The Architecture of Waste
Designing New Avenues for Public Engagement with Trash

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01
2018
SECONDA SERIE

Abstract
The system of waste processing currently exists as a linear process: trash flows from cities of high densities to sprawling landscapes of waste, but as cities grow and densify, critical systems of waste infrastructure must be re-evaluated. Instead of today's isolated and linear processes, urban and waste ecologies can become an interconnected and cyclical system. Current practices call for industrial processes to be pushed to the periphery of cities, thereby severing the relationship between the urban environment we inhabit and the one that is required to support the way we live. If architects and designers become engaged in the conversation of waste management and other industrial processes that support the demands of the city, they can begin to repair the physical and mental separation of waste and public activity while introducing cultural, economic, and environmental value in waste infrastructure.

Keywords
Waste Infrastructure, Public Engagement, Urban Design, Waste-To-Energy, Sustainable Cities

Received: April 2018 / Accepted: June 2018

DOI: 10.13128/RV-22990 - www.fupress.net/index.php/ri-vista/

Waste and the City

The system of waste processing in the United States currently exists as a linear process: trash flows from cities of high densities to sprawling landscapes of waste, but as cities grow in size and density, critical systems of waste infrastructure need to be re-evaluated. No longer can we think of waste management as an isolated process that is removed from the other systems that work together to support the needs of a city. These systems must be planned and designed in an integrated way to function as efficiently and sustainably as possible as cities grow ever more complex.

As countries all over the world are rapidly urbanizing, with cities increasing in population, density, and land area, the current method of waste management, most often landfilling in the United States, needs to be questioned and decisions about their futures must be made. Is there a more sustainable, more holistic, cyclical type of system we can envision that will help alleviate the burden that current waste management practices are placing on our cities? As Michael Manfredi and Marion Weiss examine in their book Public Natures: Evolutionary Infrastructures, within the complexities of modern cities lie synergies between infrastructure and public life that can be enhanced through designed interventions. These two realms cannot be viewed in complete isolation from one another; it is time to change and embrace the gray area that lies between stark black and white of infrastructure and the public realm. «Larger than life but part of it, infrastructure has an immediate presence; it shapes our environment and urban life in vital, authentic, and often messy ways [...] We look at the physical elements of infrastructure and the often marginalized sites they produce as possible contributors to a meaningful public realm. What if a new paradigm for infrastructure existed? What if the very hard lines between landscape, architecture, engineering, and urbanism could find a more synthetic convergence?» (Manfredi, 2015, p. 6).

We can think of cities as ecosystems, containing complex networks of organisms and systems that are self-sustaining in nature. A successful ecosystem is one that is able to support itself, using an output from one system as an input for another system, occurring in a cyclical nature. Unfortunately, most American cities do not function in this way; most cities' waste systems operate solely in a one-way fashion: waste is generated, collected, and exported to a landfill, where it remains without any future use. Pierre Belanger examines the city Kalundborg, Denmark as an example of a successful industrial economy that uses waste from one industry as fuel for another (Belanger, 2007). If American cit-

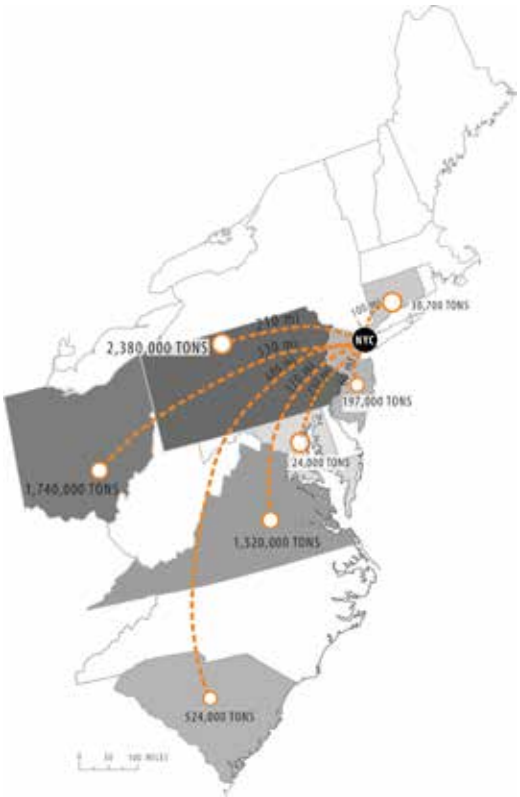

Fig. 1 – Export of New York City's Solid Waste (Image: author).

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Fig. 2 – Timeline of designers engaging in waste infrastructure (Image: author).

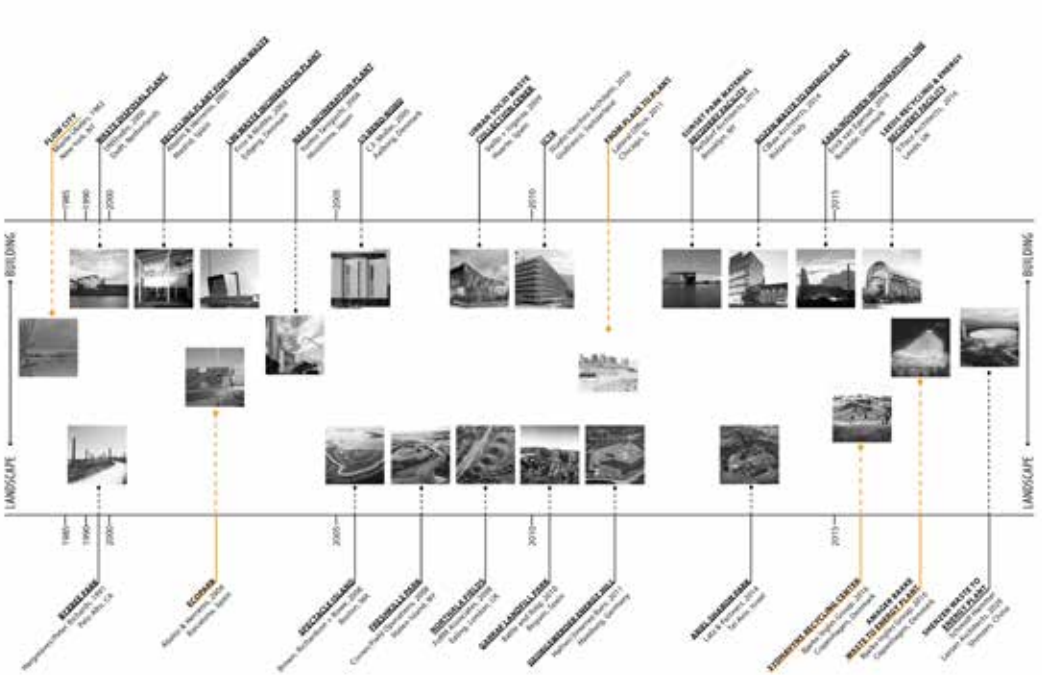
ies are going to continue to grow and thrive in the future, they must begin to think of themselves as self-sustaining ecosystems.

Imagine a city that is able to sustain itself: it processes its waste within city limits, using municipal solid waste generated from its citizens to feed an energy plant that eliminates the waste and in turn produces energy and heat to feed into the city's energy system to power people's homes. This closed-loop system would not be required to rely on outside resources to sustain the needs of the city; it could begin to sustain itself.

In stark contrast to this ideal city, New York City currently exports 6.4 million US tons of trash per day (Figure 1). None of this trash is processed within the city limits since the closing of Freshkills Landfill in 2001, but rather exported to nearby states such as Pennsylvania and Ohio, and as far away as 700 miles away via truck, rail, and boat to landfills; costing taxpayers an immense financial burden and harming the environment with all the pollution associated with motor vehicles (Accuardi, 2011). According to Pierre Belanger's Landscapes of Disassembly, «When long-term post-closure remediation is considered, estimates now place the full cost of waste dumping, including downstream impacts and greenhouse gas emissions, somewhere between 50 to 100 times the original price paid at the scales» (Belanger, p. 84). This equates to 2.3 billion US tons of trash per year plus unsustainable costs to sustain a city of 8.5 million people. This linear method of waste infrastructure cannot be sustained in a healthy way.

Valuing Waste

This short lived, linear method of waste management in which the lifecycle of trash ends quickly at the landfill illuminates the fact that there is no value placed on waste. This notion needs to be challenged as land and natural resources become scarcer while cities are growing larger, demanding more and more resources. If cities begin to place value on waste rather than spending resources of time, money, and fuel to simply dispose of it, waste can become a resource in its own right. It can become a fuel: producing energy to power people's homes, metals to be recovered and reused, and ash to be



used in construction and agriculture. If waste can be recognized and valued as a resource, it can shift its' identity from being the problem itself, to becoming part of the solution.

The lack of value in waste and other industrial infrastructures has manifested itself into the physical design of cities. These systems are inextricably tied to the way cities operate on a daily basis, yet they are designed to be removed from the public eye, essentially becoming invisible to the public and severing the relationship between the urban environment we inhabit and the one that is required to support the way we live. The disconnect between these two realms furthers the societal devaluation of waste and continues to support the notion of exporting waste to a location far outside the city that has no connection to the people that generated it.

Waste and the Designer – a Missing Link

Urban industrial zones, relegated to the periphery of cities are nevertheless a part of the built environment, and therefore should be considered within the scope of the urban environment we design. However, designers from all backgrounds from architects to urban designers to landscape architects have historically had no role in the creation of these systems. The designer has been completely left out of the conversation on waste infrastructure. If designers can apply their creative design thinking to the challenges of waste infrastructure, from the level of city planning down to the level of the building design and the landscape it sits within, the more integrated and thoughtful the solutions can be. If the industrial realm can be given the level of design consideration that is given to the traditional public realm, we can begin to break down the boundaries between the urban environment we inhabit and the one that supports us. We can begin to think of these realms overlapping and blur the lines between buildings, landscape, and infrastructure.

Because of this disconnect with the industrial landscapes that support our urban needs, as well as lack

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Fig. 3 – Delft Waste Disposal Plant (Image: curtesy of UNStudio).
Fig. 4 – Recycling Plant for Urban Waste (Image: curtesy of Abalos & Herreros).

of environmental and economic motivations, it is hard for the general public to understand and embrace the technological advances occurring in the field of waste management. By including designers in the conversations about waste management potentials, such as urban waste-to-energy, recycling, composting, they can create value in industrial environments and promote healthier communities. «Within this space of opportunity, new design concepts can offer hybrid solutions to generate clean energy, contribute to cities' social and cultural activities, and protect wider urban atmospheres and microclimates» (Georgoulias, 2015).

Today, we are at a critical junction in establishing best practices for waste management strategies as population density and consumption patterns in cities increase. With technological advances, it is time for sustainable infrastructure to be put in place to support current trends of consumption. Designers have the opportunity to bring the industrial periphery of urban environments back to the interconnected realm of public activity.

Relinking Design and Waste

In order to explore the role of the designer within the field of waste management, a timeline of projects imagined and completed by architects, landscape architects, and artists creates a visual history of the opportunities that lie when these worlds collide (Figure 2). These projects range from buildings to landscapes; from conceptual work, in-progress work, to completed works that are multi-functional in the way they engage with the process of waste. The analysis of these projects involves not only placing them chronologically, but also placing them on a spectrum from building to landscape: allowing projects to float in between these two binary conditions.

Many of the buildings in this analysis are waste-to-energy plants and recycling facilities, and the majority of the landscape projects are multi-functional parks created over capped landfills. Within this spectrum of 'building to landscape' lies a variety of program typologies and ideologies of waste management, ranging from ways to treat trash as it enters the waste stream to ways of reclaiming landscapes that have been left as residual from waste disposal.

The majority of these projects are located in Western European countries such as Denmark, the Netherlands, and Spain. Due to a variety of constraints such as political, geographic, and energy needs, many of these countries have been required to invest in alternate waste management strategies. The most common and even more primitive alternative to landfilling is burning waste. With technological advances, Waste-to-Energy plants have become

both a significant waste management strategy and a source of energy, as evidenced by their use across Europe for a significant amount of time. However, not all Waste-to-Energy plants are created equal: the projects of interest in this analysis are those that go beyond the pure functional requirements of the prescribed industrial needs and add architectural value to the built environment. The programs of the buildings examined include waste-to-energy plants, recycling, sorting, and composting centers. Many of them link an aspect of public outreach to them, whether it be a visitor's center, museum area, display area, public promenade, or other public amenity.

One example of a building that goes beyond its pure function to engage local culture is the Waste Disposal Plant in Delft, Netherlands (Figure 3). The architecture firm UNStudio elevated the program beyond its traditional use to serve as a symbol to its community: using the building's design and form to communicate the waste management policy of its city to its people. The programmatic requirements of the space include a recycling facility, compression facility, and transfer station. The movement of vehicles and waste determines the fluid form, while its gently sloping concrete surface wraps over itself to form a plateau, which separates the delivery and the sorting facilities from the public view to the river.

The Recycling Plant for Urban Waste (Figure 4) in Madrid, by Abalos & Herreros in 2001, is another example of a building that is industrial function is expanded through the architect's design. The recycling plant is «part of a wider political initiative to reevaluate and regenerate an area southwest of Madrid, which has been used as a large dumping ground and suffered social and environmental deprivation as a result» (Phaidon Atlas). The objective of this facility is to reconstruct the hillside through the generation of compost from organic waste. The building's function is greater than purely gathering waste from the surrounding region, but extends beyond to mend the scars of industrialization that the

Fig. 6 – Diagram of Amager Bakke Waste to Energy plant (Image: author).
Fig. 7 – Diagram of Sydhavyns Recycling Center (Image: author).

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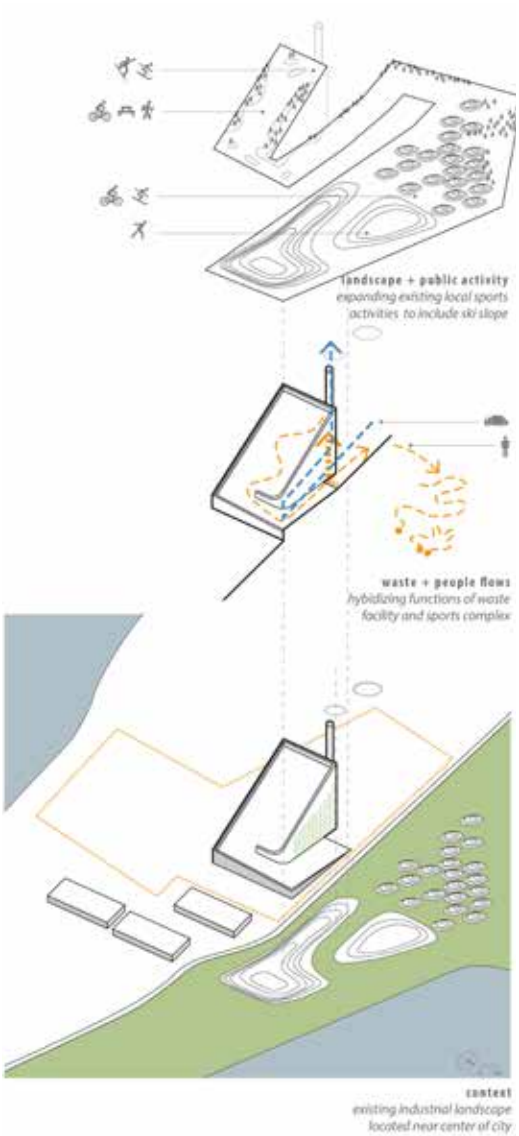
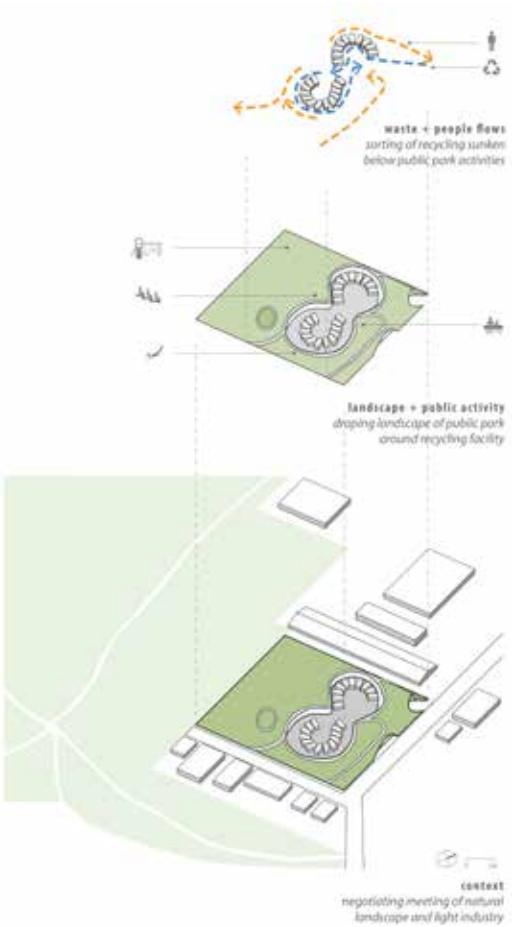
Fig. 5 – Freshkills Park (Image: curtesy of Corner/Field Operation).



AMAGER BAKKE WASTE-TO-ENERGY PLANT
BJARKE INGLES GROUP
COPENHAGEN, DK



SYDHAVYNS RECYCLING CENTER
BJARKE INGLES GROUP
COPENHAGEN, DK

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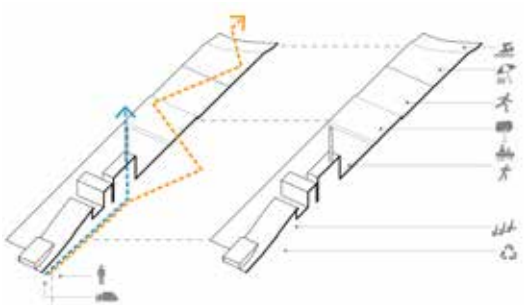
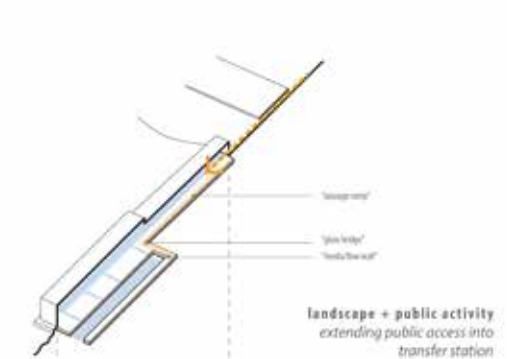


waste + people flows
engaging public with facility woven into multi-layered landscape

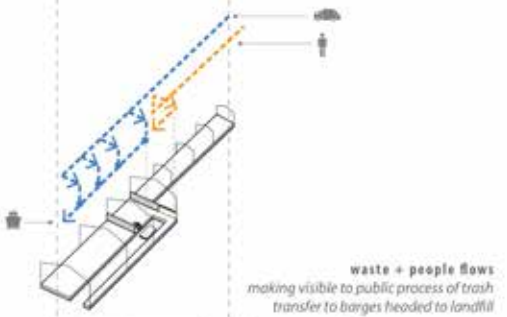
landscape + public activity
linking industrial and natural terrain through construction of crossbred landscape

context
constructing multiple intricate experiences of natural components within existing industrial landscape

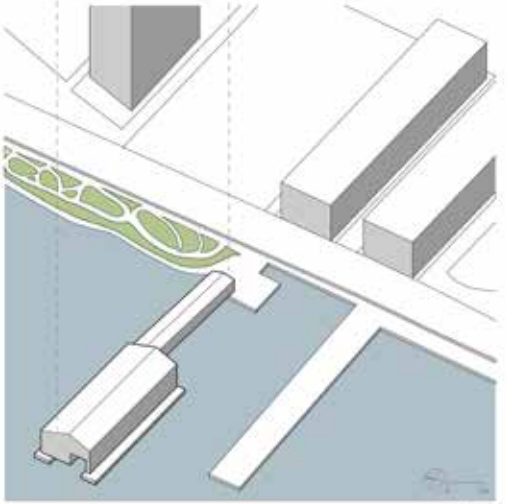
ECOPARK
ABALOS & HERREROS
BARCELONA, SPAIN



landscape + public activity
extending public access into transfer station



waste + people flows
making visible to public process of trash transfer to barges headed to landfill



context
enabling residents to experience the "violent theater of dumping"

FLOW CITY
MIERLE UKELES
NEW YORK, NY

Fig. 8 – Diagram of Ecopark (Image: author).
Fig. 9 – Diagram of Flow City (Image: author).

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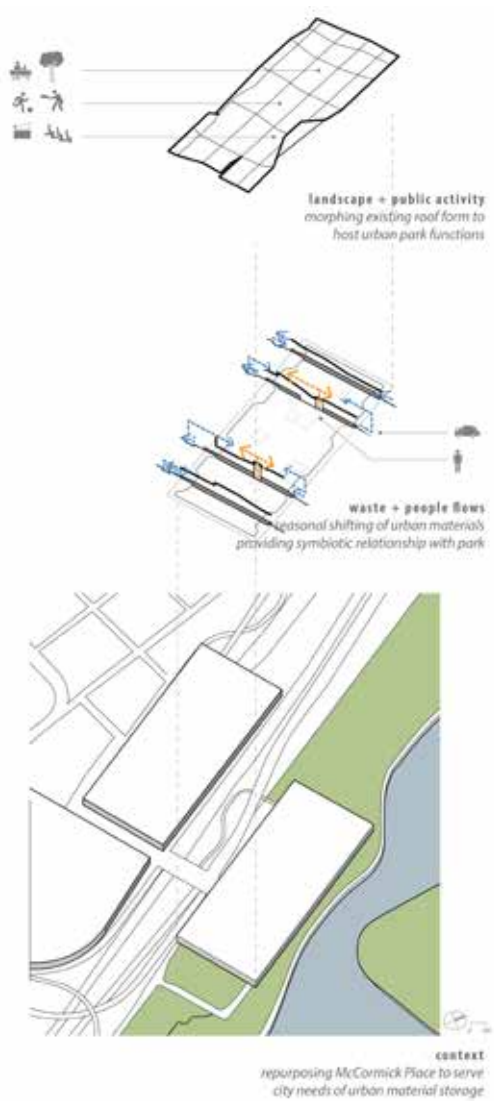
Fig. 10 – Diagram of From Place to Plant (Image: author).



city has imposed on the landscape. The complex is comprised of two buildings and a weigh station pavilion. The two buildings are constructed from a bolted steel structure that can easily be dismantled in the future and enclosed in a recycled polycarbonate. The roof structure is a single pitched green roof that merges with the sloping landscape around it. Not only is the building constructed with recycled materials, but also the entire complex is contrived as a built form that is designed for a lifetime of twenty-five years. After this time, it can be easily dismantled and elements recycled elsewhere. By thinking about the lifespan of the building as part of a larger system, it is merely a piece that is plugged into a larger whole. This elevates the building from pure function to a part of the urban landscape that adds value to its everyday functions.

The landscape projects compiled in this analysis are examples of former landfills that have been given new life. These landscapes of waste can be reclaimed as environments inhabited and used by wildlife and people. While the majority of the building examples were in Europe, a number of these landscape projects are in the United States, where landfills are the prominent means of waste disposal. These designed landscapes are able to foster multiple activities such as recreation, wildlife habitat, and energy production. One of the most prominent examples of a landfill-to-park transformation is the Freshkills Park in Staten Island, New York (Figure 5). Closed in 2001, this landfill was the major recipient of trash from all boroughs of New York and

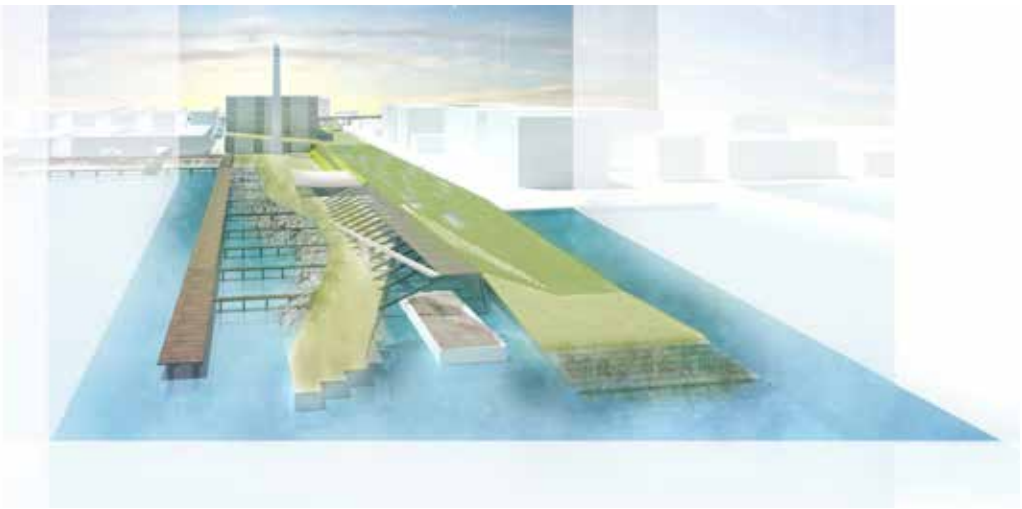


Fig. 11 – Theoretical design proposal of Sunset Park Waste to Energy plant and park (Image: author).

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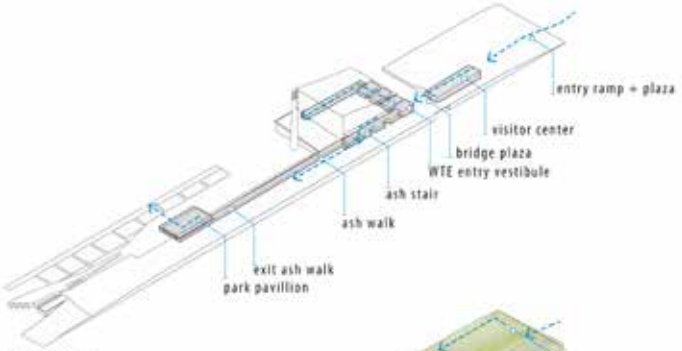
Fig. 12 – Layers of movement: waste, people, and landscape (Image: author).

was the largest landfill in the world. Designed by Corner/ Field Operations, the first phase of the park opened in 2008. Its uses include a variety of public spaces and facilities for recreation, wildlife habitat, energy production, art and culture, and education.

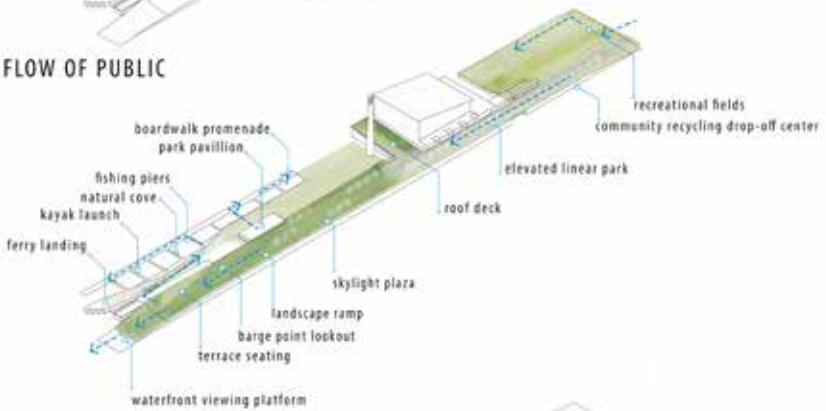
Engaging the public with waste

As mentioned earlier, cities are complex ecosystems with many interwoven systems. As we think about the opportunity to engage waste networks with other urban networks, we can start to look for synergies: places that require us to abandon our binary view of the urban environment: building vs landscape, private vs public; and instead turn to nature where complex systems overlap and any synergy between two improves efficiency. Therefore, in analyzing these waste-oriented projects, the hybrid condition elicits further analysis. Several projects, both conceptual and completed in recent years, allow us see ways in which designers were able to engage the general population in the process of waste management. All of these projects take place in cities: varying from Copenhagen and Barcelona, to New York and Chicago. These are places where urban dwellers can connect in a new way to the waste they are generating and understand the critical link between themselves and this larger system they are an integral part of.

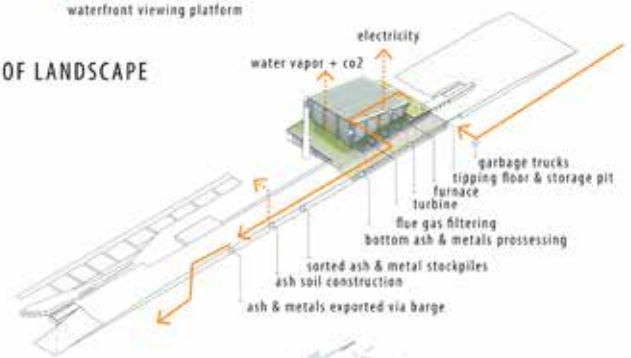
Starting in Europe, we can look to Denmark and Spain, where necessity dictated finding innovative ways to deal with waste. The waste-to-energy plant has less of a negative connotation here than in the United States, and people are quicker to embrace the need for innovative, efficient systems. In Copenhagen, two projects by Bjark Ingles Group show that it is possible to integrate public activity with waste management functions: with both a waste-to-energy plant and a recycling center. The first, Amager Bakke Waste to Energy Plant, open in 2018, combines waste treatment with public amenity to create a hybridized building typology. Figure 6, as well as the accompanying diagram for each of the following projects, shows the layers of the project and how different systems, waste and people, flow through the project. By incorporating a public ski slope into a waste to energy plant, the building is elevated from a typical industrial building to a new typology that at-



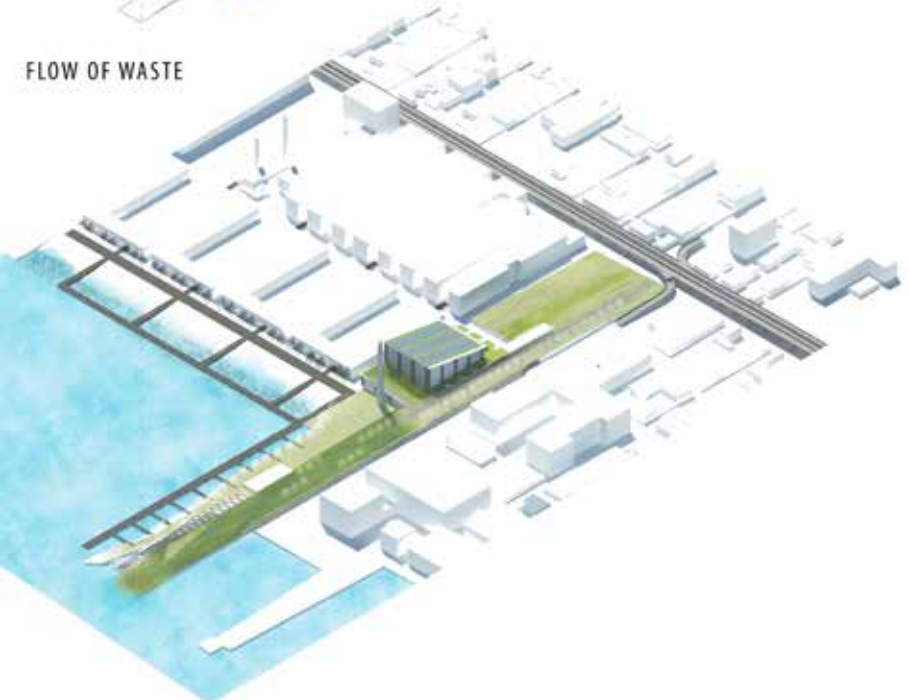
FLOW OF PUBLIC



FLOW OF LANDSCAPE



FLOW OF WASTE



tracts and encourages public interaction with what is typically regarded as negative and 'off-limits'. Located in an industrial area not far from the central historic district of Copenhagen, the building serves as a destination for visitors and locals alike.

Another project by Bjarke Ingles Group that plays with the idea of how industrial functions can be combined with public activity is Sydhavyns Recycling Center, conceptually planned in 2016. It is located in the Sydhavyns district of Copenhagen, southwest of the historic city center. Located near the water within a light industry area, this recycling center imbeds itself into the landscape, connecting with a large park (Figure 7). The project acknowledges that industry and public activity can be interwoven into a coherent space. «As a society, our investment in waste management often ends up as utilitarian facilities of concrete boxes that constitute grey areas on our city maps,» explained BIG in a statement. «What if they could become attractive and lively urban spaces in the neighborhoods they form part of?» Rather than acting as a building separated from its natural context, the building instead tucks itself underneath and within the altered landscape. As stated by BIG, the recycling center is «[...] a way to start thinking of our cities as integrated manmade ecosystems, where we don't distinguish between the front and back of house. But rather orchestrate all aspects of daily life, from consumption to recycling, from infrastructure to education, from the practical to the playful into a single integrated urban landscape of work and play» (Bjark Ingles Group, 2015). This integration between buildings and landscape in the urban environment is an important shift in design thinking. By realizing that all spaces, both buildings and landscapes are constructed entities within the city often combining complex networks of infrastructure, it can be argued that any design needs to address the overlap of architecture and landscape.

By acknowledging that these buildings of industrial use are a necessary and integral part of our cities, they can become part of the fabric of the city. A built project in Barcelona by the architecture firm Abalos & Herreros in 2004, Ecopark does just that: it is an expansion of a waste treatment facility that stiches across layers of urban fabric to tie the recycling facility to a public promenade and beach amenity (Figure 8). Located in the North Eastern area of Barcelona, the design blends programmatic services into the landscape, creating a hillside that acts as a buffer to ease the tension between the extending promenade and the nearby highway. The public plaza weaves between this hillside, a facility building, outdoor facility elements and shifted topographic changes to navigate the public from the edge of the

highway along the facility, to the beach. By linking various pieces of the public plaza along both building and landscape elements of the facility, it becomes an integral backdrop to the beach amenity.

These projects, both built and planned, illuminate the possibility of engaging the public through recreational activity with the industrial nature of waste management. We can see that the two do not need to be separated, but can exists in a designed ecosystem together. This innovative design thinking has yet to be fully realized in the United States; most waste management is still dominated by landfilling with some efforts of recycling. The conversation is beginning, however, and some conceptual projects show the potential for this new typology of integrated public-industrial waste facilities.

The first project, Flow City, is a unique project that captures the desire to link the public with the operation of trash movement in New York. This project was constructed as an exhibition along the 59th Street Marine Transfer Station along the Hudson River in 1983. It was completed by artist Mierle Ukeles, who in her manifesto describes her work as «maintenance art» and has been the unsalaried artist-in-residence at the New York City Department of Sanitation since 1977. In the artist's own words: «I call it FLOW CITY because it embodies a multiplicity of flows: from the endless flow of waste material through the common and heroic work of transferring it from land to water and back to land, to the flow of the Hudson River, to the physical flow of the visitors themselves» (Ukeles, 1996, p.201).

This exhibit enables residence to experience the 'violent theater of dumping' in an attempt to bring consciousness to people that their garbage has a life after they throw it away. «The fantasy that many people have about garbage is that it exists outside the realm of time. There's such denial involved» (Ukeles, 1996, p.10). In Flow City, people are led through a sequence of moments that run parallel to the flow of trash as it enters the station and moves into barges that bring the trash to Freshkills Landfill, Figure 9. They first walk through the 'passage ramp', which is a narrow metal grate passage that runs above a floor strewn with trash. Next, they observe the act of trucks unloading trash into barges along the 'glass bridge'. Finally, they end at the 'media flow wall': a wall of screens that show the continued journey of the trash through a series of live feed cameras, as well as images and models of Freshkills Landfill, the garbage's final resting place. While this project is not a design project by an architect, it is extremely pertinent to the conversation of exposing the invisible process of waste management to the general public. This affords the public to make the connection between the trash they put

to the curb for the garbage man to collect, and the aggregate mass of trash produced by everyone in the city, along with the labor required to handle it.

Moving from waste management to the broader logistical needs of a city, is the project From Place to Plant by Lateral Office, which reimagines McCormick Place in Chicago as an opportunity to simultaneously «address and celebrate Chicago's impressive urban logistics while extending the city's project of open space by creating a new urban park experience». Lateral Office (2011). This speculative project repurposes the building as a plant for the management of urban materials such as soil, trees, salt, sand, and snow. Conceptually, the programmatic needs of material storage shift through the seasons, and the urban park located on the roof of the building acts as a receptacle for these materials and repurposes them to suit the needs of the varying public amenities being offered, again shifting throughout the seasons. Waste flows in and out depending on the season and current need of the city and then up to the roof to serve the public in the roof parkscape (Figure 10). The proposal includes transforming the roof through a series of strategic moves: folding, punching, pulling, pushing, and bending. This allows a range of urban experiences that respond to the season, such as a beach during the summer with surplus sand from the winter or sledding parkland during the winter by blowing filtered snow from urban collection. On their way up to the roof, through transparent cores, visitors can catch views of the storage space. This project has a two-fold set of functions. It serves the needs of the city itself by storing and managing urban materials and the citizens of the city by providing a public park. Rather than achieving these two functions completely divorced from each other, which is common practice throughout American cities, Lateral Office has intertwined these functions in a symbiotic relationship in which both functions inform and strengthen each other.

The final speculative project, informed by the research and analysis of the projects proceeding, was completed by the author as final component of a thesis project. It attempts to connect urban and waste ecologies at the scale of the city as well as connect people to the trash they generate in a meaningful way. The proposal creates new avenues for public engagement with waste process-

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Fig. 13 – Public entry sequence into waste-to-energy center (Image: author).

es through the design of a waste-to-energy plant and public space. This design proposal not only invites the public into the process of waste management but also frames garbage as a resource for the production of public space in order to shift the notion of placing value in in waste infrastructures. This project is situated along the Gowanus Bay in Sunset Park, Brooklyn, New York along a largely underutilized and derelict industrial waterfront, (Figure 11), incorporating architectural and landscape design into one fluid experience. Figure 12 peels apart the layers of the design: guided by the flows through the project: flow of waste, the flow of landscape, and the flow of public. These flows operate in multiple directions and dimensions. The design extends from the edge of the city fabric, seen in Figure 13, down to the water's edge with a design agenda to join the industrial process of a Waste-to-energy facility with public activity that engages with and benefits from the Waste-to-energy plant.

The project actively engages the public with unique aspects of waste processing at key areas along the length of the facility, called out in Figure 14 as the visitor and recycling center, the crane theater, ash walk and skylight plaza, and barge point. Within each one of these areas, the public and trash intersect in a unique way. In carefully crafted locations, the public is able to engage with a stage of waste processing that is a spectacle to behold. People are able to connect with the overwhelmingly large scale at which these facilities operate and better understand the role they play in the cycle of waste.

Towards an integrated urban waste ecology

By examining ways to rethink the relationship between people, cities, and the waste they generate, this research serves to open the conversation of engaging designers in waste processing. This speculative design project along with the research that supports it seeks to act as a catalyst for further discussion about ways to reevaluate the perception, management, and treatment of waste.

All of these projects shine a light on what has historically been a missed opportunity for designers: the ability to design the often neglected and disconnected industrial realm of waste management. As our urban ecosystem grows more complex in a quickly urbanizing world, now is the time to seize the opportunity of engaging and connecting waste and urban ecologies into a system that benefits all facets of the city. We can see through these projects that it is possible to connect public activity with industrial processes and that designers can add introducing cultural, economic, and environmental value in waste infrastructure.

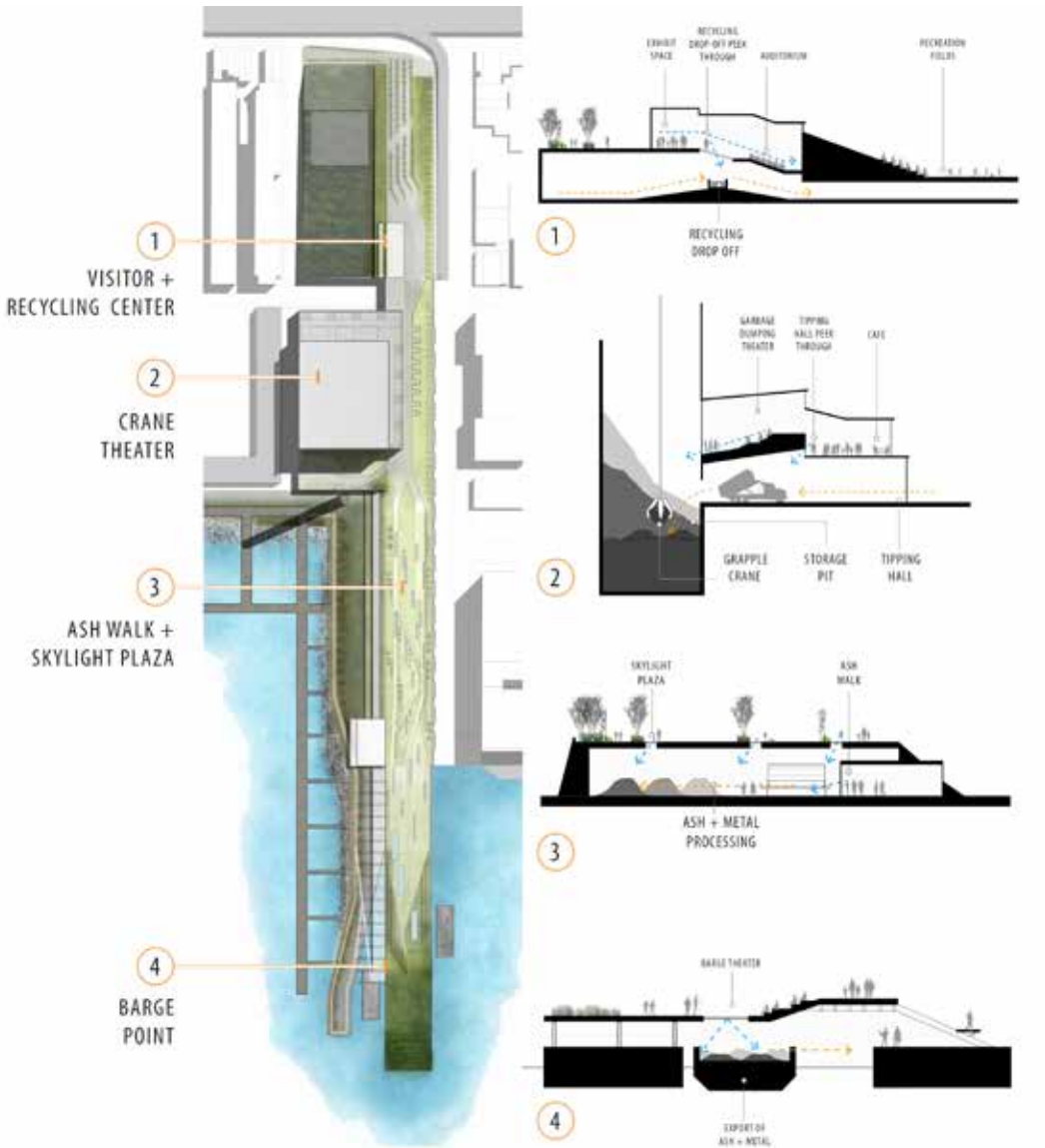

Fig. 14 – Key moments of interaction between people and trash (Image: author).

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