Chapter 2
The American Society of Civil Engineers' Report Card on America's Infrastructure

Maria Lehman

Abstract Civil engineering has been a part of human life since the beginning of human history, whether it be shelter, drinking water, the development of the wheel and sailing for transportation, or using the sun to heat and dry various food products. Founded in 1852, the American Society of Civil Engineers (ASCE) is the nation's oldest engineering society. ASCE stands at the forefront of a profession that plans, designs, constructs, and operates society's economic and social engine – the built environment – while protecting and restoring the natural environment. Since 1998, the ASCE has issued a Report Card grading America's Infrastructure. The 2021 Report Card was a public relations success. The overall infrastructure grade was a C-. Investment needs for the next 10 years total $5.94 trillion with a $2.59 trillion funding gap.

Keywords Infrastructure Report Card · ASCE · Civil engineering · Engineering public policy · Engineering legislative engagement · Infrastructure grades · Failure to act · Infrastructure investment

In order to provide context for the American Society of Civil Engineers (ASCE) Report Card for America's Infrastructure, it is important to start with the history of civil engineering and ASCE and then add the layer of my entry into the profession and my personal journey.

2.1 History of Civil Engineering

Civil engineering has been a part of human life since the beginning of human history, whether it be shelter, drinking water, the development of the wheel and sailing for transportation, or using the sun to heat and dry various food products. There are

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examples of what is now considered spectacular civil engineering back in Greek and Roman times. Consider the Parthenon, or the Roman road network and aqueducts. We are still amazed by the pyramids of Egypt. And when I recall my trip to Machu Picchu, as I turned the corner to see the entire site open up in view, it was a sacred experience. It was a place that even though you were outside, you spoke in hushed tones as the experience engulfed you. And then as you walk through the site, you are in utter amazement at the advanced engineering principles that were used, long before we understood the mathematics to make it safe and repeatable.

These are examples of the beginning of what we still call "civil engineering."

Prior to the eighteenth century, engineering was primarily done by the military. As we evolved and needed more human built environment, it became important to have more people involved in engineering, and thus the term "civil" engineering was coined. Thus, all current engineering disciplines were specialties that became their own disciplines as time progressed such as mechanical engineering, electrical engineering, industrial engineering, and so forth. That explains why to this current day, civil engineering is the most broad discipline, encompassing the entire project lifecycle and acting as the facilitator of all specialty disciplines as the orchestra conductor of the system of systems.

The National School of Bridges and Highways, France, was opened in 1747 as the first civil engineering school in the world. John Smeaton, who constructed the Eddystone Lighthouse, proclaimed himself as the first civil engineer. The first organization was formed in 1771, when Smeaton and some of his colleagues formed the Smeatonian Society of Civil Engineers, which was considered more or less a social club [1–3].

The Institution of Civil Engineers was founded in London, in 1818, and is considered to be the world's first engineering society. Thomas Telford became its first president in 1820 [4]. In 1828, the institution received a Royal Charter, formally recognizing civil engineering as a profession. Its charter defined civil engineering as [5]:

> The art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states, both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks for internal intercourse and exchange, and in the construction of ports, harbours, moles, breakwaters and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and application of machinery, and in the drainage of cities and towns.

Concurrently, the United States' first private college to teach civil engineering, Norwich University, was founded in 1819 by Captain Alden Partridge. Rensselaer Polytechnic Institute awarded the first degree in US civil engineering in 1835. Elizabeth Bragg became the first woman to receive a civil engineering degree in the United States when she graduated from the University of California Berkeley in 1876 [1, 6].

2.2 ASCE History and Role and Profession Definition

ASCE's history is articulated on its website as follows [7]:

> On Nov. 5, 1852, a dozen eminent civil engineers gathered at the Croton Aqueduct in New York City in the office of Chief Engineer Alfred W. Craven to establish the American Society of Civil Engineers and Architects. In 1868, a few years after architects had formed a professional society of their own, ASCE adopted its current name. For the first 144 years of its existence, ASCE maintained its headquarters in New York City, relocating six times to progressively larger facilities. In 1996, ASCE moved to its current global headquarters in Reston, Virginia, just outside Washington, D.C.

Further ASCE defines the profession of civil engineering and the role of civil engineers as:

> Civil engineers design, build, and maintain the foundation for our modern society – our roads and bridges, drinking water and energy systems, sea ports and airports, and the infrastructure for a cleaner environment, to name just a few.
>
> Civil engineering touches us throughout our day. Think of a civil engineer when you:
>
> - Turn on your tap to take a shower or drink clean water
> - Flick on your lights and open your refrigerator
> - Drive to work on roads and bridges through synchronized traffic lights
> - Take mass transit or take a flight for a vacation
> - Toss your empty coffee cup in the recycling bin
>
> The ASCE represents more than 150,000 members of the civil engineering profession in 177 countries. Founded in 1852, ASCE is the nation's oldest engineering society.
>
> ASCE stands at the forefront of a profession that plans, designs, constructs, and operates society's economic and social engine – the built environment – while protecting and restoring the natural environment.
>
> Through the expertise of its active membership, ASCE is a leading provider of technical and professional conferences and continuing education, the world's largest publisher of civil engineering content, and an authoritative source for codes and standards that protect the public.
>
> The Society advances civil engineering technical specialties through nine dynamic Institutes and leads with its many professional- and public-focused programs.

2.3 Personal Journey to Become a Civil Engineer

I am a first-generation American born to Polish parents who were World War II refugees. After several years in refugee camps in England, my parents decided that coming to the United States was for the future benefit of my brother and sister. They, along with my older sister Anne and older brother George, were sponsored to emigrate to the United States by my dad's cousin Leon Nowakowski, who was a doctor in Buffalo, New York. So through a long application process and saving everything they could, they bought passage on the Queen Mary and took the difficult journey. Upon arrival in New York, they were processed at Ellis Island and traveled by train

to Buffalo, New York, with $50 in their pocket. They had to learn the language and find a way to earn a living and raise a family.

My mother came from a wealthy family in Poland and was a graduate of a Swiss finishing school. She was a buyer for her father's department stores, so she would regularly travel to Paris, Rome, London, and Milan, among other large European cities. While she did not know how to cook or maintain a household, she did know how to drive a motor car, and her favorite cars were a Bugatti and a Pierce-Arrow.

My dad was born in a very small and poor farming village in western Poland and went to seminary in order to get a high school degree. He then went on to get a Juris Doctor at the University of Poznan. He went on to build his own empire as a corporate attorney and a judge.

They were married on December 26, 1938. They had been married for 8 months, when the storm clouds of war were overhead and my father left Poland on foot, prior to the German invasion. My mother stayed with her dad until my grandfather was able to get her a visa to go to Malta as she was distraught with the disappearance of her husband and the war. They had a plan and met in Cyprus. Overnight they were penniless.

That experience forced their life view that there are only two things important in life: your family and what's in your head. So education was the primary driver in our family. And from the time I was a little girl, I was always encouraged to lead, as I had the grit to stand up for what was right. I remember my dad saying that some people are built to lead and stand up for others; it is their responsibility to do that for others that don't have the strength to fight. And so, for me, this started a long series of questioning the establishment, systems, and processing and pondering why can't we do better?

I always excelled at math and science and went to a very blue-collar high school where only approximately 10% of the graduates went on to college. The vast majority of those who attended college became engineers, accountants, and math majors. The Math Department head Mr. Thomas LaPena was a fabulous teacher. We learned calculus through osmosis. He always told us that while he loved math, he was more interested that we would live by his class motto: "Cogitation and Tenacity." I am proud to say that I believe I have lived that motto and that frequently when facing a tough challenge, I can hear Mr. LaPena in my head.

My future husband Carl was attending the University of Buffalo for civil engineering when we started dating. And a career choice was born! My parents were very supportive but really didn't understand what would make me want to pursue civil engineering as a career. When I graduated, my dad asked me "Now that you have proven you can do what your brother couldn't, now what?". My response was "Be the best civil engineer I know how to be." And so it has been.

I joined ASCE as a Younger Member and did local committee work and eventually became a local Section Officer. I was pushed by my first true engineering mentor Harry Quinn to see ASCE not only as a way to give back to the profession but also as a way to grow personally and professionally. Harry taught me to "follow the money" if I wanted to lead projects. He was a tremendous mentor and he did so

effortlessly. He became like a second dad, encouraging me all along the way. And I did learn to follow the money.

I rose through the ranks in the local Section of ASCE and became Section President. Then I got involved with the New York State Council related to government affairs. We researched various topics related to the profession and advocated for change. We passed resolutions with our opinions on various topics. We also got some legislation passed. One of the things I worked on at that point was to get legislation passed to establish a dedicated highway fund in New York State. At that time, NY was one of only three states that did not have a dedicated fund. Then State Senator Tony Masiello worked with us and sponsored legislation which eventually passed. Tony left the New York Senate to become the Mayor of Buffalo, and we got to work together when I became Commissioner of Public Works for Erie County in 2000. We have been friends ever since.

That experience made me realize how little the general public and elected officials really knew about how the built environment works, how people interact with it, and how we must be stewards of our environment. So in 1993 I ran to serve on the Board of Directors for ASCE representing then District 1: New York, New Jersey, Eastern Canada, and Puerto Rico.

One of the National Committees I was assigned was Public Communications. I remember thinking this is a profession unto itself and asked the Director at the time, Jim Quigley, to teach me Public Relations 101. For 8 years, I served on Public Communications and learned all I could about the subject. In 1996, we moved ASCE headquarters from New York City to Reston, VA, to be closer to the Capitol and to be able to better influence legislation related to the built environment. Jim stayed in New York, and ASCE hired Jane Howell as the Public Communications Director.

2.3.1 Public Relations 101

According to the Public Relations Society of America, the modern definition of public relations is: "Public relations is a strategic communication process that builds mutually beneficial relationships between organizations and their publics." It goes on to say that "At its core, public relations is about influencing, engaging and building a relationship with key stakeholders across numerous platforms in order to shape and frame the public perception of an organization."

The PR process circle starts at a baseline. You need to build awareness in a broad group of people. Then you need people to understand that they need to require action by others and ultimately advocate for your cause. The circle then links up when conditions change and you need to start the process all over again.

With that definition and with what I learned from Jane, I changed my focus. Jane taught me that there is a circle of communications in public relations and that trying to change the opinions of public servants requires having their constituency be educated consumers. The average American did not understand what civil engineering

was, why they should even care about it, and even worse why would anyone want to be a "nerd"?

The profession was largely pale and male and something had to change. We thought that first we needed to establish programs for community outreach to help educate people about how critical the profession is to their daily lives and standard of living and then to consider this a great profession for all regardless of race or sex.

In 1997, I became the chair of the National Committee on Public Communications, and we used focus groups across the country to test messages and pathways. Once we were comfortable that we had "the secret sauce," we presented the plan to the ASCE Board, and it was approved. That plan helped hone the message for pre-college outreach in the 1990s, as well as producing age-appropriate hands-on activities that excite kids from kindergarten through high school about the possibility of a career in civil engineering. A formal ASCE pre-college outreach program was born.

2.3.2 ASCE National Involvement and Legislative Engagement

So it is 1993 and I am a 33-year-old woman director on a National Board. I couldn't believe that I was there. More importantly, I was convinced that we needed to make a difference in the profession. I was the third woman to serve as a director on the Board. Barbara Fox was the first and Pat Galloway was the second. Pat would eventually become ASCE's first woman President.

As a director, I was asked to serve on two other national committees: Publications and Environmental Policy. At that time, the public policy committees were very internally focused. The individual policy areas had committees that, working in concert with ASCE technical and geographic units, wrote policies that would identify the position ASCE had on many issues ranging from using specific processes and materials to funding projects to pension portability. The positions need to be refreshed on a 3-year cycle. But only senior staff and presidential officers did "Hill visits" to meet with members of Congress and advocate for the policy positions.

So in 1996, when I was chair of the Environmental Policy Committee, I asked for a 2-hour window on the agenda for a field trip activity. I told my staff contact, Martin Hight, that I would need a couple cabs and I was exercising my chair's privilege. What Martin didn't know is that my congressman, Jack Quinn, who was a friend from his time teaching in the Orchard Park Middle School, was on the House Transportation and Infrastructure Committee and was the chair of the Rail Subcommittee. I had arranged a meeting with Congressman Quinn to have him talk about the importance of technical constituents informing members of Congress on issues. So the committee took the elevator down to the ground floor of the Washington offices and took a couple of cabs to Capitol Hill. It was a great experience and we had fun. And, even better, it was the first unofficial ASCE member fly-in.

2.4 ASCE Report Card for America's Infrastructure

During that same time, there was talk of ASCE leading the charge on a Report Card for America's Infrastructure.

From ASCE's website, the history is documented [8]:

> The concept of a report card to grade the nation's infrastructure originated in 1988 with the congressionally chartered National Council on Public Works Improvement report, *Fragile Foundations: A Report on America's Public Works*. A decade later, when the federal government indicated they would not be updating the report, ASCE used the approach and methodology to publish its first Report Card on America's Infrastructure in 1998. With each new report – in 2001, 2005, 2009, 2013, 2017, and now 2021 – the methodology of the Report Card has been rigorously assessed so as to take into consideration all of the changing elements that affect America's infrastructure.
>
> In 1988, when *Fragile Foundations* was released, the nation's infrastructure earned a "C," representing an average grade based on the performance and capacity of existing public works. Among the problems identified within *Fragile Foundations* were increasing congestion and deferred maintenance and age of the system; the authors of the report worried that fiscal investment was inadequate to meet the current operations costs and future demands on the system. In each of ASCE's seven Report Cards, the Society found that these same problems persist. Our nation's infrastructure is aging, underperforming, and in need of sustained care and action.
>
> Elected officials from both sides of the political aisle and at all levels of government regularly cite the Report Card, beginning with the very first release in 1998, when President Bill Clinton referenced the Report Card's grade for Schools. News reports reference the Report Card on a daily basis, with mentions in *The Wall Street Journal*, *The New York Times*, *USA Today, The Washington Post*, and the *Los Angeles Times*, as well as on National Public Radio, NBC's *Today Show*, *60 Minutes*, *CBS Evening News*, and HBO's *Last Week Tonight* with John Oliver, among many others.

Table 2.1 shows the grades by category for each issuance of the ASCE Infrastructure Report Card.[1]

In the beginning, ASCE went it alone. Some of our sister societies were concerned that the Report Card would be viewed as an indictment on the failure of our profession to make positive change. ASCE viewed the grades as a way to shed light on the growing challenges in public infrastructure and the need for elected offices to take notice and supplement funding for public infrastructure.

Through its various iterations, ASCE has improved its public relations strategy surrounding the grades and improved the information contained in the Report Card to get the Society's message across.

The 2001 Report Card was a loose leaf packet with an online pdf and had 12 infrastructure categories. It relied on the original report – the federally issued *Fragile Foundations* as the baseline for the grades. The 2001 report was very detailed and text heavy on national conditions and had recommendations for public policy actions. It also included a cost of implementing the needed improvements as well as the estimated deficit in funding available.

[1] Each separate report card is archived on ASCE's infrastructure report card site: https://infrastructurereportcard.org/

Table 2.1 *Fragile Foundations* and ASCE Infrastructure Report Card grades

Category	1988[a]	1998	2001	2005	2009	2013	2017	2021
Aviation	B–	C–	D	D+	D	D	D	D+
Bridges	–	C–	C	C	C	C+	C+	C
Dams	–	D	D	D+	D	D	D	D
Drinking water	B–	D	D	D–	D–	D	D	C–
Energy	–	–	D+	D	D+	D+	D+	C–
Hazardous waste	D	D–	D+	D	D	D	D+	D+
Inland waterways	B–	–	D+	D-	D–	D–	D	D+
Levees	–	–	–	–	D–	D–	D	D
Ports	–	–	–	–	–	C	C+	B–
Public parks and recreation	–	–	–	C–	C–	C–	D+	D+
Rail	–	–	–	C–	C–	C+	B	B
Roads	C+	D–	D+	D	D–	D	D	D
Schools	D	F	D–	D	D	D	D+	D+
Solid waste	C–	C–	C+	C+	C+	B–	C+	C+
Stormwater	–	–	–	–	–	–	–	D
Transit	C–	C–	C–	D+	D	D	D–	D–
Wastewater	C	D+	D	D–	D–	D	D+	D+
GPA	**C**	**D**	**D+**	**D**	**D**	**D+**	**D+**	**C–**
Cost to improve[b]	**–**	**–**	**$1.3T**	**$1.6T**	**$2.2T**	**$3.6T**	**$4.59T**	**$5.94T**

[a]The first infrastructure grades were given by the National Council on Public Works Improvements in its report *Fragile Foundations: A Report on America's Public Works*, released in February 1988. ASCE's first Report Card for America's Infrastructure was issued a decade later

[b]The 2017 Report Card's investment needs are over 10 years. The 2013 Report is over 8 years. In the 2001, 2005, and 2009 Report Cards, the time period was 5 years

In 2005, the Report Card used focus groups and ad hoc conversations with our stakeholders to inform the process and outputs. The pivot for that iteration was to report on items that the market was interested in and where those needs existed. Members of Congress consistently asked for state-specific data, as they needed to tie back the large national challenge to specific challenges in their districts. And the lesson from the media is that they were more interested in local stories and anecdotes than in policy-focused news. All politics is local.

So after collecting market feedback on the 2005 Report Card, small investments were made by ASCE for the next cycle in 2009. We made small, low-cost changes to the Report Card to test in the market. Limited data provided included data to address state infrastructure needs, and engineering success stories were added for select states. The minor changes were successful. Thus, it was decided that we needed to go back to focus groups and look at reach metrics, as well as the length of the news cycle. It was decided that we needed web analytics as well as social media metrics.

In 2011, I was fortunate to be asked to join the Committee on America's Infrastructure for the 2013 Report Card. Since we had four Report Cards under our belt, it was time to assess our market presence and grow our audience to effectively

push elected officials to support infrastructure investment and sound policy. ASCE focused on innovation, as technology began to take over many aspects of our lives. It was time to refresh the Report Card to meet the current expectations of the public.

The ASCE created a website and a mobile app to replace the hardcopy report format for the 2013 Report Card for America's Infrastructure. A new branded logo was created and four new categories were added. The grading methodology was formalized into a much more rigorous process. Most importantly, new sections were added that had the estimated cost and funding deficit in every category graded. There was information on state infrastructure in all 50 states, and the narrative included local success stories. There were sections which were labeled as "solutions that work now." Social media was used to post articles on Facebook and tweets by and about ASCE that were updated in real time. Much of the heavy text was replaced with infographics, interactive charts, pictures, and YouTube videos from ASCE and our partner organizations.

The results were that we had more interest from the general public, the press, and local ASCE Sections. We observed a longer news cycle for local content, while getting more interest among local audiences, and therefore we increased our partnership with local ASCE groups.

As ASCE evaluated the metrics, the small investment was very successful; so ASCE allocated more resources to build out the Report Card components as permanent byproducts of the national report card. Facts on infrastructure systems and success stories were supplied for all 50 states. Supplemental videos were added with heavier local focus.

ASCE used its grassroots network effectively but still needed a broader reach so several cooperative organizations with "multiplier" qualities were added to access larger audiences, provide greater media reach, and acquire even more local examples. The Report Card went from a short paper technical product to a full media outreach program including spokesperson training, press packets, and social media calendars. Relationship models were developed for both historical and new partners that focused on group characteristics and tools to support partner engagement. All these elements were added to the 2017 Report Card.

2.4.1 The 2021 Report Card

The 2021 Report Card committee was populated in 2019, and I was fortunate enough to be asked to participate again as 1 of the 32 experts. We started our work in the fall with no clue as to what the future would hold. Committees were formed for each of the Report Card categories to start the research. Just as we were really getting into the data and our analysis, the COVID-19 pandemic hit. Our meetings went virtual, and we now saw how much more important our roles were. Everyone around the country was trying to keep informed about health and safety protocols to keep critical infrastructure working to ensure essential employees could get to and from work. State and local governments were extremely hard hit by supplemental

costs in keeping people safe as well as by draconian losses in revenue. We were really challenged on how to present data on needs and status when we were in the middle of a once-in-a-century pandemic.

On one of our committee TEAMS calls, we were discussing the need to get our message to Congress on the dire impacts COVID-19 was having on our physical infrastructure. An ASCE position paper was being proposed when a light bulb went off in my head. Everyone was sending Congress white papers related to the pandemic. How could our thoughts rise to the top of the pile? ASCE had great brand recognition with the Report Card with both the media and elected officials. ASCE could use the brand and publish an interim report without grades, just speaking to the impacts COVID was having. The team loved the idea, and in June of 2020, ASCE published the "STATUS REPORT: COVID-19's Impacts on America's Infrastructure."[2]

The message was successfully delivered, and the interim report was part of the pitch which yielded much needed support to the owners and operators of our infrastructure. Ultimately, Congress provided emergency funding to state departments of transportations, airports, and water systems through the various COVID-19 relief packages.

Turning back to the development of the 2021 Report Card for America's Infrastructure, we again used the standard methodology that had been used to develop the 2017 Report Card. The methodology we used looked at the following items for researching the data, developing the narrative, and ultimately assigning the grade for all 17 categories:

- Capacity
- Condition
- Funding
- Future need
- Operations and maintenance
- Public safety
- Resilience
- Innovation

Once subcommittees had pulled the data together, each subcommittee graded the category as follows:

A: Exceptional, fit for the future, in excellent condition.
B: Good, adequate for now, but some elements show signs of general deterioration that require attention.
C: Mediocre, requires attention; some elements exhibit significant deficiencies, with increasing vulnerability.
D: Poor, at risk, with many elements approaching the end of their service life. Condition and capacity are of serious concern, with strong risk of failure.
F: Failing/critical, unfit for purpose, with signs of imminent failure.

[2] https://www.infrastructurereportcard.org/wp-content/uploads/2020/06/COVID-19-Infrastructure-Status-Report.pdf

Then each individual subcommittee presented to the entire committee over many virtual meetings and had to defend the grades much like you would defend a dissertation. In several cases, more data were needed for the overall committee to accept the grades, and also in several cases, the subcommittees were required to come back and redefend or brought supplemental information to change the overall committee's previous decision. It was an incredibly rigorous process.

The trends that were identified included as follows: maintenance backlogs continue to be an issue, but asset management helps prioritize limited funding, federal investments have moved the needle, and many state and local governments continue to prioritize infrastructure investments to help us keep pace with our growing needs, but there are still infrastructure sectors where data are scarce or unreliable. The resulting grades are shown in Fig. 2.1 [9].

All of the data used for grading each category of infrastructure are based on publicly sourced data. That has been challenging with several categories as there are limited public databases available. Schools are one example. School facilities represent the second largest sector of public infrastructure spending after highways, and yet there is no comprehensive national data source on K-12 public school infrastructure. The limited data that are available indicate that 54% of public school districts report the need to update or replace multiple building systems including heating, ventilation, and air conditioning systems. More than one-third of public schools have portable buildings due to capacity constraints, and 45% of these buildings are in poor or fair condition. Meanwhile, as a share of the economy, state capital funding for schools was down 31% in fiscal year 2017 as compared to 2008. That is the equivalent of a $20 billion cut.

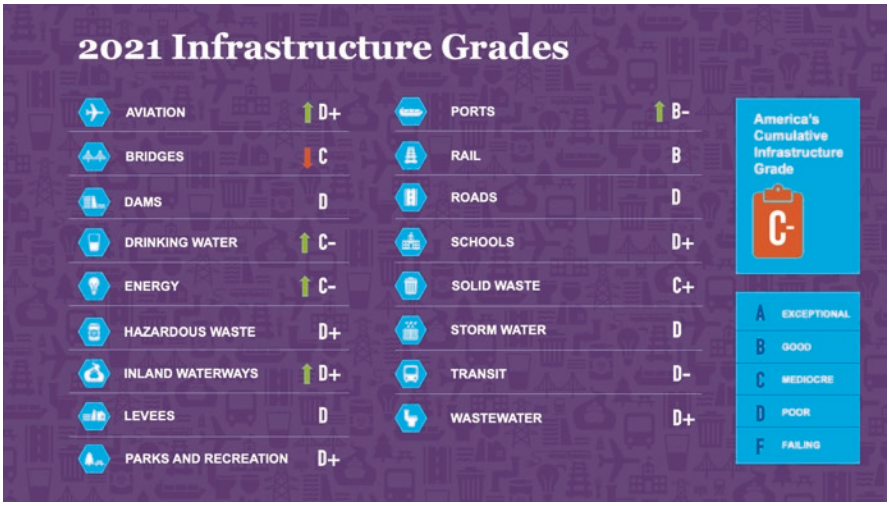

Fig. 2.1 2021 ASCE Infrastructure Report Card

Broadband is a category that has touched us during the pandemic. ASCE added it as a spotlight area but not a true category as much of broadband is private and as such there are very limited data in the public realm. The importance of broadband infrastructure has grown exponentially as we increasingly rely on it to support our connected lives. Meanwhile, civil engineers play a growing role in broadband installation, and high-speed internet is increasingly critical to the operation and modernization of our legacy infrastructure systems. Because of this, the ASCE Committee on America's Infrastructure felt it important to make recommendations on how to improve broadband infrastructure. However, the committee determined there was insufficient information on broadband infrastructure to justify a category grade.

Overall, the cumulative infrastructure grade increased from a D+ to a C−.

Each individual category has a bibliography of sources at the end of their chapter.

The grades are only one piece of the puzzle. The executive summary and full report include key findings, discussion on how investment pays and what the cumulative investments need to be, as well as recommendations on how to raise the grades.

As for recommendations to raise the grades, these fell into three categories: Leadership and Action, Investment, and Resilience. Specifically under Leadership and Action, ASCE recommends the following:

Smart investment will only be possible **with strong leadership, decisive action, and a clear vision for our nation's infrastructure**. Leaders from all levels of government, business, labor, and nonprofit organizations must come together to:

- Incentivize asset management and encourage the creation and utilization of infrastructure data sets across classes.
- Streamline the project permitting process across infrastructure sectors while ensuring appropriate safeguards and protections are in place.
- Ensure all investments are spent wisely, prioritizing projects with critical benefits to the economy, public safety, environment, and quality of life (e.g., sustainability).
- Leverage proven and emerging tech to make use of limited available resources.
- Consider life cycle costs when making project decisions. Life cycle cost analysis determines the cost of building, operating, and maintaining the infrastructure for its entire life span.
- Support research and development of innovative materials, technologies, and processes to modernize and extend the life of infrastructure, expedite repairs or replacements, and promote cost savings. Innovation should include a component of integration and utilization of big data, as well as the "internet of things."
- Promote sustainability, or the "triple bottom line" in infrastructure decisions, by considering the long-term economic, social, and environmental benefits of a project.

Under Investment, if the United States is serious about achieving an infrastructure system fit for the future, some specific steps must be taken, beginning with **increased, long-term, consistent investment**. To close the $2.59 trillion 10-year investment gap, meet future needs, and restore our global competitive advantage, we must **increase investment from all levels of government and the private**

sector from 2.5% to 3.5% of US gross domestic product (GDP) by 2025. This investment must be consistently and wisely allocated and must begin with the following steps:

- Congress should fully fund authorized programs.
- Infrastructure owners and operators must charge, and Americans must be willing to pay, rates reflecting the true cost of using, maintaining, and improving infrastructure.
- The surface transportation investment gap is the largest deficit among the categories of infrastructure ASCE examines. Continuing to defer maintenance and modernization is impacting our ability to compete in a global marketplace and maintain a high quality of living domestically. Congress must fix the Highway Trust Fund.
- All parties should strive to close the rural/urban and underserved community resource divide by ensuring adequate investment in these areas through programmatic set asides.
- All parties should make use of public-private partnerships, where appropriate.

Resilience is paramount as future investments are made. We must **utilize new approaches, materials, and technologies to ensure our infrastructure** can withstand or quickly recover from natural or man-made hazards. Advancements in resilience across all infrastructure sectors can be made by:

- Enabling communities, regardless of size, to develop and institute their own resilience pathway for all their infrastructure portfolios by streamlining asset management, implementing life cycle cost analysis into routine planning processes, and integrating climate change projections into long-term goal-setting and capital improvement plans
- Incentivizing and enforcing the use of codes and standards, which can mitigate risks of major climate or man-made events such as hurricanes, fires, sea level rise, and more
- Understanding that our infrastructure is a system of systems and encouraging a dynamic, "big picture" perspective that weighs tradeoffs across infrastructure sectors while keeping resilience as the chief goal
- Prioritizing projects that improve the safety and security and systems and communities, to ensure continued reliability and enhanced resilience
- Improving land use planning across all levels of decision-making to strike a balance between the built and natural environments while meeting community needs, now and into the future
- Enhancing the resilience of various infrastructure sectors by including or enhancing natural or "green" infrastructure

The Report Card includes examples of game changers in all the categories. These are project innovations that deliver innovation to the solution. Examples of projects moving the needle are listed in the report and are shown prominently on the website and app, so that people see examples in each state.

Fig. 2.2 2021 ASCE Infrastructure Report Card investments required. Much of these data were taken from the ASCE Failure to Act study completed in 2021

The Report Card also included a table of cumulative investment needed in the major categories as shown in Fig. 2.2 [10].

2.5 ASCE's Failure to Act Series

The evergreen question about the Report Card is "So what does this mean to me?"

Concurrent with the Report Card, ASCE began a series of independent economic reports that take a deep dive into what the status quo means to the average American. It seeks to quantify the fact that a healthy economy can't be supported by a crumbling infrastructure. And what are the future implications?

As described on the Infrastructure Report Card website [11]:

> **The Failure to Act report series answers this key question—how does the nation's failure to act to improve the condition of U.S. infrastructure systems affect the nation's economic performance?** In 2020 and 2021, ASCE released five Failure to Act reports in a series covering 11 infrastructure sectors that are critical to the economic prosperity of the U.S.
>
> These reports were followed by a fifth, comprehensive final report, *Failure to Act: Economic Impacts of Status Quo Investment Across Infrastructure Systems*, which addressed the aggregate economic impact of failing to act in more than one sector. This report addresses the current infrastructure gaps between today's needs and investment and how they will affect the future productivity of industries, national competitiveness, and the future costs to households.
>
> Recent Failure to Act reports include:

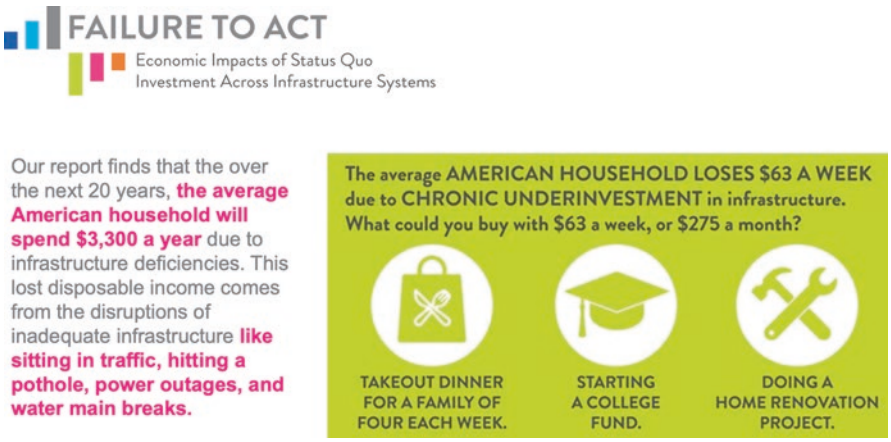

Fig. 2.3 Failure to Act summary

Ports and Inland Waterways (2021) — Underinvestment in ports and inland waterways stand to increase waterborne shipping costs from 8% to 22%, on average, by 2039. Manufacturing, agriculture, and production and extraction are most impacted.

Airports (2021) — A recent uptick in airport infrastructure investment is paying dividends for the residents and businesses in the U.S. However, as spending returns to previous averages, the economy will suffer. Specifically, airport congestion will cost U.S. industries and households approximately $28 billion in 2029 and $41 billion in 2039.

Electricity (2020) — An additional investment of $16.9 billion per year between now and 2039 in our electricity infrastructure can protect 540,000 jobs and $5,800 per household in personal income.

Water and Wastewater (2020) — By investing in our water infrastructure to make it more reliable, we can prevent $250 billion in increased costs to businesses by 2039.

Surface Transportation (2021) — These findings show that if industry costs are passed on to customers, costs per household could be as high as $12,500 over 20 years, or $625 dollars per year. Losses to households and industries will amount to $677 billion over the 2020–2029 period and $1.3 trillion during the 2030–2039 decade.

The comprehensive report can be summarized as shown in Fig. 2.3.

2.6 Impact of the 2021 Report Card

United for Infrastructure, a coalition for which ASCE is a Steering Committee member, convened an Infrastructure Candidate Forum in Las Vegas on February 16, 2020. The Forum elevated infrastructure as a top issue of the public agenda. Joe Biden, who was then a Presidential candidate, addressed an issue that 90 percent of swing state voters saw as a top priority for elected officials. The host committee consisted of the International Union of Operating Engineers, Transportation Trades Department, AFL-CIO, North America's Building Trades Unions, Transport Workers Union of America, American Public Transportation Association, ASCE,

Value of Water Coalition, American Council of Engineering Companies, American Road and Transportation Builders Association, Association of Equipment Manufacturers, Airports Council International-North America, and Build Together.

I had the honor and privilege to be there for the candidate discussions and Q&A on their views regarding infrastructure. It was especially poignant to see that the items that President Biden and Secretary Pete Buttigieg spoke about almost a year before they became President and Transportation Secretary were part of the President's plan for the future of infrastructure for a prosperous US future. Much of the language in the ASCE Report Card, the Solutions Summit held immediately following the reveal of the Report Card, and the Failure to Act reports have been not only cited, but used as part of the development of the resulting infrastructure plans and bills of the Biden administration. While ASCE has seen success with the Report Card, it has never hit a grand slam home run like it did in 2021.

As of the end of June 2021, 4 months after the release, the media hits have been higher than for any previous Report Card. There have been 2091 print and online placements that have yielded 1.6 billion print and online impressions. There have been more than 400 original articles written and 1520 broadcast clips with a viewership of more than 65 million. 57 million total stations were reached, including 33 radio interviews with 5 million listener impressions heard on more than 2225 radio stations. There have been 85 press release pickups with a potential audience of 99 million. And ASCE members have really engaged in spreading the news as there have been 468 engagement actions by members.

So by any measure, the Report Card has been a resounding success in getting the message out that our work as civil engineers is critical to our quality of life and we need our political leadership to get it done.

2.7 Personal Thoughts

As I look back to my professional and ASCE life, I see that the activity around public awareness and active advocacy has really been a uniting thread throughout my career. It has been a very exciting journey, and I am very thankful for the thousands of people who have been engaged throughout the journey. It proves that if you have the facts and the passion, amazing results can be achieved.

References

1. Ambrose, Susan A., Kristin L. Dunkle, Barbara A. Lazarus, Indira Nair and Deborah A. Harkus, Editors. *Journeys of Women in Science and Engineering: No Universal Constants*. Temple University Press: Philadelphia, Pennsylvania. 1997.
2. "John Smeaton", Wikipedia, https://en.wikipedia.org/wiki/John_Smeaton, accessed September 26, 2021.

3. "Institution of Civil Engineers", Wikipedia, https://en.wikipedia.org/wiki/Institution_of_Civil_Engineers, accessed September 26, 2021.
4. Institution of Civil Engineers, "Our history," https://www.ice.org.uk/about-ice/our-history, accessed September 26, 2021.
5. "Civil Engineering Defined," http://www.smweng.com/smw-civil-engineering-defined, SMW Engineering Group, Inc., accessed September 26, 2021.
6. Kass-Simon, G. and Patricia Farnes, Editors. *Women of Science: Righting the Record*. Indiana University Press: Bloomington, Indiana. 1990.
7. "History," About ASCE, American Society of Civil Engineers, https://www.asce.org/about-asce, accessed September 26, 2021.
8. "Report Card History," 2021, Report Card for America's Infrastructure, https://infrastructurereportcard.org/making-the-grade/report-card-history/, accessed September 26, 2021.
9. "America's Infrastructure Scores a C-", 2021 Report Card for America's Infrastructure, https://infrastructurereportcard.org/, accessed September 26, 2021.
10. "Investment Gap 2020-2029," 2021 Report Card for America's Infrastructure, https://infrastructurereportcard.org/resources/investment-gap-2020-2029, accessed September 26, 2021.
11. "Failure to Act Economic Reports," 2021 Report Card for America's Infrastructure, https://infrastructurereportcard.org/resources/failure-to-act-economic-reports/, accessed September 26, 2021.

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Maria has won numerous national, statewide, and local awards including the ASCE President's Medal, UB's School of Engineering Alumna of the Year, and the New York State Society of Professional Engineers Engineering Manager of the Year.