing oneself provides another arena for play within the construction of these new dynamic landscape intersections. What role does chance vs. instruction play in the movement, as well as the construction of these paths? Today, there is a need for physical and cultural landscapes to be fluid, reconfigurable and dynamic. The expo as path can begin to realize these adjacencies.

Lastly, the Situationists practiced the dérive, a technique of rapid passage through varied ambiences. Expo Copenhagen could be realized as a rapid passage through different countries and continents. There is an importance placed on the journey, one of non-classical constructs, one that involves both play and an awareness of the journey’s psychogeographical effects. These effects could begin to dictate portions of these new connections and components such as ecological science, energy use, consumption and urban growth. Both digitally and physically these new paths and nodes give way for unique new experiences associated with Expo Copenhagen and the urban playground beyond.

“Expo Copenhagen, re-imagining movement on the waterfront.”
Experience and interaction are two important factors in Expo Copenhagen. Participation is key for the exchange of information and the movement of these dynamic paths. It is possible for the paths to expand and extend in order to activate areas of the expo, which have become ‘favorites’ or opposingly are currently inaccessible or unexplored. Participants could gather a wealth of information, as seen on the right, but also be able to leave information for following visitors to collect. The paths begin to create an informational feedback loop for the ongoing six-month long EXPO. These modes of info gathering, sharing and depositing could be transferred for Copenhagen’s daily use post-expo.

Constant, in the 1960s, conceived of New Babylon, or the global city. His manifestos and theories surrounding movement within a city were radical, but today is a time to rethink Constant’s New Babylon. Can Copenhagen’s expo in 2020 begin to re-imagine a landscape of interconnected pathways which is not only about the land and capital, but about knowledge? In “The Creative Babylon, a short history” Sylvia Bianchini and Luis Falcon state that The cities that have more of an ability to define an intelligent future are those that have vision, creative leadership, a mature civil society and effective formulas for inter-institutional collaboration. With the use of the harbor and Nordhaven’s underused waterfront, the city will be able to be activated in new ways not only physically, but with the collection of new knowledge in the form of digital information. Above, are just a sampling of they ways the ‘path’ can begin to capture knowledge and share with the expo participants, as well as those around the globe through smart devices, the web, and possibly physical distribution of both written materials such as newspapers, as well as art pieces which could be generated for the expo. A ‘New New Babylon’ would be ignited in Copenhagen, and tested as a playground for its inhabitants. Constant focused on play, leisure and opportunity, a quality implicit in the design of these new floating structures.
In 1893, Fredrick Law Olmsted was one of the first to use a natural feature, such as Lake Michigan, as the highlight of the World's Fair. Copenhagen could learn from Olmsted's vision so many years ago. He took advantage of Chicago's permanent natural feature, Lake Michigan, and developed the larger aesthetic vision surrounding this one element. Olmsted's design vision began with the lake and radiated from there, incorporating both vegetation and new buildings to reach the level of the lake's grandeur. Copenhagen's harbor is even more integral to the city than Lake Michigan was to Chicago and can truly showcase the city's future design vision through the Expo, as well as beyond.
Expo Copenhagen's new path system will activate Nordhaven during the expo, but will certainly go beyond benefiting this newly developed area post-expo. As we know, the world expo is often associated with vast urban infrastructural waste. The dynamic path system, which will activate the harbor during the expo, will also do the same in the months and years to come following Copenhagen's Expo. The path's dynamic nature will allow them to move into other parts of the city post-expo and reactivate a neglected water's edge. Harbor intervention projects around Copenhagen, such as BIG architecture's Harbour Bath are treasures within the city. The expo's path can be deployed around the city and will undoubtedly become a valuable addition to the city's urban infrastructure, creating new spaces for recreation, play and events.
The blocks are a multi-functional, reconfigurable portion of Expo Copenhagen. At moments they are part of the path, changing the topography, altering one's direction, or drawing you near with multi-media displays. For the expo, each country would obtain a block, creating new adjacencies and boundaries in association with the reconfiguring paths. Post-expo the blocks could be distributed throughout the Copenhagen city fabric. The blocks could then support cultural events involving arts, music and more. It is also possible the blocks could be rented out to begin to generate a new form of economic income for the city. It is also a possibility for the blocks to travel beyond Copenhagen's borders after the expo and land in the major cities of the participating countries. The cubes can iconically carry on EXPO Copenhagen across the globe. The larger object is comprised of 36 2'x2' smaller blocks in a 6x6 grid formation. Each block will have the ability to emit sound, display video and capture information.
Reconfiguration of the paths can lead to new patterns and procedures within the landscape.
TECHNOLOGY
DESCRIPTION

COLLECTING

Movement and motion can generate energy. Expo Copenhagen’s new paths have the potential to harness energy through movement, as well as photovoltaics, which could convert the day’s solar radiation into energy. The energy generation and harnessing could be used to light the pathways, energize the blocks along the path, or contribute energy to the surrounding buildings and infrastructure. This image of Copenhagen’s harbor in the evening exemplifies the dynamic atmosphere of the water’s edge. The new paths, seen here with cyclists traveling through the water.

SENSEing

Sensors can be placed within the path at strategic corners and locations along the structure to collect personal data and receive information from the expo visitors and the Copenhagen citizens.

ATTACHING

ROTATING

COLLAPSING

hinges allow for a flexible walkway

Industrial strength magnets and clamps allow for easy attachment and separation

the central core of each path uses a motorized rotation device to shift the pieces 360 degrees

Image courtesy of j.mourier at flickr.com
JULIE W. GAWENDO

Julie Gawendo is about to receive her Masters degree in Landscape Architecture from Harvard University’s Graduate School of Design. She has a deep passion for the city, and through this passion developed a love of wandering the urban environment. With an undergraduate degree from Boston University, she has spent most of her time in Boston and New York, but through personal, as well as educational and professional development has had the opportunity to travel and explore collaborative design projects around the world. These global, multi-disciplinary experiences, including this project with the MIT SENSEable City Lab, have strengthened her passion for design. Her fascination with movement in the city on all scales continues to grow with each encounter and investigation.
C4

Gravitational Flux København

by Christian Lehmkuhl
PROJECT DESCRIPTION

Since the first Expo 1851 in London, the world has seen two world wars, countries divided and united, men walking on the moon as well as economical rise and ecological demise. Originally entitled to present the latest technological advances, the world’s fair over time developed to a stage for political rivalry, cultural exchange and finally a place for what is called, nation branding - the poster-child for unsustainable development. A short-term exhibition of million dollar pavilions with little content and no connection to their surroundings.

The days of the Expo as a platform to present and share a country’s inventions are certainly over, for once companies are nowadays often multinational enterprises with transnational or global marketing strategies and can therefore hardly be attached to a single nation. Furthermore even small companies and individuals are trying to protect their intellectual property with international patents and maybe even more importantly, release dates and market entry strategies for all innovative products are carefully planned in order to maximize impact and profit.

The concept of the Expo as a place of cultural exchange seems also to be rendered obsolete in times of globalization, where flying and traveling has become easily affordable for most parts of the western society and digital information about virtually every place in the world is available any time.

One of the major motives for considering to host a major event (olympic games or expo) is to increase the value of the city. Even though this is a legitimate approach, the value is often limited to a higher profile, coming along with excessive initial costs, uncertainty about the returns and an idle development area. Due to the praxis of remote or enclosed exhibition areas there is usually little enhancement to the urban fabric or the life of the residents, missing out on the opportunity to achieve any substantial, lasting effect.

Planning an Expo brings a number of issues to a city, but is also a chance to improve the quality of life beyond the exposition. Traditionally the lifetime and reuse of the pavilions are of some concern, but over the last years this problem became more and more addressed by the architects (using strategies of re-assembling, re-locating, re-configuring or re-using). What stays is the problem of “Context”: Pavilions are planned on an assigned plot with no knowledge about the surroundings while the Expo Masterplan is de-signed with no knowledge about the pavilions. As Jean Nouvel put it: “Architecture without context does not qualify as architecture.” That might be true, but maybe it can be interpreted in a different way. What if the surrounding was not steady, but in a constant flux – putting the built environment into a different context, providing different qualities, allowing reinterpretation of the everyday place. An Expo always comes with a certain risk and effort to a city and its people, which are too often not repaid by Post-Expo benefits for the residents of the host city. Furthermore, water access and urban performance have been identified as issues for this project.

Over the last years, Copenhagen has positioned itself as one of the world’s leading cities in green development, coining the term “to copenhagenize” as a synonym for a sustainable metropolitan development. The quality as a city on the water, residents obsessed with biking, green energy initiatives and a grown urban fabric are assets, which are hard to imagine in context with the traditional Expo concept. One of the unique characteristics, that distinguishes the city maybe more than anything else is its sense for community and participation. A quality that becomes obvious not only in the well-known Fristaden Christiania (a self-proclaimed autonomous neighborhood of circa 1000 people living as a Commune), but also in a high number of community housing projects. In addition, the whopping 20 percent of Danes who are working directly for the government, an income tax close to 50 percent which allows Denmark the highest welfare expenditure of all nations, more than 75 percent of the employees organized in labor unions and a election turnout of more than 86 percent at the last Folketingvalg are strong indicators.

This project takes up on this heritage of participation, proposing a self-learning system that is directly influenced by the interests and the behavior of Copenhagens visitors and residents. Floating urban spaces activate the Expo and the city equally, organizing their movement depending on experience of performance and real-time data of individual demand, generating a responsive, intuitive environment, which will be a initial fit for every user.

“Architecture without context does not qualify as architecture.”

Jean Nouvel
“What if the surrounding was not steady, but in a constant flux – putting the built environment into different context while allowing to re-read and re-interpret the place everyday?”

ISSUE 1. CONTEXTUALIZATION
Due to the specific peculiarities of collaborative work, the Expo in general and the Expo pavilion in particular is usually a place with little relation to its surroundings. Jean Nouvel stated: “Architecture without context does not qualify as architecture.” That might be true, but maybe it can be interpreted in a different way. What if the surrounding was not steady, but in a constant flux – putting the built environment into different context, allowing to re-interpret the place everyday?

ISSUE 2. POST-EXPO
One of the most pressing issues for a city, when considering hosting an Expo, is to find a way to generate lasting value for its people. The effort of planning must not be limited to a remote exhibition area with little effect on the city and should result in more than an additional subway stop or a better highway connection. The Expo is about ideas for the future and so should be the Expo planning.

ISSUE 3. WATER ACCESS
Copenhagen has developed into one of the most livable cities in the world, even coining the term to 'copehagenize' to describe the process of transferring those qualities to another city. But, Copenhagen does not yet utilize its geographical setting to the full potential, often denying their citizens access to the surrounding water.

ISSUE 4. URBAN PERFORMANCE
If there was an overarching theme for Copenhagen, it would probably be sustainability. One of the most common strategies of achievement in this matter is an increase of performance - getting more out of a limited resource. On an urban scale, public space might be considered that resource. What if there were public places that lived up to their name, actively looking for the people, always trying to utilize their program in an optimal manner.

ELEMENT 1. THE FLOATS
Self-propelled floats, provide public places with various programs, emphasizing and redefining the relation to the water.

ELEMENT 2. THE NETWORK
The floats are moving autarchic in a self-organizing, self-learning pattern between a network of docks...
PERSONAL INTERACTIONS

FLOAT PROGRAMS

HARBOR BATH PARK
A mobile green retreat

HARBOR BATH
Allows access to open & enclosed water

SOCCER | ICE RINK
Provides sportive opportunities

OPEN AIR CINEMA
Activates the water for a joint experience

FURTHER PROGRAM OPTIONS

CITY BEACH
Provides recreational space at the water

WATERFRONT CAFE
A culinary complement

MARINA
Provides docking space for sailboats

GALLERY | SMALL PAVILION
Exhibition space wherever needed

“What if the Expo or even the city would intuitively provide you with the environment you need?”
The 'Profiler' is a small application working on a mobile device, creating a profile of the users preferences of urban interaction. Profile data is generated by three subtle feedback systems, integrated in an user information system. The main feature of the program is the 'Search' function, which allows the user to determine the location of different functions within the city. Further, the program notifies the user of interesting urban opportunities in his proximity, matching his profile. The longer the system is in use and the more complementary data is included (time, season, weather, events, ...), the more proficient it becomes in projecting my interests.

1. The user is interested in a specific urban program offered by the floats
2. The mobile device connects to the system and shows a map and directions
3. The mobile device saves the search topic in connection with complementary data (time, season, weather, events, ...)

Result for user: The problem is solved, user knows the location of the program
Result for the program: 'Profiler' has learned new preferences > updates Profile

1. The user is moving around the Expo city in close proximity to a float equipped with one of his 'Favorites' (program)
2. The mobile device detects the float and notifies him
3. The user reacts by approval or rejection of the suggestion

Result for user: Interesting urban opportunities arise by just walking the city
Result for the program: 'Profiler' has learned new preferences > updates Profile

1. The user is moving around the Expo city and is entering a float
2. The mobile device detects the float and its urban program
3. The mobile device saves the used urban program in connection with complementary data (time, season, weather, ...)

Result for user: Data is collected in the background without user interaction
Result for the program: 'Profiler' has learned new preferences > updates Profile
URBAN INTERACTIONS

URBAN SCHEDULE

The movement within the System (CAS) will be organized by an Urban Schedule, which works based on a threshold rating system. As the calendar is self-organizing and self-learning, this schedule can not be fixed but will be altered and influenced by negotiation between experience (Anticipatory Behavior) and real-time demand (Participatory Behavior).

Floats will run either on a short-term (hours), a mid-term (days) or a long-term (month) schedule, which allows you to incorporate different notions of flexibility into the system.

Urban Calendar
Float B (Harbor Bath), Location 24 Post-EXPO, short-term schedule

Anticipatory Behavior
Experience allows you to anticipate people’s behavior and therefore helps to optimize and stabilize the system.

Collect data of the demand in the past is put into context with time, day, weather and season and then compared to all other locations, to evaluate the performance of this float at this location under these circumstances.

Participatory Behavior
Real-time information about participating people allows you to react to actual demand and therefore helps to make the system flexible and dynamic.

The local demand is constantly monitored and put into context with the whole network, which results in a Gravitational Field of Demand for the whole city.

“What if you could re-read and re-discover your everyday surroundings?”
Decision about the behavior of a float is based on a threshold concept, using the calculated value of the participatory and the anticipatory component. When a float is docked to or approaching a station, the local demand for the respective program is compared to the real-time demand of other locations and results in a score between -2 and +2, representing an “under-demand” or an “over-demand” respectively. Furthermore, the “Experience” of that specific program at this location is compared to the performance at other docking stations and results in a score between -2 and +2, representing an “under-achieving” or “over-achieving.” If the float stays at a location will be determined by the value of the added numbers, which can be anything between -4 and +4. The respective action is presented in the Decision Matrix below. If the decision is in “Limbo” (value between -1 and +1), data from other locations come into consideration.

**Gravity Sensing 2**
The individual ‘Favorites’ for this event in time (defined by season, weather, weekday ...) as determined by the user profile generate functional gravity.

**Gravity Sensing 1**
Proximity-based sensing of mobile devices, running the ‘Profiler’ application.

**Override**
As the floats are useful tools to activate an area (new development), by providing instant quality space and program, it might be desirable for the city to be able to override the self-organizational program. This might be easily achieved by allowing for a tweak of the value of “Experience” or “Gravitation” for a certain location.
FLOAT DESIGN

The floats are composed of three parts, the program space, the frame and the floating device. As the float fleet can be understood as a Mass Customization project, it is preferable to share great numbers of components among the vessels, therefore the floating device and the frame are basically the same for all possible design option. The actual program of the float is determined only by the beam structure. The use of parametric modeling comes with a number of advantages. First, it assures a standard design within the fleet, while also allowing for the necessary design vocabulary to fit the broad range of potential programs. Further the ‘landscape-style’ construction offers an wide array of levels and situations fostering the connection to the dock or interconnection to the other floats. Different cover materials might be attached and create together with the folding construction, a wide array of solutions fitting the different needs for the respective programs. The beams are mounted on a support plate, which is connected to the actual floating device by pneumatic actuators.

“What if public space was never wasted, but rather it was always provided at the location that it was needed at most?”

Float Design
Example: Harbor Bath
SWATH DESIGN & ACTIVE LEVELING

The design utilizes the SWATH (Small Water surface Area Twin Hull) principle, which aims at minimizing the area of the boat that pierces the waterplane. This strategy is based on the fact, that the effect of waves on a swimming object is greater, the closer the object is to the water surface. The proposed design positions the floating device completely under water, while only thin blades stick out, to make the connection with the beam structure. The passive SWATH strategy to reduce the proneness to waves is complemented by an active leveling system, utilizing pneumatic actuators. The structural frameplate of the float is suspended by four pneumatic muscles from the floating device. Due to this flexible connection, the two elements can move in relation to each other. Level sensors actuate the muscles in order to keep the upper plate in an absolute horizontal position, while the lower, floating part is moving with the water. The system is fairly robust, consisting only of sensor, processing unit, compressor, vents and muscles.

Besides the positive countereffect on waves, the construction allows you to alter the height of the upper deck, compared to the water level and adapt to different drafts (weight).

WAVE ENERGY HARVESTING

Ocean waves contain a tremendous amount of energy and should always be considered, when planning an on-water project. However, often the technology is not reliable or efficient enough to provide a suitable alternative. Wave power devices extract energy directly from the surface motion of ocean waves or from pressure fluctuations below the surface. This energy can either be harvested or directly translated into movement. This wave propulsion mechanism works, by a set of fins reacting to the movement of the water. The front edge of each fin rotates like a door on a hinge.

A driveshaft connects the back of each fin to a set of springs. When a wave pushes the back of a fin up or down, one spring or the other expands to absorb the energy. As the wave passes, that energy is released, and the fin whips on its hinge and pushes water backward. That action has the equal and opposite reaction of pushing the boat forward. It is not suitable to generate high speeds, but it works no matter from which direction the waves are coming. For the proposed project, this kind of system can be utilized to its max due to the fact, that the steady upper part of the vessel will provide a much stronger counterpoint, than a regular floating device.
Christian Lehmkuhl is a trained architect interested in the intersection between design, society and technology. His research investigates the theoretical and practical appliance of adaptive, responsive environments in relation to issues of energy, life cycle and climate change. He is holding a professional degree in Architectural Design from the Technical University Berlin, where he concentrated on Digital Media and Mass Customization. Christian is currently pursuing post-professional studies in History, Theory and Criticism of Architecture at the Massachusetts Institute of Technology, while also working as a PhD researcher at the HCU Hamburg in Germany. Funny fact: Christian shares his last name with the Statsraad Lehmkuhl, a Royal Norwegian Navy three-masted sailing ship, which seems fitting for a project with scandinavian floats.