Executive Summary

In the face of critical concerns about climate change and explosive urban population growth, cities worldwide are beginning to explore how “Smart City” approaches can address these challenges. The 2017 Urban Design Studio explores how the design, planning, and management of cities can create a resilient urban fabric, flexible enough to accommodate ongoing growth and capable of absorbing inevitable future environmental shocks.

The studio investigates one of 2020 Summer Olympic Game sites, Urawa Misono, a satellite town of Tokyo’s metropolitan region, as a pilot for this approach. Working with partners at the University of Tokyo, the National Institute for Environmental Studies (NIES) and the Global Carbon Project (GCP), we explore the role of smart city technologies, ecological performance modeling, and third-party sustainability certifications in designing an alternative future for Urawa Misono.

Our resulting proposal is an ecologically responsive, disaster-resilient, and human-sensing urban environment.

A highly interdisciplinary effort, this studio was led by Dr. Perry Yang (Georgia Institute of Technology), Dr. Yoshiki Yamagata (Global Carbon Project and National Institute for Environmental Studies), and Dr. Akito Murayama (University of Tokyo). Studio participants include Georgia Tech graduate students from architecture, city planning, policy, industrial design and interactive computing.

Recommendations

Use of performance zoning as a planning support system (PSS) that enables smarter, more sustainable development

Development of smartphone apps that enable community engagement in planning and encourage exercise and use of alternative transportation modes

Installation of sensors to enable transformation of and multi-use of parking lots and other public spaces

Use of smart street lighting to reduce energy consumption and cost

Conversion of grey infrastructure to green infrastructure

Creation a central green promenade that improves public experience and creates a sense of place

Maximization of thermal comfort by avoiding clustering of tall buildings to ensure adequate

Understanding the tradeoff between building height and footprint in relation to energy consumption and solar capture

Expand transit and mobility options by extending the Saitama railway north to include a new transit station and providing a bus rapid transit strip from Saitama City to Koshigaya

Continue to monitor congestion as new development occurs and identify under-utilized roads for potential pedestrian and bicycle uses

Attract new investment that enables a denser, more walkable central activity center
Urawa Misono is a sub-center of Saitama City, the most populous city in Saitama Prefecture, Japan. While Saitama City boasts a population of 1.26 million, Urawa Misono has remained largely rural. Only 45 minutes by train from Tokyo by rail, it is the final stop on the Saitama Rapid Railway Line. Every two weeks, thousands of soccer fans swarm the stadium and walk or drive to the Saitama Stadium, constructed in 2002 to host the FIFA World Cup. Saitama Stadium is an important site for the 2020 Summer Olympic Games, prompting local and regional officials to consider how they will accommodate the massive influx of event spectators and maximize the impact of this influx for broader development goals. Even without the Olympics, Urawa Misono’s current population is projected to triple in size to over 32,000 by 2030.

Simultaneously, Urawa Misono recently became a certified Comprehensive Special Zone. This designation also identifies Misono as a pilot project zone for smart technologies. Planned projects include 100 Smart House units with home automation technologies, next-generation automobiles, and smart energy implementation. With site potential for further intensification, increasing commuting times and air pollution.

Context

Urawa Misono is a sub-center of Saitama City, the most populous city in Saitama Prefecture, Japan. While Saitama City boasts a population of 1.26 million, Urawa Misono has remained largely rural. Only 45 minutes by train from Tokyo by rail, it is the final stop on the Saitama Rapid Railway Line. Every two weeks, thousands of soccer fans swarm the stadium and walk or drive to the Saitama Stadium, constructed in 2002 to host the FIFA World Cup. Saitama Stadium is an important site for the 2020 Summer Olympic Games, prompting local and regional officials to consider how they will accommodate the massive influx of event spectators and maximize the impact of this influx for broader development goals. Even without the Olympics, Urawa Misono’s current population is projected to triple in size to over 32,000 by 2030.

Simultaneously, Urawa Misono recently became a certified Comprehensive Special Zone. This designation also identifies Misono as a pilot project zone for smart technologies. Planned projects include 100 Smart House units with home automation technologies, next-generation automobiles, and smart energy implementation. With site potential for further intensification, increasing commuting times and air pollution.

Objectives

The challenge of planning in an international context was further compounded by the “smart city” directive. The term “smart city” has become commonplace in urban planning in recent years. While there is no universally agreed upon definition, descriptions of smart cities typically refer to integrated and inter-operable networks of digital infrastructure and information and communication technologies (ICT) that collect and share data and improve the quality of urban life (Albino, Beradi, and Dangelico 2015). However, unlike related concepts such as the digital city, the intelligent city and the city of the future, the smart city is not limited to the diffusion of ICT, but also commonly includes people (Albino, Beradi, and Dengel 2015). Due to the dynamic nature and complexity of the project, the Studio came up with three guiding objectives outlined below through an internal charrette process.

Sustainability

The first objective articulated by our partners and internal team was for our design to be environmentally sustainable. To do this we used urban metabolism to promote civic engagement.

Adaptability

Our second objective was centered around the idea of a smart city as a living organism that can adapt to changing needs and demands. We suggested integrating smart technologies and IoT into the design of the city in order to make it more responsive to the environment and the people living in it.

Equity

Our third and final objective focused on the importance of the people living in the smart city. We fear strongly that smart cities should not only conserve energy and reduce waste, but also improve quality of life and promote civic engagement.

Objectives

The challenge of planning in an international context was further compounded by the “smart city” directive. The term “smart city” has become commonplace in urban planning in recent years. While there is no universally agreed upon definition, descriptions of smart cities typically refer to integrated and inter-operable networks of digital infrastructure and information and communication technologies (ICT) that collect and share data and improve the quality of urban life (Albino, Beradi, and Dangelico 2015). However, unlike related concepts such as the digital city, the intelligent city and the city of the future, the smart city is not limited to the diffusion of ICT, but also commonly includes people (Albino, Beradi, and Dengel 2015). Due to the dynamic nature and complexity of the project, the Studio came up with three guiding objectives outlined below through an internal charrette process.

Sustainability

The first objective articulated by our partners and internal team was for our design to be environmentally sustainable. To do this we used urban metabolism to promote civic engagement.

Adaptability

Our second objective was centered around the idea of a smart city as a living organism that can adapt to changing needs and demands. We suggested integrating smart technologies and IoT into the design of the city in order to make it more responsive to the environment and the people living in it.

Equity

Our third and final objective focused on the importance of the people living in the smart city. We fear strongly that smart cities should not only conserve energy and reduce waste, but also improve quality of life and promote civic engagement.

Objectives

The challenge of planning in an international context was further compounded by the “smart city” directive. The term “smart city” has become commonplace in urban planning in recent years. While there is no universally agreed upon definition, descriptions of smart cities typically refer to integrated and inter-operable networks of digital infrastructure and information and communication technologies (ICT) that collect and share data and improve the quality of urban life (Albino, Beradi, and Dangelico 2015). However, unlike related concepts such as the digital city, the intelligent city and the city of the future, the smart city is not limited to the diffusion of ICT, but also commonly includes people (Albino, Beradi, and Dengel 2015). Due to the dynamic nature and complexity of the project, the Studio came up with three guiding objectives outlined below through an internal charrette process.

Sustainability

The first objective articulated by our partners and internal team was for our design to be environmentally sustainable. To do this we used urban metabolism to promote civic engagement.

Adaptability

Our second objective was centered around the idea of a smart city as a living organism that can adapt to changing needs and demands. We suggested integrating smart technologies and IoT into the design of the city in order to make it more responsive to the environment and the people living in it.

Equity

Our third and final objective focused on the importance of the people living in the smart city. We fear strongly that smart cities should not only conserve energy and reduce waste, but also improve quality of life and promote civic engagement.

Adaptability

Our second objective was centered around the idea of a smart city as a living organism that can adapt to changing needs and demands. We suggested integrating smart technologies and IoT into the design of the city in order to make it more responsive to the environment and the people living in it.

Equity

Our third and final objective focused on the importance of the people living in the smart city. We fear strongly that smart cities should not only conserve energy and reduce waste, but also improve quality of life and promote civic engagement.

Adaptability

Our second objective was centered around the idea of a smart city as a living organism that can adapt to changing needs and demands. We suggested integrating smart technologies and IoT into the design of the city in order to make it more responsive to the environment and the people living in it.

Equity

Our third and final objective focused on the importance of the people living in the smart city. We fear strongly that smart cities should not only conserve energy and reduce waste, but also improve quality of life and promote civic engagement.
Co-Design Process

PHASE I: Initial Design and Development of Performance Analytics

A more traditional studio practice begins with a client and a site. Designers devise a series of alternative proposals, which are then analyzed and evaluated by planners. These conventional urban design techniques emphasize a completed urban form, ignoring the constant evolution of cities. By contrast, our Urban Systems Design (USD) method develops a design model that nurtures interaction, synergy of creativity and scientific iteration. The USD model integrates urban design, performance evaluation and emerging technologies through processes of studios participating in an interdisciplinary World Cafe design charrette in Atlanta.

During our studio’s initial phase, our team divided into sub-groups based upon our strengths, opportunities and desired contributions to the project. Four teams emerged: Conceptual Design, Performance Modeling, Community Engagement, and Smart City Computing. Our early studio work had two main goals: understanding our studio’s charge within the legacy of 1960’s Metabolism, and a site. Designers devise a series of alternative proposals, which are then analyzed and evaluated by engineers. These conventional urban design techniques emphasize a completed urban form, ignoring the constant evolution of cities. By contrast, our Urban Systems Design (USD) method develops a design model that nurtures interaction, synergy of creativity and scientific iteration. The USD model integrates urban design, performance evaluation and emerging technologies through processes of.

Early on, our teams anticipated potential silos between our respective design, modeling, and smart city technology specializations. In response, we devised our respective design, modeling, and smart city technology specializations. In response, we devised disciplinary dialogues about envisioning what a Smart City could balance the current site constraints with our own ideas about what Misono should become.

Our performance modeling team began to consider which metrics would be most important for evaluating (and also marketing) an eco-urban design for Urawa Misono. Additionally, we tested performance modeling techniques on neighborhoods in Central Tokyo, an opportunity to practice newly-acquired skills in the real world and between Misono and other developed areas of Tokyo. We utilized GIS to explore how urban form variables, such as density and land-use, coupled with natural factors like topography and climate zones, affects evaluation criteria, including human comfort, visibility, walkability, urban mobility, and the energy, food and water production and consumption.

Effectual Community Engagement efforts also began during these initial studio stages. An online survey was created as a way for local residents to provide input in the early conceptual design stages. After consulting with our partners in Tokyo, we began to understand how we would need to alter our American conceptions of community engagement to gather input from Japanese residents.

The next two days comprised a Smart City Symposium at the University of Tokyo, where we presented our initial work, and a Smart City Month of Things (IoT) workshops. During these workshops, we worked with students from the University of Tokyo and Denki University to improve our design and consider how to better incorporate IoT into our proposal. We spent the following day executing urban reconnaissance exercises: active observations of social, cultural, behavioral, spatial and temporal patterns in Central Tokyo.

In response to this new data and feedback, we spent the next two days at the National Institute for Environmental Studies (INES) in Tsukuba, modifying our design and conducting additional performance evaluation analyses to strengthen our proposal. On our final day in Japan, our team presented our revised design (CD-3) to local government officials, academics, and business stakeholders at the Community Center in Urawa Misono. After our presentation we facilitated a discussion between the stakeholders and the studio participants to gain a deeper understanding of their vision for Urawa Misono.

Our final phase of studio remains an adaptive process, synthesizing the abundance of insight gained in Japan with prior design and analysis work. After returning to Atlanta, we dedicated the last several weeks of our studio period to creating a locally-informed design and proposals for our studio’s team. Additionally, we prepared a final report for the Smart City (IoT) workshop. This final design has been evaluated by our performance modeling teams, and, if developed, is expected to achieve LEED’s Platinum rating for neighborhood development (LEED-ND).

The remaining sections of this report elaborate on the performance zoning and PSS, each of the designs, and, if developed, is expected to achieve LEED’s Platinum rating for neighborhood development (LEED-ND).

Community engagement efforts also began during these initial studio stages. An online survey was created as a way for local residents to provide input in the early conceptual design stages. After consulting with our partners in Tokyo, we began to understand how we would need to alter our American conceptions of community engagement to gather input from Japanese residents.

Three initial designs (CD-1, 2, and 3) were created based on the principles determined by the initial performance modeling and the themes that came out of the blue sky brainstorm. These three concepts focused on transit-oriented development, neighborhood metabolism, and city-as-garden. In addition to considering what design constraints the studio would most readily enable metabolism, each of these three visions also explored particular performance zoning and PSS, each of the designs, and, if developed, is expected to achieve LEED’s Platinum rating for neighborhood development (LEED-ND).

PHASE II: Tokyo Co-Design Workshop

In March, we traveled to Japan to present our most recent design and analysis to our partners and local stakeholders. On our first day, we met our partners at the Urban Design Center of Misono (UDCM) and obtained on-site field data to inform our design. We also visited Kawagoe, a city in Saitama which exhibits patterns of Japanese urban form dating to the Edo Period.

Currently, the designs’ ability to achieve our studio’s goals for a sustainable, adaptable, and equitable Urawa Misono.
Many previous products of urban design work have been presented as, either implicitly or explicitly, the final masterplan that the future planning process needs to be actualizing. Presenting urban design plans as a fixed image of the future and not allowing unpredictability or changeability have often been responsible for the gap between the proposed urban design plans and the outcomes – actual city. Typically the agents who carry out the making of a city are private developers. Current planning-related regulatory tools sets do not have the means to mandate that developers follow a proposed urban design plan to every detail down to the architecture level. Hence, the actualized outcome of an urban design plan in the real world is inevitably different from the plan due to the unpredictable, uncontrollable decisions made by the developers.

The deviation of the actual development from the proposed plan in the real world is narrow due to the definition of planning. The existing planning-related regulatory tool sets do not have the means to mandate that developers follow a proposed urban design plan to every detail down to the architecture level. Hence, the actualized outcome of an urban design plan in the real world is inevitably different from the plan due to the unpredictable, uncontrollable decisions made by the developers.

It is important to emphasize that the final output of our studio should not be considered an 'end-state' master plan. After the final output is delivered to stakeholders of Urawa Misono, it will function as the starting point for future discussions. We attempt to provide a PSS that enables easy-understandable visualization and evaluation layers to make data-driven decisions, narrowing the gap between the presented urban design plan and the actualized city in all dimensions. We hope that the PSS will bridge the output of our studio to the future Urawa Misono.

Structure
The PSS consists of two parts: the presentation layer and evaluation layers (Figure 3). These layers differ in their purposes. The purpose of the presentation layer is to provide a simple and intuitive illustration of zonal performances. The performance zoning maps shown in the next section of this document is an example of the presentation layer. Because the layer is translated as a simplified visualization of more complex calculations beneath it, it is easy to understand and thus accessible for non-expert stakeholders. This layer serves as a major input to the planning processes. Beneath the presentation layer are multiple evaluation layers. These are the layers where actual performance metrics are calculated. The outputs from these layers provide information based on which the presentation layer is created. Due to the complexity, these layers may be presented to stakeholders who are interested in specific dimensions of performance, enabling them to make more nuanced decisions.

The separation of the presentation layer and evaluation layer is necessary because of the potential spillover effect. Spillover effect refers to the case where a modification in one zone in which the modification occurs but also other zones. The separation of the presentation layer and evaluation layer is necessary because of the potential spillover effect. Spillover effect refers to the case where a modification in one zone in which the modification occurs but also other zones.

The modified urban design plan is displayed in a form translated into the presentation layer through zonal statistics. If the modified urban design plan is displayed in a form translated into the presentation layer through zonal statistics. If the modified urban design plan is displayed in a form translated into the presentation layer through zonal statistics. If the modified urban design plan is displayed in a form translated into the presentation layer through zonal statistics. If the modified urban design plan is displayed in a form translated into the presentation layer through zonal statistics. If the modified urban design plan is displayed in a form translated into the presentation layer through zonal statistics. If the modified urban design plan is displayed in a form translated into the presentation layer through zonal statistics. If the modified urban design plan is displayed in a form translated into the presentation layer through zonal statistics.

Presentation Layer
Building Layer
- Polygon
- Zone
- Network Layer
- Polygon
- Parcel-Zone
- Elevation Layer
- Raster
- Parcel-Zone

Figure 3. Structure of Planning Support System
Performance Zoning

Performance zoning, as a concept, is not new to this project. Proposed originally in 1980 by Lane Kendig as a replacement for the traditional practice of Euclidian zoning, in this approach and development land use are controlled by the performance of the urban form rather than local and global goals. Performance zoning encourages mixed-use over single-use spaces and encourages high performance development. At the time though Kendig’s proposition was criticized as being overly focused on public and decision makers and as a tool for resolving trade-off between complexity and computational time. A limitation of computational models is a trade-off between computational time and the public’s ability to understand the fundamental performance qualities of each block. The theory was that each block can stand in for a development of an area and provide a benchmark that any development must reach while also controlling the quality of the urban form without being overly prescriptive about the design possibilities.

Along with the original six typologies, variations were developed that were used to describe six possible developmental conditions. These variations served two purposes. The first was to identify the patterns in urban form that resulted in the best performance in the abstract analytical vacuum, and the second was to provide variations on the themes presented in the original six typologies. Holding the FAR (floor area ratio) value constant to account for a consistent population density, other factors such as BCR (building cover ratio) were allowed to vary for the three schema applied. These took the form of a centralized model in which a majority of the development is moved towards the centroid, a linear model in which the height of buildings falls off in a linear fashion, and a decentralized model in which the FAR is spread across the site and away from the centroid. Analysis was carried out by both the Atlanta and Tongji teams and optimal conditions were recommended.

The block typologies allow for an additional problem to be addressed. There is a significant trade-off effect between various performance elements, such as solar power generation, food production and population density. As density increases, for example, the amount of land area available for food production and solar power generation decreases. This ‘iron triangle’ requires that there be trade-offs and means that it is not always possible for each zone to independently achieve the overall system criteria of being net zero. A1, for instance, requires high density development and may be able to achieve many of the density requirements but its productivity in terms of food and water will decline. Taken in contrast to lower density developments, such as C3 or D1, there becomes an opportunity to offset the impacts of the higher density developments with more productivity. In a way this is, conceptually at least, a similarity to the Transfer Development Rights strategy developed for the preservation of rural lands. While this system through as opposed to trading density, in the form of FAR, from site to site rather performance metrics are traded, density for other land intensive uses. Taken at large this causes the site as a whole to approach a net zero state as C zones begin to offset A zones allowing for more land to be used for agricultural purposes as density is moved in towards the core area.

The trade off requirements between zones and the density gradient necessitated the development of some limitations within the zones. While earlier schemes that toyed with the idea of organic growth allows urban nodes to move naturally through each phase from town-like development to dense urban core, the process supposed by the PSS for achieving net zero required artificial growth limitations. Each performance zone had the available typologies constrained in both type and variation. In principle, the idea being that the sum of the performance characteristics of, for example A1, will be offset by the sum of the performance characteristics of C3 and other zones. This can only be achieved through variation within the limitation of the initial set.

Figure 5. Block Variation Rules

Figure 6. Iron Triangle of Performance Trade-offs
The Smart City is a term that has defied clear definition. One studio survey participant responded that smart cities are nothing but “buzzwords from global corporations”. This suggests a lack of consensus on the nature, use, or usefulness of smart city technologies. With an eye towards applications at varying time horizons, the Smart City Computing (SC) team has been investigating not only what “smart city” means, but also the potential for fully realizing a smart city.

One approach made by the SC team is to view the integration of technologies, especially Internet of Things (IoT) as an opportunity to connect people to the city itself. The Internet of Things (IoT) has been defined in Overview of the Internet of things (ITU, 2012) as a global infrastructure for the information society, enabling advanced services by interconnecting physical and virtual things based on existing and evolving inter-operable information and communication technologies. IoT applications that leverage ubiquitous connectivity, big data and analytics are enabling Smart City initiatives all over the world. These new applications introduce capabilities such as the ability to remotely monitor, manage and control devices, and to create new insights and actionable information from massive streams of real-time data. As a result, IoT is transforming cities by improving infrastructure, creating more efficient and cost effective municipal services, enhancing public transportation, reducing traffic congestion, and keeping citizens safe and more engaged in the community.

Through the studio, the SC team has been exploring how cities can be transformed. Given guidelines provided by our Japanese partners, the team explored the possibility of implementing IoT technology in alignment with their guidelines. Investigations moved toward integrating the varying scales of health (the person), home (the building), and the city. At the level of the individual, the team focused on the mobile app because of its worldwide popularity. The team proposed an app to support mobility and alternative transit modes within and around Urawa Misono. Inspired by the popular augmented reality games like PokemonGo, which attracts players to the specific locations for Pokemons, our app would also provide incentives. These would include coupons or descriptions of significant sightseeing locations to attract people along different routes through the city. Working with real-time mobility and population data in Urawa Misono, the app aims to help balance the pedestrian load around the city, especially during soccer events at Saitama Stadium.

At the city level, we focused on infrastructure and space. The team proposed a smart lighting system that would signal joggers and cars, reduce energy costs for public street lights, reduce light pollution, and which could be adjusted based on the traffic condition. An interactive bus stop was also designed for public transportation users to encourage use of alternative transportation modes and to provide a new way for residents and visitors to interact with the city.

As IoT technologies offer the possibility to rearrange and transform the city, the team explored the possibility of re-arranging idle space to create more multi-use and multi-functional space in the city. Situational public space was proposed, which would have the ability to monitor real-time utilization of parking lots and public space in the city and transform these spaces when they’re not in use. The plan for Urawa Misono is to implement sensor and projector modules in some spaces around the stadium, enabling the space to morph between being a parking lot and a public exercise space. This proposal is also extended and combined with the mobile app idea. During stadium events when traffic is heavy and parking is limited, the system could adjust the price of the parking spots and encourage drivers to park farther from the stadium and walk to reduce congestion.

Overall with IoT technologies implemented in the city, a whole smart city system is planned to enhance the interaction between people and the city in Urawa Misono. The conceptual scenarios presented by the diagrams as well as the videos showing how people could live with the technologies.
New technologies are changing how we interact with space and are creating new ways for people to experience the urban environment. This change shifts how we can, and should, think about the configuration and uses of public space. Changing public space from the static arrangements of the conventional park, plaza or street towards more dynamic and interactive urban experiences. The programming of the urban environment no longer subject to ‘single authorship’. Rather, the smart city renders the urban designer, much like the author, dead (Barthes 1967). Space is now free to be driven by demand and desire, by both performance and potential. The city moves from the stagnant psycho-geographies that extend out of the sensuous and fuzzy nature of memory and thus the whole of the human experience as the urban environment towards experiences that encompass and collective patterns captured across time. This allows for the development of diverse, individual psycho-geographies that extend out of the sensuous and fuzzy nature of memory and thus the whole of the human experience as the urban environment is dissolved into the ephemera (DeBord 1956; Radovic 2014).

The smart city, enabled by technologies of spectacle, instead creates ephemeral environments that are unique in both space and time. The quality of the street changed through both direct individual action and collective patterns captured across time. This transitory condition seeks to capture more than the transitory condition seeks to capture more than the types of activities more than the types of activities more than the physical senses; it seeks to capture the imagination and potential. The city moves from the stagnant psycho-geographies that extend out of the sensuous and fuzzy nature of memory and thus the whole of the human experience as the urban environment towards experiences that encompass and collective patterns captured across time. This allows for the development of diverse, individual psycho-geographies that extend out of the sensuous and fuzzy nature of memory and thus the whole of the human experience as the urban environment is dissolved into the ephemera (DeBord 1956; Radovic 2014).

The smart city, enabled by technologies of spectacle, instead creates ephemeral environments that are unique in both space and time. The quality of the street changed through both direct individual action and collective patterns captured across time. This transitory condition seeks to capture more than the physical senses; it seeks to capture the imagination and potential. The city moves from the stagnant psycho-geographies that extend out of the sensuous and fuzzy nature of memory and thus the whole of the human experience as the urban environment towards experiences that encompass and collective patterns captured across time. This allows for the development of diverse, individual psycho-geographies that extend out of the sensuous and fuzzy nature of memory and thus the whole of the human experience as the urban environment is dissolved into the ephemera (DeBord 1956; Radovic 2014).

When the design moved away from the static design of the traditional master planned development towards a more dynamic environment that grew like a garden, the new plan called for infill development using specific typologies whose geometry could be easily repeated across space. For the development of the smart city concept this meant the urban fabric was built with the technologies in mind. It became clear to those working on the project that these would not become “spaces that serve” (McCollough, 2011). The fear was that the technologies would become a prescriptive part of the environment and that the smart city would never adapt to new technologies or uses. When the design moved away from the static design of the traditional master planned development towards a more dynamic environment that grew like a garden, the new plan called for infill development using specific typologies whose geometry could be easily repeated across space. For the development of the smart city concept this meant the urban fabric was built with the technologies in mind. It became clear to those working on the project that these would not become “spaces that serve” (McCollough, 2011). The fear was that the technologies would become a prescriptive part of the environment and that the smart city would never adapt to new technologies or uses.

Further Research

When designing for an urban system there are a series of relationships that must be accounted for. As mentioned earlier, some of these represent relationships that exist in a mutually exclusive state where an increase in one necessitates a decrease in others. While not all relationships behave in this manner, many do. Below are some of the relationships observed both qualitatively and qualitatively throughout the design investigation.

It is important to further understand the relationships between the various metrics. Of specific interest are those identified in the ‘iron triangle’ of land use (density, food production and water power) generally. This method is understood conceptually due to all three being related and having the potential to be increased through one the other. The conceptual understanding needs to be advanced to a quantitative representation so that the designer can then be trained to select a value within the trilemma as a starting position. From this starting point the planner is able to design around a specific set of values of food, water power and density that can then be used to create robots or sets of zones, which taken together have performance that approach the net zero goal.

The understanding of these trade-offs and their connections to design is critical as computational and machine learning approaches require clear examples in order to be trained effectively. This requires working backwards from an existing design to its representation within a given relationship set, such as those mentioned above. This means putting a building or development and being able to trace back through the design to the original performance goals through both the current performance metrics of the final form and from analysis of design documents (drawings, etc.)

Figure 11. Metrics Relationship Model

Situational Typologies

of experiences provided by the space and the technologies needed to create those situations.
Conceptual Design

Producing a design that is truly conceptual is a non-linear process. It involves research, iteration, critique, revision, and collaboration. As is often the case in design, the metric of success is not productivity alone; it is sensitivity and decision-making based on an infinitely large set of criteria. The task of the Conceptual Design (CD) team was to find a process that distilled the most important of these criteria into an attainable set of goals for the smart development of Urawa Misono.

To help kick off this process, the CD team initiated a charrette - a visioning exercise in which members of the entire studio share their knowledge and opinions about the project. The resulting information was extremely valuable, but was tangled up in sketches, diagrams, and scribbled text. To make sense of it all, the project leaders and the CD group organized the information into three major categories, informed by a reading by Carl Steinitz: Organization, Expression, and Allocation. With this organizational tool, the team was able to categorize the major drivers of the development and begin to form design investigations.

The next step in the conceptual design process was to complete a series of design investigations based on the inputs from the first phase. Three investigations by small groups explored three different sets of ideas. The first design investigation (CD-1) focused on transit-oriented development, a central green promenade, centrally concentrated density, and walkability. The second design investigation (CD-2) explored the implications of density spread through concentrated nodes, linear development patterns, urban metabolism, and agriculture. The third design investigation (CD-3) explored the concepts of widely dispersed density nodes, the city as a Japanese garden, constructed moments of discovery, and winding meditative pathways.

The goal for the midterm (CD-M) was to create a single proposal based on the three design investigations. It was important to not simply design by consensus, but to work collaboratively to bring out the best of all three investigations. For this process to be successful, team members had to be self-critical and open to the ideas of others. For the midterm proposal, the CD group arrived at a design that addressed a wide range of issues relevant to the Urawa Misono smart city development. Along with a rendered master plan, the group produced a set of diagrams which illustrated the key concepts, a 3D model for visualizing the development, as well as an outline of building typologies.

The phase of work that was to be completed in Japan was kicked off with a design workshop with local students from the University of Tokyo. Along with a site visit, this workshop led to fruitful discussions about the local culture and existing site typologies. Once again, the design was iterated (CD-J) and the idea of planning support systems through the implication of performance zoning and the definition of block typologies began to emerge. Each performance zone or block typology had a specific criteria of density and performance, as well as suggested urban context in the form of a matrix of cellular typologies. The cellular typologies are fundamental typological designs that describe the basic performance and geometries of each urban context. Each performance zone is assigned a number of the typological blocks that allow for performance metrics and system-wide impact to be easily and quickly measured by the addition of any design that follows the general scheme of the typology. This output (CD-J) was presented to stakeholders and government officials and feedback was taken into account as the design was reworked into the final concept (CD-F).

After returning to Georgia Tech, the block typologies and the boundaries of the performance zones were refined. These zones were handed off to the Performance Modeling team to analyze and improve. CD then modeled the entire Urawa Misono site following these established block typologies. A comprehensive drawing presentation was to be developed that included - including a large representational drawing and a full set of diagrams to illustrate the major design moves.
The final design (CD-F) takes into account the ideas of transit-oriented development, a central green promenade, urban metabolism, agriculture, constructed moments of discovery, and walkability that were initially established after the first design charrette. There is a lineage that can be traced to the original sketches and concepts.

For the final drawing, it was decided to shift the graphical representation from a 2D master plan view to a 3D axonometric master plan to better express the strong three-dimensional ideas of the raised green promenade and density dispersion. The majority of this axonometric drawing would have simple boxes representing the buildings implemented throughout the site, while key areas around the newly established wetlands and the original train station would have detailed buildings to more clearly show the ideas of the block typologies. The group also produced a set of diagrams to illustrate the key concepts found within the final master plan.

It was extremely desirable to be able to fully illustrate the Smart City ideas established by the SC team within the final conceptual drawing. Therefore, more detailed and human-scaled drawings representing these ideas were added within the axonometric master plan drawing. Moving from left to right on this drawing, the following ideas are more closely illustrated: situational kinetic facades, situational public spaces, pedestrian navigation app, responsive lighting systems, and metabolist inspired public spaces. The Smart City group also developed an app that allows navigation based on preference while also offering incentives to encourage pedestrians to use different routes. This helps to lessen heavy traffic on any one specific path by encouraging users to take longer, more scenic routes in order to claim rewards such as local coupons. Responsive lighting systems are implemented at night where sensors recognize vehicular or pedestrian traffic and enable streetlights to guide their paths. These sensors prevent energy waste when roads are empty while allowing users to feel safe and secure.

The Smart City ideas established by the SC team within the final conceptual drawing. Therefore, more detailed and human-scaled drawings representing these ideas were added within the axonometric master plan drawing. Moving from left to right on this drawing, the following ideas are more closely illustrated: situational kinetic facades, situational public spaces, pedestrian navigation app, responsive lighting systems, and metabolist inspired public spaces. The Smart City group also developed an app that allows navigation based on preference while also offering incentives to encourage pedestrians to use different routes. This helps to lessen heavy traffic on any one specific path by encouraging users to take longer, more scenic routes in order to claim rewards such as local coupons. Responsive lighting systems are implemented at night where sensors recognize vehicular or pedestrian traffic and enable streetlights to guide their paths. These sensors prevent energy waste when roads are empty while allowing users to feel safe and secure.

The main train station was inspired by metabolist ideas of layering public spaces. The highest layer, the green promenade, is located atop the train station and serves multiple purposes including information sharing, game playing, and connectivity. Users at these bus stops can play games, win prizes, or get directions to other bus stops to pass time. This interactive option also offers safety and company during their wait.

Recommendations

The final recommendations regarding conceptual design for the government officials and stakeholders of Urawa Misono Smart City include the implementation of two major ideas on the site. The first is infrastructure changes – changing grey infrastructure to green infrastructure. These changes allow for the same amount of capacity while creating a better experience within the city. The green promenade in particular improves public experience and creates a sense of place at the functional core of Urawa Misono. The implemented ideas of metabolism create a sense of co-location with layers of train station, green promenade, shopping, and parking all located within the most central part of the city. The other major move is the planning support system that creates a framework for smarter development in terms of design, experience, and...
Final Axonometric Drawing with Smart City Illustrations
Proposed Smart City Systems for Urawa-Misono

SITUATIONAL KINETIC FACADES

Kinetic facades have the ability to open or close based on the amount of sunlight a building receives. They also have the ability to fold down onto tracks on the ground to form hard paving, tables, or chairs within the public courtyard.

On game days, this land can be used for parking, but on normal days in which parking is not in demand, smart sensors in the light posts can turn this space into a public amenity.

SITUATIONAL PUBLIC SPACES

PEDESTRIAN NAVIGATION APP

The app developed for Urawa Misono allows navigation based on preference while also offering incentives to encourage pedestrians to use different routes. This helps to lessen heavy traffic on any one specific path by encouraging users to take longer, more scenic routes in order to claim rewards such as local coupons.

RESPONSIVE LIGHTING SYSTEMS

Smart street lights are implemented at night where sensors recognize vehicle or pedestrian traffic and enables street lights to guide their path. These sensors prevent energy waste when roads are empty while allowing user to feel safe and secure.

METABOLIST INSPIRED PUBLIC SPACES

The main train station was inspiration by metabolism ideas of layering public spaces. The highest layer, the green promenade, is located atop the train station and offers a public amenities to city-goers even in the densest section of the city. Some shops and buildings are located at this level and many more are located on the lower street level. Parking is hidden beneath the promenade and shops.

INTERACTIVE INFRASTRUCTURE

Interactive bus stops serve multiple purposes including information sharing, game playing, and connectivity. Users at this bus stop can play games with users waiting at others bus stops to pass time. This interactive option also offers safety and company during their wait.
Sustainability Certification

The scope of this studio’s work, scale of the project site, and variety of mechanisms and frameworks at play require a comprehensive overview tool. Because the intent of the studio is to provide a fully functional model for Urawa Misono, an assessment tool will help define a set of benchmarks and determine final priorities. The most reasonable solution was to pursue one of the many sustainable development certification programs. This certification was used as a starting point for the broader analyses conducted by the studio.

CASBEE

The Comprehensive Assessment System for Built Environment Efficiency (CASBEE) is a method for evaluating and rating the energy performance of buildings and the built environment. CASBEE was developed in 2001 through the collaboration of academia, industry and national and local governments. It offers a comprehensive assessment focused on the quality of buildings and the built environment. CASBEE for cities is intended as a policy evaluation tool that serves as a guideline and a starting point for the broader analyses conducted by the studio.

For the studio was to reach LEED Platinum. This certification was used as a starting point for the broader analyses conducted by the studio.

CASBEE for Cities is the large scale performance evaluation tool, using a triple bottom-line approach of “environment,” “society” and “economy.” CASBEE for Cities compares the current built environment efficiency to the projected future efficiency after policy implementation. By comparing the two values, CASBEE for Cities is measured as a tool of the effectiveness of city policies.

CASBEE originated in Japan and therefore has a strong foothold. In fact, CASBEE for Cities is intended as a policy tool not necessarily as a plan for the site, and variety of mechanisms and frameworks at play require a comprehensive overview tool. Because the intent of the studio is to provide a fully functional model for Urawa Misono, an assessment tool will help define a set of benchmarks and determine final priorities. The most reasonable solution was to pursue one of the many sustainable development certification programs. This certification was used as a starting point for the broader analyses conducted by the studio.

LEED

LEED, or Leadership in Energy and Environmental Design, is a framework for identifying, implementing, and measuring green building and neighborhood design, construction, operation, and maintenance. LEED was developed by the U.S. Green Building Council, but has gained a strong international foothold. In fact, LEED is the most widely used third-party verification for green buildings, with around 1.85 million square feet being certified daily.

LEED emphasizes integrated design, integration of existing technology, and state-of-the-art strategies to advance expertise in green building and transform professional practice. LEED has four levels of certification, depending on the point thresholds achieved: Certified (40–49), Silver (50–59), Gold (60–79), Platinum (80+). There is greater nuance in scoring, and even a lower point value may prove valuable if it reflects the greater development priorities of an area.

LEED is a voluntary, market driven, consensus-based tool that serves as a guideline and assessment mechanism. While CASBEE and LEED share similar goals, LEED has a stronger foundation in real estate development principles. LEED for Neighborhood Development (LEED ND) is the large scale certification program. All LEED programs offer plan and development options, making it a useful financing tool as certification can happen prior to construction.

The final LEED ND Plan assessment shows a preliminary Platinum certification assuming all recommendations are implemented.

Green Bonds

A green bond is a tax-exempt bond issued by federally-qualified organizations or municipalities for the development of brownfield sites. Green Bond issuers often evaluate construction and real estate projects based on the certification under a recognized environmental or building rating system. Buildings are classified into levels of certification, and the ones that certify under certain point thresholds are recognized as green buildings.

There are several criteria that define a green building. These include: energy efficiency, water conservation, air quality, indoor environmental quality, and use of environmentally preferable products.

The effective use of green bonds can help to finance the development of brownfield sites. These bonds can be used to fund specific projects such as those that promote energy efficiency, water conservation, and the use of sustainable materials.

Green bonds are becoming increasingly popular as a financing tool for sustainable infrastructure projects. They provide an opportunity for organizations to raise capital with an environmental or social focus.

Green bonds can help to accelerate the development of brownfield sites by providing a more predictable and stable source of funding. This can lead to faster project completion times and reduced development costs.

Green bonds can also help to increase investment in sustainable infrastructure projects. By offering a higher yield than traditional bonds, green bonds can make these projects more attractive to investors.

Green bonds can be a valuable tool in efforts to develop and rehabilitate brownfield sites. By providing a dedicated source of funding, green bonds can help to overcome some of the funding challenges that are often associated with these projects.

Green bonds are a promising tool in the effort to finance sustainable infrastructure projects. By offering a combination of environmental, social, and financial benefits, green bonds can help to accelerate the development of brownfield sites and support broader efforts to improve sustainability.
Our performance metrics were initially determined by the criteria outlined by LEED-ND. Our intention was to use these metrics as minimum standards and exceed them with the throttleable goals of designing net-zero community. From LEED-ND, we determined that we would measure food, energy and water consumption and production, as well as thermal comfort, to create a self-sufficiency ratio and understand our site’s performance. Through modeling we determined that while the community could not be designed as net-zero from the onset, we developed a set of recommendations for the Urawa-Misono stakeholders to consider to pursue a net-zero or net-positive carbon future. On a human scale, with assistance from our colleagues at the Eco Urban Lab at Tongji University, we explored the thermal comfort on our designs. Through these metrics, we are able to understand various factors that affect the comfort of people in a space.

Net-Zero as an Iterative, Collaborative Process

From researching case studies of attempts to create net-zero communities, we determined a process that could move communities towards a carbon-neutral future. Figure 2 shows net zero as an iterative, and collaborative process. While the scope of our studio was establishing the performance zone standards, as well as thermal comfort, to create a self-sufficiency ratio and understand the comfort of people in a space. Through modeling we determined that while the community could not be designed as net-zero from the onset, we developed a set of recommendations for the Urawa-Misono stakeholders to consider to pursue a net-zero or net-positive carbon future. On a human scale, with assistance from our colleagues at the Eco Urban Lab at Tongji University, we explored the thermal comfort on our designs. Through these metrics, we are able to understand various factors that affect the comfort of people in a space.

Net-Zero as a Community and LEED-ND

Energy, Food, Water & Thermal Comfort

Performance Zoning & Thermal Comfort

Performance Zoning Variation

Theme 1: Centralization
Agglomeration of land use and functions focused on increasing density and height in the aim of generating better energy performance across blocks.

Theme 2: Decentralization
Minimization of entrapped (courtyard) open spaces to promote inter block air flow testing whether it improves the quality of life experientially and qualitatively from the human comfort perspective. Does increasing the ratio of open (green) space enhance comfort?

Theme 3: Linear
Two types of linear relationships will be studied through the exploration of the theme. (1) Typologies 1 and 2 are focused on increasing building proximity and density in the aim of generating better energy performance across blocks. (2) Typologies 3, 4, and 5 examined the sector that will be impacted - commercial, residential, transportation and clear scoping of these actions (i.e. bicycle parking, pedestrian walkways, etc.).

Recomendations

From the results in thermal comfort, the linear typology variation performed the best. As previously discussed, the typology is characterized by a linear gradient of building heights from one side of a block to another. A simple finding from this analysis was the impact of tall buildings’ on thermal comfort - an increase in shade and wind speed creates an unpleasant environment. This needs to be taken into account when designing the densest areas of Urawa Misono.

Performance Zoning Variation

Each block typology has a unique FAR that must remain constant throughout theme variations. What changes between each iteration is the distance between buildings, closeness of the amount of entrapped open space, enclosure, and the heights of buildings.
LEED-ND
LEED-ND performance is based on our ability to optimize building energy performance on site. Our evaluation, in relation to energy performance, is rated based on Solar Orientation, Renewable Energy Production, District Heating and Cooling, Infrastructure Energy Efficiency and Light Pollution Reduction. Our team’s energy reduction techniques are established to be performed differently at each of the three tiers of the design. In Tier 1 we would rely on household contribution to the district energy plan, encouraging energy reduction through incentives. Tier 2 looks at network system energy reduction, and the larger accumulated effects of energy. Tier 3 involves the whole system approach, directing large scale infrastructure changes to adapt current site conditions for reduction of energy needs with more permanent changes in mind.

Energy Consumption
Energy consumption, for our purposes, is determined through a summation of the four major consuming components of energy that would have the most effect on the achievement of a Net-Zero community: heating, cooling, lighting, and equipment loads. A direct comparison of the level of consumption for each typology variation helped to determine the least consuming block, which then allowed us to develop form based solutions designed to reduce energy demands on site. Our aggregated design approach does require this block analysis eventually to be supplemented by a site energy analysis periodically as the site grows and more energy efficient blocks are added or adapted. These two sets of results would provide us with a fuller picture of the effect of these blocks when grouped together in a network.

Energy Production
In order to receive LEED-ND credit, a certain percentage of energy loads must be provided by renewable energy. We initially planned on expanding our portfolio to various types of renewable in place in Japan (wind, geothermal), but determined they were not currently feasible on our site. Subsequently, we focused on rooftop solar capture due to the policy precedent that exists in Saitama City, and the presence of rooftop solar in Urawa-Misono. Through analyzing the typologies and their variations, they are able to understand which typologies perform best in regards to rooftop solar capture (Figure 13). However, our design recommendations are based on consideration of the trade-offs between rooftop solar and energy consumption.

Energy Self-Sufficiency
Energy self-sufficiency is a measure of the net energy gain on site measured here on the form of each typology variation. Within each typology, self-sufficiency is rated to determine the most and least reliant block formation. Inter-typology comparisons may be made to determine the best means of aggregating the typologies throughout the site. Our comparative analysis of solar gain to energy consumption indicated an indirect effect of form based solar orientation. Designers may use this information to determine the best means of aggregating the typologies throughout the site, balancing energy performance on site to achieve a more resilient community.

Figure 12. Solar radiation results (typologies with the best photo voltaic capture are outlined in black)

Figure 13. Solar radiation results (typologies with the best photo voltaic capture are outlined in black)

Figure 14. Calculation of PV capture and consumption for self-sufficiency ratio

Recommendations
Our studies looked at the effect of form on energy resilience, and specifically observed the effect of BCR changes while maintaining a constant FAR. While holding FAR constant, BCR showed an inverse effect on energy gains and consumption, with increases in BCR improving photo voltaic capture and decreases reducing energy consumption. Other modifications designed to improve the resilience of our development consider the trade-off relationship between energy conditions. Compact shapes with limited height variations reduce thermal gains while limiting obstruction to photo voltaic potential. Maintaining density while varying building heights increases shading, relieving required condition. BCR increase of cluster of buildings improves photo voltaic potential though also increases energy consumption. Improvements in building form, thermal mass, and envelope insulation contributed to more energy efficient building.

Table 1. LEED-ND analysis for annual energy consumption and production

<table>
<thead>
<tr>
<th>Typology</th>
<th>FAR</th>
<th>BCR</th>
<th>Annual Solar Production (kW)</th>
<th>PV Capture (kW)</th>
<th>Annual Energy Consumption (kW)</th>
<th>Self-Sufficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theme 1</td>
<td>3.97</td>
<td>0.2</td>
<td>7,050,404</td>
<td>796,960</td>
<td>7,847,364</td>
<td>10.03%</td>
</tr>
<tr>
<td>Theme 2</td>
<td>3.98</td>
<td>0.65</td>
<td>8,152,725</td>
<td>725,593</td>
<td>7,990,869</td>
<td>9.13%</td>
</tr>
<tr>
<td>Theme 3</td>
<td>0.4</td>
<td>6,078,006</td>
<td>772,342</td>
<td>7,151,857</td>
<td>10.06%</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. LEED-ND analysis for annual energy consumption and production

<table>
<thead>
<tr>
<th>Typology</th>
<th>FAR</th>
<th>BCR</th>
<th>Annual Solar Production (kW)</th>
<th>PV Capture (kW)</th>
<th>Annual Energy Consumption (kW)</th>
<th>Self-Sufficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theme 1</td>
<td>0.04</td>
<td>12,070,597</td>
<td>932,196</td>
<td>11,207,397</td>
<td>9.11%</td>
<td></td>
</tr>
<tr>
<td>Theme 2</td>
<td>0.4</td>
<td>7,479,161</td>
<td>470,073</td>
<td>8,049,235</td>
<td>35.06%</td>
<td></td>
</tr>
</tbody>
</table>
Indoor Consumption

Aim 1: Building Water Efficiency - use 40% less water than baseline buildings (1 point)

The paper "Study on water conservation by water saving fixtures." conducted by the University of Tokyo investigated the water savings in residences by switching to water efficient fixtures. (Kondo, Viwamoto, Ichikawa & Kamata, 2006). Their findings have been summarized in the table in Figure 15. From this study, we can estimate that by installing water saving fixtures, water consumption (in combination) can be reduced by 44%.

Figure 15. Water consumption and savings estimates

Aim 2: Wastewater Management - retain on-site at 25% of the average annual wastewater generated by the project, and reuse that wastewater to replace the use of potable water (1 point)

The electricity required for unportable wastewater treatment on our site was estimated using a comprehensive literature review of wastewater treatment by Bodik and Kubaska (2013). Unfortunately, even with this reduction, the self-sufficiency ratio did not improve.

Figure 17. Proposed stormwater management measures (location of cisterns in marked in grey)
The preliminary purpose of this exercise is to model the amount of food required by the community and evaluate how much of that can be cultivated on site. Our secondary concern is that our proposal displaces current agricultural land use. Hence the farmers and landowners must be compensated in some way.

Food in the Context of Misono

The land use on site is predominantly agricultural. Any development will inevitably displace the current agricultural yield on site. Additionally, the influx of large population will result in a higher food demand. In response to this, the project’s goal is to cultivate the fresh produce consumed by the community on site.

Given the urban constraints, the project’s goal is to cultivate only 33.6% of the food consumed in a typical Japanese diet. The projected population of the community is 32,000 members. Annual consumption of fresh produce per person (based on the national nutrition survey) is 198 kg. Hence the entire community requires 6,322,384 kg fresh produce per year.

Convention Production

Raising awareness of sustainability and food systems is increasing integration of agriculture in urban areas. Highly dense urban areas, agriculture often manifests as community farms, commercial or institutional farms and community gardens. These newer typologies have the additional benefits of being therapeutic, engaging, promote physical activity, community cohesion, entrepreneurship in addition to providing fresh food and reducing energy spent on transportation.

“A well-maintained food garden can yield an estimated ½ pound of produce per square foot of garden area over the course of the growing season” (National Gardening Association 2014). This translates to 2.44 kg per meter square of area. Such an yield compares poorly to industrial output. For instance only if 90% of the entire site of 3 square km will there be sufficient fresh food available for a year.

Improving Production with Vertical Farming

Arable land is also finite, the need to minimize the negative environmental effects of agriculture, particularly with regard to greenhouse gas emissions, soil degradation and the protection of already dwindling water supplies and biodiversity arises. Vertical Farming holds the promise of addressing these issues by enabling more food to be produced with less resources use.

The advantages of this method are the multiplication of agriculturally productive land (by growing in vertically stacked food gardens), the increase in crop yields (by using optimized production methods, such as light exposure variations, or additional CO2 supply), the protection of the crops from weather-related problems as well as pest and diseases (as opposed to outdoor farming), and the minimization of water requirements (through water recycling) (Banerjee and Adenauer 2014).

Vertical Farming

The design is adopted from the “The economics of vertical farming” research paper published by Macrothink Institute and Institute for Food and Resource Economics at the University of Bonn. The study was stimulated in Berlin, Germany. A vertical farm of 900,000sqm with a total of 37 floors, 25 of them solely for the purpose of crop production and 3 for aquaculture. Further, 3 uniformly distributed floors are for environmental regulation and 2 in the basement for waste management. In addition there is one floor for cleaning of the growth trays, one floor for packing and processing the plants and fish and one for sales and delivery at the basement.
The observations of the existing mobility facilities were enhanced for the availability of Person Flow Data from the Saitama Railway. Future investment in performance-based zoning, denser land use typologies, and expanded transit options could aid in reducing the reliance on vehicular travel to the surrounding area and for game day visitors to Saitama Stadium.

Saitama Stadium game day traffic and parking

While there is a large stadium, there is still heavy amounts of vehicular traffic entering and leaving the stadium. The congestion was experienced by the design studio team while visiting Misono and is apparent in the travel demand modeling developed for this project. These issues are due to the auto-dependency of the area around the expressway and is a challenge that could be better managed by more trips to Tokyo utilizing the Saitama Railway.

Misono is an auto-oriented and suburban environment. Data obtained from the study area, the land use typologies, and the existing road network shows that the projected growth in the area will be auto-oriented and not fully utilize the access to the Saitama Railway. Future investments in performance-based zoning, denser land use typologies, and expanded transit options could aid in reducing the reliance on vehicular travel to the surrounding area and for game day visitors to Saitama Stadium.

Saitama Stadium as the biggest attractions. Even though the last station of the Saitama Railway is located in the stadium, the road network is heavily congested during the peak hours of travel. The road network is dense and includes multiple east-west and north-south arterial roads connecting the study area to the adjacent Tohoku Tollway, and surrounding cities of Saitama City to the west, Itabashi to the north, Koganei to the east, and Higashikawaguchi to the south. The arterials are built for a city exceeding Misono's current density, thus the road network is not fully utilized around the stadium. The congestion was experienced by the design studio team while visiting Misono and is apparent in the travel demand modeling developed for this project. These issues are due to the auto-dependency of the area around the expressway and is a challenge that could be better managed by more trips to Tokyo utilizing the Saitama Railway.

Figure 21. Saitama Stadium game day traffic and parking

Existing external road network is overbuilt for current and future travel patterns. Limited investment in performance-based zoning. The western neighborhood of Saitama Prefecture with the existing Aeon Mall and Saitama Stadium as the biggest attractions.

The mobility group tested the accessibility of Misono relative to other station areas on this line. Figure 21 shows this comparison between the Misono ID, trip ID, longitude, latitude, gender, age, purpose, time of day, and different classifications of data. The observations of the existing mobility facilities were enhanced for the availability of Person Flow Data from the Saitama Railway. Future investments in performance-based zoning, denser land use typologies, and expanded transit options could aid in reducing the reliance on vehicular travel to the surrounding area and for game day visitors to Saitama Stadium.

The observations of the existing mobility facilities were enhanced for the availability of Person Flow Data from the Saitama Railway. Future investments in performance-based zoning, denser land use typologies, and expanded transit options could aid in reducing the reliance on vehicular travel to the surrounding area and for game day visitors to Saitama Stadium.

Saitama Railway is the primary access to the Saitama Railway. The road network is dense and includes multiple east-west and north-south arterial roads connecting the study area to the adjacent Tohoku Tollway, and surrounding cities of Saitama City to the west, Itabashi to the north, Koganei to the east, and Higashikawaguchi to the south. The arterials are built for a city exceeding Misono's current density, thus the road network is not fully utilized around the stadium. The congestion was experienced by the design studio team while visiting Misono and is apparent in the travel demand modeling developed for this project. These issues are due to the auto-dependency of the area around the expressway and is a challenge that could be better managed by more trips to Tokyo utilizing the Saitama Railway.

Figure 21. Existing Road Network (Road Hierarchy)

Saitama Stadium game day traffic and parking

While there is a large stadium, there is still heavy amounts of vehicular traffic entering and leaving the stadium. The congestion was experienced by the design studio team while visiting Misono and is apparent in the travel demand modeling developed for this project. These issues are due to the auto-dependency of the area around the expressway and is a challenge that could be better managed by more trips to Tokyo utilizing the Saitama Railway.

Figure 21. Existing Road Network (Road Hierarchy)

Saitama Railway is the primary access to the Saitama Railway. The road network is dense and includes multiple east-west and north-south arterial roads connecting the study area to the adjacent Tohoku Tollway, and surrounding cities of Saitama City to the west, Itabashi to the north, Koganei to the east, and Higashikawaguchi to the south. The arterials are built for a city exceeding Misono's current density, thus the road network is not fully utilized around the stadium. The congestion was experienced by the design studio team while visiting Misono and is apparent in the travel demand modeling developed for this project. These issues are due to the auto-dependency of the area around the expressway and is a challenge that could be better managed by more trips to Tokyo utilizing the Saitama Railway.

Figure 21. Existing Road Network (Road Hierarchy)
Mobility

Compactness Analysis

Compact development refers to the development utilizing land efficiently through creative and intensive site, neighborhood, and district designs. Density relates to compactness and promotes more effective use of all mobility modes and urban systems. Compactness in design is likely an attribute that could positively impact energy usage as well.

Green Space Analysis

Green space, in this context, refers to urban open space in the study area that is utilized for parks and other open areas. The landscape of urban open spaces can range from playing field to highly maintained environments to relinquished natural landscapes. The proposed green central promenade is a significant green space in the CD-F design that impacts the compact environment around it. The proposed redistribution of water retention into the plan through application of contrasting network models.

Alteratives Analyses

As described, quantitative analyses were completed for the initial CD-M design and the final proposed CD-F design. Once the CD-F design was completed, the design was aggregated into three alternatives. The three alternatives are made up of a baseline design and two major design and policy decisions that could substantially impact the mobility and travel demand of the study area. The three alternatives are further described below.

Alternative 1

Alternative 1 is the baseline CD-F design described previously. The plan is focused on using the existing transportation facilities and optimizing mobility and energy. Major improvements included in the plan include increasing the density of the road network, improving the walkability by developing with higher building density and more efficient road networks, and by creating better access to the proposed central promenade of the train station and Saitama Stadium.

Alternative 2

Alternative 2 proposes changes to the baseline CD-F design by relocating the retail usage currently located within the Aeon Mall into the proposed CBD. The existing Aeon Mall parcel could be redeveloped into additional green space or residential. Removing the mall has been mentioned as a possible alternative by the local government and may aid in mitigating congestion. The retail in the CBD would likely influence mobility patterns to favor transportation modes other than the single-occupancy vehicle.

Alternative 3

Alternative 3 proposes a new train station north of Saitama Stadium. The train station north of the stadium would create another opportunity for a Transit Oriented Development and could aid the local government in attracting additional high-tech office tenants. While the congestion that is currently created by the Aeon Mall will still likely be present, the additional train station on CD-F could still increase the station's utility in multimodal usage. The additional train station would further activate the area north of the stadium and create a new employment center within the study area.
Walkability Analysis

Currently, Urawa-Misono is an auto-oriented city. The road infrastructure in place is insufficient to accommodate the target population of 32,000 residents. Given the current dominance of car-dependent as well as road infrastructure that can perpetuate this trend, the achievement of a walkable city greatly relies on how successfully the city can reduce car trips and promote active modes of transport such as walking. Improving walkability may also promote the use of public transit, an important part of sustainable mobility.

In doing so, the design of the built environment can play an important role. The way facilities and streets are designed determines the distance one needs to travel to access daily destinations (i.e., grocery store, bank, or transit station) and how well streets are connecting these destinations. In other words, proximity and connectivity are important factors (Saelens, Salis, and Frank, 2003) to keep in mind when designing for a walkable future of Urawa-Misono.

Walkability Analysis Results

The Composite Walkability Index is used to measure the walkability level in the site. The index consists of a Walkability Analysis, Land Use Diversity, and Recommendations.

Alternative 1

Composite Walkability Analysis

The composite walkability map shows Misono’s most walkable area surrounding the station because there is a highly diverse land use mix and denser streets. Future long-range designs should address poor pedestrian connectivity in the north and part of the eastern areas.

Reach Analysis

Reach analysis calculates the number of buildings that are reachable within 400 meters of network distance. The histogram below shows a normal distribution. This indicates most of the buildings are within easy access.

The histogram below shows a normal distribution. Reach analysis calculates the number of buildings that are reachable within 400 meters of network distance. The histogram below shows a normal distribution. This indicates most of the buildings are within easy access.

Alternative 2

Composite Walkability Analysis

The composite walkability map shows Misono’s most walkable area surrounding the station because there is a highly diverse land use mix and denser streets. Future long-range designs should address poor pedestrian connectivity in the north and part of the eastern areas.

Reach Analysis

Reach analysis calculates the number of buildings that are reachable within 400 meters of network distance. The histogram below shows a normal distribution. This indicates most of the buildings are within easy access.

The histogram below shows a normal distribution. Reach analysis calculates the number of buildings that are reachable within 400 meters of network distance. The histogram below shows a normal distribution. This indicates most of the buildings are within easy access.

Alternative 3

Composite Walkability Analysis

The composite walkability map shows Misono’s most walkable area surrounding the station because there is a highly diverse land use mix and denser streets. Future long-range designs should address poor pedestrian connectivity in the north and part of the eastern areas.

Reach Analysis

Reach analysis calculates the number of buildings that are reachable within 400 meters of network distance. The histogram below shows a normal distribution. This indicates most of the buildings are within easy access.

The histogram below shows a normal distribution. Reach analysis calculates the number of buildings that are reachable within 400 meters of network distance. The histogram below shows a normal distribution. This indicates most of the buildings are within easy access.

Travel Demand Model Overview

Travel demand modeling was completed as a tool to understand how the vehicular road network will function in the future after the proposed new development is completed. Four-step travel demand modeling was utilized to estimate the overall transportation network performance in relation to the density distribution and total floor area across the whole site. The four-step model and PTV Vissim software were utilized to perform the travel demand modeling.

As mentioned, there is currently congestion being experienced on the external road network; however, the newly constructed internal road network has a low demand and a substantial amount of available road capacity. The traffic volume data available for this analysis was minimal; so assumptions were made for existing traffic volumes and verified with an initial run of the Vissim model.

The four-step model is made up of the following steps: Trip Generation, Trip Distribution, Mode Split, and Trip Assignment. The data collection and analysis for each of these model steps are described below. However, the Trip Assignment is initiated by the Vissim model and needs no further discussion.

Trip Generation

The trip generation, or the number of trips the new development is expected to attract, was developed for each of the proposed development zones in the study area. The total floor area in each performance zone for the projected uses was calculated for the trip generation. Based on each land use type and the total floor area, regression equations from previously completed Governor of Transportation Engineers studies were utilized to the data of each land use type. The results of these previous studies are based on American trip generation expectation; therefore, they are considered to be conservative estimates in Japan.

Mode Split

Like the Trip Distribution, the Mode Split is based on the person flow data. As stated, the person flow data used for this study was the Aeon shopping mall. The existing trips are using vehicular modes. These mode split values were used as a conservative estimate; however, in the alternatives the mode split was projected based on land use assumptions and on the goals of higher modal trips in the study area and more specifically, the performance zones impacted by the design changes in each of the alternatives.

Figure 25. Composite Walkability for Alternative 1

Figure 26. Reach Analysis for Alternative 1

Figure 27. Walkability Analysis for Alternative 1

Figure 28. Composite Walkability for Alternative 2

Figure 29. Composite Walkability for Alternative 3

Figure 30. Trip Distribution

Figure 31. Mode Split

Figure 32. Trip Distribution

Figure 33. Mode Split
Recommendations

Based on the qualitative review and quantitative analyses described above, the mobility group recommends the following steps for the community to meet goals set forth by UDCMi for each of the following major transportation modes.

Roadway

- To continue to monitor the congestion within the study area as the community grows to identify roadways that are underutilized and that may be candidates for road diets to provide more right-of-way for pedestrian and bicycle uses.
- To develop a parking strategy that uses smart technology for demand-oriented parking costs during games at Saitama Stadium and that located parking near the existing tollway.
- Plan for an extension of the Saitama Railway north to Iwatsuki as a long-term investment.
- To develop a parking strategy that uses smart technology for demand-oriented parking costs during games at Saitama Stadium and that located parking near the existing tollway.

Pedestrian/Bicycle

- To extend the Saitama Railway an additional station north of Saitama Stadium in the short-term.
- To develop a more walkable, dense activity center on both sides of the river.
- To continue to monitor the walkability of the study area as the area redevelops.

Transit

- To plan for a more transit-oriented, walkable area that minimizes the need for further roadway investments, outside of general maintenance.
- To continue to monitor the walkability of the study area as the area redevelops.

Overall

- To develop a more walkable, dense activity center on both sides of the river.
- To continue to monitor the walkability of the study area as the area redevelops.

Mobility

To simulate and analyze the traffic flow of game day conditions, several traffic simulation models were developed using PTIVis 9 to investigate the existing challenges. PTIVis is a traffic modeling software which provides flexibility in the concept of time and connectors allowing users to model geometries with any level of complexity. Vissim provides internal functions for the flow of automobiles, truck and pedestrian, as well as various settings for different road environments.

The first model is based on the current road conditions. The input traffic volume is estimated game day volume. The input vehicle type and proportion are adjusted by 2015 weekday Tokyo traffic report and lower limits. The two worst congestion areas of the model are shown above. The entrance and exit of Iwatsuki Highway have severe congestion with long queues. The results from the simulation indicate that the longest queue time could be 10 minutes or more.

Alternative 1 shows acceptable traffic conditions during the AM peak period, with traffic volume distributed evenly throughout the site. The noticeable congestions occur at the new station stays consistent with Alternative 1. Nevertheless, by adding the second station, there is an increase in the proportion of transit in the mode split of the area. Therefore, the traffic condition around the new station stays consistent with Alternative 1.

Alternative 2 extends the railway to the north of the stadium and proposes a new station in the area. As stated, this new station would attract a new job center and would increase the amount of trips traveling to and from the study area. The results show that there are more congestions in the road network, because the new station is adding more traffic to the whole network. Nevertheless, by adding the second station, there is an increase in the proportion of transit in the mode split of the area. Therefore, the traffic condition around the new station stays consistent with Alternative 1.

Alternative 3 shows the analysis with removal of the mall, relocating the retail into the CBD area. As is shown in the results, the traffic congestion in Alternative 1 is significantly improved in Alternative 3 because by relocating the mall, the original site generates less vehicle trips, and more people will go shopping in the CBD area using transit. Just stated, this new station would attract a new job center, and from the study area. The results show that there will influence residents and visitors to take different modes of transportation and likely reduce automobile dependency in the study area.

Vissim Model Analysis

To simulate and analyze the traffic flow of game day conditions, several traffic simulation models were developed using PTIVis 9 to investigate the existing challenges. PTIVis is a traffic modeling software which provides flexibility in the concept of time and connectors allowing users to model geometries with any level of complexity. Vissim provides internal functions for the flow of automobiles, truck and pedestrian, as well as various settings for different road environments.

The first model is based on the current road conditions. The input traffic volume is estimated game day volume. The input vehicle type and proportion are adjusted by 2015 weekday Tokyo traffic report and lower limits. The two worst congestion areas of the model are shown above. The entrance and exit of Iwatsuki Highway have severe congestion with long queues. The results from the simulation indicate that the longest queue time could be 10 minutes or more.

To simulate and analyze the traffic flow of game day conditions, several traffic simulation models were developed using PTIVis 9 to investigate the existing challenges. PTIVis is a traffic modeling software which provides flexibility in the concept of time and connectors allowing users to model geometries with any level of complexity. Vissim provides internal functions for the flow of automobiles, truck and pedestrian, as well as various settings for different road environments.

To simulate and analyze the traffic flow of game day conditions, several traffic simulation models were developed using PTIVis 9 to investigate the existing challenges. PTIVis is a traffic modeling software which provides flexibility in the concept of time and connectors allowing users to model geometries with any level of complexity. Vissim provides internal functions for the flow of automobiles, truck and pedestrian, as well as various settings for different road environments.

The first model is based on the current road conditions. The input traffic volume is estimated game day volume. The input vehicle type and proportion are adjusted by 2015 weekday Tokyo traffic report and lower limits. The two worst congestion areas of the model are shown above. The entrance and exit of Iwatsuki Highway have severe congestion with long queues. The results from the simulation indicate that the longest queue time could be 10 minutes or more.

Vissim Model for the Stadium Area

To simulate and analyze the traffic flow of game day conditions, several traffic simulation models were developed using PTIVis 9 to investigate the existing challenges. PTIVis is a traffic modeling software which provides flexibility in the concept of time and connectors allowing users to model geometries with any level of complexity. Vissim provides internal functions for the flow of automobiles, truck and pedestrian, as well as various settings for different road environments.

To simulate and analyze the traffic flow of game day conditions, several traffic simulation models were developed using PTIVis 9 to investigate the existing challenges. PTIVis is a traffic modeling software which provides flexibility in the concept of time and connectors allowing users to model geometries with any level of complexity. Vissim provides internal functions for the flow of automobiles, truck and pedestrian, as well as various settings for different road environments.

To simulate and analyze the traffic flow of game day conditions, several traffic simulation models were developed using PTIVis 9 to investigate the existing challenges. PTIVis is a traffic modeling software which provides flexibility in the concept of time and connectors allowing users to model geometries with any level of complexity. Vissim provides internal functions for the flow of automobiles, truck and pedestrian, as well as various settings for different road environments.

To simulate and analyze the traffic flow of game day conditions, several traffic simulation models were developed using PTIVis 9 to investigate the existing challenges. PTIVis is a traffic modeling software which provides flexibility in the concept of time and connectors allowing users to model geometries with any level of complexity. Vissim provides internal functions for the flow of automobiles, truck and pedestrian, as well as various settings for different road environments.

To simulate and analyze the traffic flow of game day conditions, several traffic simulation models were developed using PTIVis 9 to investigate the existing challenges. PTIVis is a traffic modeling software which provides flexibility in the concept of time and connectors allowing users to model geometries with any level of complexity. Vissim provides internal functions for the flow of automobiles, truck and pedestrian, as well as various settings for different road environments.
The 2017 Urban Design Studio explores how the design, planning, and management of cities can create a resilient urban fabric, flexible enough to accommodate ongoing growth and capable of absorbing inevitable future environmental shocks. The studio used one of 2020 Summer Olympic Sites, Urawa Misono, as a pilot for this approach.

Working with partners at the university, the National Institute for Environmental Studies (NIES) and the Global Carbon Project (GCP) we explored the role of smart city technologies, ecological performance modeling, and third-party sustainability certifications in designing an alternative future for Urawa Misono.

This inter-cultural and interdisciplinary studio process yielded a new vision for performance zoning (originally proposed in the 1980s) as a planning support system (PSS) to enable smarter, more sustainable development over time. Together our final recommendations, listed in the beginning of this report and throughout, are intended to help create an ecologically responsive, disaster-resilient and human-sensing urban environment.

References


Acknowledgements

We would like to thank the many people who contributed to this studio and made it possible.

Georgia Institute of Technology

Perry Yang, Associate Professor, School of City and Regional Planning and School of Architecture; Director, Eco Urban Lab

Eco Urban Lab Research Group

Yuan Wu, Project manager, Eco Urban Lab Shanghai office

Lisa Li, Office manager, Eco Urban Lab Shanghai office

Zhikai Peng, Research Assistant, Eco Urban Lab Shanghai office

Master of City and Regional Planning Program

Robert Binder

Dorothy Galletti

Viviana

Tiernan Zeng

Emma Fuchs

Masako Monone

Ellen Ray

Rehavti Ropinio Veriah

Karinra Bojangula

Briana Kuo

Zachary Langerlader

Gabriel J. Papp

Master of Architecture Program

Paul Stadil

Zachary Hicks

Sean Rencurel

Patricia Samartín

Abigail Aragon

Interactive Design and Digital Media Group

SuBhi Wang, MS student of Interactive Design

Duo-Wei Yang, undergraduates of Computational Media

Haian Xu, undergraduate student of Computational Media

Caylee Vorce, undergraduate student of Computer Science

Academic Studio Reviewers

Ellen Dusham-Jones, Professor, School of Architecture; Director, Urban Design Program

Alan Balfour, Professor Emeritus, School of Architecture

Ellen Dusham-Jones, Professor, School of Architecture, Department of Computing; Director, ACME Lab

Dennis Shames, Associate, Professor of Architecture; Director, Digital Building Lab

Michael Chang, Deputy Director, Brock Byers Institute for Sustainable Systems

Misono UCDMI and Industrial Stakeholders

Yuki Oikomoto, Director, Urban Design Center of Misono

Haruaki Noda, Professor, Department of System Design Engineering, Keio University

Kanaz Matsui, Assistant Professor, Tokyo Denki University

National Institute for Environmental Studies / Global Carbon Project

Yoshiki Yamagata, Director, Global Carbon Project, NIES

Hiroaki Nakai, Professor, Department of System Design Engineering, Keio University

Kanaz Matsui, Assistant Professor, Tokyo Denki University

Ayyoub Sharifi, Executive Director, Global Carbon Project, NIES

Dalitsu Murakami, Post-Doctoral Researcher of NIES

Takahiro Yoshida, PhD Candidate, Tsukuba University

Anaissie Mikladova, PhD Candidate, Sofia University

The University of Tokyo

Akiti Murayama, Associate Professor, Department of Urban Engineering, University of Tokyo, SUAR

Xu Kai, Civil Engineering, Ph.D. student

Michi Nishiyama, Civil Engineering, Master student

Biruktawit Taye, Civil Engineering, Ph.D. student

Tanakorn Sitiaprasit, Civil Engineering, Ph.D. student

Hiroki Baba, Urban Engineering, Ph.D. student

Bindu Shrestha, Civil Engineering, Master student

Germa Yada, Urban Engineering, Master student

Genma Yada, Urban Engineering, Ph.D. student (March 19, 2021)

Ossuaki Manyama, Urban Engineering, Master student

Bryan Tran, Urban Engineering, Intern student

40