Robots in Paradise

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Abstract: The way in which modes of transportation have historically impacted land use and urban form is profound. Whether it is industrial development along waterways, the distance between western cities, or the sprawl of development near highway interchanges, transportation technologies have shaped our built environment. The advent of autonomous vehicles (AV) or driverless cars has the potential of impacting land use and urban form, and our built environment perhaps more dramatically than any other transportation technology in history. This paper describes a landscape architecture studio that, in response to Hawaii's Governor Ige's 2017 executive order, applied geodesign strategies to speculate, plan, and evaluate land use change and landscape architectural designs for a fully AV environment in the City of Honolulu, Oahu, Hawaii.

Keywords: Geodesign, autonomous vehicles, pedagogy, remote collaboration

1 Introduction

The widespread adoption of autonomous vehicles (AV) has the potential to mandate new land use policies that would in turn change the size and location of parking facilities, the number and direction of travel lanes, the places in which we work and live, and the geometries and circulation of roadways (NACTO 2017). These changes will free up land to be repurposed for other uses and provide commercial, social, or ecological services (LUO 2019). It is also anticipated that the emergence of AV technology will impact several federal environmental policy initiatives. These include smart growth, mobile source planning for ozone nonattainment, urban brownfield policies, renewable energy policies, and environmental justice policies (HARRINGTON & SCHENCK 2017).

The challenge for any AV scenario is how the AVs interact with human-driven vehicles. Connected vehicle technology, an integral component of AV, allows vehicles to communicate with each other via onboard sensors and cloud computing technology. However, human-driven vehicles are not connected – leaving more opportunities for human error, hence-forth, restricting the potential design change to our roadways and land use patterns. One way forward is to establish barriers and borders to separate AV and human-driven vehicles. Soon, this will be accomplished through dedicated lanes on our roadways, such as the HOV lane (SORREL 2016), but other scenarios look to delineated districts (GARIKAPATI 2018). Like the ways in which planners have converted roadways to pedestrian only zones, there will be areas where only fully autonomous vehicles will be allowed access. One scenario may be leveraging the watery borders of an island to provide the proving grounds for AV technology and allow for creative land use change.

1.1 Overview

This paper describes a landscape architecture studio that applied geodesign strategies to speculate, plan, and evaluate land use change and landscape architectural designs for a fully AV

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environment. AV technology is rapidly developing. The day in which fully autonomous vehicles populate our roadways is no longer in the realm of science fiction. Last year, Waymo announced that it had driven over ten million miles in twenty cities with their driverless cars (LUO 2019, KOROSEC 2018, OHNSMAN 2018). This past July, Tesla promised to wirelessly push out updates to hundreds of thousands of its cars to enable "full self-driving" capabilities sometime this year (SIDDIQUI 2019). Some advocates predict that by 2030 these vehicles will be so reliable and affordable that they will displace most human-operated vehicles, providing many social, behavioral, and environmental benefits to society (LITMAN 2020). Skeptics, on the other hand, see challenges with safety, public policy, and zombie traffic jams (MUOIO 2017). This debate forms uncertainty.

Landscape architects and allied design professionals routinely anticipate change through uncertainty. These anticipatory design scenarios follow deductive logic. More so than other design professionals, landscape architects are frequently given uncertain program requirements or landscape design goals as clients are unsure of a site's potential or possibilities. "The value of speculative and generative interventions to contemplate not what is or what should be but rather what could be (FORLANO 2019, 21)." In these instances, uncertainty demands creativity.

This studio performed anticipatory design scenarios of potential change from wide-spread AV use in the City of Honolulu on the island of Oahu in the State of Hawaii. In collaboration with representatives of the Hawaii AV Institute at the University of Hawaiʻi at Mānoa and OLIN, this studio aimed to respond to Hawaiian Governor David Ige's invitation for the testing of AV in the Aloha State.

Excerpt of Governor Ige's executive order (November 22, 2017)

> "The State of Hawaii ("State" or "Hawaii"), with its optimal conditions for testing connected autonomous vehicles (CAVs), has stepped out ahead-extending open arms to motor vehicle manufacturers and technology companies from around the world, signaling that the Aloha State is open for business for testing and deploying the new driverless vehicle technology; …today there is something akin to a space race to see who will develop driverless vehicles and advanced wireless technologies (i. e., the Internet of Things)-both of which have the power to influence the future outcomes for the daily lives of all Americans. – Hawaii, with its unique, favorable conditions, has become the ideal locale for testing (IGE 2017)."

This studio researched potential change, scoped potential sites, and developed potential landscape designs that are made possible from widespread use of AV. The designs are prototype scenarios for future work of the institute, state, and other agencies.

2 Project

"AVs offer the first opportunity to rethink urban life and city design since cars replaced horse-powered traffic and changed the design of cities for a hundred years (DUARTE & RATTI 2018, 3)." This studio studied the potential impacts of widespread AVs use and subsequent design opportunities for the City of Honolulu, Hawaii. Honolulu is ranked as having some of the worst vehicle traffic in the country (INRIX 2018). With a population of 340,000 in the city, and less than one million in the surrounding urban area, Honolulu is not a large city. It is known for its beautiful seaside locale and as a vacation destination. However, the island of Oahu's unusual topography forces Honolulu's urban area to spread thinly along the seashore – making travel difficult for commuters from outlying communities – particularly from the west. The City of Honolulu is addressing this problem with a new light rail corridor and deployment of AV in HOV lanes (MAI 2017).

The Hawaii AV Institute is currently evaluating the potential testing of AV in the HOV lanes between the airport and downtown (MA 2019) but is interested to learn about potential land use changes and subsequent impacts from their long-term goal of state-wide deployment of AVs. The Honolulu Rail Transit (HART) project has catalyzed a series of Transit-Orientated Development (TOD) projects. These projects aim to incorporate public transit, commuter parking, bicycles, and pedestrian circulation. Overall, the TOD project hopes to concentrate housing, shopping and jobs around transit centers in order to minimize sprawl into the valleys and Hawaiian ʻaina. These projects do not consider the potential changes to land uses that are afforded using AV technology. The studio focused on six of the eight proposed TODs as areas of interest (AOI) for speculating land use changes and design prototypes.

Students were not developing new design for TODs, instead they were modifying the proposed designs as prepared by other design professionals to create potential designs in anticipation of AV adoption. That is, the proposed designs were considered to be the existing conditions and point of departure for the students to work from.

3 Pedagogy

As a depth studio intended for both graduate and undergraduate landscape architecture students, the course incorporates and builds on design thinking, critical analysis, and technical implementation developed in previous studios. The overall objectives of the studio asked students to:

- Understand how to apply a geodesign framework to design with uncertainty
- Generate conceptual designs from remote observations
- Creatively program new land uses that are afforded by widespread use of autonomous vehicles
- Represent and share final designs as an ArcGIS StoryMap

One hurdle to overcome in applying the geodesign process in an academic setting is the absence of real-world stakeholders. For this reason, adaptations to the framework were made while keeping with the spirit of the process (Fig. 1).

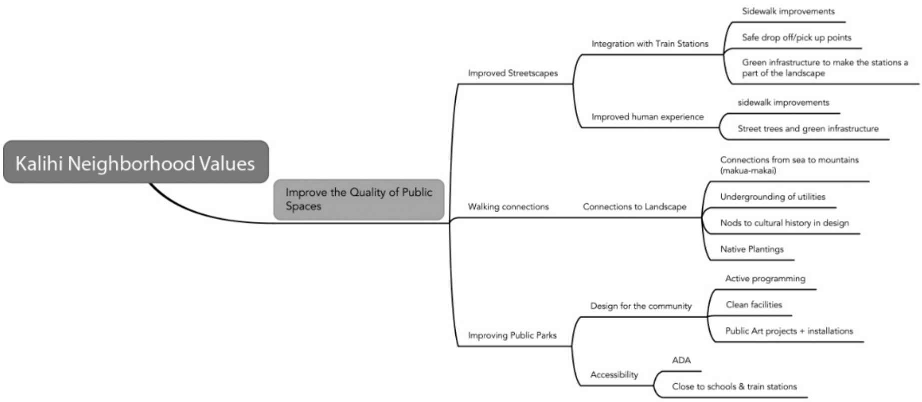

Fig. 1: Mind map of Kalihi neighborhood values by students Daniel Call, Kirsten Eaton, Graham Mills

3.1 Framework

This studio followed a geodesign process as outlined by Steinitz's Framework for Geodesign (STEINITZ 2012). The Steinitz framework asks the design team to go through three iterations of six models to scope a problem, to specify a method of inquiry, and to ultimately perform the relevant analysis, design and evaluation. We have found this sophisticated process is not always intuitive for landscape architecture students, therefore, traditional phases of design (i. e. conceptual design, schematic design, and design development) were logically incorporated into the framework. By infusing traditional phases of design into the framework, students were able to relate the objectives of geodesign to their learned design process. Ideally, the geodesign team would be interdisciplinary – including scientists, designers, technologists, and people of the place. Our project was monodisciplinary and, while there were virtual presentations and reviews with the representatives of the Hawaii AV Institute and the City of Honolulu, the design process was anticipatory – not participatory. As such, students made educated assumptions to the values of stakeholder groups though aggregated census data and publicly available minutes from the TOD community meetings (CITY AND COUNTY OF HONOLULU 2019). The final designs of the studio were made available to the Hawaii AV Institute and other agencies as ArcGIS StoryMaps for future work.

The three iterations of the framework were delivered as three of the four modules:

1) Module 1 – Scope the Study | Discovery → Conceptual Design
2) Module 2 – Specify the Methods
3) Module 3 – Perform the Study | Schematic Design → Design Development
4) Module 4 – Disseminate

The students had to discover what changes were possible or which may occur.

Module 1 asked the students to hypothesize change and to scope the proposed TOD designs as existing conditions. They speculated potential change from AV adoption through a review of futurist literature (e. g. change in mobility, land use, human behavior, urban form, economy, and environment). They also participated in the game "The Thing From the Future"

(CANDY & WATSON 2017) where they teased additional, sometimes nonsensical ideas, to incorporate as potential change in their TODs. This formed conceptual designs for change. They also addressed the questions of Steinitz's six models of the framework to gain a better understanding of the study area. Steinitz's six models and modified questions:

1. Representation – How should the TOD be described?
2. Process – How does the TOD work or function?
3. Evaluation – Does the TOD work or function well?
4. Change – How might the TOD be changed from what is proposed?
5. Impact – How might these changes affect the processes of the TOD?
6. Decision – How should the TOD be changed?

For the decision model, the students identified the core values of each TOD, through gleaning TOD community reports. These core values turned into requirements of their designs. They Translated these requirements into the stated design intent for their study to inform the next iteration of the framework.

Module 2 asked the students to specify the methods of the study by asking the same model questions in reverse order. Beginning with the decision model, students translated the core values into the goals and requirements of the study. Through a mind mapping exercise, students identified physical form indicators from the community core values to form relevant impacts to evaluate in their study (WALKER 2017). While many of the indicators were not easily measurable, it allowed the students to more clearly relate the community needs to their potential designs. Ultimately, the second iteration narrowed the data requirements for the study as well as developing a strategy for visual and graphic representations.

Module 3 asked the students to perform the study by going through the six models in order. This round, students incorporated more traditional design approaches to the models. Steinitz structures the first 3 models to assess the study area and the last three models to implement change (Table 1).

Table 1: Traditional Design Approaches in Steinitz's Models

Assessment
Representation – Inventory
Process – Analysis
Evaluation – Conclusion
Implementation
Change – Design Iterations
Impact – Design Evaluation
Decision – Design Selection

As guided by the framework, students paired process and impact models of natural, economic and social functions of the existing TOD designs to their potential designs to measure the impacts of change.

3.2 Collaboration

The studio formed six monodisciplinary teams of undergraduate and graduate landscape architecture students (five teams of 3 and one team of 2). Additional expertise for this studio was provided through moderated sessions with strategic collaborators. Those collaborators included:

- Will Belcher, PLA, ASLA – Founder + Principal with Ground Control
- S. Ilgin Guler, Ph.D, Assistant Professor, Department of Civil and Environmental Engineering, The Pennsylvania State University
- Yadan Luo – Landscape Designer – OLIN, Philadephia, PA
- David T. Ma – Chairman of the Board of Directors for Hawaii AV Institute, Professor and Interim Associate Dean, College of Engineering, University of Hawaii, Manoa
- Dave Rolf – Executive Director of the Hawaii Automotive Dealers Association, Board Member Hawaii AV Institute
- Kenneth Schmidt – GIS Administrator at City and County of Honolulu

4 Discussion

The studio had some difficulties in hindsight. First, not all TODs were adopted plans; some plans had complete roads, and clear building footprints, etc., while others were merely conceptual land use designations. This deficit forced some teams to make additional assumptions as to the future scenarios of the developments. Second, the physical form indicators that were developed during the methods plan were often unmeasurable. These included indicators that required forecasting for which data was unavailable (e. g. canopy inventory) and/or modelling requirements (e. g. traffic counts and economic growth) were beyond the capabilities of the students. As an example, other AV studies have used transportation models to simulate connected vehicle conditions. Third, the students had excellent ideas for digital representation that would have gone in depth in certain areas of the study, however, the time restraints of the studio did not allow for learning of new techniques and software.

Some examples of innovative urban design scenarios possible with the adoption of AV that came out of the studio included: adaptive systems that blurred the boundaries between pedestrian and vehicular zones, allowed for varying multi-temporal uses, and even enlivened the urban night time street scape with in-hardscape lighting that delineates pedestrian safe areas (Fig. 2), multilevel parking and vehicle circulation with integrated micro-mobility (Fig. 3), street conversions which integrate narrower roads, bike lanes and elevated mass transit with integrated green space and bioswales (Fig. 4), and a scenario which proposed a 54% reduction in impervious surface by utilizing narrower AV corridors combined with in-street plantings (Fig. 5). Other scenarios looked at solar charging parking structures for vehicle storage while providing only drop-off areas for residents (Fig. 6) and creating car-free zones for pedestrians by restricting connected vehicles to main roads (Fig. 7).

Fig. 2: Airport TOD: Flexible Zones. Rendering by students Wenjuan Li, Xintong Tan, Shiyuan Wang.

Fig. 3: Waipahu TOD: Multi-level circulation with micromobilty. Rendering by students Shengwei Tan, Le Sun, Yiru Zhang.

Fig. 4: Kalihi TOD: Street Conversion. Rendering by students Daniel Call, Kirsten Eaton, Graham Mills.

Fig. 5: Downtown TOD: Vegetated Streets. Rendering by students Alex Markovic, Mike Rehrig, Chenlu Zhu.

Fig. 6: Pearl City TOD: Autonomous vehicle parking and solar charging and drop-offs. Rendering by students Brandon Patellos, Xiaoyu Xie.

Fig. 7: East Kapolei TOD: Car Free Zones. Rendering by students Trentin Herrington, Eusung Kim, Liwei Chen.

One marked success of this studio is that this is the first time these students worked through a complete geodesign process. This allowed them to be more strategic in their design approach, design evaluation, and their choice of representation. In some cases, this was also the first time they were asked to measure the success of their design. Through a geodesign impact model, students were able to assess metrics of their potential AV TOD design.

With respect to the virtual collaborations, students were able to learn about the projects and receive feedback on their assumptions and design development from design professionals, academics, and experts in the field. The collaborators also remarked how they were able the learn more about the AV potential from the students' designs.

Using Esri StoryMaps to disseminate the final analyses and designs was also successful. They followed a "Story Map Cascade℠ template, as the cascade format is most suitable for a linear narrative of the design process, and published the maps to ArcGIS Online. Students were able to turn all of their studio work into a digestible, spatially oriented, story telling devise. Not only did they include their final iteration of the geodesign study (design development), but they were able to add more background information to support their design intents. This included values mapping, conceptual prototypes, or preliminary scenarios, renderings, video fly-throughs of 3D models, renderings, visualized data analysis in charts and graphic form, and of course, maps. These were shared with the Hawaii AV Institute and other agencies. Excerpts from the Story maps are included below (Fig. 8).

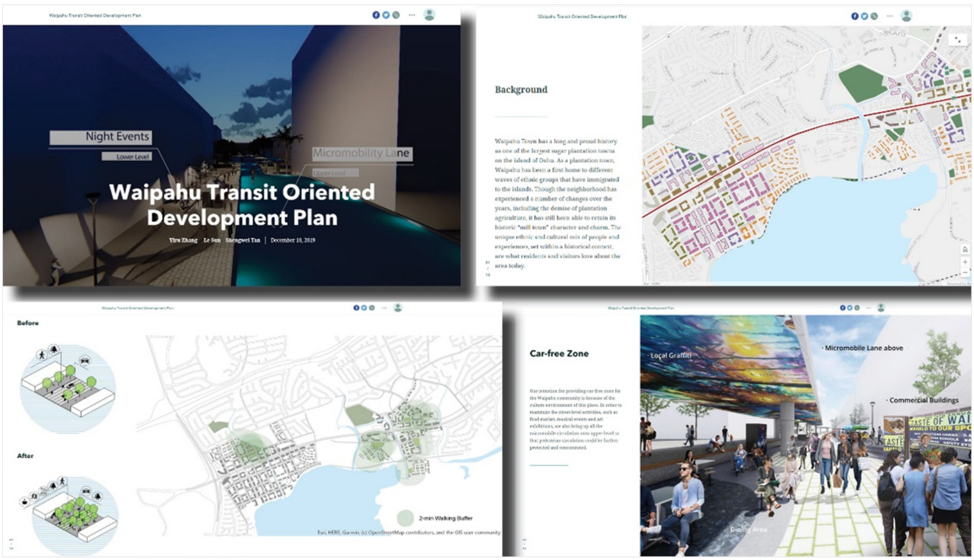

Fig. 8: Waipahu TOD: StoryMap excerpts. By students Shengwei Tan, Le Sun, Yiru Zhang.

5 Conclusion

Overall, the studio was a success in facilitating anticipatory design through a Geodesign process. Students learned critical methods for performing a study and collaborators were inspired. However, the student design scenarios did not go as far as they could have. Students focused too much on pragmatism and should have been more disruptive. Although they researched various impacts that AVs will have in different economic, environmental, and social sectors, most groups still focused heavily on repurposing parking lots into green space and establishing drop-off locations. They had difficulty getting away from thinking about AVs being "just cars". They need to envision the bigger picture of AV beyond facets of mobility in urban design. Planners and futurists see AV impacts as being much more profound, stretching from land use to economy and new forms of urban life. We need to work to help students understand this broader potential in the future. For Hawaii, the role of AV technologies may allow for a more sustainable development and a restorative future of the waterfront as asserted in the State's vision in 1970.

"Existing neighborhoods might in time be relocated entirely. It is not inconceivable that Honolulu's urban concentration would eventually shift away from the shore and the mountainsides to selected valleys, where self-contained communities in compact vertical structures would line the extremities. The valley floors would remain as great natural parks, with all human amenities and services confined within the perimeter. The waterfront that is presently occupied by commercial, residential, and industrial buildings could be reclaimed" (DATOR 1999).

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