Willingness to Invest in a Carbon and Water Neutral Future: Mobilizing Community Decision-Making and Anchoring Bias

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This paper extends the heavily studied heuristic of anchoring bias to citizens' willingness to invest in the sustainable infrastructural improvements in transportation, energy, and water necessary to achieve carbon and water neutrality in their city. A public-private-academic partnership formed between GLHN Architects & Engineers; City and County staffs; and university Bachelors of Architecture students used quantitative analysis and design inquiry to create augmented virtual realities (VR) and rendered visions of a carbon and water neutral future in Tucson, Arizona in 2050. This paper analyzes the results from three evaluation tools that measured over 200 citizens' willingness to invest in this future after experiencing these new anchoring images and virtual realities: (1) verbal survey, (2) tactile graph, and (3) visual maps. The paper concludes that the introduction of new anchoring images can positively impact citizens' willingness to invest in the necessary retrofits in transportation, energy, and water infrastructure for a carbon and water neutral future.

INTRODUCTION

Anchoring bias is the cognitive tendency to rely heavily on an initial piece of information when making a decision, especially under uncertainty. This phenomenon was first documented by Nobel prize winning psychologists Tversky and Kahneman (1974) to characterize bias in the way people intuitively assess probabilities.[1] In participatory design and planning, citizens may be overly reliant on the reality in which they live as their anchoring image. If images are not provided to citizens about how a plan, policy, or proposition may impact their lived reality; citizens may tend to rely on their direct lived experience to fill-in the visual information gap. To correct this potential decision-making distortion, citizens can attach to new visions that they judge as viable to support bolder choices for their future cities, particularly under the uncertainties of climate change. Without the support of new visual anchors, citizens may overly attach future plans, policies, and propositions to the constraints of current realities, leading to distorted decision-making processes.

Through a case study of Tucson, Arizona, this paper extends the heavily studied heuristic of anchoring bias to citizens' willingness to invest in the sustainable infrastructural improvements in transportation, energy, and water necessary to achieve carbon and water neutrality in their city by 2050. A public-private-academic partnership formed between GLHN Architects & Engineers; City and County staffs; and university Bachelors of Architecture students used quantitative analysis and design inquiry to create augmented virtual realities (VR), rendered visions, and physical maps of a carbon and water neutral future for the year 2050. These projected futures were then experienced by citizens attending a large downtown exhibit of the work. This paper analyzes the results from three visual products paired with three evaluation tools that measured citizens' willingness to invest in a carbon and water neutral future after experiencing these new anchoring images. The three engagement tools used were both conventional (visual map) and novel (tactile graph and VR with verbal survey).

This paper begins with a review of literature on decision-making heuristics and community engagement in the process of city planning and design for climate change. Next, the methods this study used for community engagement and evaluation are outlined. Results of the three methods of verbal survey, tactile graph, and visual maps and presented and analyzed. The paper concludes that the presented work provides a replicable model for academia to join with practice and local governments to (1) engage citizens in envisioning the future sustainability of their city's long-term policy adoption and (2) provide feedback to government on citizens' willingness to invest ahead of voting. The results suggest that the introduction of new anchoring images can positively impact citizens' willingness to invest in the necessary retrofits in transportation, energy, and water infrastructure for a carbon and water neutral future. These conclusions are important in the case study context of Tucson where citizens determine the general plan for their city's future course of development by vote every ten years.

The Power of Visual Perception in Communicating Climate Change Impact and Solutions

In the last several decades of public discussion around climate change, progress toward new planning and design policies has seemed markedly slow, given the dire warnings of science. Several studies drawing from professional experience and research conclude that conventional outreach, planning processes, and policies are not significantly reaching or mobilizing communities.[2] Research points to a handful of contributing phenomenon in the way public perceptions and decision-making operates. Documented barriers to

engagement in the integration of climate planning include the complexity of climate science, long time horizons of projected climate changes, and depicting the impacts of climate change in distant realities (e.g. melting ice caps rather than flooding in your hometown).[3, 4] Marshall (2014) points to 'the silence of climate change' or the difficulty of seeing a long term, insidious effect within the immediate reality.[5] In this 'seeing is believing' type of argument, citizens have a hard time believing and planning for future impacts that do not visually register in their immediate context. Images of faraway landscapes in future decades do not make personal impacts clear to citizens of a particular city. Further, human cognition does not align well with long time scales, which generally seem to be limited to anticipating 15-20 years into the future.[6, 7] These complex spatial and temporal processes may partially explain why climate change has only recently begun to be addressed in local contexts, such as cities. Research has proven that climate change is only meaningful in community planning if the potential impacts and response options can be understood and handled within local planning processes and policy development.[8,9]

Several researcher teams have addressed the potential for visualization of local realities as a tool for community communication of climate impacts.[10, 11, 12, 13] Visualizations of known landscapes has been proved to help community members integrate scientific information and local realities across multiple impacts and adaptation strategies.[14, 15] In a summation of a decade worth or research on making climate change visible to communities, Sheppard (2015) distills three broad principles for planning and design professionals: make it local (put it in a context that community members care about), make it visual (visual perception can make the concepts and realities of climate change clear and compelling), and make it connected (look holistically at the bigger picture and integrate all aspects of climate change that interact with society).[16] Following these three principles, the Tucson 2050 Exhibit sought to engage citizens in a local, visual, and layered discussion about the city's climate planning and design future. The exhibit was designed under the supposition that architects can play an influential role in engaging citizens in climate planning and design through effective visualization tools that help the public understand future implications alongside solutions for the detrimental effects of climate change on their local realities.

Heuristics of Decision-Making and Climate Change

The heavily studied decision-making heuristic of anchoring bias lends greater clarity to these observed trends in community engagement and climate change. A heuristic is an intuitive, rapid, and automatic system which "reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations."[17] In anchoring bias, a person's tendency is to focus too heavily on one piece of information when making decisions. In city planning, this can occur when a citizen cannot vision a future scenario because they are biased to the present reality, the image they live with and know well. This decision-making distortion has been heavily studied and demonstrated in a variety of contexts to varying effects. In a recent literature review, Furnham and Boo catalogued robust effects in legal judgements, valuations and purchasing decisions, forecasting, negotiation,self-efficacy, and probability estimates.[18, 19,20, 21, 22, 23, 24, 25, 26, 27, 28, 29] Overall, the literature demonstrates that the higher the ambiguity, the lower the familiarity, relevance, or personal involvement with the problem, the stronger the anchoring bias.[30] In unsuccessful public engagement activities, climate change has been articulated as a distant problem with uncertain impacts – fitting well within this high ambiguity, low relevance category.

Positively, studies have demonstrated that the decision-making distortions can be mitigated.[31, 32] Specific to the line of investigation of this paper, bias and bias-mitigation from anchoring has been documented in visualization and visual analytics. In one recent study, visual anchors were seen to impact the decision-making process, while numerical anchors had a significant effect on the decision-making outcome.[33] In the Tucson 2050 exhibit, citizens are given numerical goals as outcomes (e.g. a carbon and water neutral city by 2050, with 50% reduction by 2030) and visual images through VR, posters of renderings, and maps to aid provide new anchors.

The City of Tucson's Voter Approval Process for the General and Sustainability Plan

Plan Tucson, the City of Tucson's General and Sustainability Plan, was adopted by voters in November 2013. The plan is comprehensive, with over a hundred goals spanning four 'environments': built, social, economic, and environment. However, the 2013 goals lack measurable targets that can be monitored. In its expansiveness, there is a lack of clarity of priorities or a fundamental communication of what counts as successful goal achievement. The Tucson 2050 exhibit attempted to link the language of Plan Tucson with visuals of what that implemented future could look like. The exhibit sought to provide greater specificity and clearer communication of what elements of the Plan addressed overall climate change mitigation goals.

The citizens of Tucson approve the general plan of the city every ten years. Although this process of voter approval creates broader awareness and engagement around the City's goals, it can also be a very limiting process if citizens are not equipped with new visions of what a possible future is realistically attainable. Without this information, citizens may often have difficulty getting past their immediate reality and may become oppositional to planning goals that symbolize change from the status quo. Decision-making distortions can be a barrier to progress on climate planning. The Tucson 2050 exhibit identified this basic need in Tucson planning and sought to provide images of possible futures to bring citizens toward consensus in changes to the built environment that supported carbon and water use mitigation. The City of Tucson is currently undergoing the process of the next formation of its general plan with a newly elected mayor in November 2019.

Figure 1: Workflow. Image credit: ARCH 451a Spring 2018 Studio.

METHODS

Tucson 2050: A Vision for A Future Downtown exhibit was open to the public in April-May 2018 in downtown Tucson and engaged over 350 citizens in visions for the city that achieved carbon and water neutrality by year 2050 without sacrificing livability or growth. The work was produced during the course of a semester (see Figure 1, workflow) with three stages. First, students were divided into areas and assigned to a relevant mentors from City and County staffs. The mentors included: City Energy Manager, City Director of Planning and Development Services, County Sustainability Manager, County Principal Transportation Planners, and County Environmental Planning Manager. Second, student pairs created prototypical solutions (the size of a city block) for how their individual research areas could contribute to a carbon and water neutral city by 2050. For the last third of the semester, students were divided into spatial areas of downtown. Areas were one of three sub-district areas with a dominant land use or one of four main infrastructures. A culminating exhibit that was opened at the end of this workflow in downtown Tucson.

The whole project aimed to engage three community groups: (1) five government expert mentors from city and county staffs, (2) over 350 citizens from across Tucson through the exhibit, and (3) eleven architecture students that will be the future professionals creating the integrated design solutions for mitigating climate change through the built environment. The 2,800 square-foot exhibit was comprised of three main components, each with a set of community engagement activities to promote education and evaluate the success of the new anchoring images. Although the activities were not designed as systematic investigations with control groups, the robust public feedback offers insight into how perceptions were altered by the exhibit and how the program may be improved in the future. The exhibit hosted two open houses: on a Friday evening at the end of April and during the "Second Saturday" monthly big downtown event in May. Throughout the two days that the exhibit was open to the public (8 hours total), student pairs manned each of the three community engagement stations:

Twenty 2050 Prototypes and Tactile Graph

Visual Product: Twenty prototypes were designed for downtown that addressed carbon and water mitigation by 2050 in five grouped categories: transportation, public health and the arts, energy, water and open space, and economy and historic (Figure 1). Prototypes were displayed as axonometric line drawings with associated calculations in posters.

Engagement and Evaluation tool: A live tactile graph was created where citizens registered their willingness to adopt new behaviors and practices to integrate new carbon and water neutral promoting behaviors into their lives. Degree of willingness (numbers 1-5, where 5 is most willing) was measured on a tactile graph to five key questions, each corresponding to one of the sets of prototypes (Figure 2).

Rendered Visions of Three Sub-Districts and Virtual Reality with Verbal Survey

Visual Product: Three rendered visions of a carbon and water neutral downtown were designed and displayed in posters

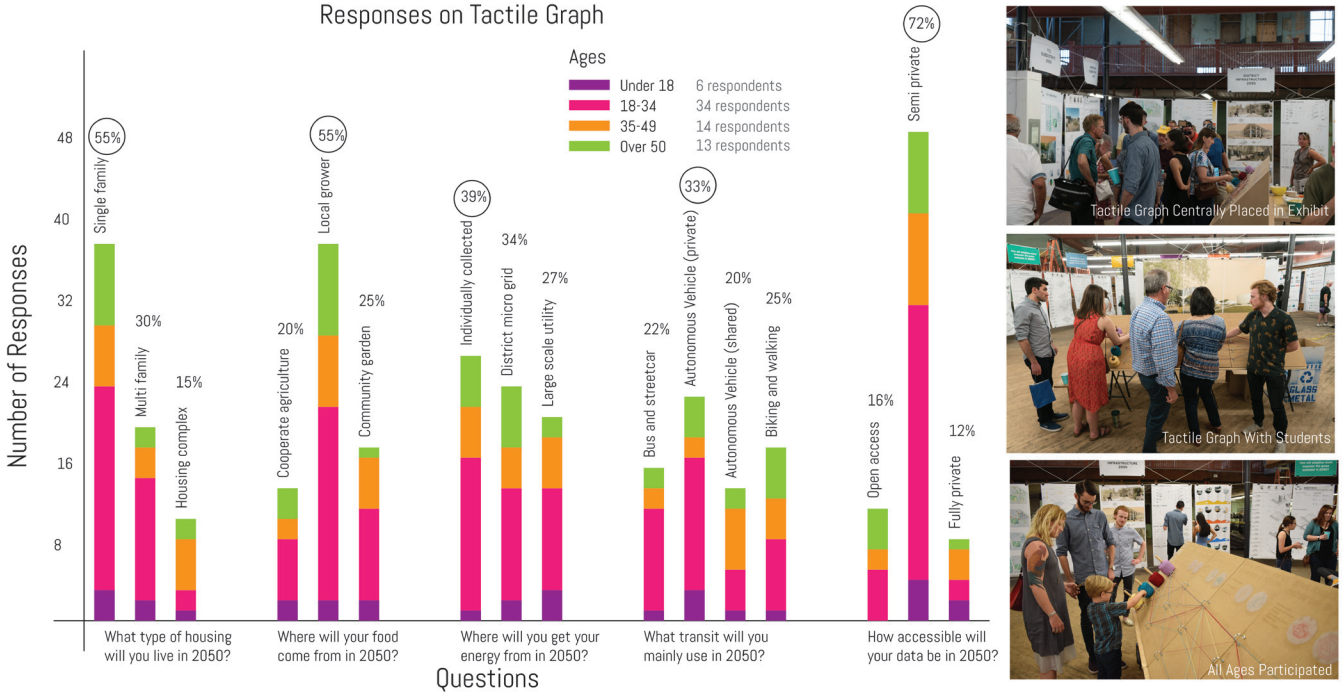

Figure 2: Tactile Graph. Image credit: ARCH 451a Spring 2018 Studio, Ben Stewart.

and virtual reality scenes across three sub-districts: (1) Mercado residential sub-district, (2) Tucson Convention Center civic sub-district, and (3) Congress commercial sub-district (Figure 3 and 5).

Engagement and Evaluation tool: A total of six rendered future scenes (two scenes for each of the three sub-districts) were displayed through virtual reality headsets for greater public comprehension (such as urban farming with native species on a roof deck or a multi-modal street shaded by solar panels). A verbal survey was administered through Qualtrics software after experiencing the six virtual reality scenes. Demographic data for each survey participant was taken before the headset was worn (Figure 3).

Future Infrastructure and Visual Maps

Visual Product: Four infrastructures of energy, transportation, water, and open space (living infrastructure) were integrated to tie the total downtown vision together. These were displayed in posters and a physical model (8'x8') of downtown with the three sub-districts integrated through the four infrastructures.

Engagement and Evaluation tool: Two large posters of Tucson Today and Tucson in 2050 solicitated public feedback. Participants used three colors to mark the two large posters (red=do not like, yellow=area of interest, green=like). This data was used to understand what citizens liked or did not like about the new anchoring images (Figure 4).

RESULTS

The exhibit engaged over 350 community members that attended over the two nights. The results from the three engagement and evaluation activities that were stationed within the exhibit showed an overall trend in willingness to accept the new anchoring images as visions for 2050 downtown Tucson. Of the activities, the tactile graph had the highest number of participants (Figure 2, at 67 respondents) followed by the verbal survey with the VR headsets (Figure 3, at 37 respondents) and finally the visual maps (Figure 4, at 26 respondents). This may be due to the short time commitment and central placement of the tactile graph. The verbal survey was novel and alluring with its virtual reality headset component. The visual maps were the most conventional engagement activity and drew less attention by the public. Overall, the exhibit drew from across ages, genders, and residents of multiple neighborhoods. The majority were between the ages of 18-34 and lived in or adjacent to downtown.

Tactile Graph (Figure 2, at 67 respondents)

Based on the tactile graph, the average participant believed that in 2050 they would live in a single-family house, buy their food from a local grower, get energy that was individually collected, use private autonomous vehicles, and have data that was shared semi-privately. These responses where middle-of-the road sustainable – neither favoring the responses that were 'most sustainable' or 'least sustainable.' These responses, on the whole, favored answers that gave some amount of privacy whether living in a single-family home (rather than denser

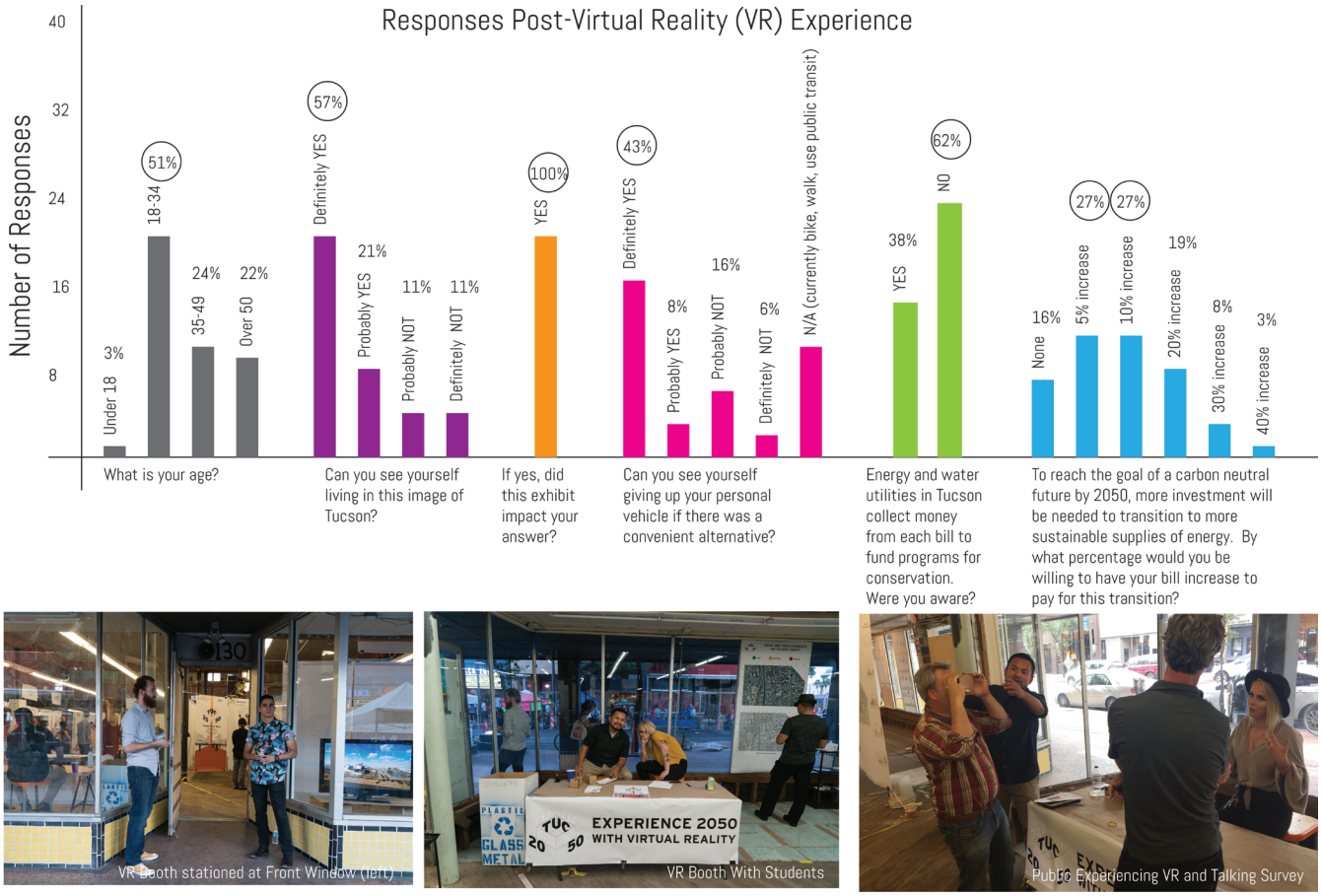

Figure3: Virtual Reality Engagement. Image credit: ARCH 451a Spring 2018 Studio, Thomas Yazzie and Madison Neperud.

multifamily building), riding in a private autonomous vehicle (rather than a shared vehicle), or making their data semi-private (rather than completely open). Though respondents were willing to adopt some new behaviors in their 2050 vision of themselves, they also favored a lifestyle with individual control rather than a complete and open sharing. The majority (51%) of respondents were between the ages of 18-34, with ages 35-49 at 21%, over 50 at 19%, and under 18 comprising the remainder.

Verbal Survey (Figure 3, at 37 respondents)

After experiencing the exhibit, 78% of 37 respondents said that they could see themselves living in the future community presented in the exhibit (a definitely yes or probably yes response). The majority of attendees claimed a willingness to pay an increase of 10-20% on their energy and water bills to fund the sustainable infrastructure shown in the exhibit, with an upper bound of 30% by 8% of those surveyed. Similar to the tactile graph, the majority (51%) of respondents were between the ages of 18-34, with ages 35-49 at 24%, over 50 at 22%, and under 18 comprising the remainder.

Visual Maps (Figure 4, at 26 respondents)

Of the 26 respondents, most focused on civic spaces and historic structures. On the current day map, there were 14 red 'problem areas' recorded with 24 green 'positive' responses. Problem areas were concentrated around the Tucson Convention Center, though several areas were marked. On the 2050 map, there were 14 green 'positive' responses evenly distributed throughout the designed district.

Overall, the exhibit gained broader traction in the Tucson community with media coverage and state awards. The exhibit was covered in local magazines (Figure 5), regional television, and multiple interviews on local radio programs. The project has won awards for education: Association for Environmental Studies and Sciences (AESS) national President's Award for Educational and Environmental Collaboration and Excellence and the American Institute of Architects (AIA) Arizona Chapter 2019 Design Award for Community Education. The overall Tucson 2050 project won an award for leadership in 2017: the ACSA/AIA national Practice and Leadership Award.

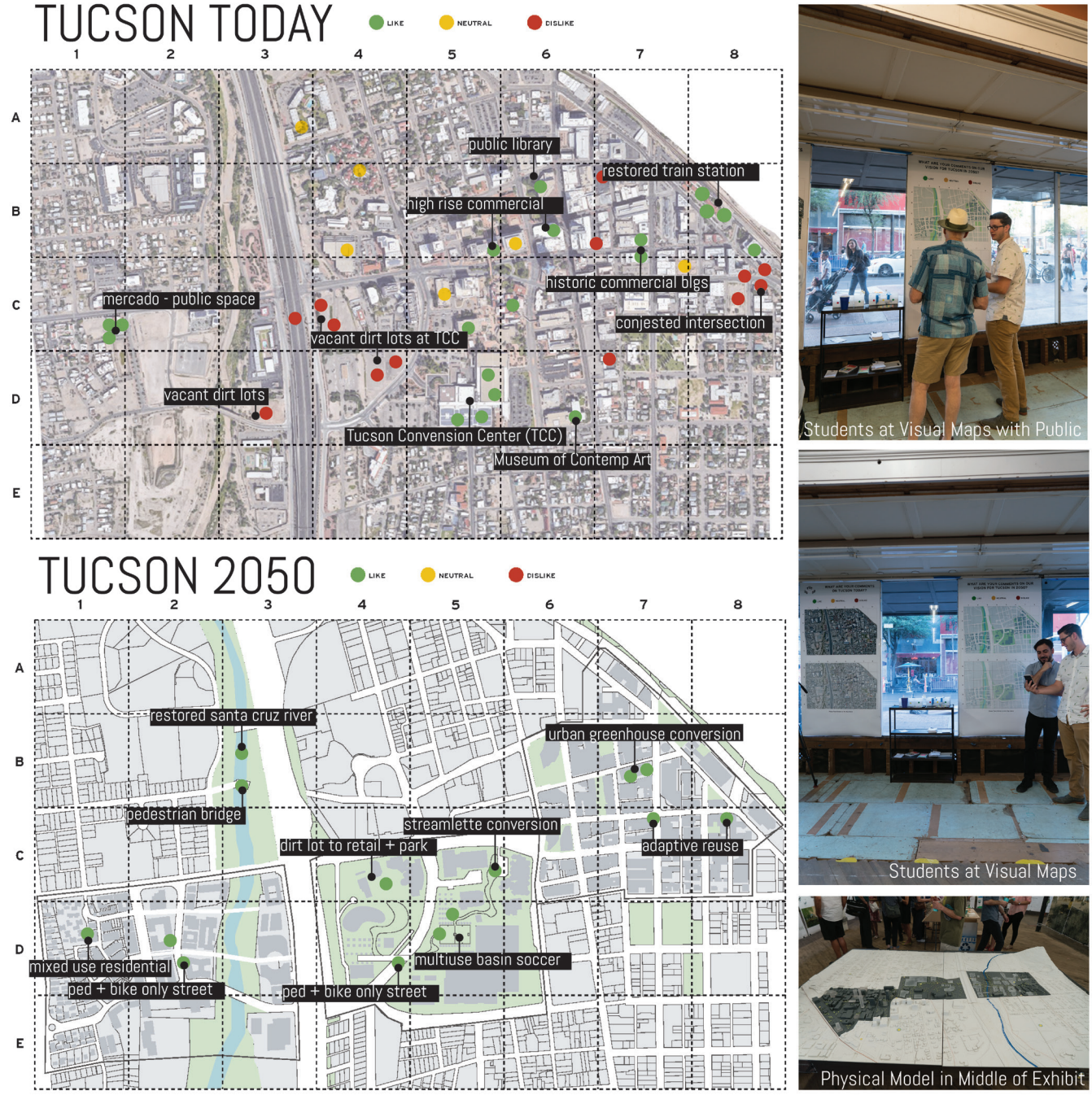

Figure 4: Visual Map Engagement. Image credit: ARCH 451a Spring 2018 Studio, Jeremy Goodman and Jason Sciarrotta.

DISCUSSION

The goals of the Tucson 2050 public exhibit were two fold: (1) engage citizens in envisioning the future sustainability of their city's long-term policy adoption and (2) provide feedback to government on citizens' willingness to invest ahead of voting. The first goal sought to correct potential decision-making distortions and 'the silence of climate change' effect. This section discusses the degree to which these two goals were achieved with the new visual anchors and three community engagement methods.

Engaging Citizens in Envisioning the Future Sustainability of Their City

As a tool for engagement and quick community response, the tactile graph was most effective. It drew the greatest number of responses and let citizens see and discuss the preferences of their fellow community members. However, this data collection

design may have a strong response bias as respondents could have been swayed by seeing their peers' responses on the visual graph. Despite this critical weakness in objective data collection design, the tactile graph was the most successful tool for facilitating community engagement and discussion.

The verbal survey with the virtual reality images did not have this issue of respondent bias – all responses were confidential and anonymous. This tool was the best at collecting targeted responses to understand community preferences, change in preferences based on the new anchoring images, and willingness to invest in the displayed visual future. Of the positive respondents, there was universal agreement that the exhibit swayed their response. Thus, this tool is best for data collection, but is a weaker tool for quick engagement and facilitating community discussions.

The mapping exercise was useful to specifically locate community preferences. Though this tool seemed less appealing to attendees, it remains a classic and important tool for planning and design professionals to glean the information they need to complete master planning and design work. Respondents tied comments directly to geographic areas and categorize their views as positive, negative, or neutral.

Overall, the exhibit was successful at engaging a set of future architects (and their friends and classmates) in envisioning the future of their city and government officials in envisioning new solutions outside of the traditional, assumed answers. Through the process, City and County experts engage across departments and jurisdictions with young designers to integrate current policy and thinking into a holistic vision for the city's future. The five government mentors universally noted that the conversations facilitated by the project rarely occur in the course of their work. The exhibit taught students an iterative process in design-research that dialogued between a possible and desired future by citizens using the expertise of City and County leaders. Further, the exhibit connected with citizens off the streets who attend Second Saturday to experience a future outside of many of their assumptions.

Providing Feedback to Government on Citizens' Willingness to Invest Ahead of Voting

For the second goal, the exhibit and engagement activities were useful to beginning discussions on potential futures for Tucson downtown. To get hard data able to feed into focused policy, future work is needed. Based on the interests areas expressed by participants, future work can continue to flesh out more specific areas that will lead directly to policy. Future exhibits, for example, could look solely at increasing walkability and bikability and test strategies to accomplish this through visual aids. Though the feedback from the three activities of this exhibit were useful facilitators to sparking discussions at the exhibit and between the community mentors after the exhibit, the evidence is still circumstantial in terms of direct policy implications. What can be said is that of the attendees of the exhibit, the visual images had a strong effect on their perception of the future and their willingness to invest in this future. The method of the exhibit and engagement were effective, but could be better linked with direct policy questions in the future.

CONCLUSION

Tucson 2050 is a model for bottom-up change empowered by the visual communication skills of architecture. It is a model through which architects can connect with government officials and the public on cohesive visions for sustainable urban designs. As a result of the work, the project has secured multiyear investment from private and public partners. Future work will collaborate in a more focused way with government officials to identify key policy questions that can be envisioned through design and engaged through visual displays and interactions. Overall, the exhibit provided evidence that visual material as anchoring images of a possible future is an important and effective tool to engage a broad base of citizens. The School of Architecture and the author are currently involved in discussions on how to aid the City in eliciting early public opinion and feedback to identify 'winning' issues ahead of the next general plan cycle starting in 2022. Architects can play a critical role in shaping and inspiring public opinion on possible sustainable futures for our cities.

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Figure 5: Media Coverages and Postcards from 2050. Image credit: ARCH 451a Spring 2018 Studio.

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