GEORGIA INSTITUTE OF TECHNOLOGY - USA

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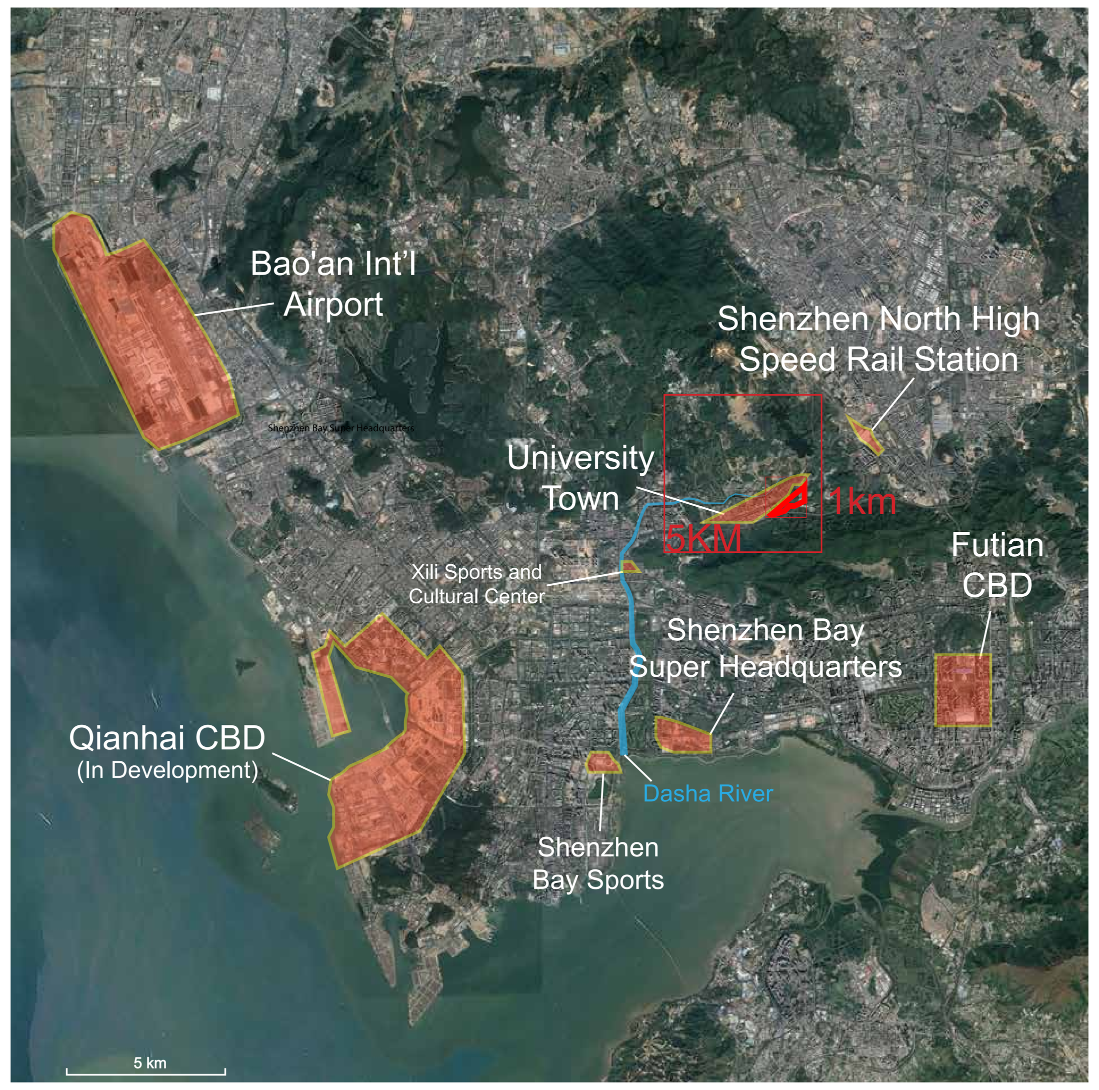


Shenzhen City, with 5km and 1km study areas outlined in red squares.

Existing Conditions: 2020

Sustainability and Resiliency: The campus should be environmentally-conscious and conservation oriented. It will be designed to minimize energy use, water use, and waste production, as well as support effective and efficient stormwater management.

Connectivity and Mobility: The campus should be designed to achieve a safe environment for multimodal transport, primarily walking and biking. Interconnectivity of destinations and ease of access will be of pivotal concern to network and building design. The design will be mindful of the city and the surrounding sites, and it will integrate seamlessly into the Shenzhen network. Space embedded with ICT will help students and faculty connect with counterparts across the globe.

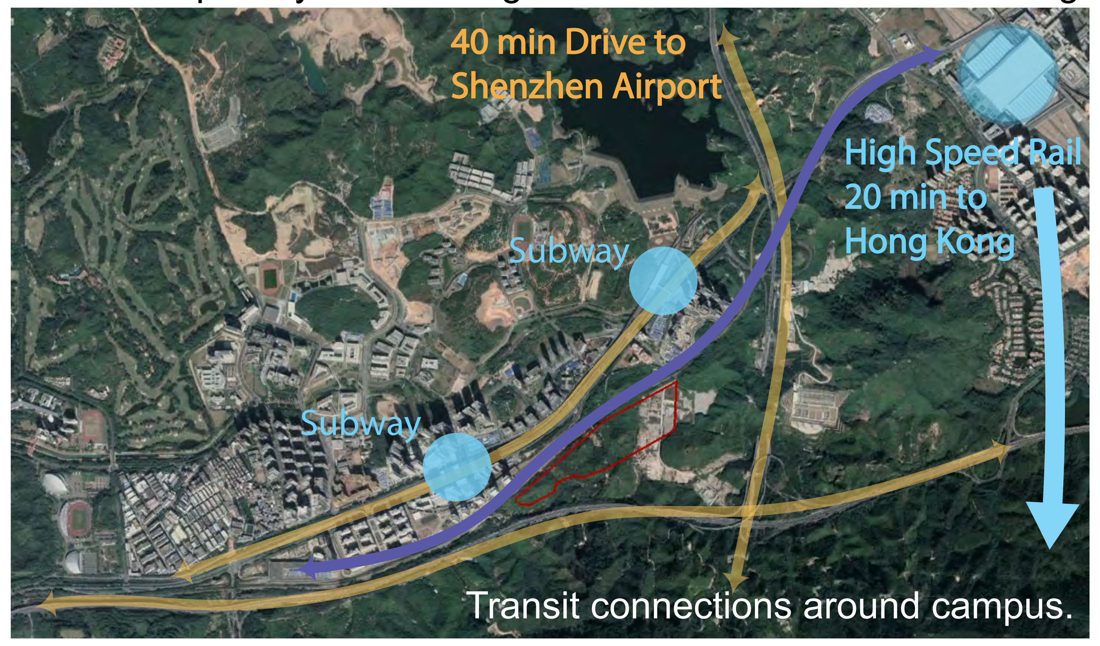
Predictiveness and Efficiency: The campus should be designed in anticipation of change and growth. Buildings will support efficiency use of space and materials, adhering a "long-life, loose-fit" principle.

Responsiveness and Experience-driven: The GTSI campus should be designed in harmony with the original natural environment, with building placement responding to the shapes and contours of the land. Sensing network will also measure and respond to conditions that affect human comfort throughout the campus.

Guiding Principles For Campus Design

Geodesign Approach for Smart Resilient Campus

The Georgia Tech Tianjin University Shenzhen Institute (GTSI) is a tri-party initiative between the City of Shenzhen, Tianjin University, and Georgia Institute of Technology to build a new campus in Shenzhen. We seek to produce a set of value principles and design guidelines about smart campus systems design to inform the decision-making.



Project Context

Early Adopter #1: Clustered development pattern with closer relationship to topography, design at human scale. Adoption of energy and AV technologies, and low impact development.

Early Adopter #1: 2035

Early Adopter #2: Decentralized development pattern with closer relationship to topography, design at human scale. Adoption of energy and AV technologies, and low impact development.

Early Adopter #2: 2035

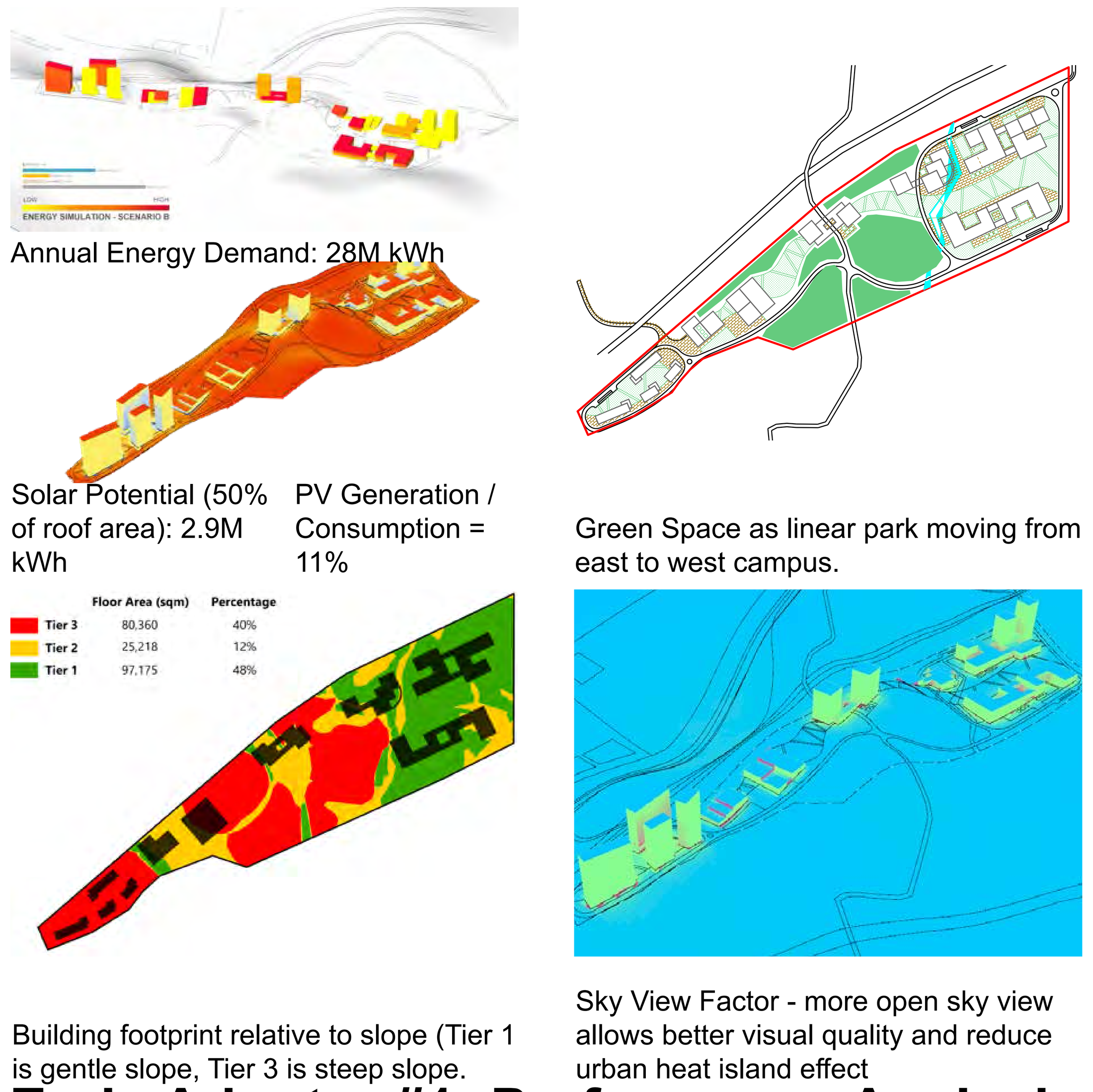
Client requested three proposals for the campus, which is to be built in the next 3-5 years.

We propose two campus design alternatives to the Early Adopter scenario. The Non-Adopter Scenario A (next page) follows existing policy and regulations that prohibit any development over the terrain, and only allow campus buildings to be placed on the Tier One flat area. The two alternative scenario B & C depict Early Adopters, setting only 50% campus buildings on the Tier One area, and allow the rest of 50% campus buildings to creatively engage with the natural terrain and optimize natural resources based on landscape and water systems.

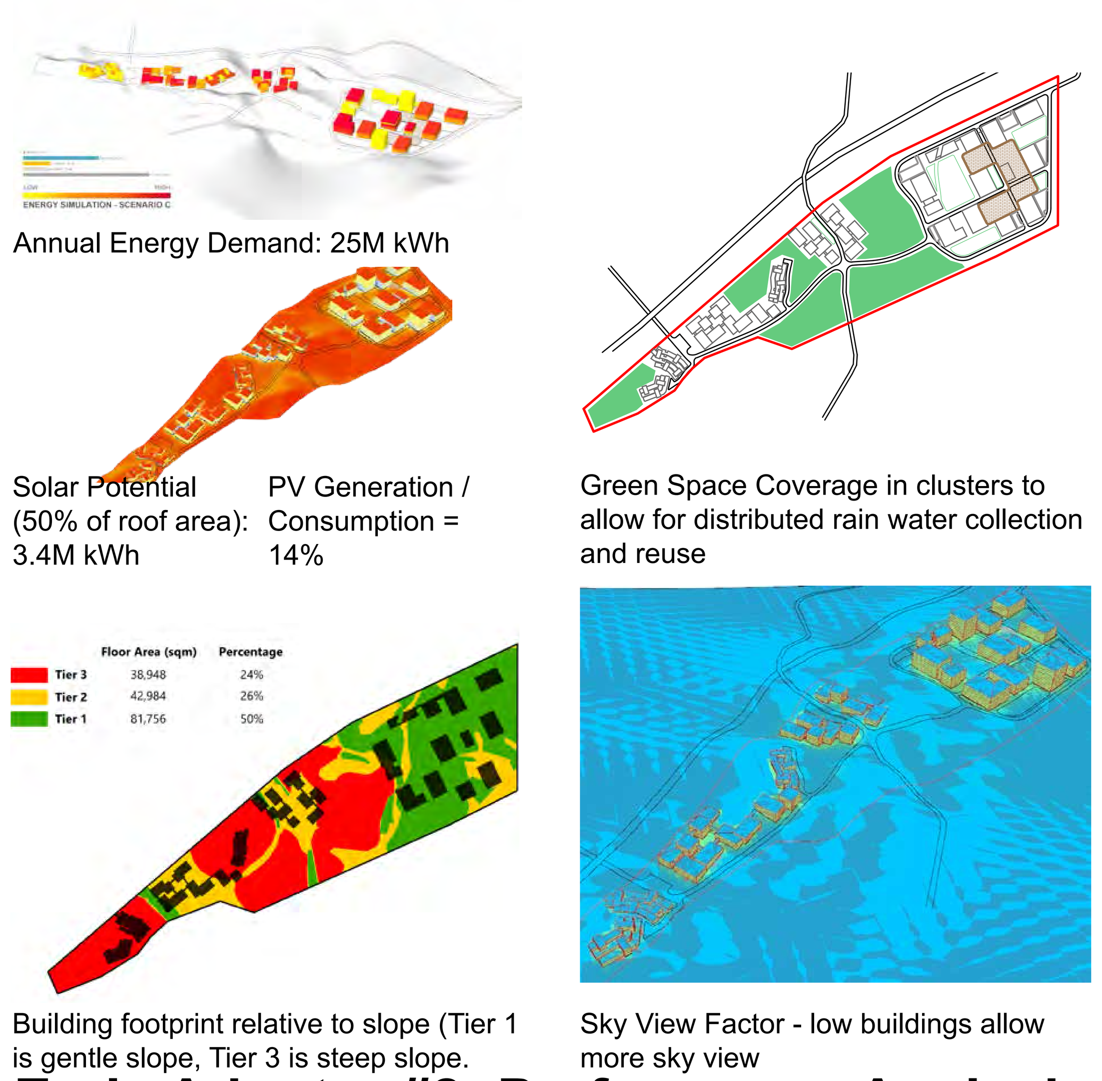
Infrastructure systems and technological innovations, including next generation solar and onsite waste-to-energy production, autonomous vehicle infrastructure, and digital twin for facility management and remote education will layer on top of design decisions made in the next two-three years.

Current high-density and compact development in Shenzhen

Design Requirements



Early Adopter #1: Performance Analysis



Early Adopter #2: Performance Analysis

Requirements

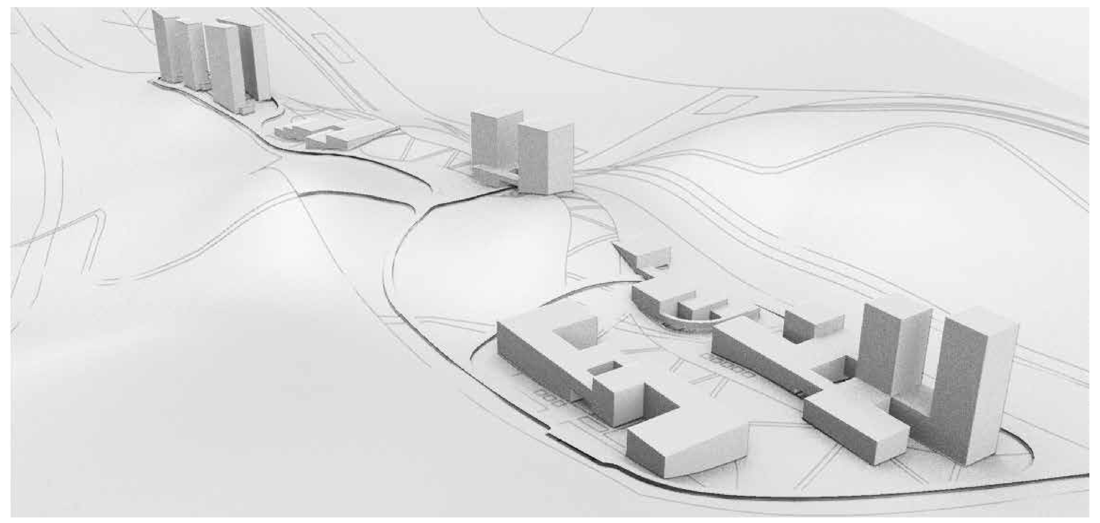
1. Georgia Tech - Tianjin University Shenzhen Institute (GTSI) will be by the funded by the Shenzhen government and adhere to Chinese regulations.
2. Client required multiple options for 2035 scenario.
3. Campus for 3000 students and 800+ faculty and staff, total 180,000 sq.m. of built space. Site is approximately 800 m east to west, and 162,000 sq.m in area.
4. We aim for zero discharge and zero energy campus using ecological planning.

Innovations

1. **ENE 2035/2050 1** Renewable Energy Sources
2. **TRA 2035/2050 1** Autonomous Revolution
3. **MIX 2035 3** People oriented Smart *Campus*
4. **MIX 2035 11** Smart City as Smart Systems
5. **MIX 2035 16** Sustainable Urban Infrastructure
6. **INS 2035/2050 8** The Future of E-learning
7. **INS 2035/2050 7** Education for the Future
8. **GRN 2035 1** Resilient landscape infrastructure
9. **GRN 2035 3** Increased vegetation linked with stormwater infrastructure
10. **GRN 2035 4** Linear vegetated corridors as linear parks

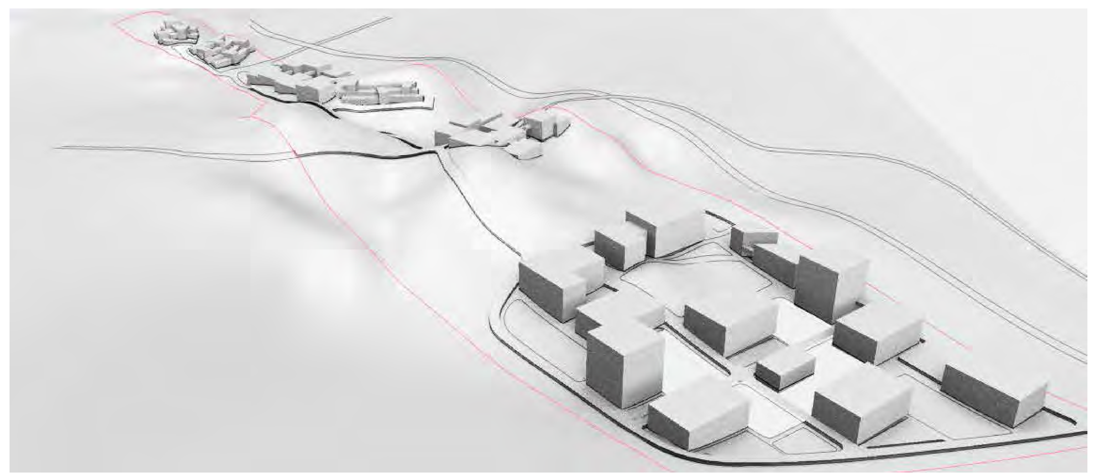
Early Adopter Scenario #1

Scenario B proposes a "clustered" design. Buildings are grouped by use, comprising clusters. Each cluster is organized around a courtyard. The courtyards are frequent and suggest the largest land allotment for landscaping among all scenarios. Land development leverages more of the site while placing 50% of footprint on the flat areas. The buildings range from one story to high-rise and their placement is dispersed. An East-to-West direction axis connects the gateway, public, and private territories.



Early Adopter Scenario #2

Scenario C proposes a "decentralization" pattern, and takes inspiration from a "campus village" concept. Individual buildings constitute its own micro ecosystems, and the design is appropriate to a smaller radius for daily personal activities. In the center of the eastern area is a sunken plaza. Several buildings surround the plaza and have access through entrances and exits at multiple elevations. Though the buildings in the western half of the site are built on steep terrain, they respond to the slope with a terraced construction. Buildings with larger footprints are delegated to the eastern terrain with gentle slope that are easiest for development. This allows buildings and their users to engage more closely with nature with minimal negative impact to the natural environment.



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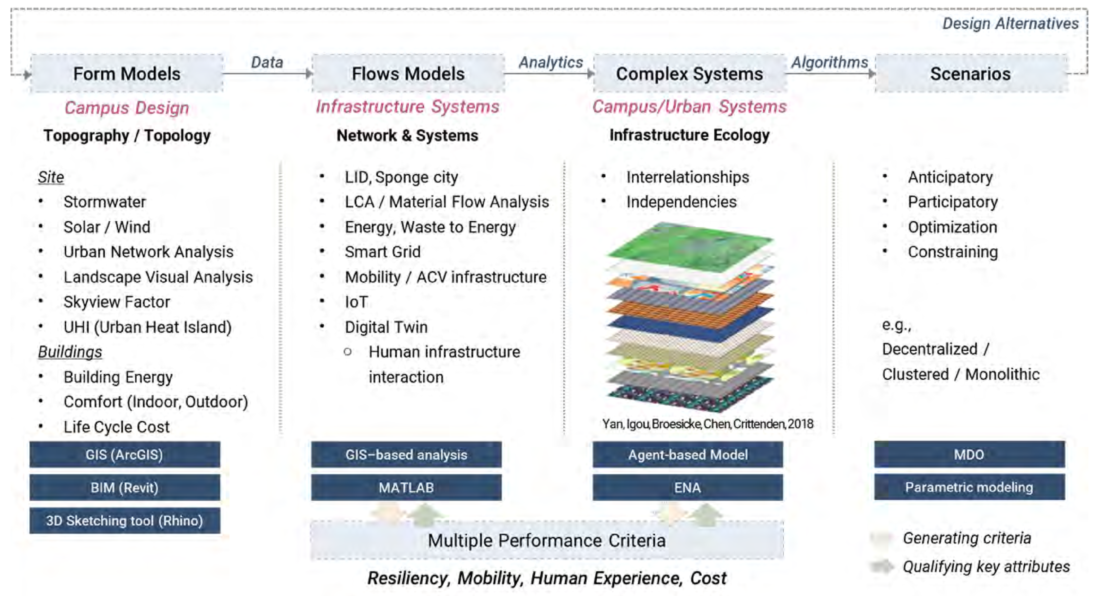


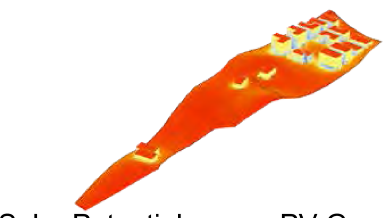
We propose an iterative process that steps through generation and analysis of Form Models, Flow Models, Complex Systems, and Design Scenarios. The Form Models are representations of campus context and design. Flow Models are representations of infrastructure systems and their networks. We explore the interrelationships and interdependencies through modeling the campus as Complex Systems. Through this process of understanding the site, designers generate design scenarios through anticipatory, participatory, optimization, and constraining approaches. The cycle is iterative to achieve the key criteria for resilience, mobility, human experience, and cost.

Methodology

Non-Adopter: following typical Shenzhen development patterns and mechanically adhering to regulations of not disturbing topography.

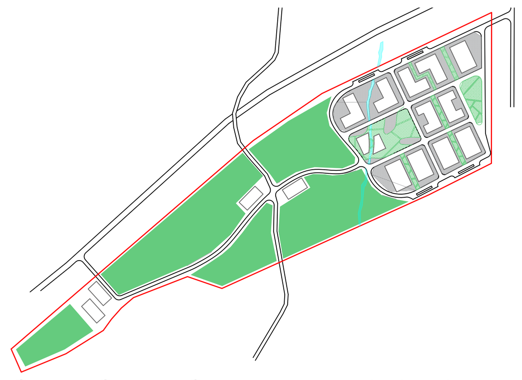
Non-Adopter: 2035

Annual Energy Demand: 24M kWh

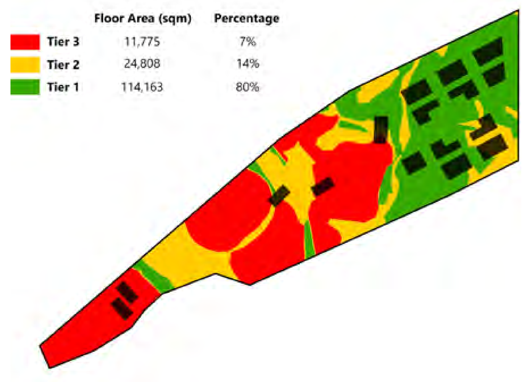


Solar Potential (50% of roof area): 1.4M kWh

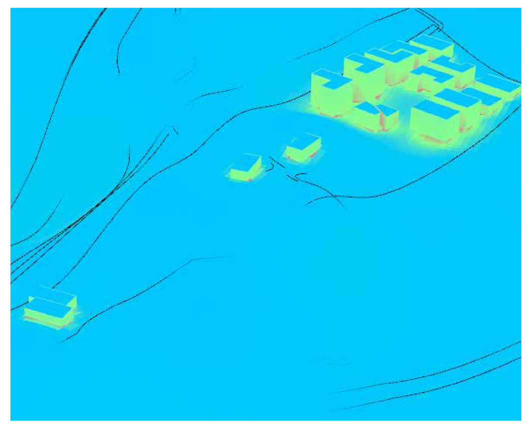
PV Generation / Consumption = 6%



Green Space Coverage maximized over western hills. Green space in East campus allows for some infiltration and addition of underground storage.



Building footprint relative to slope (Tier 1 is gentle slope, Tier 3 is steep slope.



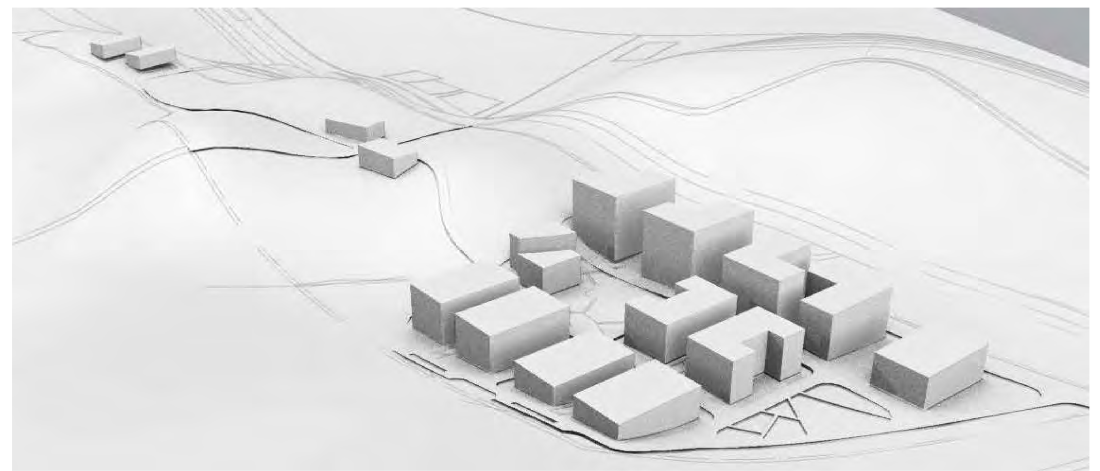
Sky View Factor - Skyview between buildings is limited

Non-Adopter: Performance Analysis

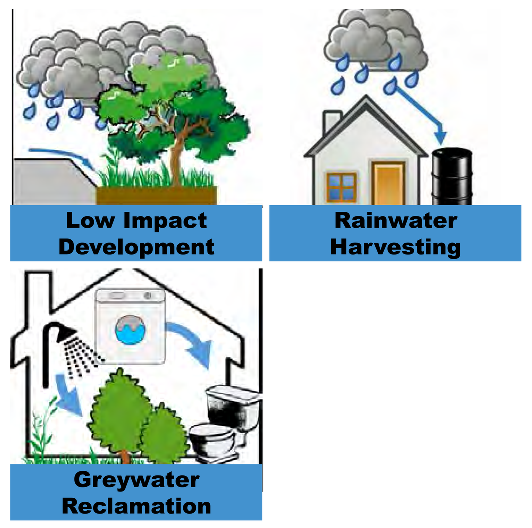
Non-Adopter Scenario

Scenario A follows existing policy and regulations in Shenzhen and minimize development on topography with sleep slope. This arrangement results in the concentration of ninety percent of required development within a limited location of the flat but lowest elevation land to the east, and may cause environmental and social consequences.

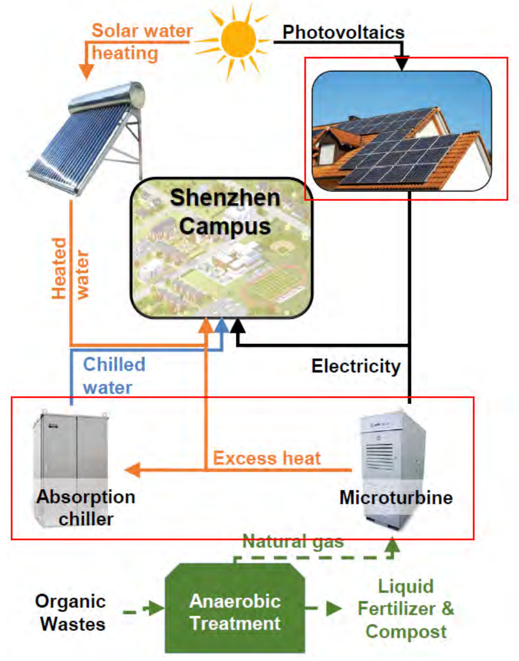
Embracing a compact urban design, the dense arrangement matches that of neighboring developments. Visual connectivity is maintained in all directions, with significant vantage points and long sightlines from upper levels. Podium and sky cloud walkways between buildings connect spaces and uses.

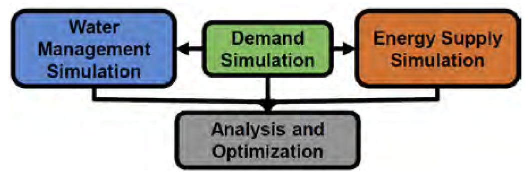


Gigatech Platform and Multi-Disciplinary Design Optimization (MDO) approach integrates over 50 technologies to find synergies that improve the quality of life, human welfare, and the environment by providing design guidance for integrated sustainable and resilient infrastructure. Components of resilient campus infrastructure systems:



Based on energy demand simulations for each building on the campus, we create design options for system combinations to supply the energy, heating and cooling needs of the campus. Diagram on right shows one option: a microgrid with a PV System (160 kW) and Gas Turbine (270 kW) Supplying Feeder. The options are analyzed based on both water and energy performance.

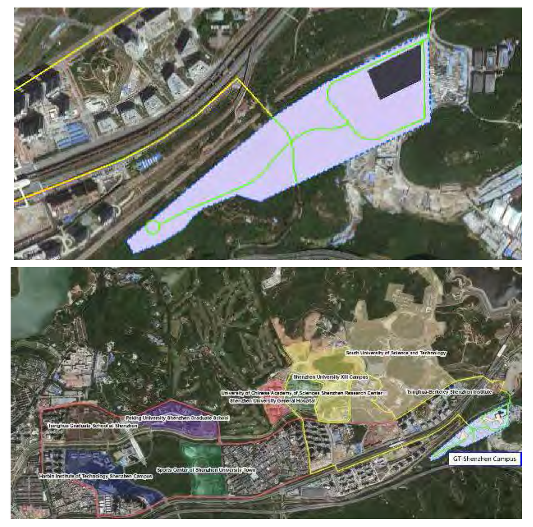


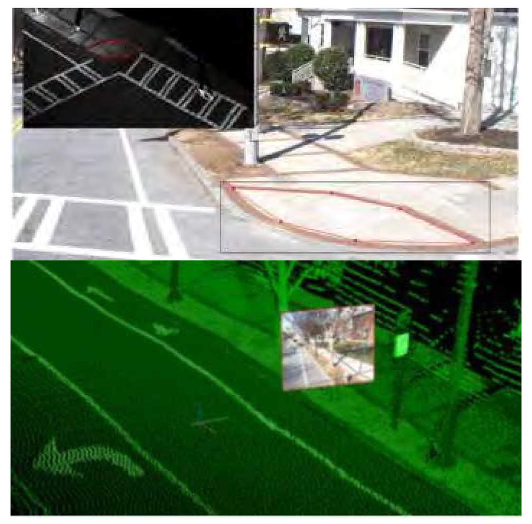


Examples of the types of engineering analyses and optimization conducted to evaluate infrastructure system options.

Integrated Resilient Campus Infrastructure Systems

Comprehensive road and on-board technology for Autonomous Vehicle Infrastructure can be implemented and tested at GTSI campus and extending to the university town area to the north and west of campus.



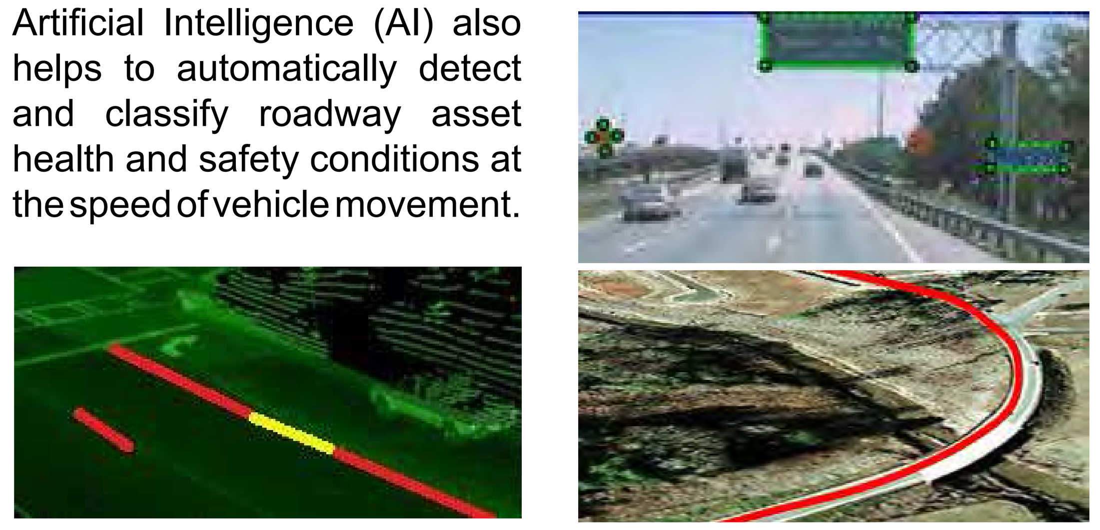


3D and 2D imaging technologies are used to detect paved and unpaved roads, markings, traffic, traffic signs, lighting, trees, etc. Roadway digital mapping enables innovative applications in road safety, maintenance, sustainability and resilience.

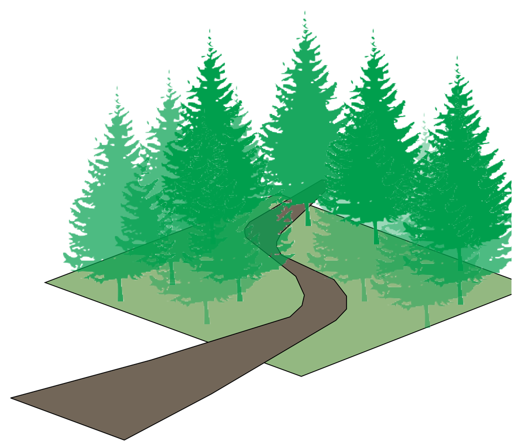
Research and testing goals:

- Future transportation infrastructure that supports safe and healthy mobility of pedestrians, bikers, drivers, and autonomous vehicles at different scales of the transportation network: GT-Shenzhen Campus, University Town, and Shenzhen Nanshan District.
- Smart infrastructure and mobility that supports innovations in the interactions between road infrastructure and pedestrians, bikers, scooters, drivers, and autonomous vehicles.

Artificial Intelligence (AI) also helps to automatically detect and classify roadway asset health and safety conditions at the speed of vehicle movement.



Smart Roads And Autonomous Vehicles for Safety, Mobility, and Health

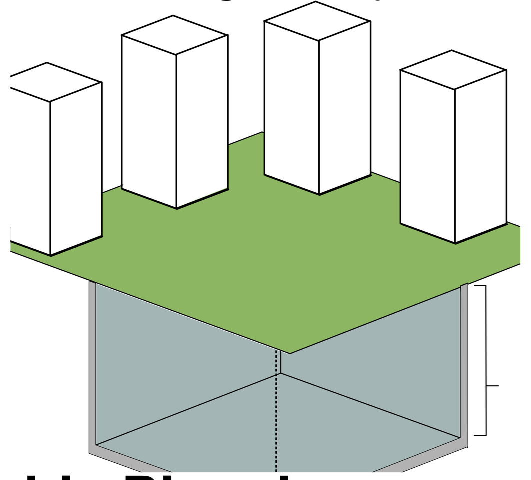


Enhanced Conservation

Responding to Terrain

Pocket Parks

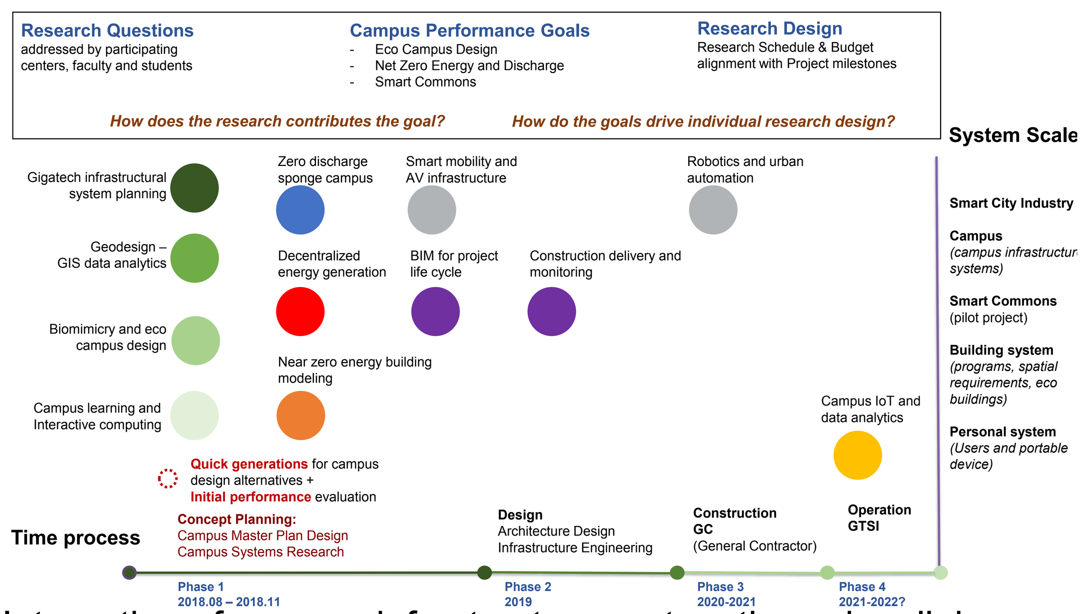
Storm Management Systems



Ecologically Sustainable Planning

The Georgia Institute of Technology College of Design team organized a co-design and research collaboration process for preparing the Shenzhen campus concept plan that integrates campus design and engineering systems. The co-design process included two coupled components: an urban design workshop to explore design scenarios to test spatial arrangements and energy resilience performance, and research collaboration with laboratories from sustainable systems, civil and environmental engineering, digital building, and building construction to explore potential interactions among system designs and design optimization. Combining research and teaching the GTSI conceptual design process involved multiple stakeholders from university administration, research faculty, and graduate students to solidify the vision, goals, principles, and technologies to apply to this campus.

Collaboration Framework



Integration of campus infrastructure system through collaboration of different laboratories in GT.

Collaboration Framework

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