



**VAN
ALEN**

AMERICA'S INFRASTRUCTURE

**REPORT
19**

WHAT IS VAN ALLEN REPORT?

VAN ALLEN REPORT is an interdisciplinary digest that explores how people and communities can successfully adapt to change. Published semiannually online, **VAN ALLEN REPORT** gathers expert perspectives on subjects that are redefining society's relationship to cities and the built environment on a local, national, and global scale.

VAN ALLEN REPORT is a broad, sweeping examination of the present and things to come, intended to catalyze fresh thinking among those who shape cities—designers, planners, policymakers—as well as anyone eager to learn more about how the future of the built environment will impact their minds, bodies, and everyday lives.

VAN ALEN REPORT 19: AMERICA'S INFRASTRUCTURE

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Cover Image:
Black Hawk Bridge in Lansing,
IA. Built in 1931, the bridge has a
sufficiency rating of 39.9%. Of Iowa's
24,000 bridges one in five is rated
structurally deficient – the third
worst rating in the United States.
Photo by Tony Webster.

FOREWORD

When Van Alen Institute runs a design competition, teams are connected with various experts and stakeholders throughout the process. We have learned that interdisciplinary collaboration between communities, designers, and other professionals gives design teams a better understanding of both the problems they are working to solve and the complex needs of the communities they aim to serve.

For the first Van Alen Report in twelve years, we are adapting this interdisciplinary model in order to discuss America's infrastructure crisis. Looking at infrastructure from different perspectives is sensible because infrastructure touches so many different facets of our lives—for better and for worse. As Nicole DuPuis, an expert in urban innovation at the National League of Cities and a contributor to this report reminds us, functional infrastructure “delivers

our safe, clean water; it provides the public spaces in which we engage in civic life...; it gets us safely to the places where we live, work, play, and pray.” However, when infrastructure falls apart, economic prospects, social ties, sense of security and wellbeing, and trust in our public officials crumbles along with it.

The perspectives gathered here help illuminate a path forward as the United States debates its infrastructure's repair. But this exercise raises an obvious question: how did we get into this mess in the first place? Throughout the report, the causes of America's infrastructure crisis are alluded to frequently but no single contributor explores the overall predicament in depth. Therefore, in the introduction, we decided to contextualize the situation as it relates to the perspectives collected.

For this report, we haven't restricted the conversation to a single



Designers and stakeholders meet during past competitions. Photos by Cameron Blaylock

method of financing, recent technological development, or specific political proposal. Rather our contributors offer insights on how society may approach financing, technology and policy broadly to make smarter decisions about infrastructure—decisions that may result in better and more just outcomes for all.

We hope that as you read the five perspectives presented here, you will appreciate the range of expertise and diversity of opinion. That said, this report is largely focused on improving existing infrastructure. Recent events in Houston have revealed yet again the limits of both the infrastructure we have in place and our ability to conceive the transportation, energy, and water infrastructure needed for the future. To expand this report, we are asking our network of passionate designers, scholars, professionals, and urban thinkers for ideas and strategies to help cities meet the daunting challenge climate change poses. We look forward to hearing from you and

sharing your insights.

Andrew Brown, Editor

David van der Leer, Executive Director



Designers and stakeholders
meet during past competitions.
Photos by Cameron Blaylock

INTRODUCTION

Much of America's infrastructure is reaching the end of its lifecycle. About 40 percent of America's bridges are over 50 years old, and, between 2000 and 2015, the average age of our streets and highways increased from 23 to 28 years. Declining federal support for maintenance and an affinity amongst politicians for ribbon cutting over pothole filling has exacerbated the aging process.

The Highway Trust Fund, the federal government's fund for transportation infrastructure, is approaching a \$180 billion deficit, while its dedicated source of revenue, the federal gasoline tax, has not been raised since 1993. Less federal involvement has left state and local governments to shoulder more of the burden. That said, states sometimes divert their declining gas tax revenues toward non-infrastructure items, leaving local

governments to face the problem with only limited and unreliable support from Washington and state legislatures.

The replacement of the eastern span of the San Francisco Bay Bridge serves as the quintessential infrastructure boondoggle. Originally billed at \$250 million in 1995, the span ultimately cost taxpayers \$6.5 billion. While a simple viaduct would have proven sufficient, Jerry Brown, then Mayor of Oakland, led the charge for a "signature" span, which resulted in the final single tower design. That tower, combined with engineering studies and rising labor and steel costs throughout construction—and a flawed process of cost estimation—dramatically escalated the final price.

To secure money needed for existing infrastructure like municipal water systems or for new projects like automated transportation,



The San Francisco Bay Bridge.
Photo by Steve Jurvetson.

many cities and states are initiating public-private partnerships (P3s). Ideally, P3s should balance risks and rewards on both sides, but recent experience suggests all sides should enter with caution. Uber and the city of Pittsburgh dissolved their partnership to bring driverless taxis to the city once it became clear that Uber was unlikely to live up to its commitment to provide job creation, free rides, or support for the city's federal grant application to improve transportation.

Some cities that completely buckle under mounting cost pressures face a daunting prospect: emergency management. At best, emergency management laws, currently enacted in 19 states, rescue troubled cities from dire fiscal straits. At worst, cost cutting becomes an objective unto itself and local concerns are treated with indifference or contempt. In Flint, Michigan, state-appointed managers decided to save money by drawing the city's water from the Flint River.

The ensuing contamination disaster gave way to a crisis of confidence in government. Many city residents still feel badly mistreated and alienated from the officials charged with protecting their water. Having had a critical piece of its infrastructure compromised, it's unclear whether Flint will ever fully recover.

Lastly, at a time when oil pipelines are proliferating in North America, and more communities are forced to live with these assets for generations, it is worth asking whether the social benefits of that infrastructure will last nearly as long. Authorization for the Dakota Access and Keystone pipelines and America's withdrawal from the Paris Agreement notwithstanding, increased disruption of production, along with developments in alternative energy, raise doubt about the long term usefulness of such projects. Beyond Standing Rock, resistance to pipeline construction has sprung up across the country, and, in his essay for this report, Julian Brave NoiseCat notes



People march to Governor Rick Snyder's home to protest Michigan's emergency management law.
Photo by Austen Hufford

the oil industry's concerns over the impact of resistance on future production. Though gas prices are currently low, so, too, is the price of crude (about \$50/barrel). The availability of oil from both OPEC and North America may be driving oil prices toward a new more industry-disruptive normal.

On the consumption side, uncertainty grows. Over 130 American cities joined the Global Covenant of Mayors for Climate and Energy, a significant development given that cities, with their large volumes of cars, produce roughly two-thirds of the nation's emissions. Their efforts to support cleaner, more energy-efficient commutes will likely be aided by increased numbers of electric vehicles, which are projected by Bloomberg New Energy Finance to achieve price-competitiveness with liquid fuel-based vehicles by 2022. In the solar market, prices have plummeted, spurring the generation of electricity that is clean, cheap, and renewable. Since 2008, battery

costs have fallen 80 percent and Tesla plans to produce batteries that can last 215 miles after a single charge. Even as reauthorization of Dakota Access increases supply, we may be witnessing a tipping point in oil demand.

Andrew Brown, Editor

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PERSPECTIVES



DAVID LEVINSON is an American civil engineer, transportation analyst and professor at the University of Sydney. Levinson is the author of several books on the subject of transportation and serves as an editor for the Journal of Transport and Land Use. He is also co-author of the Brookings Institute report “Fix It First, Expand It Second, Reward It Third: A New Strategy for America’s Highways”



STEVE FRIESS is an Ann Arbor-based journalist whose work appears in Time, Undark Magazine, BuzzFeed News and the New York Times. Friess formerly covered technology and politics for Politico, and is the author of “For All They Know,” a case study on Flint’s water crisis.



NICOLE DUPUIS is Principal Associate for Urban Innovation at the National League of Cities. She specializes in analysis of infrastructure, transportation, technology and telecommunications. She is co-author of the recent National League of Cities reports, “Paying for Local Infrastructure in a New Era of Federalism,” and, “Trends in Smart City Development.”



A prolific architecture critic and commentator, **AARON BETSKY** contributes frequently to design publications and has been vocal advocate of design as a tool to bring communities together. He has worked as a designer for Frank O. Gehry & Associates and Hodgetts + Fung, and served as the director of the Netherlands Architecture Institute, the Cincinnati Art Museum, and the 11th Venice International Architecture Biennale. He currently serves as dean at the Frank Lloyd Wright School of Architecture at Taliesin and Taliesin West.



JULIAN BRAVE NOISECAT is a policy analyst at 350.org. His writing regularly appears in the Guardian and other publications. He was formerly a New York City Urban Fellow and received a Clarendon Scholarship to read for a Master’s in Global and Imperial History at the University of Oxford. He is a proud member of the Canim Lake Band Tsq’escen.

DAVID LEVINSON

INFRASTRUCTURE SPENDING DONE RIGHT

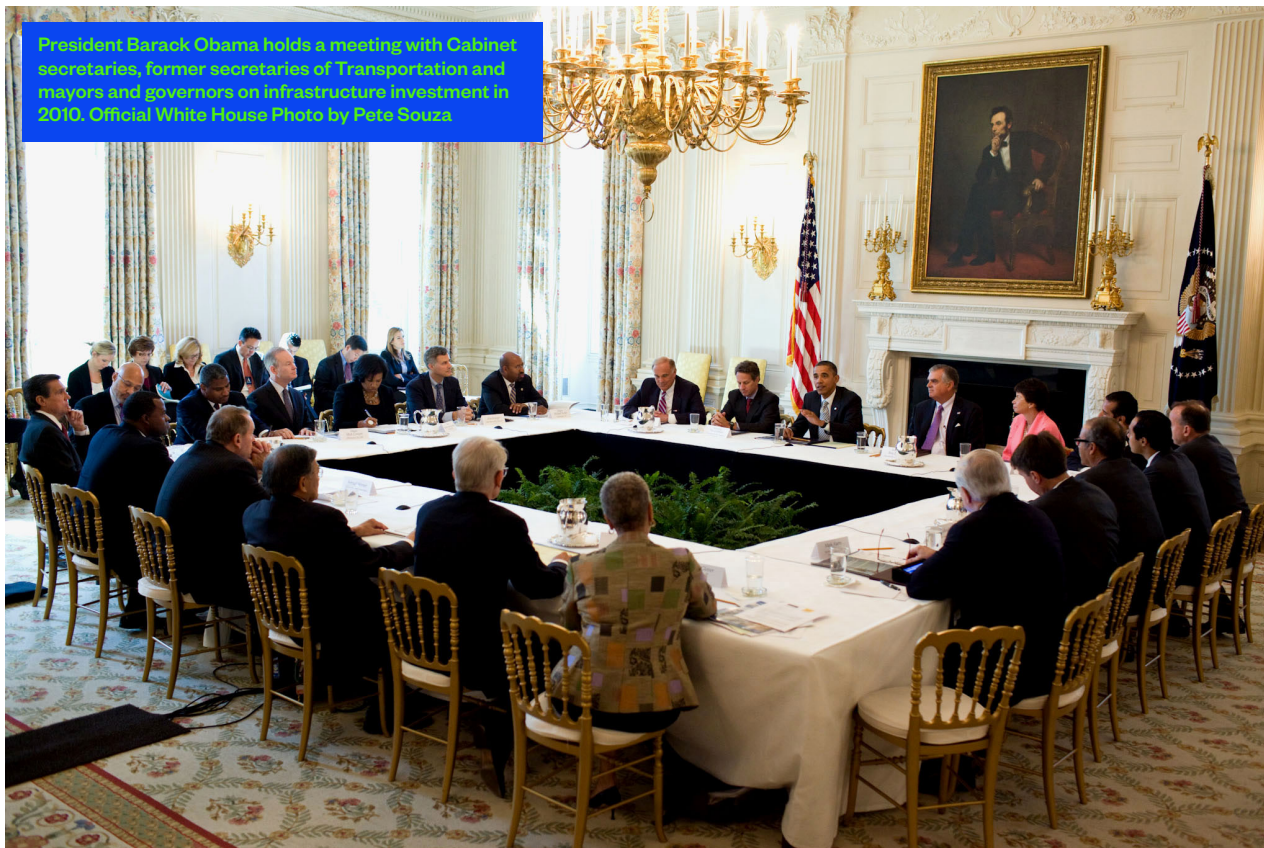


EDITOR'S NOTE

Infrastructure as stimulus spending appeals to politicians and voters because it appears to kill three birds with one stone. Critical infrastructure is repaired or newly constructed, job opportunities are created for the unemployed, and the greater economy is set on a course for growth. But how and where funding is spent can muddle these objectives. Disproportionate federal spending in rural areas over dense, growing cities undermines long-term economic impact, while growth in automation renders hope of mass job creation dubious. Moreover, politicians often prioritize new infrastructure over maintaining our vital network of existing roads, bridges, and railways. David Levinson, transportation expert and professor of civil engineering at the University of Sydney, explores the real impact of infrastructure spending and argues for the priorities that provide greater prosperity over the long term.

Title photo by Mustafa Khayat

President Barack Obama holds a meeting with Cabinet secretaries, former secretaries of Transportation and mayors and governors on infrastructure investment in 2010. Official White House Photo by Pete Souza



On December 6, 2008, in the throes of the Great Recession, then President-elect Barack Obama laid out key parts of his Economic Recovery Plan. In his radio address, he boldly asserted “...[W]e will create millions of jobs by making the single largest new investment in our national infrastructure since the creation of the federal highway system in the 1950s....If a state doesn’t act quickly to invest in roads and bridges in their communities, they’ll lose the money.” This plan turned into the American

Recovery and Reinvestment Act, with a total budget of \$831 billion. It dedicated \$105 billion to infrastructure, of which \$48 billion went to transport.

The value of the projects from the 2009 stimulus remains questionable. Projects tended to fall in rural areas (mostly road resurfacings) not because the work was essential, but because they were “shovel-ready” and easy to do. The projects were easy because they were already designed and had environmental permits in place. The

fact that these projects were so far along in development, yet remained unbuilt, suggests that they were not the highest priorities for the local and state transportation agencies that oversaw their construction.

Though administrations have changed, the disproportionate allocation of federal spending to rural areas over more developed cities—where the majority of needed infrastructure work exists—will likely go unabated. President Trump has proposed various tax incentives to stimulate \$1 trillion worth of private investment toward the nation’s infrastructure. While Trump has discussed urban-based projects, like rebuilding New York City’s poorly-managed airports, the Republican party—which he leads but which is comprised mostly of rural voters—will likely exacerbate the overfunding of rural projects even more, if only to get its own representatives and senators re-elected.

Along with project location, setting job creation as an objective of infrastructure spending can also undermine the economic value of projects. At the time of the 2009 stimulus, unemployment was around 10 percent. With more workers looking for jobs, spending on infrastructure during a recession may arguably bring labor off the sidelines, while also taking advantage of the temporary wage drop due to a spike



We all know that maintenance, repair, and reconstruction are not sexy. Yet... detailed maintenance work employs more people than large-scale brand new construction.

The quintessential image of job creation via infrastructure investment: WPA workers on the Henderson Street trunk sewer in Seattle, 1937. Photo via Seattle Municipal Archives

in joblessness. In short, the state can get more infrastructure built for less and put people to work who would have otherwise been unemployed. Today, however, unemployment is around 4.7 percent. Competition for labor is up, and, with it, construction wages. Without slack in the labor market, new projects are more likely to shift employed workers around, not add new jobs to the economy. Worth noting is President Trump's assertion that his proposed tax breaks will pay for themselves. If these privately-funded projects fail to increase the net number of jobs, the hope for additional revenue to offset tax incentives will never become reality.

Further complicating the job scenario is the capital-intensive nature of construction today. Macro-economists and policymakers who think of highways and transit lines as engines of job creation are remembering grainy black and white images of Civilian Conservation Corps workers slinging pickaxes as they built roads through national parks. Construction projects are more capital intensive than they were in the 1930s, using heavier machinery and far less labor. As technology advances, and construction equipment becomes increasingly automated, jobs will become highly skilled and decrease in number. Most infrastructure construction jobs currently require two

or three years of apprenticeship and on-the-job training. In the future, infrastructure stimulus may offer little for unemployed people without extensive construction experience.

While the creation of jobs from infrastructure construction is limited, there are potential long-term benefits in terms of jobs. In most parts of the United States, our system connects everything worth connecting, and does so as cost-effectively as possible. There's little need for new infrastructure, but there is, however, great urgency to rehabilitate the infrastructure we already have.

Local and state governments are generally responsible for preserving existing infrastructure. Additional federal support is helpful, but we should be sure that any support is pushed toward maintenance and not new infrastructure, which largely serves as a distraction. We all know that maintenance, repair, and reconstruction are not sexy. They do not result in ribbon cuttings with smiling politicians getting their pictures taken and posted in the local news. Yet, on a per-dollar basis, detailed maintenance work employs more people than large-scale brand new construction. Moreover, it is best to run the costly equipment required for road construction at a continuous level, thus maximizing its productivity. Continuous use is achieved by a steady rate of spending on projects, not

stimulus-related spikes or failures to authorize infrastructure expenditures.

Economic activity increases with accessibility—more specifically, the ability for workers to reach jobs and stores, and for business entities to easily interact. This occurs with faster and more direct transportation, denser land use, and increased access to developed urban areas rather than less economically active rural areas. That said, it is cheaper to build in rural areas than cities, so the cost-to-benefit ratio is not obvious. This ambiguity is worth noting. While infrastructure policies may aim to even out spatial inequities and “spread the wealth,” that ambition is at direct odds with the desire to maximize the productivity and efficiency of infrastructure.

Public works are justifiable when the social benefits exceed the cost, not simply when they create spikes in job growth or score political points. To maximize the amount of infrastructure that society enjoys per dollar, the government needs to be efficient with how infrastructure money is spent. From an infrastructure perspective, if a road project employs some people, that provides a nice rhetorical flourish, but, if projects are solely aimed at employing people, the expenditure is a waste that, in the long run, shrinks the economy. The debt borrowed to build said projects ultimately comes due. ■

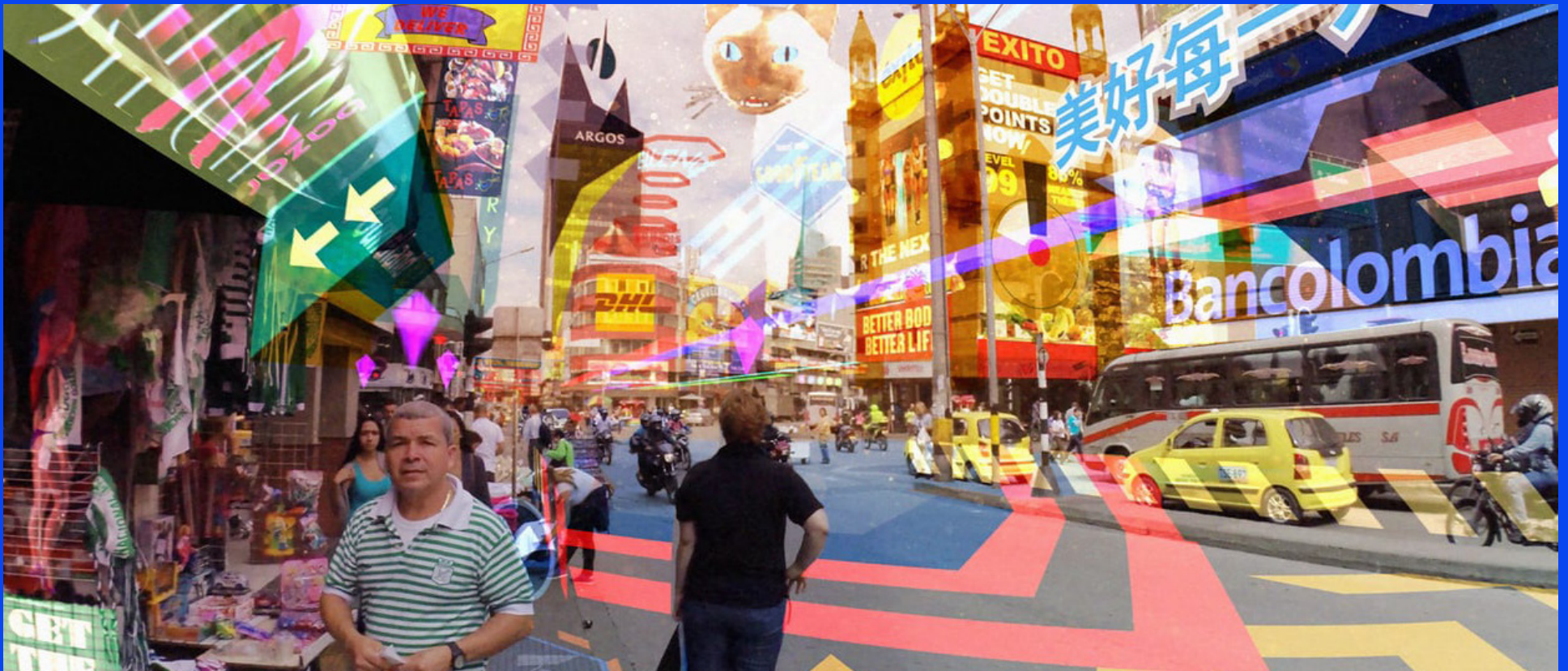
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NICOLE DUPUIS

THE AGE OF THE SMART CITY

Better Cities Through Smarter Infrastructure



EDITOR'S NOTE

A city's strength is defined by how well it delivers essential services, identifies and responds to the needs of its citizens, and supports equity within its society. The advent of smart cities—municipalities that harness the power of data and the Internet of Things to improve the performance of infrastructure and city services—has unleashed unprecedented opportunities for cities to better themselves and the quality of life of their citizens. These potential gains are not automatic. City leaders will need to balance the cost of integrating new technology with maintaining existing infrastructure, find partners and financing to support the work, and ensure that the poor and vulnerable also share the benefits that accrue. In this article, Nicole DuPuis, Principal Associate for Urban Innovation in the City Solutions and Applied Research Center at the National League of Cities, explores the choices facing cities as they confront this staggering challenge.

Title Photo from "HYPER-REALITY" by Keiichi Matsuda



Infrastructure can be likened to the skeletal system of the United States—critical to its function and success. It is the means by which we move goods, reach jobs, connect with family, and explore nature, and it is as essential to the country as bone is to the body. This metaphor might seem like hyperbole, but all it takes is one falter, one accident, one disaster to remind us of how difficult life is without well-managed, well-maintained, and functional transportation, water, or cyber infrastructure. Infrastructure delivers our safe, clean water; it provides the public spaces in which we engage in civic life, and most

importantly, it gets us safely to the places where we live, work, play, and pray.

More and more, infrastructure is inextricably linked to technological change. Today, every city wants to be a smart city, and that means investing in new types of tech-laden infrastructure—broadband, sensor networks, utility monitoring systems. These new types of “smart” infrastructure have the ability to impact and alter the buildings we use, the ways we get around, and how we use information.

The movement toward smart infrastructure is typically driven by

two primary factors: One is allowing cities to function more efficiently, and the other is positioning them to be more responsive to community members. However, the ultimate goal of smart infrastructure implementation and adoption should be to create better, more equitable urban environments in which people can thrive. Even as cities struggle to navigate the challenges of meeting today’s infrastructure needs, it is worth imagining what well-connected, smart infrastructure might bring to our cities in the future—and how it will impact our everyday lives. Autonomous vehicles on our roadways could provide urban planners with the data they need to develop safer, more efficient mobility corridors where different transportation modes communicate and move fluidly together, making signals obsolete. As we move toward greater usage of shared vehicles and away from a mobility model that relies on parking, cities might be able to recapture parking lots and garages and redevelop them into assets that bring more value to people. Wi-Fi hotspots peppered throughout cities could promote increased and more egalitarian access to information and help alleviate the digital divide. City residents could be safer with street light networks that use embedded

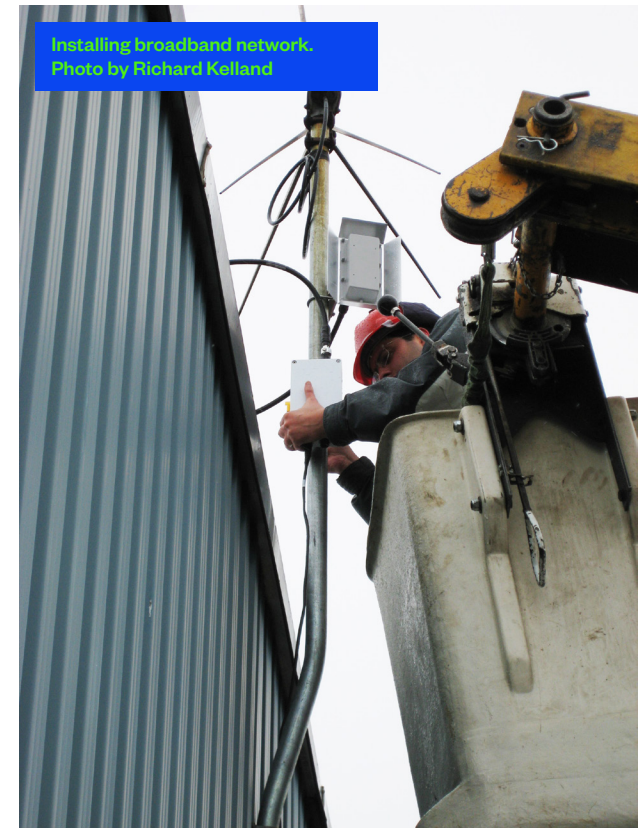
sensors to detect gunshots or flash during emergencies. Smart utility systems could allow cities to collect information from sources like water, electric, and gas meters, and make repairs as soon as they are needed—not just when residents call them in.

While the oncoming age of the smart city signals progress, it also represents an added challenge for municipalities across the country. Today, the majority of local governments struggle to keep their existing infrastructure—roads, bridges, and water/wastewater systems—in good repair, which subsequently precludes them from even beginning to consider new investments. The influx of new smart city applications is promising but puts an additional burden on cities to build out their broadband and wireless infrastructure in a time when many of them can barely afford to keep their other infrastructure assets up to par.

While the federal government once played a much more significant role in funding the nation's infrastructure, today the majority of this responsibility falls to state and local governments. The federal funding source for infrastructure, the Highway Trust Fund, is rapidly approaching insolvency. The Fund is capitalized by the federal gasoline tax, which has not been raised since 1993. Meanwhile,

reductions in per capita vehicle miles traveled, coupled with increased fuel efficiency standards, have resulted in net revenue losses. If current spending and revenue projections are accurate, the Fund will amass a deficit of \$180 billion over the next decade. State governments are also struggling with declining gas tax revenues, combined with state budget constraints that sometimes pressure governments to divert gas tax revenue to balance the state budget instead of addressing critical infrastructure needs. This leaves dedicated infrastructure funds and programs for the cities in these states unreliable. Thus, we see a sort of domino effect where limited support from the federal level combined with constrained state budgets leave local governments assuming the majority of the fiscal responsibility for infrastructure.

This burden becomes more difficult for cities because much of the country's existing infrastructure is coming to the end of its useful lifecycle. This means that communities are relying on infrastructure that is falling below a standard of good repair or that is inadequate to meet their needs. Because local governments are the most accessible to the communities they serve, they tend to bear the brunt of frustrations with sub-par infrastructure, even in cases where the responsibility should



be shared. Filling potholes and keeping water systems running safely and efficiently never stop being priorities for local elected officials.

The overall decline in infrastructure investment, rapid deterioration of existing infrastructure assets, and the need for significant upgrades is commonly referred to as the “infrastructure deficit.” The infrastructure deficit is no small hurdle for cities and states. The American Society of Civil Engineers’ (ASCE) Infrastructure Report Card estimates that approximately \$3.6 billion in investment is needed to get the nation’s infrastructure up to a state of good repair by 2020. In addition to that monstrous figure, National League of Cities (NLC)’s research consistently finds infrastructure maintenance and investment among the top issues of concern for cities.

Along with existing maintenance burdens associated with aging infrastructure, cities are now feeling pressure to invest in smart city applications and the new types of infrastructure that support them. Sensor networks and high-speed broadband are touted as requirements for a future that promises autonomous vehicles and an Internet of Things (IoT) ecosystem in cities. The expense of this new investment is daunting and cities are uncertain about which technologies

to commit to, what the next big thing will be, or how to ensure interoperability with both existing and future assets. The hype around this is immense, pressuring cities to get on board with all of this lest they be left behind or excluded from the 21st century economy.

Technological disruption makes these predicaments all the more difficult. However, focusing on outcomes, potential partnerships, and best practices will help cities to forge a path forward and make infrastructure investment decisions that will sustain them in the future. Furthermore, as the lines between technology and governance become more blurred, so too will the lines between public and private. Given that much of the smart cities revolution was initially perpetuated by the private sector—in the form of new applications and systems marketed to cities—it is fair to assume that many of these same private sector organizations (specifically telecommunications and IoT-focused tech companies) have a vested interest in ensuring cities have adequate infrastructure to support the products they are selling.

As cities face mounting infrastructure challenges, they should look for ways to partner with non-governmental actors, like universities and the private sector. Partnerships provide many benefits to cities, including

increased access to funding and expertise that might not otherwise be available. They also allow cities to share the risks of large infrastructure projects. Public-private partnerships, also known as PPPs or P3s, are contractual arrangements between public agencies (state or local governments) and the private sector to provide infrastructure for the public. Both public and private partners contribute financially and share in the risk and reward. The government partner administers and regulates the infrastructure, while the private sector infuses capital and focuses on the operational and executive aspects. These arrangements have been most successful overseas, with some emerging success in the United States. NLC’s recent research found that 32 states have some variation of public-private partnership-enabling legislation.

While P3s offer new opportunities to meet infrastructure needs, there are drawbacks to collaboration with non-governmental actors. Cities should ensure a clear, mutually agreed upon purpose or mission for new partnerships. They should also weigh the motivation and commitment of potential partners. New partnership arrangements should clearly delineate authority and responsibility, and set formal arrangements in place for

Technology is not an end in itself but just a means to achieve a certain goal. It is still up to cities, and the decision-makers who lead them, to consider what they want their ultimate ends to be...

"Internet of Things in Connected Cities" graphic courtesy of National League of Cities

INTERNET OF THINGS IN CONNECTED CITIES

TRANSPORTATION CONGESTION SENSORS

- Smart transportation systems use sensors to detect congestion and bottlenecks in traffic patterns. They also rely on cameras to enforce speed and traffic infractions. In doing so, these tools gather real time information that can be used by city DOTs to make mobility networks safer and more efficient.

WATER AND WASTEWATER MONITORING

- Monitoring devices can detect leaks as well as changes in water pressure to determine whether water infrastructure is working properly.

PARKING APPS AND KIOSKS

- Apps coordinate with smart parking meters to inform drivers of where there is parking availability.

BRIDGE INSPECTION SYSTEMS

- Sensors monitor the structural soundness of bridges and inform city engineers of any issues. Drones are used to inspect hard to reach areas.

SELF-DRIVING CARS

- Self-driving cars shuttle people in and out of the city, providing rides for others and making deliveries while their owners are occupied with work or other activities.

WASTE MANAGEMENT SENSORS

- Sensors detect the amount of garbage in receptacles around the city so that sanitation workers can maximize efficiency in their routes.

LIGHTING

- LED lights are weather adaptive and communications are automatically sent to the Department of Public Works when the bulbs need to be changed.

FIRE DETECTION

- Sensors monitor conditions in public parks and wooded areas that might be prone to fire. Sensors can also detect fires in buildings and initiate a call to the fire department in an emergency.

ENERGY MONITORING

- Power plants can be monitored for safety and city officials can be informed of any influx in radiation levels.

SOLAR PANELS

- Solar panels can be monitored to determine how much energy they are providing and whether they need maintenance.

Every consumer product and piece of infrastructure increasingly has the ability to sense surrounding stimuli, to communicate with other devices and people, and to draw on the computing and storage power of the cloud. This phenomenon has been dubbed the **internet of things**. The more smart devices

and sharing platforms there are, the more data is generated about consumer's preferences and habits. But what does this mean for cities? Smart cities are employing the same technology to connect their disparate utility, infrastructure, and public service grids, generating real-time aggregate data. This, in turn, can

help cities manage their programs and services more effectively and gauge their impact immediately. The city of the future is an interconnected one, where devices communicate with one another in a constant stream of data that provides real-time information to the public and to the municipality.

DRONES

- Drone can be used for law enforcement and firefighting, as rural ambulances, for infrastructure inspections, and for environmental monitoring. Commercial uses include precision farming, aerial photography, and in the near future, package delivery.

SURVEILLANCE CAMERAS

- Cameras ensure security by monitoring activity in areas that are not frequented by public safety officers. Areas that are not open to public access can be monitored to keep unauthorized personnel out.

BODY CAMERAS

- Public safety officers can wear body cameras that capture footage of interactions between themselves and city residents to ensure safety for both parties.

WEARABLE DETECTION

- Cities can build in smartphone and wearable detection sensors so that people can be an active part of the internet ecosystem, communicating with the city, and with each other.

BROADBAND INFRASTRUCTURE

- A reliable internet ecosystem is the glue that holds the internet of things together.

SMART LOGISTICS/FREIGHT

- Platooning trucks carry freight efficiently from the port to their final destination. Smart inventory systems inform operators about when freight is moved between different locations.

VEHICLE FLEET COMMUNICATION

- Public transit and city fleet vehicles communicate with their home agency when it is time for maintenance or replacement.



continued contact, communication, and accountability. Taking all of these organizational pieces into account will improve the chances of a successful partnership.

Cities of all sizes have found themselves saddled with infrastructure challenges, and there might be a need for some creativity in facing them. Partnership with non-governmental entities, especially in the age of the smart city, represents an opportunity for cities to manage existing challenges and make investments that will sustain them well into the future. Making smart investments and decisions today might give cities the ability to fulfill their original and most important role as equitable, livable hubs designed by and

for people. However, that hope rests largely on the assumption that technologies can help make people's lives better in cities. Technology is not an end in itself but just a means to achieve a certain goal. It is still up to cities, and the decision-makers who lead them, to consider what they want their ultimate ends to be, and how they want their communities to look. ■

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JULIAN BRAVE NOISECAT

DISRUPTION BEYOND STANDING ROCK

The Indigenous Fight for Equitable Infrastructure



EDITOR'S NOTE

How do we balance the needs of people who use and depend upon an infrastructure asset with the needs of those who live in that asset's immediate vicinity? That question is central to the future of pipeline development as the growth of hydraulic fracking has caused pipeline projects to proliferate. Nowhere was this tension more visible than at Standing Rock, where the indigenous community, concerned about the local impact of the Dakota Access Pipeline, fought the construction of a section they believe threatens their water and quality of life. Exploring this issue is Julian Brave NoiseCat, a writer and policy analyst at 350.org. He takes us through local concerns about the pipeline, while illustrating the consequences of development that excludes local communities from the building process, and identifies the signals of change that herald fundamental shifts in both the demand for pipelines and the way indigenous people are consulted in matters related to infrastructure, construction, and land use.

Title Photo: Demonstrators assemble in opposition to Dakota Access. Via Creative Commons

Dakota Access Pipeline protest at the Sacred Stone Camp near Cannon Ball, North Dakota. Photo by Tony Webster.



A Land of Stark Contrasts

Forty-one percent of Standing Rock citizens live in poverty. That is almost three times the national average. The reservation's basic infrastructure is chronically underfunded. Schools are failing. Jobs are few and far between, and 24 percent of reservation residents are unemployed. Healthcare is inadequate. Food is insecure. Many depend on unsafe wells for water. Roads are often unpaved. Housing is in short supply, substandard, and overcrowded. If the people of Standing Rock did not take in their beloved family and friends, there would be mass homelessness.

Meanwhile, Energy Transfer Partners' Dakota Access Pipeline has a price tag of \$3.8 billion, bigger—by almost a full \$1 billion—than the entire budget of the Bureau of Indian Affairs,

which serves 5.2 million citizens representing 567 federally recognized tribes across the United States. The most expensive piece of infrastructure in their community will not be the schools, homes, or hospitals they desperately need. Instead, it will be a pipeline that they have vehemently opposed.

Energy Transfer Partners failed to consult with the community before commencing construction, defying domestic and international precedents embedded in treaties dating back to the 1800s and legislation dating back to the Indian Civil Rights Act of 1968. Had Standing Rock been consulted properly, they would not have given their consent for a pipeline that desecrates sacred ancestral remains, violates their treaty rights, and leaks petroleum into their water supply.

In the short term, Dakota Access threatens the indigenous nations, ranchers, and communities downstream of the pipeline route. Over the long-term, Dakota Access endangers people far beyond. The pipeline will dramatically decrease transportation costs for fracked Bakken shale oil, locking in an estimated thirty coal power plants-worth of emissions per year amidst an imminent global climate catastrophe.

How can pipelines be hammered through Native communities in blatant disregard of treaties signed by the highest government officials of these lands? How can a multi-billion-dollar pipeline take precedence over long-needed basic infrastructure? How is any of this acceptable?

The Colonial Present

The totality of this picture can only be captured in a word rarely if ever used in contemporary politics—colonialism. Indigenous presence is contained, erased, and then forgotten, so that the United States can continue to live upon and profit mightily from lands taken from indigenous people. Erasure is a double-edged sword. It leads the powerful to underestimate indigenous resistance, opening pathways to victory precisely because indigenous people have been written off.

In a special message to Congress, Richard Nixon inaugurated the current era of Native American self-determination in 1970. Politicians like Nixon saw self-determination as an opportunity to reduce bureaucracy and limit government spending, but it also empowered indigenous people to parlay minor gains in self-governance into a powerful global movement. Indigenous movements from the United States to Canada and Australia to New Zealand won paradigm-changing victories pushing states to forego assimilationist policies and recognize indigenous rights to self-determination and self-government.

These too often forgotten victories laid the political, legal, and institutional groundwork for indigenous people to turn front-line resistance, politics, law, and media into a potentially transformative movement at Standing Rock and beyond. Today, indigenous people stand at the forefront of political action and thinking, fighting for a democratic, pluralist, and post-colonial framework that recognizes robust indigenous sovereignty as essential to the global fight against racism, inequality, environmental degradation, and climate change. In an era of growing concern about these issues, indigenous people can call thousands and even millions of local and global allies to their cause.

Local and Global Allies

Local landowners who don't want pipelines in their backyards created an unlikely but powerful coalition called the Cowboy Indian Alliance, which played a crucial role in persuading President Obama to reject Keystone XL and will stand against its reincarnation under Trump.

The labor movement is another potential ally for the indigenous movement. While laborers have little choice but to take work where it's offered, the unions that represent them might be mobilized against the industry and in favor of emerging and promising job-creating industries like renewable power and resources. Unions were divided in their support for Dakota Access, but with dialogue between the indigenous and environmental movements and the rise of alternative energies, they may yet be persuaded to oppose pipelines in the future.

Far away from oilfields and pipelines, the indigenous movement has allies who can help fight developments that violate indigenous rights. Many investors, including prominent banks, cities, and pension funds have divested from Dakota Access parent companies. Movements to divest from fossil fuels can target companies seeking to exploit indigenous lands. Progressive environmental and financial regulations could discourage

risky natural resource speculation and divert and diminish returns on capital flows to these industries. In response to the opinions and demands of their citizens and lawmakers, cities like San Francisco, Seattle, and Davis are withdrawing their money from banks that support Dakota Access.

Disrupted Production

Fracked oil costs more to refine and transport to market than other forms of crude. This makes it a more risky—and more dangerous—business.

The decision not to consult Standing Rock prior to construction was surely one rooted in financial expediency. However, given the length of delay and negative attention drawn by the standoff, foregoing a fully inclusive approach to stakeholder engagement and indifference to indigenous concerns came with serious consequences that are still unfolding even now as oil begins to flow through the pipeline.

Investors, bankers, and business partners are risk averse. They don't like delays, and they don't like bad headlines. Standing Rock produced both—and similar acts of resistance are increasing in number. Engineering consultants Black and Veatch noted in 2015 that the delay caused by opposition groups was the biggest source of

Foregoing a fully inclusive approach to stakeholder engagement and indifference to indigenous concerns came with serious consequences that are still unfolding even now as oil begins to flow through the pipeline.

A November 2016 protest against DAPL in front of San Francisco City Hall.
Photo via Creative Commons





Richard Nixon delivers his 1971 State of the Union Address. Photo via NARA

concern among industry executives. Litigation against indigenous claims is costly and can impede and even halt natural resource development on and across indigenous lands.

Infrastructure in an Indigenous Century

The United Nation's framework of Free Prior Informed Consent is the starting point for indigenous movements and progressive parties seeking to reshape infrastructure and policy and achieve more just outcomes moving forward. Examples of effective progressive models and policies around the world that might be emulated include the Waitangi Tribunal and Settlements in Aotearoa/New Zealand, the Royal Commission on Aboriginal Peoples in Canada, the

plurinational constitution of Bolivia, and the White House Tribal Nations Conferences hosted by the Obama Administration.

One promising precedent on the path to a post-imperial future has emerged in Aotearoa/New Zealand, where, through the Waitangi Tribunal, the Whanganui iwi Maori recently won a 140-year legal battle to recognize that their ancestral Whanganui river has legal rights equal to those of a human being.

The Whanganui settlement, which was signed by the Whanganui iwi in 2014 and enacted into law by New Zealand parliament last week, established two guardians to act on behalf of the river, one from the crown and one from the iwi. In addition to

legal recognition of the personhood of the Whanganui river, the settlement provided financial redress to the iwi of NZ\$80m, and an additional NZ\$1m contribution to establish the legal framework for the river. While the implications and effects of this legal experiment are yet to be seen, this is a potentially revolutionary precedent that offers a path forward for redefining relationships between governments, indigenous peoples, and the land in the 21st century.

This more equitable future springs from dialogue with indigenous leaders and communities. It is rooted in recognition and respect for indigenous sovereignty.

Instead of building pipelines that threaten water, land, and life, we must invest in schools, homes, hospitals, transportation, and cultural centers that enable indigenous children and nations to flourish. We must return lands and resources to indigenous control and include indigenous voices in decisions that shape the infrastructure of tomorrow. We must recognize what indigenous peoples have believed all along: that land and water are sacred living ancestors whose well-being humanity depends upon for our continued health and existence upon this earth. This planet's greatest resource does not lie in the ground. It lies in the people, places, and

communities who lead the way forward to a more just, equal, democratic, and pluralistic future for the first people of this land and all who share it with us.

Many, with good reason, have declared this the Chinese century. But in the wake of Standing Rock, growing support and strength of the indigenous movement and emerging local and global trends suggest that, when we envision a more just, equal, and green world, this might also become the indigenous century. ■



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AN INTERVIEW WITH STEVE FRIESS

LESSONS FROM FLINT'S WATER CRISIS



EDITOR'S NOTE

Every day in America there are citizens whose faucets flow with contaminated drinking water. Nowhere was this more visible than Flint, Michigan, where the late response of public officials to signs of wide-spread lead poisoning left many residents severely ill and deeply distrustful of city and state government. The Flint Water Crisis is a reminder that, along with materials, labor, and financing, trust is an essential component to the design and implementation of infrastructure. For lessons learned from this crisis we turned to two sources. First, we interviewed Steve Friess, journalist and author of “For All They Know,” a case study on the crisis that shows how challenging life has become in Flint and how difficult it has been for officials to establish a sense of water security. Secondly, to illuminate the larger problem of contaminated water in America, we turned to the National Resources Defense Council, which has worked to illustrate the scope of lead and copper contamination nationwide and offer recommendations going forward for Flint and the rest of the nation.

Title Photo from “Greetings from Flint — Chapter 1” by COIabs + INDECLINE



AB What most surprised you while you were investigating the crisis in Flint?

SF The thing that surprised me the most was how little of what we take for granted as known science is actually known. Most of us assume science understands water biology, the delivery of safe water to people, and the life cycle of pathogens and bacteria. It turns out that scientists don't actually know this. The process of looking at what was happening in Flint brought to light how many times scientists and other experts would answer what I believed was a reasonably simple

question with, "I don't know."

AB And that scientific uncertainty extends beyond water quality in Flint?

SF Joan Rose [expert in water microbiology, water quality, and public health safety] from Michigan State University was somebody I thought could explain how *Legionella* or any other bacteria live and move through the water system to infect people or make them sick.

She said that there's quite a lot we don't know about the microbial health of water. I assumed at that moment that she was talking about

Flint specifically. So I asked her, "You mean in Flint?" She said, "No, I mean in general." These are the experts. It was surprising that they were so open about the things that are unknown.

AB Currently, Flint is in the process of replacing hundreds of miles of pipe throughout the city. Where is the city in that process, and how long will this work take?

SF It's hard to tell. Congress just passed more than \$100 million to help pay for the replacement of the pipes in Flint. There are different estimates as to how many pipes need to be replaced. The record keeping on where the piping—lead, galvanized steel, and copper—is located is old and antiquated, and often inaccurate or hard to read. It creates a logistical challenge to figure out exactly how many pipes need to be replaced and where they are. It's certainly impossible to know how long it will take.

AB How did the condition of Flint's water infrastructure contribute to the crisis?

SF The original problem—the way that Flint ended up being poisoned—was not simply because some of the pipes were made of lead, but because they put improperly treated water through a system that was corrosive. It pushed away

The water pickup station in Flint's Ward 8. Flint established these stations in every one of the city's wards. USDA photo by Lance Cheung.



In a way, Flint has actually adjusted to its new normal of not being able to use its sinks and is rejecting the notion that the city's water is now safe.

the protective lining that most water systems have accumulated over time from phosphates and chlorine that have been added to the water. That biofilm broke down. The pipes started to leach lead into the water and, now, some pipes are more fragile than others. They have added additional phosphates and other chemicals to the already treated water to rebuild that biofilm.

Scientists say they've been successful and the water coming through the pipes now is relatively safe. In a lot of ways, things are better. But is that enough to fix the

problem? It's also a matter of public perception. It's a radical breakdown in the public's faith in both scientists and their government.

AB Considering everything the city is facing during its recovery, does that lack of trust present a significant obstacle as Flint attempts to recover?

SF Yes, it does. There's a portion of my case study in which I discussed an alternative idea from 3M. The company developed a method of building a pipe within a pipe. It would strengthen the original pipe and prevent the water from

ever interacting with the lead. It is a scientifically sound idea from everybody I've spoken to. It is also a political non-starter.

It would be significantly less expensive than digging up all these pipes and replacing them, but there is your conflict. There are scientific, logistical, and financial reasons to adopt 3M's solution—or something like it—but there's also the fact that you've got a population of badly treated, now highly-politicized minority families and communities, who will not accept anything less than seeing their streets ripped up

The city and the state have tried to argue that things are different and will improve going forward, but it's going to take a lot of time. I don't know if it will ever be exactly normal.



and those pipes that poisoned their kids removed.

AB You spent time with families in Flint for several weeks while you were there. Can you describe how their lives and routines have been impacted? Has a new “normal” been established?

SF Not really. Their lives are shaped by the lack of certain things most of us do normally. They almost never use their kitchens, or the kitchen sink, or the water that comes out of the faucet for common things like having tea, or boiling something. The mom in the family I lived with

used to cook all the time. Now, she doesn't cook very much at all, primarily living off of take-out and tons of bottled and filtered water.

They've done an impressive job around Flint in getting free faucet-mounted filters onto thousands of spouts. The problem is that those filters have life cycles too. They are supposed to be replaced. Who knows if this is being done correctly, or if people are able to obtain the filters at all. There are very obvious logistical problems. Ultimately there are people who try their best not to use the water out of the tap for much of anything.

In a way, the city of Flint has actually adjusted to its new normal of not being able to use its sinks and is rejecting the notion that the city's water is now safe. People are still getting sick. There's a great deal of confusion, suspicion, and rejection of science.

AB Have state and local authorities made any special, concerted effort to bridge the gap between themselves and the public, in the interest of restoring public confidence?

SF I think so. In the period I've been in Flint, there's always some sort of public neighborhood meeting at a church or school to explain things.

Local authorities are trying really hard to be forthright.

It's just that people have been badly treated. Keep in mind, not only were there government decisions that poisoned all these people, but also when these people noticed they were being poisoned, their concerns were dismissed for a long time. The city and the state have tried to argue that things are different and will improve going forward, but it's going to take a lot of time. I don't know if it will ever be exactly normal.

AB You've spoken to so many stakeholders in Flint, both government officials and ordinary people. From your time focusing on this issue, are there any insights on how we can avoid crises like these going forward? Did anything jump out at you during your study?

SF This problem was completely avoidable. Testing for water quality was not as available as it should've been. Officials weren't looking for the kinds of things that would have been hallmarks and indicators of this problem.

There has been a lot of talk about adding a number of other types of tests for toxins in addition to lead and copper, two toxins for which testing is required under the law.

There is actually very little in the law from the EPA or state environmental agencies that require a city or a state to test for other types of contaminants as water moves from a municipal water system into people's private homes.

I suggest additional testing, additional awareness, and, obviously, transparency in communicating what the data is showing. There were indications early on that something was awry. Some of this information got either missed, misdirected, or ignored. People who were trying to raise issues were silenced or ostracized in various ways. I will say that, yes, the testing I'm suggesting can be more expensive, but, if it had been conducted, it would have told this story a lot sooner.

A Better Way Forward

The contamination of water and its devastating effects are not felt by Flint alone. Poor management by public officials, deficiencies in the Safe Drinking Water Act, and persistent racial and socioeconomic bias are some of the factors contributing to what has become a national problem. In 2016, the National Resources Defense Council (NRDC) used official EPA records to map lead-related issues in drinking water across the country. The resulting report, “What’s in Your Water? Flint and Beyond,” provides a comprehensive map of counties

with copper and lead violations, and provides recommendations for resolving issues with contamination in Flint and the nation as a whole. We’ve provided NRDC’s summary of its recommendations below (courtesy of nrdc.org):

- Fix Flint, with immediate emergency relief as well as long-term infrastructure and systemic improvements.
- Get the lead out. Invest in the rest of the country’s water infrastructure, removing lead service lines and fixing other water problems with

a prioritization of underserved communities.

- Fix our drinking water laws and rules. Implement and enforce a bolstered Lead and Copper Rule, while letting citizens more easily sue for relief from contaminated water.
- Address environmental injustices, allowing communities who bear a disproportionate burden of polluted water to participate in developing solutions to drinking water infrastructure challenges. ■



The Flint, MI water treatment plant.
Photo via Creative Commons

AARON BETSKY

GOOD DESIGN OVER GRAND GESTURES

A Wiser Approach to American Infrastructure



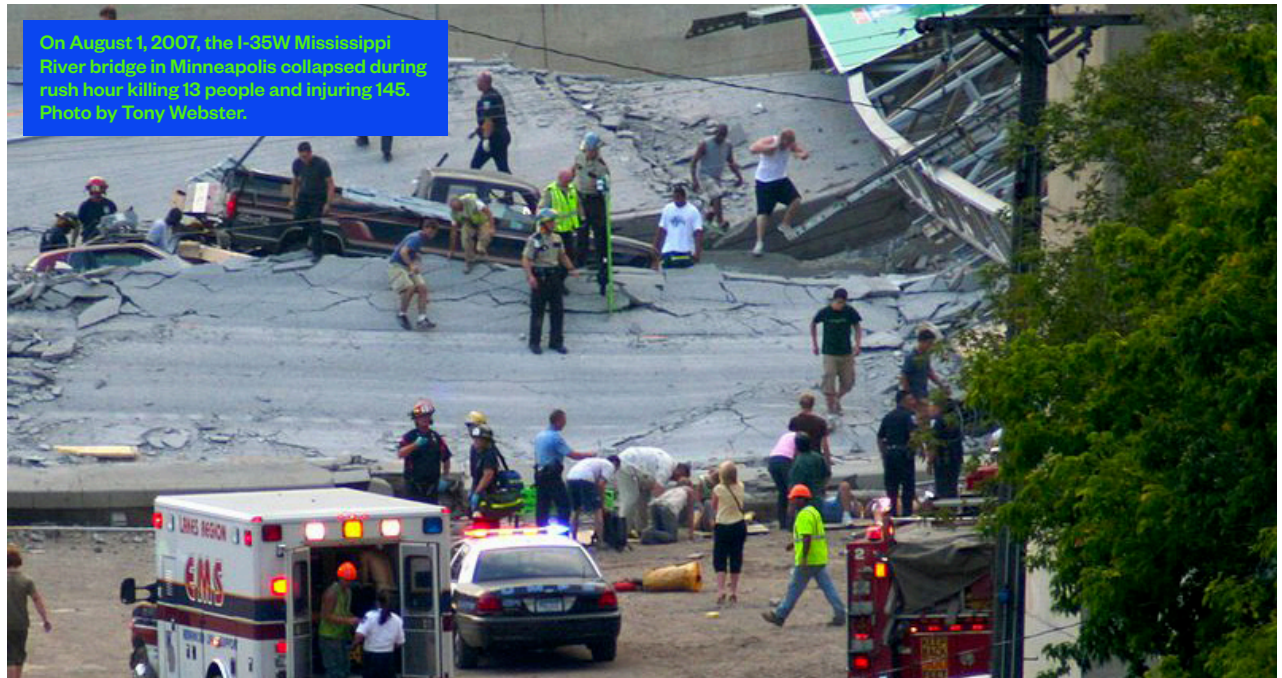
EDITOR'S NOTE

The idea of rebuilding America's infrastructure often inspires ambitious plans and political promises, but grand aims are so often hobbled by flawed execution. Projects like the "Big Dig" in Boston or the San Francisco Bay Bridge's eastern span are infamous due to massive delays and cost overruns. For our final perspective, Aaron Betsky, Dean of the Frank Lloyd Wright School of Architecture, recommends that the United States rethink its approach to getting the infrastructure it needs. He presents a sweeping vision of how, through new technology and design, the nation may find ways to improve the performance of existing infrastructure and build greater value into the new. Betsky also imagines a future where design interventions may be small, flexible, and tactical in nature, but, when linked together through thoughtful and inspired planning, may yet achieve an impact that is greater than the sum of their parts.

The eastern span of the San Francisco Bay Bridge, old and new. Title Photo by Frank Schulenburg

Across the country, roads, bridges, and tunnels are falling apart; airports are overcrowded and unable to handle the volume of traffic they attract; congestion is wasting millions of hours of productive time and millions of tons of non-renewable resources from the tailpipes of idling cars; uneven development is isolating the poor in places without adequate public transportation or services.

It would be nice to imagine that we could solve all these problems with grand gestures. Unfortunately, that is not only impossible, but unwise. First, support for a \$1 trillion infrastructure plan, even if it leverages tax credits to spur private investment, is uncertain given very divergent views within Congress about the need for any federal involvement at all. Second, given that Congress hasn't raised the federal gas tax since 1993, the burden of supporting our infrastructure will shift even more to local and state governments. To improve their infrastructure, some urban areas may be able to attract financing. But because private investors will only select profitable projects, poorer suburbs and areas beyond dense urban cores may find themselves left out, leaving them more isolated and unequal in their distributions of resources. Furthermore, the benefits of privatizing public services have been ambiguous,



proving so expensive that in some cases (Coeburn, Virginia's water system) communities have reversed course, while in others (Indiana Toll Road) the companies and banks involved have crept away in defeat.

So, what, then, is to be done? Here, designers and planners have the opportunity to propose smart solutions. Though many of us see infrastructure as massive, inflexible, and expensive, great designers can apply their imaginations to improving existing infrastructure. Innovative design can increase performance and add types of use, or conceive new projects altogether that provide flexibility, vary in size and cost, but still do much to

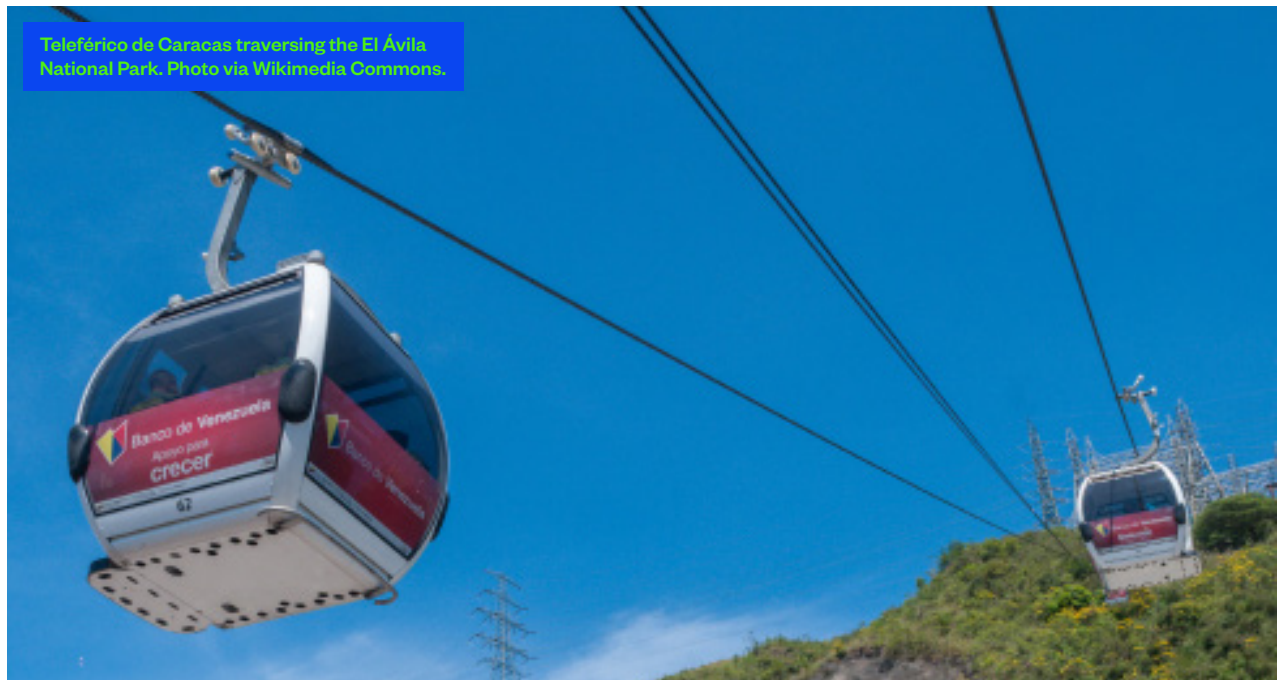
improve mobility, reduce pollution, give shelter from extreme weather, or better connect people within and between communities.

Perhaps first, innovators should turn their attention toward smart technologies that can help us get more from the infrastructure we already have. Airlines and airports are using technology to increase efficiency of their services, scheduling, and pricing in ways that, though sometimes painful for the consumer, are rather brilliant in optimizing the use of materials and personnel. The fact that you don't have an extra seat next to you on the plane is, from that perspective, a good thing, as the airline company is not wasting fuel

flying an empty chair. In the future, the airlines may rely on laser guidance and satellite tracking to sequence planes more efficiently, so they can both fly more directly and closer together.

Designers and planners will have to propose smart solutions that make sense both economically and socially.

Additional funding for investigations into materials and methods could connect us in more flexible and sustainable ways. That means, for instance, looking at the ways in which we put roads together. In Europe, there are many experiments with new forms of expanded asphalt—road surfacing materials made by harvesting and processing existing asphalt. They are made out of recycled materials and let water drain through so that it can be collected and recycled, absorbing up to 90 percent of the tire noise, which, in turn, is 70 percent of all highway noise. They can eat pollution and, even, through either absorption and conversion of kinetic energy or embedded solar panels, produce energy. All of this would mean that we could get more use out of our existing roads, and they would be less wasteful



Teleférico de Caracas traversing the El Ávila National Park. Photo via Wikimedia Commons.

and less of a nuisance to those who have to be their neighbors.

Beyond new materials, designers may also conceive of new ways to eliminate the need for roads altogether. Though not appropriate in all cases, cable cars, in municipalities like Caracas, Medellín, and several other South American cities, are an attractive alternative. Reducing the size of not only cars, but also everything from buses to fire trucks—a challenge given that their uniformly monster size is determined by unions and regulations—could further mitigate the need for new road construction. In the case where roads are already planned, they may add value in more pragmatic ways,

such as the plans for the extension of the I-15 highway from Las Vegas to the Mexican border, which is supposed to provide room for high-speed trains and green spaces as part of the initial construction.

They may take action in small ways that are temporary in nature—in the manner of the “parklet” movement—or join the long slog by sitting on committees and boards responsible for infrastructural improvements. The BeltLine around Atlanta is a good example of how both these tactics may come together effectively. Designers came up with the idea of providing small, temporary parks and amenities along an abandoned transportation

**The only way to preserve equity
is to fund the provision of
improved, flexible, distributed,
and smart infrastructure.**

The Splash Pad at Perkerson Park, an amenity within Atlanta's BeltLine.
Photo via Creative Commons



The BIG U by Bjarke Ingels Group. The Rebuild by Design competition was a partnership between U.S. Housing and Urban Development (HUD), Municipal Art Society, Regional Plan Association, NYU's Institute for Public Knowledge and Van Alen Institute, with support from The Rockefeller Foundation and other philanthropic partners. Image by BIG Team.

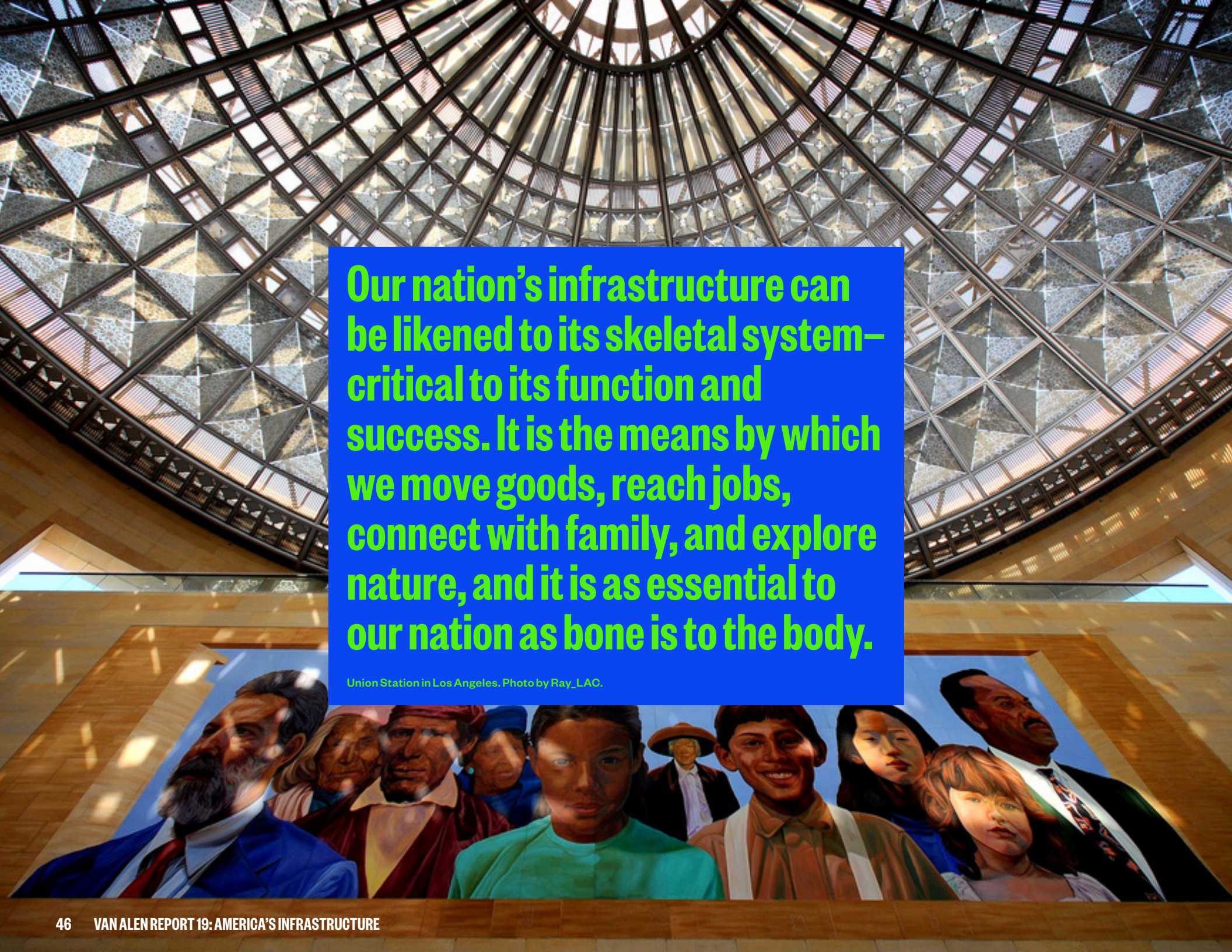


corridor that, when combined with new street car routes and connected transit, could stitch together Atlanta's far-flung suburban communities. The project showed how designers may start with small, temporary elements and, through smart planning, provide larger and potentially more impactful projects, even if they are never built.

Examples of such visions abound. Probably the most inspiring

construction now underway are projects conceived through Rebuild By Design. The post-Hurricane Sandy design competition awarded \$930 million to projects that strengthen the New York metropolitan area's ability to withstand rising water levels. Altogether, the project features many different components, including the necklace Bjarke Ingels has designed for lower Manhattan, combinations of

parks that will act as buffers and dykes, storage sites for excess water, and small-scale interventions at the street level to improve drainage. In other words, there is work to be done, but this is not a time for grand gestures. This is a time to be smart, be creative, and stay flexible. ■



Our nation's infrastructure can be likened to its skeletal system—critical to its function and success. It is the means by which we move goods, reach jobs, connect with family, and explore nature, and it is as essential to our nation as bone is to the body.

Union Station in Los Angeles. Photo by Ray_LAC.

ENGAGE

WHAT ARE THE BEST STRATEGIES TO ADDRESS CLIMATE CHANGE?

While this report focuses heavily on systemic policy challenges for development and delivery of quality infrastructure, recent events make it difficult to ignore the growing threat also posed by global warming, sea-level rise and extreme weather.

As cities work to adjust their relationship to water, we want our network of designers, planners, engineers, scientists, and policy-makers to send us ideas for how leaders can adapt and protect the critical infrastructure upon which our communities rely. What tools and strategies exist to make heavy infrastructure more resilient and green infrastructure more effective? How can cities secure necessary investment for construction and maintenance? What approaches to community involvement may assure

support among all stakeholders and help people – especially those in vulnerable populations – adjust to this new “normal”?

Please send all comments to vai@vanalen.org. A selection of ideas and strategies will be published in an update to this report and sent to Van Alen Report subscribers.



Hurricane Harvey delivered more than 40 inches of rain to Eastern Texas over 4 days. Photos via U.S. Department of Defense

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Special Thanks to

Mitchell Beer, Smarter Shift
Jonathan Peress, Natural Resource Defense Council
JoElla Straley, National League of Cities

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