Cultivating a Strategic Project Portfolio through Transportation Asset Management

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Across partisan lines and in government, academia, business, and the advocacy community, many analysts and stakeholders agree that the United States suffers from an "infrastructure deficit," or a gap between what the nation should be spending and what we are spending on surface transportation and other areas of infrastructure, such as water, aviation, and broadband. This deficit constrains economic growth and productivity, often with disparate impacts on people who need help accessing jobs, health care, education, and other services.

The national discussion about infrastructure policy and financing tends to focus on how we pay for infrastructure, either at the program or project level. Equally important but sometimes overlooked issues in federal policy conversations, however, are what we are paying for and how we should decide what to pay for. What are the most important investments to make with the money we have? How are these projects identified and selected, and what does it cost to build assets that deliver on various policy objectives? What projects yield the best outcomes across such objectives as travel efficiency, service delivery, economic growth, and equitable access to opportunity? New transportation asset management requirements designed to expand the use of life-cycle cost analysis, risk management, and long-term planning across agencies' portfolios can help answer these questions in ways that can be integrated into transportation planning processes. And, as debate about a prospective infrastructure package intensifies, there could be ways to craft new funding mechanisms in ways that encourage and build upon deployment of asset management principles.

Policymakers and the public have at times lacked confidence in infrastructure project selection processes, long caricatured by earmarks and the prototypical "bridge to nowhere." Over the past decade this perception has led to several federal policy changes, including the elimination of earmarks, a shift toward competitive federal grant funding, and movement by the federal government to employ cost-benefit analysis to award those funds. Some recent competitions for funding have required applicants to enumerate traditional economic benefits as well as potential effects on the environment, connectivity, access and mobility, and public health—important considerations that tend to be more difficult to quantity than other factors, such as those that measure state of good repair.

A less prominent yet potentially far-reaching new technical planning requirement may offer a more comprehensive way to integrate cost-benefit considerations into the ways state and regional transportation agencies develop and update their project portfolios. In 2016, the Federal Highway Administration (FHWA) finalized a rule implementing provisions of the 2012 Moving Ahead for Progress in the 21st Century Act (MAP-21) and the 2015 Fixing America's Surface Transportation (FAST) Act that call for asset management planning. By 2018, all recipients of federal formula grant dollars must complete asset management plans for pavements and bridges within the National Highway System. Recipients of transit funding are now guided by similar regulatory requirements.

Thoughtful and rigorous implementation of transportation asset management requirements can strengthen the portfolio of executable infrastructure projects nationwide, with benefits to public-sector transportation agencies across jurisdictions, prospective private investors, and the communities and economies that will ultimately be affected by the value of those investments. Employed deliberately, asset management can help planners and decisionmakers look across a portfolio, consider a range of investments, and determine how best to minimize risk and disruption while maximizing benefits for the economy, individual communities, and the traveling public. Asset management can also provide a platform for integrating a variety of costs and benefits into project and portfolio planning, including consideration of factors such as environmental risks; access to jobs, health care, education, or other services; and integration of new technology with existing infrastructure.

With less than a year until the first plans are due, transportation agencies have an opportunity to leverage the implementation of asset management planning through an early focus on capacity building, development and dissemination of best practices, and advanced consideration of how asset management data from implementing jurisdictions across the country might be aggregated and analyzed at the national scale. But federal requirements are deliberately broad and, given their novelty, there is limited precedent for what successful implementation looks like and how it can be deployed and evolve in ways that will maximize its potential to help identify, manage, and prioritize project portfolios across the country.

This brief aims to spark a discussion about how a data-driven asset management approach can address concerns about infrastructure spending, cost-benefit analysis, and the selection, prioritization, and cultivation of a strategic infrastructure project pipeline. It does not offer policy recommendations but instead focuses on illuminating opportunities and posing questions and topics for further analysis

and discussion at all government levels. Moreover, although this brief focuses on transportation infrastructure, the concepts and questions discussed could be applicable elsewhere.

The Nation's Infrastructure Investment Gap

In the lead-up to the most recent surface transportation authorization bill, the FAST Act, Secretary of Transportation Anthony Foxx frequently invoked an infrastructure deficit, or sizable gap between what the United States is spending and what we should be spending on surface transportation and water, aviation, and broadband investments. A recent report ranked America's electric and telephone infrastructure 21st globally, behind most nations in the developed world (Global Competitiveness and Risks Team 2016). A range of researchers, nonprofits, business groups, and professional associations have endeavored to quantify this gap, identify economic implications, and offer solutions. Although invaluable in framing the policy context for a national debate around infrastructure policy, these sources do not focus on what projects across the country make up aggregate need, what different kinds of investment can mean for different places, and the choices inherent in different options for resource allocation at any total spending level.

Quantifying the Magnitude of the Gap

Attempts to quantify the size of the nation's transportation infrastructure gap tend to focus on high-level aggregation of cost needs. The American Society of Civil Engineers' (ASCE) oft-cited "trillion dollar" figure establishes an order of magnitude for debate around legislative needs. ASCE's most recent quadrennial Infrastructure Report Card estimated that America's road, rail, and bridge infrastructure was underfunded by $1.1 trillion through 2025 (Economic Development Research Group 2016).

The US Department of Transportation's (US DOT) 2015 Conditions and Performance (C&P) report (widely relied upon and extrapolated from as a source of systemwide data for surface transportation) identified an $836 billion backlog of unmet capital investment needs for highways and bridges alone (FHWA and FTA 2017). The report projects that for these assets, addressing current unmet needs, as well as emerging needs over the next two decades, would require about $142.5 billion in federal, state, and local spending; combined spending levels in 2012 (the year upon which the data in the 2015 report are based) totaled about $105.2 billion. For transit, C&P data point to about $26.4 billion per year in investment needs to improve rail and bus system conditions, relative to $17 billion annually as of the 2012 data in the report.[1]

Impacts on Productivity and Economic Growth

Several studies have looked at the relationship between spending on infrastructure and economic growth and productivity. Although isolating the impact of infrastructure investment on growth is difficult, the Hamilton Project at the Brookings Institution recently noted that labor productivity growth has fallen in the past decade concurrent to a decline in government infrastructure spending, particularly at the state and local levels (Schanzenbach, Nunn, and Nantz 2017). Conversely, several

studies argue there is a correlation between private-sector productivity gains and public infrastructure investment (US Treasury 2010).

Looking at the problem from a different vantage point, recent analysis in the US DOT's *Beyond Traffic* report aimed to quantify the impacts of underspending relative to impending growth in capacity needs. For example, the report notes an expected US population growth of 70 million in 2045 relative to 2015 that will be increasingly concentrated in a series of "megaregions" in the South and West. These regions could absorb as much as 75 percent of the population growth, but they may not be on course to have the infrastructure needed to accommodate that level of growth. The report also points to increasing freight capacity needs, particularly with retail shifting to online shipping, and to the increased pressures such a shift will place on current capacity (US DOT 2017).

Moreover, underinvestment can disparately affect people who need better access to jobs and opportunity. Transportation costs represent the second-largest average expense for American families (after housing and before food costs). For Americans in all five quintiles of household income, transportation costs absorb more than 16 percent of each paycheck (NEC and CEA 2014). Poorly maintained infrastructure contributes to these costs. A 2015 study showed that the average motorist lost $516 a year because of higher vehicle maintenance and gas costs as a result of driving on poorly maintained roads. These costs were not evenly distributed. Motorists in some urban areas paid almost twice as much (TRIP 2015). Underinvestment in other types of infrastructure, such as transit systems, sidewalks, and water systems, also can disparately affect the working class, seniors, and people with disabilities.

Funding and Financing Solutions

In light of the spending needs described above, debate quickly turns to the question of how we bridge the gap through federal funding, public and private financing, or a combination of these funding sources.

Within transportation, constraints on the revenues accrued to the Highway Trust Fund, primarily from the gas tax, have tended to focus debate around possibilities for supplementing revenues through augmenting fuel taxes or fees or other user models, such as a "vehicle miles traveled" payment model. A range of scholars at the Eno Transportation Center, the Brookings Institution, and elsewhere have discussed these models and views on how they should be administered.[2]

These models vary from increased direct state investment, to new regional organizations for administering public-private partnerships, to a revamp of federal transportation funding. Many of the most proactive solutions in recent years have come from state and local governments deploying revenue-generation models ranging from fee increases to congestion pricing to tolling to motor fuel tax increases. As part of the FAST Act, FHWA provided funding for pilot projects in seven states to explore alternative funding mechanisms, including road user charges based at gas stations, on-board mileage counters, and registration fees based on estimated mileage per gallon.[3]

Federal policymakers, as well as researchers at institutions including the Bipartisan Policy Center, the American Enterprise Institute, and elsewhere have pointed to the role private capital and public-

private partnerships can play in augmenting investment levels (Bipartisan Policy Center 2016). Across party lines, recent presidential administrations have looked to expand the role of private financing and public-private partnerships. The Bush administration took measures to expand the use of public-private partnerships by, for example, executing early loans under the Transportation Infrastructure Finance and Innovation Act, which was first authorized in 1998 (USDOT 2016c). The Obama administration launched a government-wide "Build America Investment Initiative" in July 2014 to "increase infrastructure investment and economic growth by engaging with state and local governments and private sector investors to encourage collaboration, expand the market for public-private partnerships (PPPs) and put federal credit programs to greater use." The current administration has also indicated that increasing the role of private finance in infrastructure is a significant priority (OMB 2017).

Data Limitations and Analytical Opportunities

Attempts to aggregate the dollar value and economic implications of infrastructure investment and underinvestment are invaluable to helping define the scope of the debate, the order of magnitude of investment needs, and the case for government and private investment. Yet research tends to run up against common limitations, relying heavily on the same finite data sources, especially ASCE and the US DOT's C&P report (for transportation infrastructure). These sources tend to provide a relatively high-level view of investment needs.

ASCE, for example, developed its estimate from national data on infrastructure conditions, but it did not disclose how costs were estimated. The US DOT's C&P methodology provides a model for estimating how different investment levels could affect key metrics on state-of-good-repair backlog (e.g., structural deficiency of bridges) and comprises some of the best and most established data in the field. But, by design, the C&P report is framed from the vantage point of understanding the impacts of federal aid highway dollars, which are expended primarily by state and local government entities.

These perspectives are similar in their tendency to take a top-down methodological approach that is reflective of a literature focused more on answering the question of how we pay for infrastructure than on what we are paying for and how we should decide what to pay for.

How Projects Are Identified and Prioritized

Although recent research has tended to focus on the breadth of investment need and how we pay for infrastructure, practitioner experience and the political impasse over identifying an ongoing revenue source to support the federal Highway Trust Fund point to the equal importance of considering what we are investing in and the methods used to evaluate potential projects and make purposeful investment choices given finite resources. Policy changes over the past decade have reinforced the need for such a conversation and created a window of opportunity for thoughtful analysis to help improve decisionmaking capabilities by cultivating a more strategic pipeline of prospective projects for public- and private-sector investors and communities.

Movement Away from Earmarks in Project Selection

Most federal transportation spending flows to surface transportation programs, through the Highway Trust Fund, to state departments of transportation (that have broad discretion for using it) by a formula system first developed in the Eisenhower era. Although arguably outdated in some respects, the formula system is deeply embedded in the implementation of federal and state transportation programs and is practically and politically difficult to alter (Puentes 2008).

For many years, a significant share of transportation funds was also preset by Congress through earmarks, established either in surface authorization bills or the annual appropriations process. One analysis showed that in 2006, 13.5 percent of the US DOT's budget authority was congressionally directed by earmarks (Kirk, Mallett, and Peterman 2017). Whether or not the "bridge to nowhere" (the Gravina Island Bridge project in Alaska, which was eventually cancelled after a decade of national debate and scrutiny) was in fact typical, it and the perception of earmarks that it stoked prompted a change, with bipartisan support, as part of a broader movement toward transparency for government spending.[4] Senators Barack Obama and Tom Coburn championed earmark reform before 2008, and the Obama administration continued that effort beginning in early 2009. Congress adopted a ban on earmarks (or "congressionally directed spending") in 2011 (Kirk, Mallett, and Peterman 2017).

Competitive Transportation Funding Programs and Cost-Benefit Analysis

Roughly concurrently with the movement away from earmarks, the establishment of new competitive funding programs, most notably the Transportation Investment Generating Economic Recovery (TIGER) program, as part of the American Recovery and Reinvestment Act (Recovery Act), tested a different model for selecting projects that was based on demonstrated project attributes.

Tasked by Congress to award funds—initially $1.5 billion in the Recovery Act—"to State and local government or transit agencies on a competitive basis for projects that will have a significant impact on the Nation, a metropolitan area, or a region,"[5] US DOT established an application process that required the applicant to conduct a cost-benefit analysis for projects, quantifying project benefits alongside selection of the department's performance goals as identified in accordance with the Government Performance and Results Act. These goals include quality of life, economic growth, and sustainability. With TIGER extended each year since the Recovery Act through annual appropriations, US DOT has published annual program guidance articulating application criteria, including refining project evaluation criteria to better include traditional economic benefits and potential effects on the environment, connectivity, access and mobility, and public health (US DOT 2015).

More recently, the FAST Act established the Nationally Significant Freight and Highway Projects program, which the previous administration named "FASTLANE" and the current administration renamed "INFRA," to provide federal financial assistance to freight and highway projects of national or regional significance. By statute, evaluation of applications must consider "(A) the cost effectiveness of the proposed project; and (B) the effect of the proposed project on mobility in the State and region in which the project is carried out," thus codifying details of the selection process to a more precise degree

than TIGER's statutory guidelines.[6] Although US DOT has flexibility in further defining selection criteria, the statutory framework remains in place for the full five-year duration of the program, which is authorized through 2020.

Competitive grant programs play an important role in stimulating policy conversations about how projects can be selected based on the substance of what they are expected to achieve. Moreover, the competitions provide an incentive for applicants to evaluate their portfolio of projects more broadly, with an eye toward costs and benefits and identifying and advocating for strong candidate projects. But at present competitive programs represent only a small fraction of federally budgeted transportation dollars. In fiscal year 2016, for example, the INFRA and TIGER programs—the two largest sources of competitive funds for surface transportation dollars[7]—made up less than 2 percent of the total departmental budget. By comparison, formula dollars for highway and transit made up roughly 70 percent of US DOT's actual fiscal year 2016 budget.[8] Competitive programs alone are likely not sufficient to drive changes in project planning and accounting.

Asset Management for Setting Transportation Spending and Project Priorities

A less prominent but far-reaching new technical planning requirement offers an important complement to high-profile programs such as TIGER and INFRA that can potentially integrate cost-benefit considerations into the ways state and regional transportation agencies nationwide develop and update their project portfolios. Recent statutory and regulatory requirements demand that all transportation agencies charged with spending or suballocating federal highway formula funds develop asset management plans focused on life-cycle cost analysis and prioritizing limited resources. FHWA finalized a rule implementing these requirements in October 2016.[9] Similar protocols are evolving within the transit community. For highway funding, initial plans are required by April 2018, with a completed plan meeting all requirements by June 30, 2019, to be followed by FHWA certification that a valid plan is in place. Subsequently, states must receive certification every four years that they have valid asset management development processes in place.[10] Transit agencies are preparing their asset inventories and will be required to complete their initial plans by October 2018. The discussion about how to support asset management implementation efforts is thus timely and relevant.[11]

Generally driven by engineering and economics, and often less visible than competitive programs in the national policy conversation, asset management could be a mechanism through which communities can translate state of good repair and other priorities into an executable, data-driven framework to inform decisionmaking at scale.

What Is Transportation Asset Management?

Transportation asset management requires agencies to focus on maximizing the economic efficiency of transportation assets through strategic life-cycle management (FHWA and AASHTO 2013). FHWA

worked toward implementing asset management requirements over a decade, completing, for example, a series of sample state case studies in 2003 and 2004 to demonstrate gap analysis and argue that better asset data could improve states' decisionmaking.[12] Subsequent surface transportation authorization laws—MAP-21 in 2012 and the FAST Act in 2015—succeeded these early efforts with requirements that states develop transportation asset management plans for all pavements and bridges within the National Highway System. As noted above, FHWA finalized a regulation implementing the new requirements in October 2016. Both FHWA and a range of supporting organizations like the American Association of State Highway and Transportation Officials now support implementation through best practices guides such as the *AASHTO Asset Management Guide* (AASHTO 2011).

Asset management focuses on maximizing the impact of infrastructure investments through cost-benefit analysis of spending across the asset life cycle:

> Asset management is a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost.[13]

Transportation asset management plans are intended to be business plans for transportation infrastructure management, laying out goals, strategies, life-cycle management processes, and long-term financial forecasts for the agency implementing the plan. Key themes in asset management, illuminated through regulations FHWA finalized in 2016, include the following:

- **Long-range financial planning and life-cycle cost analysis.** Asset management requires consideration of how to price and pay for portfolio investment needs over at least 10 years, as well as the requirement to consider the lifetime costs or benefits of assets within the portfolio. These elements are intertwined in evaluating costs and benefits and in considering how to sequence investment needs. These requirements can sharpen the way a decisionmaker looks at the need for, and value of, different assets and how to select and sequence investments across a portfolio in ways that maximize return on investment.

  For example, costs over a decade to implement a patchwork of palliative repairs to a structurally deficient bridge might exceed the one-time cost of replacing it, even if the replacement entails a significant one-time investment. If decisionmakers look only at one-year costs, the replacement would appear to outweigh the price tag on the "band aid" approach. Life-cycle cost analysis can also quantify the importance of building assets that are durable in extreme weather and factor in the costs of repeat damage. FHWA's asset management rule tasks explicit consideration of these factors.

  Planning over a longer-term horizon can also help provide a structured mechanism to identify emerging needs and prepare for future work. This advanced lead time can help increase taxpayer confidence by providing a transparent and methodological process for evaluating new ideas and concerns. Early community engagement around projects can also make it possible to

front-load coordination around key issues such as defining the scope, purpose, and footprint of a project.

- **Aligning agency mission with a risk-based asset management approach.** The underlying idea of risk-based asset management is that an agency should define goals for achieving state of good repair based on an understanding of risks to the system, and then manage those goals in a cost-effective manner driven by data. Understanding the likelihood and potential cost of different risks can help inform choices about how to manage an individual asset or group of assets. For example, knowing how many times over its lifetime a road might be expected to flood in a storm and what the repair or replacement costs might be could inform decisions about flood protection needs, or even about whether to reconsider portions of an alignment most prone to repeat flooding, if the road is being reconstructed.

  Risk-based analysis can also help transportation agencies choose between projects when resources are limited, but it sometimes yields counterintuitive results. For example, a heavily trafficked bridge or set of bridges on the cusp of deficiency might pose a greater risk to the traveling public—and to becoming increasingly costly to fix—than a visibly decaying bridge that is used less frequently. Yet choosing to not prioritize the latter asset can be difficult to explain to the public even if the former optimizes safety and efficient use of dollars. Using a transparent risk-based methodology can be helpful in making the case for hard choices.

- **Maximizing the efficiency of investment through better data.** The rule estimated that benefits of implementation ($341 to $454 million, depending on the discount rate) would outweigh the costs ($46 to $54 million) by a ratio between 7:1 and 8:1. This rule underscores that taking care of infrastructure should yield significant payback, not only through indirect economic impacts, but through avoided repair costs, as well as improvements in operations and safety. Moreover, the rule asserts that asset management will increase "transparency and accountability to the public and the political leadership. This can help gain support to fund highways and bridges to improve condition and performance of assets that benefits the users in the long run, rather than allowing assets to deteriorate because of a lack of funding and incur higher costs later."[14]

Asset Management for a Range of Asset Types

Asset management is also expanding within the transit community, creating opportunity for regions to look at multimodal portfolios. Like the state DOTs that administer highway funds, transit agencies are beginning to develop asset management plans in response to industry best practices and requirements from the Federal Transit Administration (FTA). In July 2016, pursuant to a requirement in MAP-21,[15] FTA issued a final rule requiring transit agencies to develop and implement transit asset management plans that include an asset inventory and the condition of those assets, state-of-good-repair standards and certain performance measures, and—in a more prescriptive step than the highway rule—a "prioritized list of investments to improve the state of good repair of their capital assets." Transit operators are then required to set targets and report on them within the National Transit Database.[16]

FTA collaborated with transit agencies and researchers to develop initial guidance for categorizing assets relative to transit state-of-good-repair guidelines and to develop a software tool to help transit agencies use their asset inventories to assess the cost to achieve a state of good repair across their system.[17] As explained in FTA-issued implementing documents (FTA 2012), asset categories include rolling stock (e.g., buses or railcars), equipment (e.g., construction or maintenance equipment), infrastructure (e.g., fixed guideways or power), and facilities (e.g., passenger facilities or parking).

FTA's rule is separate from the FHWA rule, reflecting the differences in the agencies' programs and funding recipients, and the specific requirements also differ somewhat. However, execution of the requirements provides implementing jurisdictions, particularly those in geographic proximity of one another, with opportunities to collaborate, to share information across agencies, and to seek opportunities to collect and organize information in ways that will make plans interoperable. Streamlining the two frameworks through implementation could help advance a portfolio approach that is multimodal and considers the interaction between different types of transportation assets. Ultimately, looking at a region's multimodal transportation portfolio could also provide a framework for considering how transportation and nontransportation infrastructure assets align and compare.

Implementing Asset Management

Although federal requirements catalyzed the asset management discussion, state and local agencies will, through implementation, likely define the scope of their impact. Irrespective of policy decisions, federal requirements represent a floor rather than a ceiling, and federally available data and measurement conventions are limited by design. Carefully constructed analytical efforts designed to help implementers in this area could also help maximize the potential of early implementation efforts over the coming years.

Federal Requirements Create a Floor, Not a Ceiling

Federal guidelines set minimum thresholds that encourage, but do not require, implementing agencies to go beyond the requirements in scope of information tracking and in using the information to make decisions.

Asset management differs from cost-benefit requirements in programs such as TIGER and INFRA because it is not a selection criterion for funding. As the FHWA's final rule clarifies, the asset management process is distinct from the state transportation investment plan process states use to identify the projects to which they may apply their federal formula dollars. The final rule specifies, for example, that a 10-year asset management planning requirement does not amount to a requirement that the state produce a 10-year state transportation investment plan.

Nevertheless, the rule does call for "state DOTs to integrate asset management plans into the transportation planning processes that lead to their [State Transportation Investment Plans]," meaning

that states should at least consider those plans in building out their investment strategies. FHWA does not approve those investment strategies, which are determined at the state's discretion, consistent with the structure of the federal aid highway program more broadly.[18] As such, asset management is a tool to inform project selection, not a justification requirement for any one project. But the requirement's breadth means that the analysis can help planners look across a portfolio and make informed choices, rather than focusing solely on individual projects' merits. Employed with deliberation, the two approaches can be complementary.

To that end, although the rule appropriately provides significant discretion to states, it encourages them to take a more expansive approach than is required by the rule to maximize the utility of asset management as a planning approach. For example, the rule encourages states to include in their asset management plans "other public road assets" beyond those required by virtue of being part of the National Highway System, over which FHWA has jurisdiction. But "discretionary" (i.e., non–National Highway System) assets are not subject to the same regulatory requirements.[19]

From a regulatory perspective, the flexibility to include "other public road assets" empowers states to make decisions on nonfederalized portions of the road network. But the recommendation in the rule nonetheless raises an important point that the data in states' asset management plans may well be most useful to state decisionmakers if they encompass a more comprehensive representation of the state's inventory of infrastructure assets. In a similar vein, asset management planning could provide a structure for considering a broader range of costs and benefits within a fixed process that organically informs statewide transportation planning.

Federal asset management rules require certain base elements, but they provide states and transit agencies significant discretion in implementing their plans and in supplementing their scope. For implementing jurisdictions, this discretion creates an opportunity to consider how to meet the requirements and how to leverage them into as useful a decisionmaking tool as possible, particularly for considering life-cycle costs and benefits. But the open-endedness within the rules also means that their impact is not a given. To that end, with roughly a year before the first due date for asset management plans, there are several questions and areas for discussion that policymakers might consider in the interest of refining goals and plans for implementation.

State-Driven Program Structures and Best Practices

The state-driven structure of asset management implementation, and transportation programs in general, encourages implementing agencies to set and manage clear priorities of their own. This structure, combined with some inherent fluctuation in federal guidance, may create opportunity for outside analysis to play an important role in establishing long-term research efforts that provide ongoing support for state and local implementation.

In general, periods of transition create some uncertainty relative to policy implementation priorities, and such research could help retain the ongoing and long-term continuity that has benefitted work leading up to the current transportation asset management program. Importantly, the build-up to

the current regulations spanned the Bush and Obama administrations, as well as bipartisan authorizing legislation, and the current administration has thus far supported implementation efforts.

However, changing policy priorities may affect related areas of regulation, such as implementation of performance management requirements. In February 2017, as part of the broad regulatory freeze implemented by the current administration, FHWA postponed implementation of the following programs until May 20, 2017, pending review: the final National Performance Management Measures; Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program; and Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program.[20] In May 2017, FHWA announced that some elements of those rules would become effective while other elements proceed through further review.[21] FHWA recently proposed for comment a rule that would repeal a component of the rule on performance measures that required reporting on greenhouse gas emissions.[22]

Importantly though, asset management rules themselves, which were finalized in July 2016 (by FTA[23]) and in October 2016 (by FHWA[24]), were not affected by this action, and the current administration has reiterated that asset management is a priority. For example, USDOT's notice of funding availability for FY 2017 TIGER funding, issued in September 2017, includes, as a criterion for evaluating projects on the basis of "state of good repair," that the "project is appropriately capitalized up front and uses asset management approaches that optimize its long-term cost structure."[25] The notice also encourages the use of "innovative practices in contracting, congestion management, and asset management." The inclusion of this language in a solicitation for competitive funding is a good indication of how transportation agencies' performance on the basis of asset management principles could be integrated into decisions about how to select and prioritize projects.

Best Practices for Life-Cycle Cost Analysis and Long-Range Financial Planning

Accounting for the full costs of planning, constructing, and maintaining assets—and aligning analysis across a portfolio to project investment needs and set priorities—yields a complex network of information needs. It also creates an opportunity for research to help practitioners in the public and private sectors to better understand project cost structures, life-cycle costs, and how different costs and benefits factor into the financial life of a project. To support more precise life-cycle cost analysis, research could leverage historical engineering, financial, economic, and other data associated with project delivery and maintenance to help establish benchmarks for what illustrative projects of various types cost to build and maintain over their lifetime. Research could also explore ways to incorporate a broader array of direct and indirect costs and benefits into life-cycle cost analysis estimates. This information could help in making choices between projects and in managing and investing in projects or a project portfolio. Some examples of areas for research are described below.

Best Practices for Life-Cycle Cost Analysis

As states and transit agencies begin to produce initial asset management plans—2018 requirements require drafts that will be developed in the years to follow—there will be opportunity to look across jurisdictional data and identify trends and best practices based on preliminary data, which could in turn help agencies enhance their products during the first years of implementation.

Early asset management plans will likely include a range of methods for projecting deterioration of existing assets, when they would need to be repaired or replaced, and what it would cost to do so at different points in time. Some early-adaptor states already use sophisticated software that measures use of different assets in the network and system conditions to help provide a profile of repair needs based on a combination of asset wear and demand for the resource. These tools help agencies collect and model data coming from sources such as historical records of when assets were built or last upgraded, as well as road and different types of inspections for roads and bridges that capture factors like smoothness (for roads) or structural integrity (for bridges). These types of engineering data form the core of a transportation asset management plan. Evaluating how different agencies collect their information and use it to model future deterioration, repair, and replacement needs will be important to understand how best to project what the life cycle of a project looks like, and, combined with understanding the true costs for repair or replacement, how best to estimate the life-cycle cost for keeping an asset in good repair.

Best practices, developed over time, could also help improve looking at longer-term costs, which is important for determining, among other things, when it may be more cost-effective to rehabilitate rather than replace an asset. The FHWA rule requires, at minimum, 10 years of information, stating that "if bridge assets normally last for 70–100 years, only information covering the next immediate 10-year period is required to be included in the plan."[27] Although projecting beyond the 10-year window may be more difficult and is not required for compliance purposes, the ability to predict longer-term costs accurately could be helpful for effective project management.

Benchmarking Project Costs

The accuracy of life-cycle cost analyses can also be improved by developing better benchmarks for what repairs or reconstructions typically cost. To some degree, each project has its unique attributes, be it a specific configuration of traffic needs, historical or cultural resources in the surrounding environment, or community concerns. And certainly, the specific configuration of factors surrounding a given project (e.g., a road, a bridge, or an intermodal station) informs its ultimate costs. But commonalities across projects could be aggregated to provide better insight into typical costs for different types of projects. Looking across data from a range of federal, state, and local data sources could likely help illuminate trends and help project sponsors develop realistic budgets for maintaining existing assets, as well as upgrading or supplementing them (though the latter activities would likely expand the scope of study beyond, strictly speaking, asset management).

Although federal government data are mostly tracked at the state or transit-agency recipient level, some samples provide unusual insight into the subrecipient level, which offers more insight into project-level information. One fruitful avenue would be to use information assembled through implementation of the Recovery Act, which required reports on the status of weekly spending. With a tracking field to capture subrecipient information, the federal government collected an unusually granular data sample. These data remain publicly available and provide a fruitful dataset for research.[28] State and local implementing agencies also hold project-level budget information, which is, in some instances, made public for the purposes of providing transparency. A review of federal, state, and other available sources of project-level information could provide valuable insight into what different types of project could or should cost.

Opportunities to Integrate Costs and Benefits into Life-Cycle Cost Analysis

As discussed above, asset management appropriately begins by examining such factors as the structural integrity and condition of bridges and pavement, factors essential to safety and state of good repair. But asset management can also anchor broader integration of cost and benefit considerations into the analyses that inform decisionmakers when selecting projects. Other elements of life-cycle costs may be harder to quantify than measures of road and bridge quality and other direct costs, so they likely require further discussion of whether and how they should be defined and then measured. Various topics could be ripe for further exploration in the service of, over time, expanding the scope of factors that are able to be readily considered as part of life-cycle cost analysis within the asset management context. Three examples are provided below.

INTEGRATING SOCIAL AND ECONOMIC IMPACTS

The construction of infrastructure assets can be to the benefit or detriment, sometimes both, of surrounding communities, and sometimes with disparate impacts on different subsets of the population. In his introduction to *The Power Broker*, Robert Caro captures this complexity: "For highways, Moses dispossessed 250,000 persons … for his other projects … tens of thousands more … More significant even than the number of the dispossessed were their characteristics: a disproportionate share of them were black, Puerto Rican—and poor." And yet, Caro continues, "His highways and bridges and tunnels were awesome—taken as a whole the most awesome urban improvement in the history of mankind" (Caro 1975, 20–21).

The iconic example of Moses' development of New York in the mid-twentieth century illustrates how assets like highways, bridges, and tunnels could at once connect and shape a metropolis while uprooting communities and disconnecting people's lives in their wake. Although a range of subsequent protections like the passage of the National Environmental Policy Act in 1970 would almost surely temper the impacts of a present-day project, choices about how to manage the built environment affect communities and economies, whether through inhibiting or increasing access to jobs or education; attracting or restricting the capacity to generate revenue; or affecting human health because of activity levels, access to medical facilities, air pollution, or other factors.

In any of these or similar areas, further research could help measure the impacts of transportation assets to people and economies in ways that can be translated into costs and benefits and then compared against other factors. For example, if a road restricts or connects a community's access to major employers in the region, value-of-time (a factor for which US DOT provides a regularly updated model) analysis might be useful in attaching a dollar figure to the opportunity cost of allowing that asset to fall into disrepair. An improvement to that asset that could yield significant time and associated cost savings might help argue for repairing or replacing the asset ahead of one with less significant associated time savings.

Developing new approaches to measuring a variety of costs and benefits of infrastructure investment within the asset management context could be helpful in evaluating trade-offs to communities, but it would require additional research and likely significant refinement over time. In addition, it could be valuable to evaluate cost-benefit analyses that project applicants to programs like TIGER and INFRA have developed in recent years, as well as existing models that are currently available to support cost-benefit analysis in either regulatory or program contexts. Understanding these models would be important for understanding their current capabilities and inputs as well as for understanding how to develop additional inputs in ways that models could integrate.

FACTORING SMART TECHNOLOGIES INTO INFRASTRUCTURE ASSET PORTFOLIOS

Ongoing advancements in information technology are affecting the transportation system in real time, and they will continue to challenge traditional paradigms for how transportation infrastructure is expected to perform and accommodate new patterns of use. For example, will the integration of autonomous and nonautonomous vehicles necessitate different types of dedicated lanes or other changes to roadways? Will the expansion of ride sharing and car sharing shift capacity needs on various roads or require new models for managing parking?

Incorporating existing and future technologies presents a unique set of challenges to asset management planning because the changes on the technology side will need to be integrated with the planning and maintenance of transportation and other infrastructure. Highway planners must confront the potential costs and impacts of connected, electric, and autonomous vehicles on transportation infrastructure needs in the coming decades while seeking to use newly available data sources to decrease congestion and emissions on existing roads. Likewise, transit agencies are rolling out or planning to collect real-time transit data on riders and internal operations while navigating the impact of mobility-on-demand applications. Many new technologies are in their early stages, implemented only in small pilots in a few cities or states.

The novelty of these technologies means that realistic estimates for the costs of implementing them on a broad scale have not been developed, nor are there models for estimating their full benefits. Even in this early stage, though, it is clear that new technologies such as sensors and data warehouses (physical or cloud based) will affect physical transportation infrastructure. Yet it remains to be seen how the demands they create will be integrated into the planning processes (e.g., developing state transportation investment plans) that typically dictate investment decisions around infrastructure.

Asset management could provide a structure for bridging that gap and considering—and planning for—the effects of new technology on infrastructure.

Cities and states across the country are deploying a range of pilot efforts to test integration of intelligent transportation system technology and to better understand how impending changes could affect factors like legal and regulatory needs, environmental impacts, risk management, and implications for the workforce. As these efforts unfold over the coming years and yield lessons learned, it will be important to understand, among other things, what it will cost to change the physical layout of transportation networks in the service of integrating different technology innovations, what kinds of benefits those changes will yield, and how to balance these emerging needs alongside the ongoing pressures of maintaining state of good repair. Asset management planning could become a vehicle for integrating technology considerations into infrastructure planning and decisionmaking processes.

INTEGRATION OF ENVIRONMENTAL CONSIDERATIONS

Asset management requires consideration of how extreme weather and environmental conditions will affect life-cycle costs, such as the costs of building and maintaining an asset expected to be repeatedly affected by disaster events.

FHWA requires that "a State DOT's life-cycle cost analysis process must include information on current and future environmental conditions," and it notes FHWA's work to "develop a better understanding of these potential impacts." In this area, FHWA has made a range of information and materials available, and it continues to conduct research in collaboration with groups such as the Transportation Research Board.[29] In transit asset management, FTA recommends that "transit providers should consider current and future climate and weather-related hazards as part of their prioritization of investments. For example, the frequency and severity of potential hazards such as heavy rainfalls, coastal and riverine flooding, heat waves, extreme cold, and wind events may directly impact assets located in vulnerable areas." The rule also explains that transit providers should have "knowledge of the vulnerability of its system" to properly manage risks associated with different investment decisions.[29]

Though some consideration of weather factors is required, the rules are not prescriptive and afford flexibility for implementing agencies to consider the needs of their regions and to manage the requirement in a way that is feasible given their existing capacity. For jurisdictions looking for a concrete mechanism to account for resiliency factors, asset management presents a significant opportunity to account for the costs of risks like flooding, exposure to extreme heat or cold, or seismicity to different transportation assets. Determining best practices for methodology within the asset management context could ultimately help agencies and jurisdictions factor those risk-associated costs into their decisionmaking.

Other Opportunities

The topics discussed above are just a few examples of how research could help develop methodologies for measuring costs and benefits, with ultimate applicability to transportation agencies interested in

expanding their use of asset management planning. These or other areas could benefit from additional, carefully designed research geared toward generating benchmarks that could be part of transportation agencies' life-cycle cost analyses and asset management planning processes.

In any of these areas, research would need to address several methodological questions (e.g., How might different criteria be tested to develop benchmarks? How might the cost of inaction be measured?). And research should be conducted with an eye toward pragmatic application: How can findings be incorporated into asset management plans and other federally required analysis (e.g., cost-benefit analysis requirements for grant application)? What might be effective avenues for spreading best practices in analysis to a national scale as they are identified? Further analysis might explore both substantive research questions and their practical application. Both in the lead-up to initial 2018 implementation and in the initial years of the program that follow, there is particular opportunity for development and exchange of best practices and for convening implementing jurisdictions to compare ideas, early experiences, and knowledge gaps that further research might target.

Asset Management: A Chance to Develop the Pipeline

The value of asset management to transportation agencies is immediate and practical. A better inventory of costs and benefits means more information to inform decisions in a data-driven way, prioritize limited resources, and make an effective case for more resources, be it through federal or state programs or to the private market. Having reliable, comprehensive inventories of different agencies' assets and project needs could also help prospective public or private funders or financers looking to invest in projects, and better methodology for creating those inventories can bolster the case for project investment. Information developed through asset management planning can increase transparency and accountability to the public and help transportation agencies communicate and justify priorities. Clear evaluation criteria and methodology can make hard choices easier to explain to the public.

Asset management is at a critical implementation juncture that presents an opportunity to fully leverage its potential and integrate it into the way communities across the country develop their investment programs. For policymakers, there is opportunity to consider how new funding and financing tools—perhaps in the context of a legislative infrastructure package—could further encourage the deployment of asset management, including through rewarding prospective grantees who demonstrate their performance in this area. For researchers, regulatory flexibility combined with the technical challenges in meeting and going beyond the requirements in such areas as life-cycle cost assessment and long-range planning mean that research and modeling to support execution in these and other areas could have immediate and meaningful impact. The aggregation of these plans nationwide could also magnify that impact, such that as asset management programs mature, the products of efforts across the country can provide insight into national needs and further clarify the magnitude of and help inform solutions to the nation's infrastructure deficit. Finally, lessons learned from surface transportation asset management could be expanded to help evaluate needs and priorities in other areas of infrastructure, such as water, aviation, or broadband.

Notes

1. Federal Highway Administration, "New USDOT Report on Highway, Transit Conditions Reveals America's $926 Billion Infrastructure Investment Need," press release, January 12, 2017.
2. Adie Tomer and Joseph Kane, "Short- and Long-Term Strategies to Renew American Infrastructure," Brookings Institution, October 26, 2016.
3. Federal Highway Administration, "Federal Highway Administration Announces More than $14 Million in Grants to Test New Ways of Funding Highways," press release, August 30, 2016.
4. Pat Forgey, "Alaska 'Bridge to Nowhere' Plan Is No More as State Chooses Ferry for Ketchikan," *Alaska Dispatch News*, October 22, 2015.
5. American Recovery and Reinvestment Act of 2009, H.R. 1, 111th Congress (2009).
6. Fixing America's Surface Transportation Act, Pub. L. No. 114-94, section 1105 (2015).
7. This calculation is intended only to provide an order of magnitude and does not represent a comprehensive tally of all competitive transportation dollars. There have been smaller competitions in recent years, many of which have been limited-term programs that have fluctuated. This tally also excludes the Capital Investment Grant program for transit programs, which is awarded on a nonformula basis through a different process that relies heavily on project justification but does not entail interjurisdictional competitions.
8. Calculated based on obligation limitation for highway and transit formula funds as a share of total fiscal year 2016 appropriations and obligation limitation numbers (USDOT 2016a, 3–4).
9. Federal Highway Administration, "Asset Management Plans & Processes Fact Sheet: Final Rulemaking," FHWA-HIF-17-06, accessed October 12, 2017.
10. Federal Highway Administration, "Transportation Asset Management Plan Development Processes Certification and Recertification Guidance," last updated June 27, 2017, accessed October 17, 2017.
11. "Transit Asset Management: Frequently Asked Questions," Federal Transit Administration, last updated February 28, 2017.
12. "Asset Management Guidance," Federal Highway Administration, last updated June 27, 2017.
13. Definitions and Declaration of Policy, 23 USC § 101 (2011).
14. Asset Management Plans and Periodic Evaluations of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, 81 Fed. Reg. 73196 (October 24, 2016). That final rule in the Federal Register is codified in the Code of Federal Regulations as Asset Management Plans, 23 CFR 515, and Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, 23 CFR 667.
15. Transit Asset Management, 49 USC § 5326(b) (2012).
16. Transit Asset Management; National Transit Database, 81 Fed. Reg. 48890 (July 26, 2016).
17. "TERM-Lite," Federal Transit Administration, last updated February 21, 2017.
18. Asset Management Plans and Periodic Evaluations of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, 81 Fed. Reg. 73204 (October 24, 2016). That final rule in the Federal Register is codified in the Code of Federal Regulations as Asset Management Plans, 23 CFR 515, and Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, 23 CFR 667.
19. Asset Management Plans and Periodic Evaluations of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, 81 Fed. Reg. 73232 (October 24, 2016). That final rule in the Federal Register is codified in the Code of Federal Regulations as Asset Management Plans, 23 CFR 515, and Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, 23 CFR 667.

20. National Performance Management Measures; Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program, 82 Fed. Reg. 14438 (March 21, 2017). That final rule in the Federal Register is codified in the Code of Federal Regulations as National Performance Management Measures, 23 CFR 490.
21. "Two Performance Management Final Rules Take Effect," Federal Highway Administration, last updated June 29, 2017.
22. National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program, 82 Fed. Reg. 46427 (October 5, 2017). That final rule in the Federal Register is codified in the Code of Federal Regulations as National Performance Management Measures, 23 CFR 490.
23. "TAM Rulemaking," Federal Transit Administration, last updated May 4, 2017.
24. Asset Management Plans and Periodic Evaluations of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, 81 Fed. Reg. 73204 (October 24, 2016). That final rule in the Federal Register is codified in the Code of Federal Regulations as Asset Management Plans, 23 CFR 515, and Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, 23 CFR 667.
25. Notice of Funding Opportunity for the Department of Transportation's National Infrastructure Investments under the Consolidated Appropriations Act, 2017, 82 Fed. Reg. 42426 (September 7, 2017).
26. Asset Management Plans and Periodic Evaluations of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, 81 Fed. Reg. 73198 (October 24, 2016). That final rule in the Federal Register is codified in the Code of Federal Regulations as Asset Management Plans, 23 CFR 515, and Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, 23 CFR 667.
27. Information on transportation spending through the Recovery Act has been consolidated in a recent report (US DOT 2016b) that describes reporting processes, data availability, and some conclusions about spending impacts. Recovery Act data for other agencies are also available.
28. Asset Management Plans and Periodic Evaluations of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, 81 Fed. Reg. 73219 (October 24, 2016). That final rule in the Federal Register is codified in the Code of Federal Regulations as Asset Management Plans, 23 CFR 515, and Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, 23 CFR 667.
29. Transit Asset Management; National Transit Database, 81 Fed. Reg. 48922 (July 26, 2016). That final rule in the Federal Register is codified in the Code of Federal Regulations as Transit Asset Management, 49 CFR 625, and National Transit Database, 49 CFR 630.

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Lew previously was a deputy assistant secretary at USDOT. She served in Obama administration as a senior adviser at the US Department of the Interior's Bureau of Ocean Energy Management and as a policy adviser at the White House Domestic Policy Council, where she focused on energy policy, and at the Office of Management and Budget, where her portfolio focused on implementation of the American Recovery and Reinvestment Act.

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