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ENVISION AS CHOICE ARCHITECTURE: CAN SMARTER DEFAULTS LEAD TO MORE SUSTAINABLE DESIGN?

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ABSTRACT

The Envision rating system is a design tool to evaluate, grade and reward infrastructure projects that meet sustainability criteria such as reductions in greenhouse gas emissions, preservation of wildlife habitat, and accessibility to community cultural resources. Inherently embedded within the Envision system is "choice architecture", which is the numerous ways information can be presented to a decision maker. In our research, we examine how Envision's current choice architecture, as well as adjustments to it, might encourage more sustainable choices. The current default in each category of Envision is zero points, and projects earn points by improving upon industry norms. Students in a sustainable construction course randomly received the current Envision version or a modified version with a higher default score. Students used the rating system to design an outdoor community center and stream restoration brownfield site. We found the more ambitious default led to higher achievement score. Participants in the modified group processed the decision information different than the standard group. We recognize more research is needed to bridge behavior science and infrastructure planning but these findings suggest choice architecture, one behavioral approach, is a relatively low-cost method to meet more sustainable infrastructure. We describe other choice architecture interventions, which warrant further study as they may influence other civil engineering decision tools.

KEYWORDS: Envision Rating System; Choice Architecture; Sustainable Infrastructure design

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INTRODUCTION

Choice architecture refers to the many different ways information can be presented to a decision maker and how the framework of choices inevitably influences the decision (Thaler & Sunstein, 2008). Even when two methods of posing a choice are formally equivalent, each presentation may give rise to different psychological processes. Choice architecture can be socially beneficial, as seen when driver's license applicants are asked to check a box on a form if they do not want to be an organ donor. In countries where this opt-out choice architecture is in place, the percentage of organ donors is significantly higher than in opt-in formatted countries which require license applicants to check a box stating their wish to be a donor (Johnson & Goldstein, 2003).

Choice architects, those who design choices, are comparable to building architects. Just as there is no neutral building architecture: the size, shape, and materials of a building determine how users interact with the space. There is no neutral choice architecture: presenting options before others, grouping options together, pre-selecting choices, or framing attributes has positive or negative influence on decisions[3].

Choice architecture theory is being applied to improve decision processes in fields from medicine to law to finance (e.g., organ donation, tort law, retirement savings) [4]. We ask how can these same choice architecture theories improve decision processes in infrastructure development (e.g., planning and design of roads, water systems, ports, and electricity grids)? Engineers, architects, contractors, and other groups who design and build infrastructure commonly rely on planning tools such as the Envision rating system to develop their designs. This study examines Envision's current choice architecture and explores changes to its default settings.

Envision is used to evaluate, grade and reward construction projects for meeting sustainability criteria such as reductions in greenhouse gas emissions, preservation of wildlife habitat, and accessibility to community cultural resources. Founded by the American Society of Civil Engineers, the American Council of Engineering Companies and the American Public Works Association. Envision is applicable to all infrastructure projects, i.e. roads, bridges, pipelines, railways, airports, dams, levees, landfills, and water treatment systems ("EnvisionTM Sustainable Infrastructure Rating System," 2012). This broad application is unique (Clevenger, Ozbek, & Simpson, 2013). For example, Leadership in Energy and Environmental Design (LEED) is limited to improve a building's sustainable design only after the decision is made to construct a new building. Envision can help decision makers choose which type of infrastructure, if any, is most sustainable for surrounding networks. Additionally, Envision is a two-stage assessment. Stage one is a checklist for conceptual planning and early design. The checklist helps educate the project team about the assessment criteria and works to establish project goals and priorities ("EnvisionTM Sustainable Infrastructure Rating System," 2012). Stage two is the rating system intended to guide detailed design, engineering, and construction decisions. Our research focus is the stage two rating system because of the likelihood

[3] For more on choice architecture methods see (Johnson et al., 2012; Thaler & Sunstein, 2008).
[4] Organ donation see (Johnson & Goldstein, 2003); Tort law see (Johnson, 1993); retirement savings see (Madrian & Shea, 2000).

to influence specific design details. For example, stage one asks, *if* low impact development (LID) techniques will be implemented on the project. This is a simple yes or no question. Stage two asks *which* LID techniques will be implemented and how they plan to implement them.

The stage two rating system awards points in 60 credits distributed under five categories ("Envision™ Sustainable Infrastructure Rating System," 2012): Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk. Similar to LEED, these points accumulate towards a certification: Acknowledgement of Merit, Silver, Gold, or Platinum. However, unlike LEED, Envision distributes points by achievement levels. Users choose to meet one of five levels: *improved, enhanced, superior, conserving,* or *restorative*. A project that *improves* the natural world receives fewer points than a project that *restores* the natural world. Users then explain how they plan to meet the level of achievement chosen. The number of points and application varies by credit. For example, reducing green house gas emissions at the restorative level achieves 25 points while assessing climate threats can only achieve the *conserving* level, at 15 points. Envision believes cutting CO2 emissions alone is not enough to meet true sustainability and must include measurements about project leadership, community engagement and the delivery processes ("Envision™ Sustainable Infrastructure Rating System," 2012). Credits are evaluated through life cycle assessment calculations (e.g. CO2e) or written narratives (e.g. explain the steps taken to receive community feedback). Once the rating system is complete, teams can submit for third party verification and certification.

Table 1: Example of Credit Rating and Order of Achievement Levels

<table>
<tr><th colspan="5">NW2.3 PREVENT SURFACE AND GROUNDWATER CONTAMINATION</th></tr>
<tr><td colspan="5">INTENT: Preserve fresh water resources by incorporating measures to prevent pollutants from contaminating surface and groundwater and monitor impacts over operations.

METRIC: Designs, plans and programs instituted to prevent and monitor surface and groundwater contamination.</td></tr>
<tr><td colspan="5">LEVELS OF ACHIEVEMENT</td></tr>
<tr><td>IMPROVED
Possible points: 1</td><td>ENHANCED
Possible Points: 4</td><td>SUPERIOR
Possible Points: 9</td><td>CONSERVING
Possible Points: 14</td><td>RESTORATIVE
Possible Points: 18</td></tr>
<tr><td>Design for response.</td><td>Long term monitoring.</td><td>Design for prevention.</td><td>Design for source elimination.</td><td>Remediate existing contamination.</td></tr>
</table>

BACKGROUND: ENVISION AS A CHOICE ARCHITECTURE TOOL

Choice architecture is inherently embedded within the Envision framework: credits are partitioned into categories, achievement levels are associated with points, points are supported by detailed descriptions, and a default number of points are awarded to users at the beginning. Intuitively or deliberately, these features may influence the decision process. We explain by drawing connections between established choice architecture theories and the Envision rating system framework.

Our review of choice architecture began with nine theories presented in

Beyond Nudges: Tools of a Choice Architecture (Johnson et al., 2012). We examined each theory's supporting literature and underlying psychological process. For example, defaults were presented as an application to decision inertia. We reviewed examples in investments (Madrian & Shea, 2000), insurance (Johnson, 1993), and organ donation (Johnson & Goldstein, 2003). Then searched for the underlying psychological theory in each example. This led to judgment and decisions making literature in goal framing (Heath, Larrick, & Wu, 1999; Levin, Schneider, & Gaeth, 1998), satisficing (Weber et al., 2007), and loss aversion (Khaneman & Tversky, 1979). A search for these same psychological processes in other fields produced literature in energy policy (Houde & Todd, 2010), consumer behavior related to energy consumption (Allcott, 2011; Ayres, Raseman, & Shih, 2012), and environmental psychology (Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008). In each field, choice architecture concepts are viewed as a method to improve the decision process (Thaler & Sunstein, 2008) and our research suggests the same. We explored choice manipulations as a method to improve Envision decisions. But before we explain the manipulation we made to Envision, we discuss three choice structures that already exist to improve the decision process. These choice structures originate from our literature review started with Beyond Nudges and we draw connection to the application within Envision.

Partitions improve the decision making process. When presented with too many options, people can become overwhelmed, indecisive, unhappy, and even refrain from making a choice—a phenomenon called choice overload. Grouping decisions by features and presenting questions in a linear framework are shown to reduce these feelings produced by choice overload and reduce the time needed to make a decision (Fox & Langer, 2005; Martin & Norton, 2009). Each choice within the given partition will likely receive the same amount of decision time and weighting (Levav, Heitmann, Herrmann, & Iyengar, 2010).

Envision groups 60 credits into 5 categories. These categories are subdivided and related credits are linked together. For example, Quality of Life includes three subcategories: purpose, community and wellbeing. Envision draws connections between credits QL1.2: Stimulate Sustainable Growth and Development and QL1.3: Develop Local Skills and Capabilities because both credits deal with attracting businesses as a method to create local jobs. Partitioning credits under subcategories and showing connections to other credits provides a systemic method to navigate the system, which possibly reduces choice overload. Rather than seeing all 60 credits at once (each with approximately 5 levels of achievement for a total of 275 decisions), users have a limited vantage point, seeing only one partitioned category at a time. Partitions are also likely to balance users' time and decision-weight between categories. For instance, features like climate risks, which typically receive little consideration in project planning, may now receive equal consideration to features like resource allocation or project finance risk.

Overcoming status quo bias through a reward system. Status quo bias is the reluctance to change one's current position. In Pennsylvania the status quo for auto insurance is the "Full Right" to sue and challenging the status quo means asking for

"Limited Right" to receive a discount. In New Jersey, "Limited Right" represents the status quo and policyholders must actively ask for "Full Right." Johnson et al (1993) showed that the reluctance to break status quo meant 75 percent of Pennsylvania motorists obtained "Full Right" yet only 20 percent in New Jersey. This difference translates to more lawsuits filed in Pennsylvania (Fischhoff & Kadvany, 2011).

Envision is a decision tool that guides infrastructure engineers away from conventional practice. Plans that keep with convention (status quo) receive no points while plans to achieve the restorative level receive the greatest points. The decision to use Envision, or not, is like that of car owners deciding between Limited and Full right to sue. Envision helps with how, but the motivation to change the status quo must come from somewhere else. The City of Dallas, the Port of Long Beach, and Massachusetts Water Resource Authority are making that movement. Each requires project teams to use Envision to submit a proposal. Just as car owners trade benefits (limited right) for cost (high risk) infrastructure teams may feel similar trade offs. Moving away from the conventional industry design may perceive higher risk. The benefit can be a new project, public recognition or possible monetary bonuses from owners. As the new requirement to use Envision is implemented, firms will decide if the benefit is worth the potential risk.

Detailed descriptions increase confidence. Past experiences, or subject knowledge, can inform current decisions. However, this can lead to overconfidence in judgment of risk. For example, someone knowledgeable in football will feel more confident about predictions in obscure football events than in gambles of chance (such as a coin toss), even when the probabilities of both are exactly the same (Fox & Tversky, 1998; Heath & Tversky, 1991). To shift cognitive focus away from decisions based on experience, choice architects can provide more detailed descriptions of the options they want users to consider (Erev, Glozman, & Hertwig, 2008; Khaneman & Tversky, 1979). In essence, the extra description counter weights past experience changing how information is collected then processed through the brain.

When engineers use previous construction knowledge to justify current project performance, their current decisions have been informed by their prior experience. If past decisions kept with the industry norm, a reluctance to depart from these norms can develop and may led to underweighting innovative design solutions (Beamish & Biggart, 2010). Envision shifts decision weighting from experience to description by prompting users with questions about how the design team plans to explore new options. For example, "Has the project team identified and assessed possible changes in key engineering design variables?" ("Envision™ Sustainable Infrastructure Rating System," 2012). To answer these questions, Envision provides documentation and links to technical details of engineering design. This added information might improve user confidence levels and motivation to create new designs that meet longer-term objectives.

Defaults as a choice architecture. While partitions, points, and details create an Envision framework that guides users during the decision making process, we believe more can still be done to encourage the highest levels of Envision achievement—in particular meeting *conserving* and restorative goals. Here, we explore whether changes to one type of choice architecture, defaults, may impact design outcomes.

Each category of Envision begins at a default of zero points, and infrastructure projects can earn points by improving upon the industry norm. We study whether a more ambitious default, set to *conserving* (four levels above the current default), will lead to higher point scores. Users, who uphold the default, keep the points at the *conserving* level. While users that move to the industry norm lose the endowed points and receive a lower score. Changing the default option may shape users' preferences about sustainability choices differently and, as a result, infrastructure projects may achieve higher points. We explain how these user preferences are constructed. And while there are many choice architecture strategies, we focus here on defaults to construct user preferences about infrastructure design options. Our rationale is supported by query theory, in which choices are made based on a linear series of questions and these questions are dependent on the starting point, or default (Johnson, Häubl, & Keinan, 2007). Initial questions produce longer richer responses than later questions and, subsequently, this impacts the outcome (Weber et al., 2007).

Defaults can influence the linear series of questions in three ways: *effort, endorsement,* and *reference dependence* (Dinner, Johnson, Goldstein, & Liu, 2010). *Effort* references the cognitive energy exerted to make a decision. Employees who do not select a 401(k) plan, displaying a lack of *effort* to make a decision, still save money because of a predetermined default of 3 percent annual investment (Madrian & Shea, 2000). *Endorsement* means decision makers perceive the default as the recommended option because it reflects the most commonly chosen or fits within the social norm (Brown & Krishna, 2004; McKenzie, Liersch, & Finkelstein, 2006). Shoppers who believed a manufacturers default product option was selected in earnest, representing the best features and not solely the most expensive, were more likely to stay with the default option (Brown & Krishna, 2004). *Reference dependence* means the default frames the outcome as a loss or gain and this frame impacts the decision (Dinner et al., 2010). Car buyers first shown the "fully loaded" package perceive lesser models as having lost features (Park, Jun, & MacInnis, 2000). Meanwhile, car buyers first shown the base model perceive those same features as add-ons. This feeling of loss or gain is reference dependent on the starting point.

HYPOTHESIS

We suggest Envision users make infrastructure decisions, similar to consumers, by constructing preferences about options. These preferences are dependent on the reference point, or default. We also suggest, Envision may unintentionally discourage achieving the even higher levels of sustainability performance that are possible. Changing the Envision default from industry norm (i.e. base car model) to the *conserving* level of achievement (i.e. high feature car model) users will achieve more points (i.e. subtract less features) and create more sustainable designs. Table 2 shows our modified scale. Currently arranged, Envision rewards 1 point *(improved)* for creating a spill prevention plan and 14 points *(conserving)* for eliminating all potential polluting substances. The modified scale makes the 14-point option the default. Additional points are only possible by achieving the highest level, *restorative*. Achieving below the new default results in a loss of points. Now, a spill prevention plan subtracts 13 from 14 points rather than adding 1 to the 0 points. The final amount of points for each level of achievement remains the same in both versions. The only change is the process to achieve them. The new scale endows users with points (value) at the beginning and we hypothesis this restructuring will change user preferences about options and ultimately lead to a higher score and detailed design.

The *conserving* level of achievement was chosen as the modified default because it represents the environmental neutral. This means the infrastructure development plan neither harms nor improves the surrounding community or environment—the bare minimum requirement for true sustainability.

Table 2: Modifications to Envision rating scale

NW2.3: Prevent Surface and groundwater contamination.		
Levels of Achievement	*Current Scale*	*Modified Scale*
Industry Convention	*0**	(-14)
Improved	1	(-13)
Enhanced	4	(-10)
Superior	9	(-5)
Conserving	14	*14**
Restorative	18	(+4)
* Indicates default number of starting points.		

Our hypothesis follows Khaneman and Tversky's (1979) study that found a loss provokes greater degrees of discomfort than a gain provides satisfaction, by roughly a factor of two. People who own an item value its worth twice as much than if they did not own the same item (Thaler, 1980). Functional magnetic resonance imaging (fMRI) brain scans show physical mental differences in people asked to add or subtract. Subtraction takes more cognitive energy and occurs in regions closer to the emotional region of the brain (Gonzalez, Dana, Koshino, & Just, 2005; Yi-Rong et al., 2011).The effects of framing (loss or gain) take little time to establish (Khaneman, Knetsch, & Thaler, 1990), and we suggest simply changing the default may be enough to promote higher scores. Envision users currently gain points. Shifting Envision users from a point gain to a point loss frame may lead to higher motivation to keep the points in an effort to avoid the discomfort felt by a loss.

This study builds on previous judgment and decision making research, but differs in several ways. We set a default with points, rather than product features, which may lead to different outcomes or perceived value. Envision users are not choosing options about a product for purchase, but rather to influence a physical design, and this may cause users to construct preferences differently than previous studies suggest. We are also asking questions with multiple attributes, meaning users are choosing between 5 options, not just opt-in or opt-out choices. This may alter the degree of influence of the default option on the decision maker. Finally, this is the first study examining engineers' decision making by varying choice architecture. In the conclusion, we detail future studies with Envision and suggest a path for other researchers to examine choice architecture of additional engineering planning and design tools.

METHOD

Our study focused on student decisions when using the Envision rating system. Student participants from an undergraduate sustainable construction course were given a case study and asked to chose design options from two of the five Envision categories: "Quality of Life" and "Natural World" (26 of the 60 available credits). These categories asked participants how to improve community mobility, preserve cultural resources and green fields, and manage storm water runoff. The other three Envision categories were not included because they require Life Cycle Assessment calculations and identifying project team management structures and this information was not provided in the case study. Additionally, reducing the number of credits participants answered reduced the time and the cognitive load to complete the assignment.

Participants were given class credit for completing the rating system. Their grades were only based on completing the assignment and not based on achievement. We stated this during the lecture and in the case study instructions. Student participants were randomized to receive one of two Envision versions: the standard starting point with 0-points (*standard version*) or the modified starting point with 304-points (*modified version*). Participants were made aware of the possible loss or gain frame. Those who received the modified version read "Decisions made below the *conserving* level will lose you points. Decisions made above the *conserving* level will earn you points". The standard version read, "You are starting at the industry norm benchmark with 0 points. Every decision you make above industry norm will earn you points".

Our online software captured each design decision and written explanation. The online software also created a minimum number of words required for the explanation. This minimum increases with levels of achievement. For example, selecting the *improved* level of achievement requires 100 words and the *restorative* level requires 300 words. Requiring a minimum number of words reduced the likelihood participants would cheat to maximize points (selecting the highest levels of achievement for every credit) by creating a cost (writing a lengthy description). We tested and modified the word count using feedback from preliminary studies. Students preferred character minimums, rather than word minimums, and a 50-character difference between achievement levels. Users were able to identify credits as not applicable to the project, but were then required to justify why the credit was not applicable. Points for credits not applicable were deducted from the total achievable points in the system.

Survey. We define motivation as importance and effort. We measured motivation to identify if the modified default created greater participant motivation to not lose points. We used eight questions, adapted from previously developed post-task motivation surveys (Fernet, 2011; Thelk, Sundre, Horst, & Finney, 2009; Watson, Clark, & Tellegen, 1988; Wolf & Smith, 1995). Additionally, we asked if those achieving above or below the 304-point default were more or less confident than those in the 0-point default. If not meeting the 304-point default discourages future use, a higher default may not be preferred. Often, the influence of choice architecture is unnoticed by decision makers and a difference in dependent variables is minimal (Thaler & Sunstein, 2008).

We asked participants if they were aware of the default and to explain if this influenced their decision process. Mindful, or not, participant' responses would provide supporting evidence for or against our basis of query theory. We also controlled for variations in experience between participants by asking about previous internships or jobs related to the case study topics. All survey questions followed a likert scale (1=strongly disagree to 5=strongly agree) or open-ended response.

Procedure. During an in-class lecture, undergraduate student participants in a sustainable construction course learned about Envision's purpose and how to navigate and select project features. Participants were told they represent the sustainability coordinator for a project team designing an outdoor community center and stream restoration on a 0.4-acre brownfield site in rural Alabama. The Envision system would help them make site design decisions about cleanup, restoration, and construction. Participants were given the site's EPA Environmental Assessment and the community revitalization mission statement. Details like how to clean site contamination, whether to include bike paths, and where to place the outdoor community center were not provided. Each participant used the Envision credits to make individual decisions. For example, Credit NW2.2 asks if "Low Impact Development" (LID) guidelines were used to manage storm water runoff. Participants reviewed specific LID guidelines, provided by the online rating system, and then decided if and how to incorporate LID features into the project. Participants negotiated between 26 credits, choosing which were most valuable, achievable, and in line with project goals.

RESULTS

As expected, a higher default led to a higher final score. The modified group (n=16) averaged 63 percent (214/343) of applicable points and the standard group (n=25) averaged 44 percent (147/329). Scores were evenly distributed on a normal curve and a one-tail t-test identified that the difference was significant, $p=0.002$. Only two students from the modified group achieved higher than the conserving 304-point default. Thus, most modified group participants lost points while all standard group participants gained points.

If all credits were held applicable, the total possible achievable points would have been 384. Over 75 percent of all participants selected at least one credit as not applicable. The modified group held more credits applicable, 343 points, compared to the standard group, 329 points, and the modified group achieved more of these points. No significant difference ($p>0.1$) was found between group times to complete the rating process and the average time to complete the rating process was 1 hour 56 minutes.

The total scores were evenly distributed between categories. Meaning, participants equally prioritized Quality of Life and Natural World credits. The modified group achieved 68 percent (117/172) in Quality of Life and 60 percent (97/171) in Natural World. The standard group averaged 43 percent (71/167) in Quality of Life and 46 percent (75/163) in Natural World. Median values for each category were within 5 points of the average values. The results, shown in Figure 1, are divided by category and stacked showing the cumulative score.

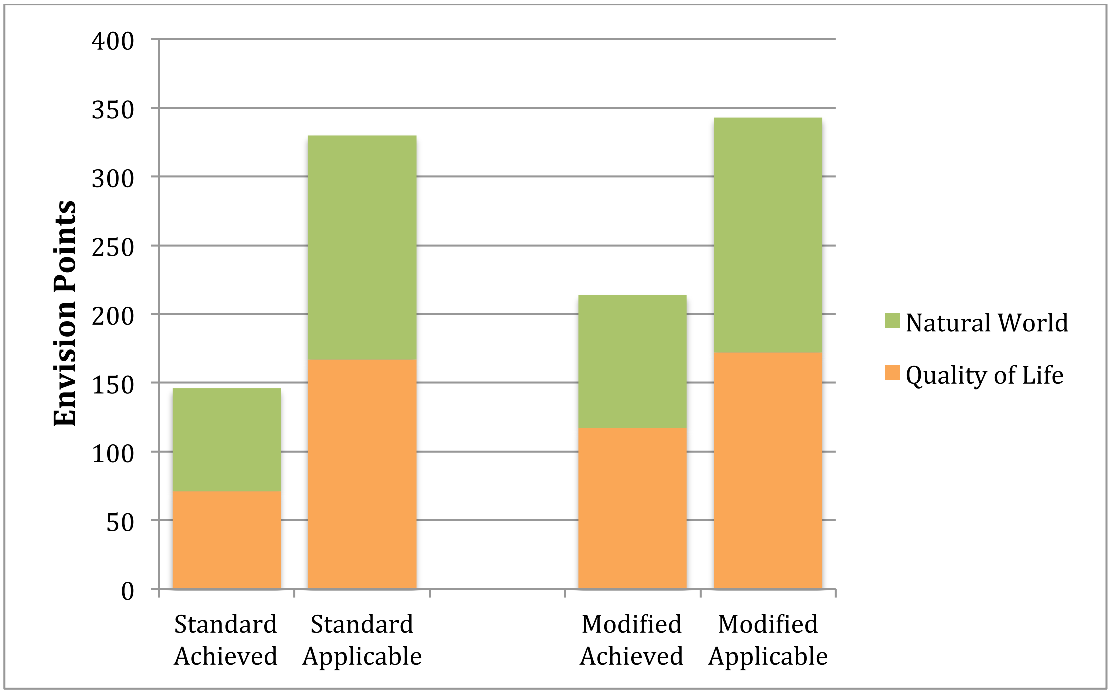

Figure 1: Standard and Modified Average Points, Achieved and Applicable

Survey responses indicated no difference in student motivation between groups. Those losing points viewed the rating process with equal effort and value as those in the standard group. Additionally, we asked if those achieving above or below the 304-point default were more or less confident than those starting with 0 points. Both groups were equally confident in their scores. And while the number of participants who scored above the conserving default was low, only two participants, both participants indicated their scores were average compared to the rest of the class. Participants from the modified group who lost points were equally happy compared to those in the standard group. Both groups believed a project could be considered sustainable by meeting the *improved* level of achievement.

We asked participants in the modified group if they were aware of the default and to explain if this influenced their decision. Of the 15 who answered the survey, two correctly answered 304 points as the default starting point, seven provide an incorrect value, and six indicated zero points. Seven of the nine participants that indicated the default number of points were greater than zero indicated the default influenced their decisions. Open-ended responses captured participants' explanations. Those mindful of the default explained, "I at least tried for conserving each time. I looked at the requirements for conserving and then thought how I could make the project reach that requirement." Another participant said, "I started at the default setting, and tried not to lose points." These responses suggest a higher default can shift a decision makers' perspective without negatively representing the Envision rating system. In fact, the two highest scores, the participants who achieved 92 percent and 91 percent of the total possible points, were students who indicated they started with the conserving level of achievement and tried not to lose points.

DISCUSSION

Our findings support previous research in consumer decision making that states defaults influence how decision-makers process information (Levin, Schreiber, Lauriola, & Gaeth, 2002; Park et al., 2000). These findings also align with query theory. The higher default orients users to a higher level of achievement and, subsequently, this affects the outcome. The modified group was more likely to review requirements at the conserving level of achievement then decide to move up or down in levels. While some participants in the modified group were more aware of the manipulation than others, it was an effective method to increase the average sustainability score.

Defaults can be defined as an option that when no choice is selected a decision is still made (Brown & Krishna, 2004). Using this definition, defaults help reduce the cognitive energy needed to make a decision (Johnson, Bellman, & Lohse, 2002). However, in our study, the modified default demanded more cognitive energy to make a decision. Levav et al. (2010) suggests the more decisions made, the fewer cognitive resources available for future decisions. A phenomenon termed depletion effect. Our participants did not experience a depletion effect; both groups equally answered credits in Quality of Life and Natural World. This may be due to participants prioritizing credits prior to beginning the rating process. Or participants in the modified group using less cognitive energy to select a level of achievement, keeping the *conserving* default, and exerting this saved energy to explain how they met the *conserving* level.

Previous research suggests, defaults can endorse a choice as a social norm (McKenzie et al., 2006). However, our findings do not support this. Participants from the modified group did not view their scores differently than the standard group. The modified default did not change participant' perceptions about sustainability or the Envision rating system. Those who met the *improved* level of achievement felt equally confident and happy in their score as those that met the *conserving* level of achievement.

We originally hypothesized the modified group would feel greater motivation to meet the higher default. We found no noticeable difference in self reported post task motivation questions. The participants from the modified group that could recall the correct default number of points achieved the highest percentage of points out of all 41 participants. Placing even more emphasis on the default may lead to even higher scores and we explain possible future studies of this research in the conclusion.

Envision's standard default preserved a low benchmark reducing the possible higher levels of achievement that were possible. Our higher default lead designers to achieve the highest possible certification given by Envision. Envision denotes certification by a percent of points: Certified (20 percent), Silver (30 percent), Gold (40 percent), and Platinum (50 percent). Our modified default increased recognition from Gold to Platinum - an average increase by 19 percent.

Limitations of the study are the participants and the case study. Preliminary design goals often change due to monetary budgets, project schedules, and multiple stakeholder objectives. We do not know how these early design decisions would hold through a final project design. However, starting with a higher preliminary Envision score could only help guide a project team to achieve a higher final score. Additionally, participants were aware this assignment was a one-time commitment. While there was no external motivation to embellish their design or choices, there were also no limitations not too. These student participants were enrolled in a sustainable construction course and already interested in sustainability topics. This could be a limitation but Envision is also a voluntary tool, and we believe, anyone using Envision will most likely be interested in using it and interested in sustainability. These results are based on student responses and we cannot draw conclusions about how choice architecture may influence civil engineering professionals. We can suggest choice architecture is an effective tool to help the next generation of engineers and make aware, a follow-up study is replicating research methods with an industry group to identify if findings are transferable.

CONCLUSION

Defaults are a specific type of choice architecture that determines the initial way users encounter options. Simply pre-checking a box is a powerful first impression. Private retirement plans with defaults set to invest, increase user savings (Cronqvist & Thaler, 2004; Madrian & Shea, 2000). Online shoppers purchase more expensive items when multiple product options are available and set to the highest priced default option (Herrmann et al., 2011). Now, we can add civil engineering students to the list of decision makers influenced by choice architecture. However, unlike previous studies, civil engineers are not consumers but professionals, in training, and their decisions will eventually influence physical infrastructures. Changing the choice architecture of engineering decision-tools is a relatively low-cost method to meet more sustainable infrastructure. The unique Envision framework allows for analysis on preference construction by measuring quantitative data in point outcomes, based on a change in value, and qualitative in design verification for each credit. Simply adding points for slight improvements unintentionally discourages the higher levels of achievement that are possible. Shifting the default to *conserving* reframes the internal questioning process of the decision-maker and subsequently encourages higher levels of achievement.

Broader Implications and Future Research. America's infrastructure systems must be designed using sustainable practices, ensuring functionality for future generations (ASCE, 2009). These findings can help meet this urgent need. Choice architecture influences up-front planning decisions. Defaults impact design outcomes. However, sustainable options are often a deviation from traditional practice, and this deviation creates cognitive barriers in the decision making process (Beamish & Biggart, 2010). Some choice architecture techniques are more powerful than others and choice effects may vary based on project structure[5] but findings from this study show promise.

[5] See (Levin, Schneider, & Gaeth, 1998) for an overview of choice shift, choice reversal or no effect in various domains and populations.

More research is needed to bridge connections between behavior science and infrastructure planning.

Specific to Envision, additional choice architecture studies could explore changes in commitment framing, goal framing, and greater emphasis to the reference point. For example, changing commitment could require users to explain why they could not meet the highest level of achievement. Credit NW 3.4 *improved* currently asks, "Does the project maintain or enhance one ecosystem function?" By reversing the commitment role, users would now "Explain why the project could not maintain or enhance all ecosystem functions" to meet the *conserving* level. This change in frame strongly implies a higher commitment, and may cause higher achievement.

Goal framing provides rules for setting a goal. Set too high and users could perceive the goal as unattainable and score less (Heath et al., 1999). In our study, participants viewed the *conserving* level of achievement as attainable and worked to achieve it. Future research should set an even higher default to identify when participants view achievement as too extreme. Another study could redesign the format of the rating system to place greater emphasize on the score. The participants in our study that could recall the modified default scored the highest percentage of the points. More emphasis on the score may increase awareness of the starting point and possibly lead to even higher achievement. Finally, an active intervention could teach participants why the conserving score is the least possible level for true sustainability and show examples of how this level is attainable.

Envision is one decision tool and we ask researchers to examine others. For instance, understanding how an engineer constructs preferences about material options when using Building Information Modeling (BIM) could help identify if shifting the order of options, number of clicks or default settings influences a change in choice. Engineers that use Intelligent Transportation System (ITS) software may perceive computer-based models as less risky than other forecasting methods due to the large data sets used to create the computer simulations. Through feedback loops we can identify how these forecasts impact project outcomes and analyze if these high confidence levels are confounded. ITS and BIM are two examples that hold high-impact decisions yet to be examined through choice architecture. We see these studies as primary research needs that hold potential to create more sustainable infrastructure at a relatively low cost to implement.

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