Developing Knowledge of Infrastructure Sustainability Using the ENVISION Rating System

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Abstract

Envision is the sustainability rating system that the American Society of Civil Engineers (ASCE) has developed to rate infrastructure facilities. The rating speaks to the triple bottom line of social, economic, and environmental goals. Existing rating systems such as *LEED* and *Greenroads* are sector-specific. A general system that covers all aspects of infrastructure does not exist, and *Envision* was designed to fill this gap. In rating America's infrastructure, ASCE evaluates capacity, condition, future need, operation and maintenance, public safety, resilience, and innovation. In the latest report card issued by ASCE in 2013, America's infrastructure collectively received a (D+) grade. Many of the facilities rated in this report card received poor grades and the highest grade achieved by any type of facility was (C+). This led to the realization of the need to identify areas of weaknesses and the attempt to improve the design process. ASCE identified the need to promote sustainability and resilience as an important starting point to enhance infrastructure performance. This approach resulted in the development of a rating system that helps designers score high marks in the design of infrastructure facilities by implementing features that increase resilience and sustainability. A course entitled sustainable infrastructure was developed and taught to highlight the advantages of sustainable design. The ENVISION rating system was introduced and explained in detail to heighten awareness of the need to implement in the design of a facility as many as possible of the features that contribute to a higher score on the sustainability scale. Students were excited to learn that many easy-to-implement features could be adopted in facility design and that would significantly enhance its rating and performance. This method of teaching showed the students the practical side of design and opened their eyes to the need to take a fresh look at innovative design possibilities.

Keywords

Sustainability, Infrastructure, ENVISION, Rating, ASCE.

Infrastructure

Infrastructure may be defined as: (1) large networks constructed over generations, which are not often replaced as a whole system; (2) a facility with a long or indefinite life; (3) systems or components that are vital for a functioning society; or (4) assets with high initial cost that can only be recovered over a long period of time.

In its 2013 report card on infrastructure, the American Society of Civil Engineers (ASCE) evaluated the condition of America's infrastructure and this resulted in a general grade of (D+). The infrastructure components that were evaluated are aviation, bridges, dams, drinking water, energy, hazardous waste, inland waterways, levees, ports, public parks and recreation, rail, roads, schools, solid waste, transit, and wastewater. It is worth noting that the highest grade any component achieved was (C+) and the lowest was (D-). A grade of (D) was qualitatively described as poor, which indicates at risk condition. The criterion used in assigning grades was based on capacity, condition, funding, future need, operation and maintenance, public safety, resilience, and innovation. ASCE-assembled a panel of 24 of the nation's leading civil engineers who analyzed hundreds of reports and studies. This panel reviewed all information from all available sources and surveyed over 2000 engineers to have a sense of what was happening in the field. ASCE estimates that the present total investment needs to maintain America's infrastructure is $3.6 trillion. As an illustrated example of ASCE's findings, Figure 1 shows a map of deficient bridges in the USA.

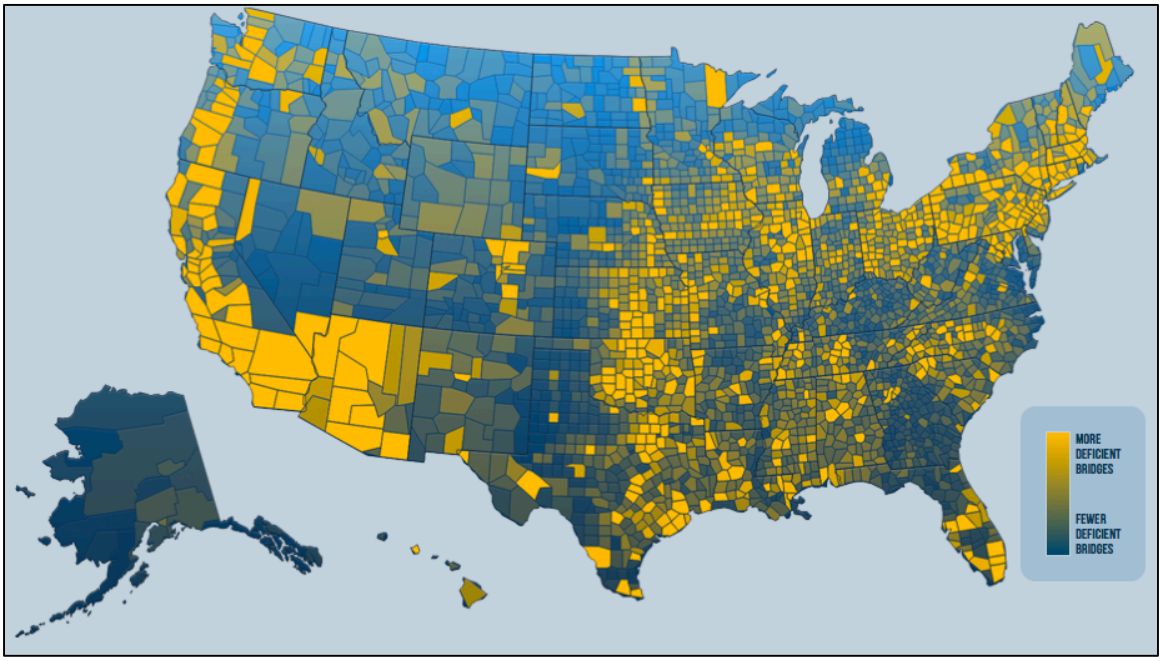

Figure 1. Deficient bridges in the USA (ASCE 2013 Report Card on America's Infrastructure)

Raising the Grade

The key solutions toward raising the grades of America's infrastructure as viewed by ASCE are: (1) increase leadership in infrastructure renewal; (2) promote sustainability and resilience; and (3) develop and fund plans to maintain and enhance America's infrastructure. To achieve this goal, ASCE developed the ENVISION rating system for infrastructure. ASCE indicated that the current rating systems for infrastructure in the United States were sector-specific, and that no system covered all aspects of infrastructure. ENVISION was designed to fill this gap and to help design and build better infrastructure facilities.

ENVISION provides industry-wide sustainability metrics for all infrastructure types to help users assess and measure the extent to which their project contributes to conditions of sustainability across the triple bottom line. It is about supporting more sustainable choices in infrastructure development. The system provides a flexible framework of criteria and performance objectives to aid local decision makers and help project teams identify sustainable approaches during planning, design, construction, and operation. It then further guides owners, communities, and designers in collaborating to make more informed decisions about the sustainability of infrastructure (ASCE [1]).

Enclosed versus Open Environment

The United States Green Building Council (USGBC) developed the Leadership in Energy and Environmental Design (LEED) rating system mainly for building projects. The factors that this system focuses on are usually the various components of the building with little direct exposure to the outer environment. Such a system may lack compatibility with infrastructure facilities serving in the open environment such as levees, dames, roads, and bridges. The main focus of the ENVISION rating system is to rate infrastructure facilities serving in the open environment where little or no control can be exerted on weather conditions. In that sense, ENVISION (1) applies to all civil infrastructure; (2) addresses design, planning, construction and maintenance; (3) applicable at any point in an infrastructure project's life cycle; (4) speaks to the triple bottom line: social, economic, and environmental goals; and (5) designed to keep pace with a changing concept of sustainability. Table 1 shows a sample of the types of infrastructure facilities that ENVISION rates.

Table 1. Types of infrastructure facilities that ENVISION rates.

ENERGY	WATER	WASTE	TRANSPORT	LANDSCAPE	INFORMATION
Geothermal	Potable water distribution	Solid waste	Airports	Public Realm	Telecommunications
Hydroelectric	Capture/Storage	Recycling	Roads	Parks	Internet
Nuclear	Water Reuse	Hazardous	Highways	Ecosystem	Phones
Coal	Storm Water Management	Waste	Bikes	Services	Satellites
Natural Gas	Flood Control	Collection & Transfer	Pedestrians		Data Centers
Oil/Refinery			Railways		Sensors
Wind			Public Transit		
Solar			Ports		
Biomass			Waterways		

ENVISION Credits

Credits in the ENVISION rating system are given in five categories:

1. Quality of life: Purpose, Community, and Wellbeing.
2. Leadership: Collaboration, Management, and Planning.
3. Resource Allocation: Materials, Energy, and Water.
4. Natural World: Siting, Land & Water, and Biodiversity.
5. Climate and Risk: Emission, and Resilience.

The system has been developed in a way that allows the user to evaluate the sustainability performance of infrastructure by using a metric to assess its performance and elevate it to a desired intent. This is done for each of the above five categories to determine what was referred to as the "Level of Achievement". The system specifies six levels of achievements: Conventional, Improved, Enhanced, Superior, Conserving, and Restorative. Depending on the realized Level of Achievement, points are earned on a scale where the least points are assigned for "Conventional" and the greatest points are for "Restorative". Each of the five levels of achievements allows more points to be earned based on innovative performance of rated facilities. Depending on the number of points the rated facility earns, a recognition level is awarded. Recognition levels are Bronze, Silver, Gold, and Platinum. Figure 2 shows the six levels of achievement versus project life cycle and stakeholder collaboration.

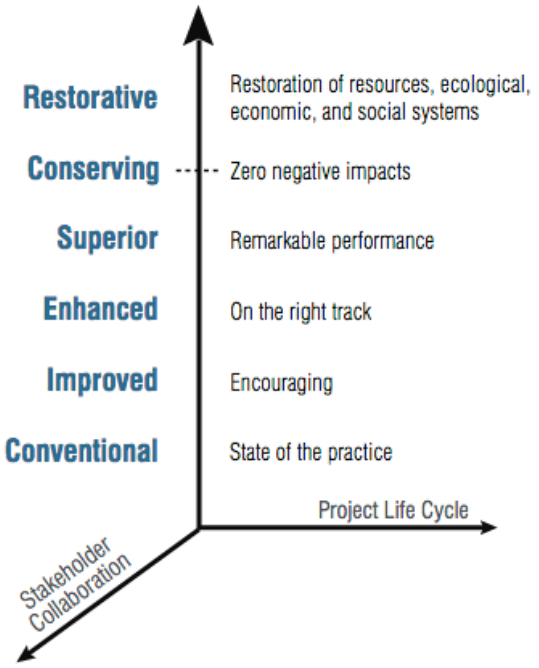

Figure 2. "Levels of Achievement" of infrastructure facilities as defined by ASCE 2015.

Relevance and Importance of ENVISION

Sustainability of infrastructure facilities is a factor that designers and owners do take seriously. The world was 3% urban in 1800, 14% urban in 1900, 50% urban in 2007, and probably headed in the next few decades to around 80% urban, which has been the stabilization point for developed countries since the mid-20th-century (United Nations [2]). In absence of sustainable constructed facilities, it could be extremely difficult to achieve the standard of living that humans aspire to. Furthermore, the increased urbanization changes the nature of landcover by introducing solid surfaces, such as concrete and asphalt. Such surfaces fully or partially prevent the natural flow of water into pervious soils to replenish groundwater, which aids in keeping plants and trees healthy, and in maintaining a cooler climate. Moreover, impervious surfaces that prevent water from infiltrating the soil cause a larger amount of water to run off into storm sewer systems, which greatly impacts the hydrological cycle of nature. All these factors add the importance and urgency of adopting rating systems that promote performance sustainability of infrastructure.

Course Materials

A course entitled sustainable infrastructure was developed and taught to highlight the advantages of sustainable design. The ENVISION rating system was introduced and explained in detail to heighten awareness of the need to implement in the design of a facility as many as possible of the features that contribute to a higher score on the sustainability scale. As stated earlier, the triple bottom line used by ENVISION to evaluate infrastructure facilities are social, economic, and environmental goals. In class discussion on the social aspect, students were encouraged to debate the value of a given project and discuss the impact of the project on its surroundings. As an example, if a new highway is under consideration, the critical questions that require in-depth discussion are the effect of the new highway on wildlife, stormwater runoff, change in area landscape, and possibility of denser traffic and extending urban sprawl. In discussing economical aspects, students were presented with questions related to the effect of a proposed infrastructure facility such as a highway on the local economy. This includes the prices of goods and services, pattern of consumption, possible changes in expenditure of disposable income, cost of fuels due to increased travel, cost of repair and maintenance of the new facility, and changes in behavioral patterns and habits of spending free time traveling to recreational areas along the route of the highway. In discussing the environmental aspects of a proposed infrastructure facility such as a dam, students were encouraged to examine the positive and negative factors related to dam construction. Positive aspects include flood prevention, water regulation, possible generation of hydropower, water storage for drought times, and creating an artificial lake in the upstream side of the dam, which could be used for recreational activities. On the negative side, dam construction may require resettlement of population, could impact wildlife in the area, could impact the pattern of fish spawning habitats, and may result in changes of the ecosystem in the area of the dam.

Class discussion regarding the social, economic, and environmental aspects of various infrastructure facilities was extremely lively. Students were fully invested in all aspects of proposed projects. It was evident that the message of sustainability resonated in such a way that made the students realize that designing a project to absolute perfection is not probably possible but trying to ameliorate the design in a way that increases the positives and decreases the negatives was the realistic way to advance the goals of the project. The students also appreciated the value of attempting to introduce innovative elements into the design. Some of these techniques were, for example, the non-traditional use, reuse, and recycling of materials, which proved to be highly desirable for conservation purposes. Students were also encouraged to study the possibility of incremental improvement in facility design and combine this strategy with a life cycle analysis. This has the effect of diminishing negative effects over the long run while improving the performance of the infrastructure facility. Students were excited at the variety of techniques that they could explore and the flexibility in adopting various provisions to heighten the level of performance of a facility. They developed excellent ability to see that there is a multitude of ways to achieve various tasks and that the procedure to do so is not rigid or constraining at all. Students were excited to learn that many easy-to-implement features could be adopted in facility design and that would significantly enhance its rating and performance. This method of teaching showed the students the practical side of design and opened their eyes to the need to take a fresh look at innovative design possibilities.

Conclusions

Infrastructure facilities that serve in the open environment are subjected to weather and climatic conditions that cannot be controlled. The performance of such facilities could be significantly impacted by such factors. The ENVISION rating system places emphasis on the sustainable performance of infrastructure facilities. The system helps the designer adopt provisions that could improve the performance of a facility from a minimum of “Conventional” which represents the state of practice to a maximum of “Restorative” where restoration of resources, ecological, economic, and social systems is achieved. Introducing this thought early in the design process could significantly alert students to the need of incorporating design features that aid in preserving resources and enhance the performance of the designed facilities. Various levels of recognition of infrastructure facilities are available within the system depending on the total points earned with respect to various evaluation categories.

References

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