Cameron C. Oskvig
Director, Federal Facilities Council
Director, Board on Infrastructure and the Constructed Environment (BICE)
National Academies of Sciences, Engineering, and Medicine

Mr. Oskvig is a professional engineer with over 25 years' experience in the planning, design, construction, and management of the built environment. As director of the BICE he oversees the development and management of activities which focus on questions of technology, science, and public policy related to the built environment.

NATIONAL ACADEMIES *Sciences Engineering Medicine*

The National Academies Perspectives on Infrastructure and Sensing

Presentation to UPISC Collaboration Workshop

Cameron Oskvig , Director, Board on Infrastructure and the Constructed Environment (BICE)

NOVEMEBER 2023

National Academies of Sciences, Engineering and Medicine

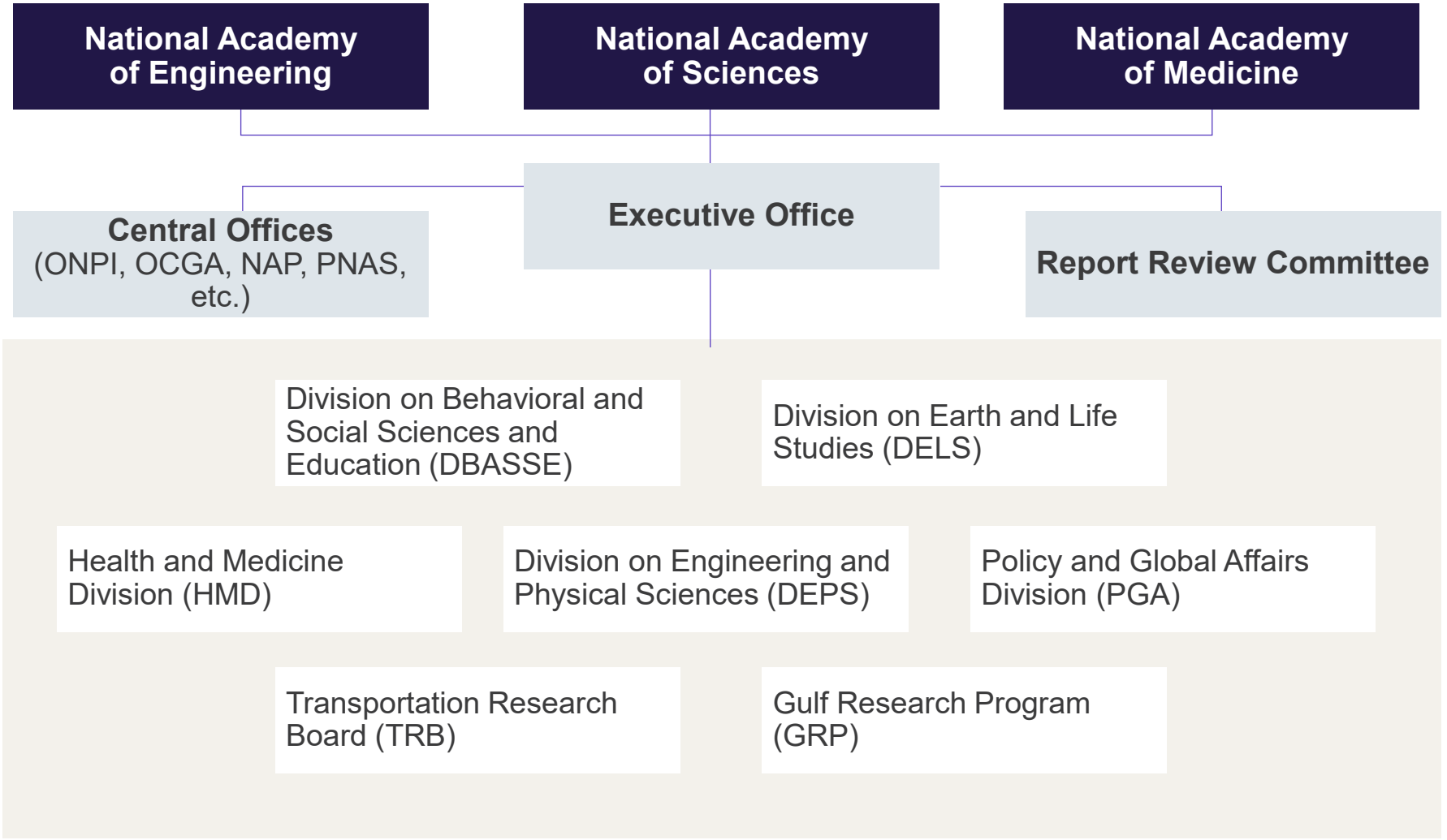
1863 congressional charter: ". . . investigate, examine, experiment, and report upon any subject of science or art. . . ."

- 501(c)(3) nonprofit organization
- Receive no congressional appropriations
- Approximately 70% funding from government

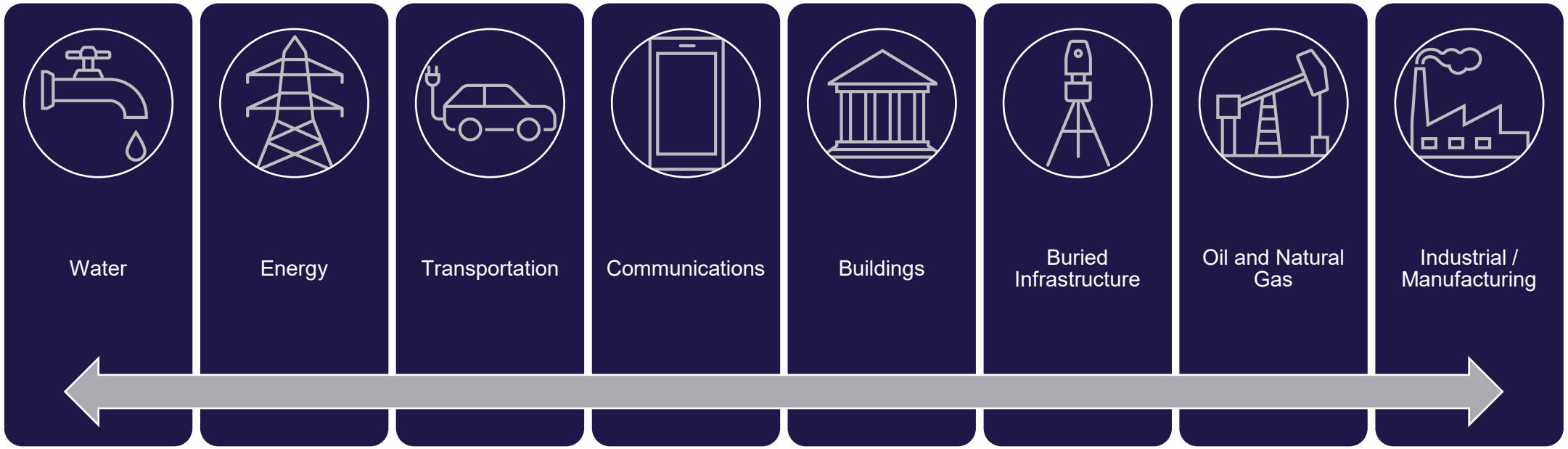
Annually

- Approx. 200 reports and proceedings
- >7,000 volunteer experts
- About 1.5 million publications are downloaded and approximately 135 million pages of are read online

Program Units within the Academies



Cross Sector Collaboration



National Academies Capabilities Profile

Expert, evidence-based, and objective advice on science, engineering, and health matters.

Provide Consensus Advice

- Guide policy and practice throughout consensus findings and recommendations based on science, engineering and medicine
- Establish research agenda
- Inform policy makers
- Guide grant making and development of RFP's

- Consensus Studies
- "Fast Track" Studies
- Research Program Review
- Program Assessment
- Peer Review

Manage Original Research

- Apply identified best practices
- Manage peer review process and grant program
- Create opportunities for new science
- Understand and prepare for emerging technologies

- Commissioned White Papers
- Grants
- Gulf Research Program
- TRB Research Contracts

Convene Experts

- Interact with experts on specific topic
- Engage in ongoing dialogue with stakeholders
- Be part of a community of practice
- Take action with others operating from a common knowledge base

- Standing Cmte
- Workshop
- Webinars
- Meeting of Experts
- Roundtable & Forums
- Rapid Expert Consultation

Promote the Scientific Enterprise

- Demonstrate commitment to science, engineering, and medicine
- Expand networks via fellowship to include practitioners
- Contribute to an informed public

- Fellowship Programs
- Lecture Series

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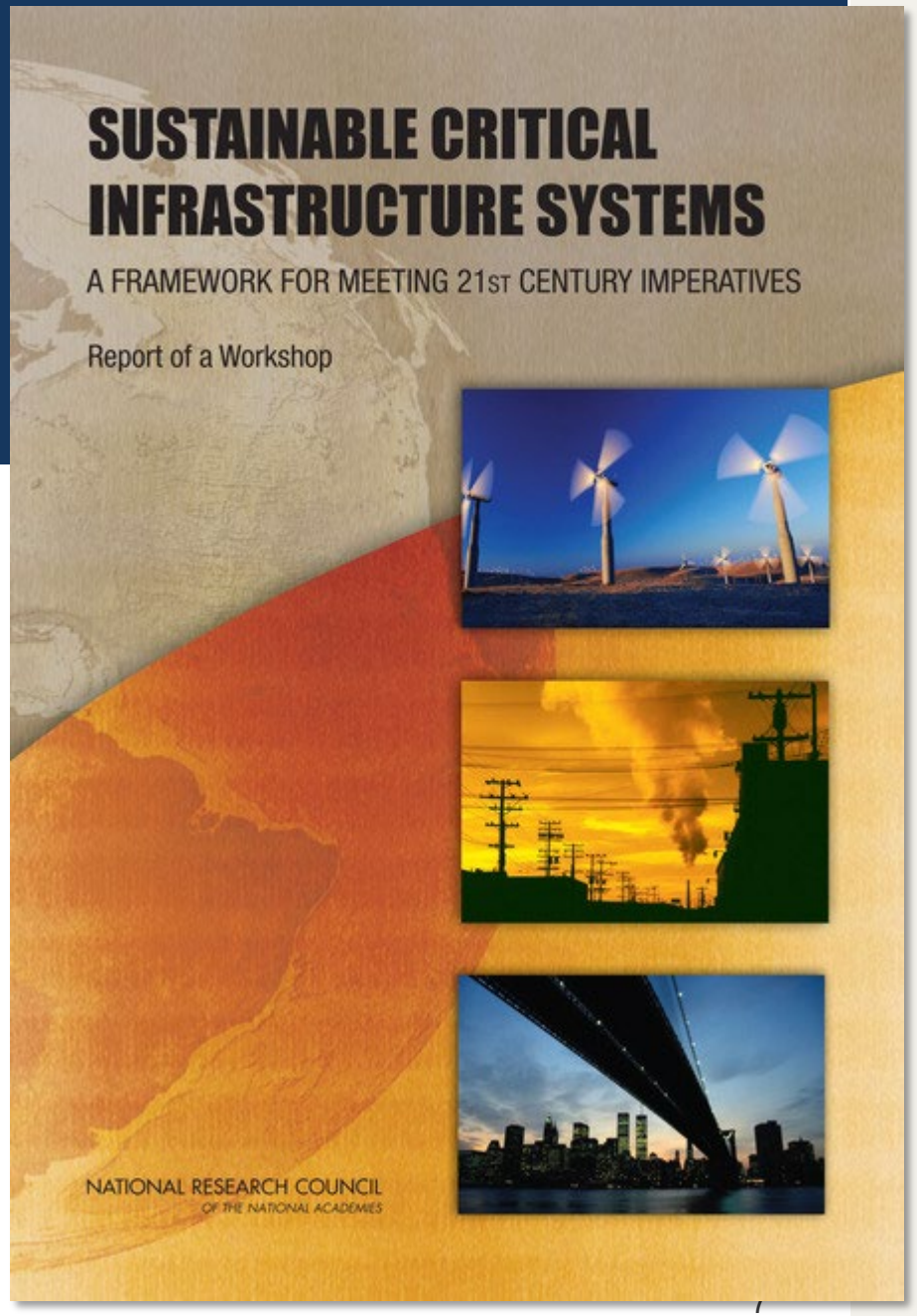
Framework

Structure for establishing public expectations about the reliability, resiliency, efficiency, and cost of critical infrastructure systems which can guide actions for solutions that are physically resilient, socially equitable, cost-effective, and environmentally viable.

1. A **broad and compelling vision** focused on a future of economic competitiveness, energy independence, environmental sustainability, and quality of life
2. A **focus on providing the essential services** involving water and wastewater, power, mobility, and connectivity
3. **Recognition of the interdependencies among critical infrastructure systems** to enable the achievement of multiple objectives and to avoid narrowly focused solutions
4. **Collaborative, systems-based approaches** to leverage available resources
5. **Performance measures** to provide for greater transparency in decision making by quantifying the links among infrastructure investments, the availability of essential services, and other national imperatives

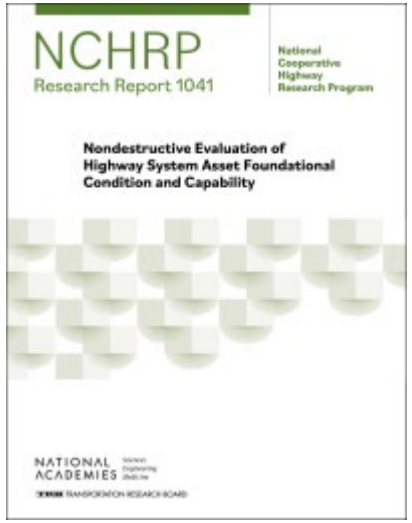


Consideration of “sensors” within National Academies’ publications

Number of publication with references to search in National Academies Press

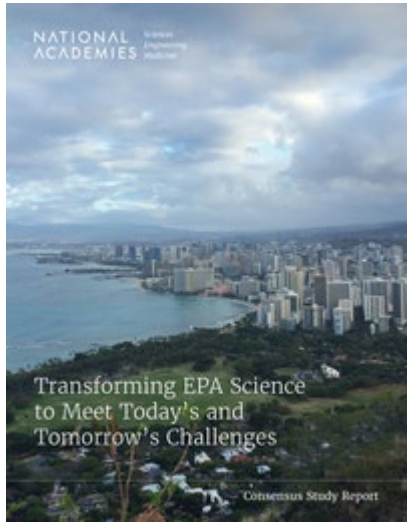
- **3153** “sensors”
  - **697** “sensors” topic category of “infrastructure and transportation”
    - **315** “optical sensors”
    - **135** “fiber sensors”
    - **40** “optical fiber sensors”
    - **148** “wireless sensors”
    - **179** “passive sensors”
    - **178** “active sensors”
    - **86** “wearable sensors”

Technology Assessment and Setting Research Agenda



[Nondestructive Evaluation of Highway System Asset Foundational Condition and Capability] (2023)

- Review of nondestructive technologies
- Identify the potential for further advancements to improve capabilities to assess and monitor the foundational integrity, condition, and service capability of highway system assets.
- Inform decision-making for research program development, investment in technology adoption, data management, and strategic planning.



[Transforming EPA Science to Meet Today's and Tomorrow's Challenges] (2023)

- Includes recommendations on fostering innovation, using sensing data, strengthening research collaborations
- Identified scientific and technological advances that ORD should consider in its research planning under the topics of measurements to inform exposure assessments, biotechnology, participatory research, and data science and machine learning.

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Technology Assessment and Setting Research Agenda

[Corrosion of Buried Steel at New and In-Service Infrastructure] (2023)

- Monitoring could be accomplished by installing or retrofitting infrastructure with sensors
- Fiber optic sensors have proven successful in the laboratory for monitoring corrosion and in the field for monitoring strain of buried steel and buried reinforced concrete infrastructure, they are an aspirational method for monitoring corrosion of buried infrastructure.

[Developing Wearable Technologies to Advance Understanding of Precision Environmental Health: Proceedings of a Workshop–in Brief] (2023)

- Discussion of emerging applications and the latest advances in wearable technologies.
- Explored the potential of wearables in capturing, monitoring, and predicting environmental exposures and risks to inform precision environmental health

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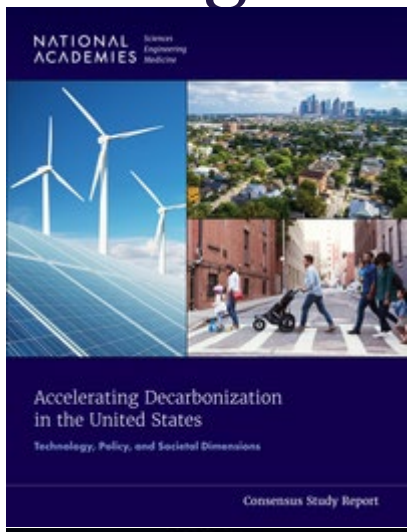
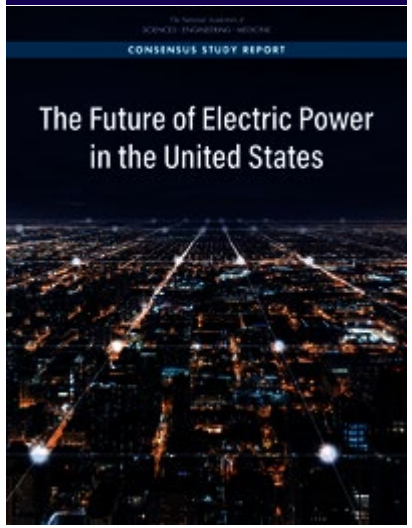
Decarbonization, Resiliency, and Other Drivers of Change in the Electric Power System





[Accelerating Decarbonization in the United States: Technology, Policy, and Societal Dimensions] (2023)

- Recommendations to help policymakers achieve a just and equitable energy transition including policy, technology, and societal dimensions.
- Addresses federal and subnational policy needs to overcome implementation barriers and gaps with a focus on energy justice, workforce development, public health, and public engagement.
- Recommendations for the electricity, transportation, built environment, industrial, fossil fuels, land use, and finance sectors.

[The Future of Electric Power in the United States] (2021)

- The report addresses technology development, operations, grid architectures, and business practices, as well as ways to make the electricity system safe, secure, sustainable, equitable, and resilient.

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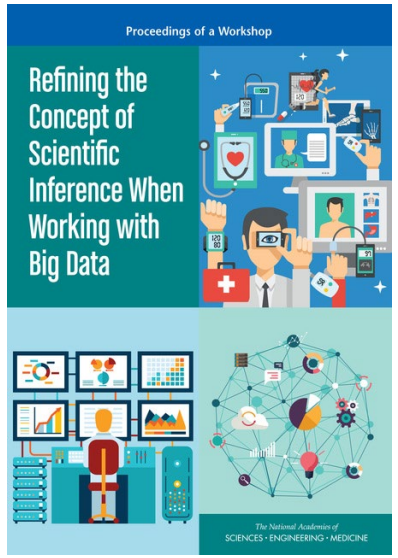
Analytics, Machine Learning, and AI

"Generating data is not the same as providing actionable intelligence; this requires conversion of the data into usable information."

Seeing Photons: Progress and Limits of Visible and Infrared Sensor Arrays. 2010. https://doi.org/10.17226/12896



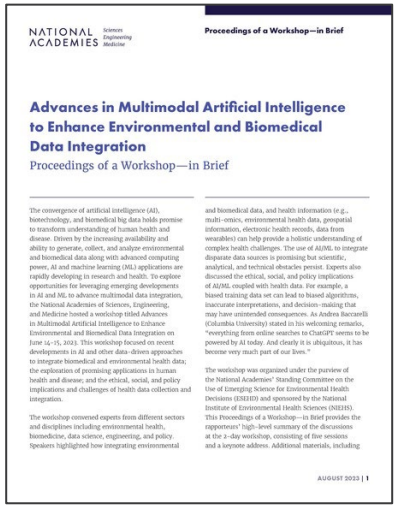
Refining the Concept of Scientific Inference When Working with Big Data: Proceedings of a Workshop (2017)

- challenges and opportunities in performing scientific inference reliably when working with big data.
- Explored new methodologic developments and potential research program areas

Artificial Intelligence and Justified Confidence: Proceedings of a Workshop–in Brief (2023)

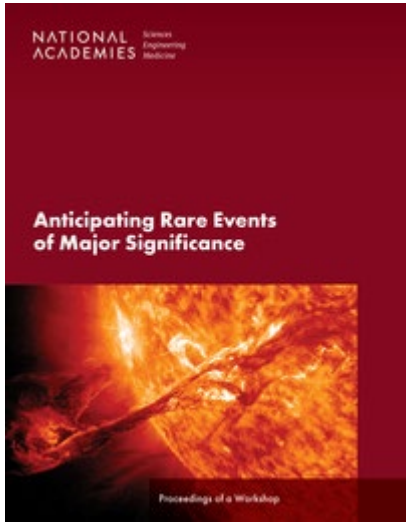
- Explored how industry and other branches of the military have successfully integrated machine learning/artificial intelligence tools into a command and control architecture

Diverse Sensor Data and Integration



[Advances in Multimodal Artificial Intelligence to Enhance Environmental and Biomedical Data Integration: Proceedings of a Workshop–in Brief](#) (2023)

- Recent developments in AI and other data-driven approaches to integrate biomedical and environmental health data;
- Exploration of promising applications in human health and disease;
- Ethical, social, and policy implications and challenges of health data collection and integration.



[Anticipating Rare Events of Major Significance: Proceedings of a Workshop](#) (2022)

- Analytical methods, computational advances, data sources, and risk assessment approaches for anticipating rare events

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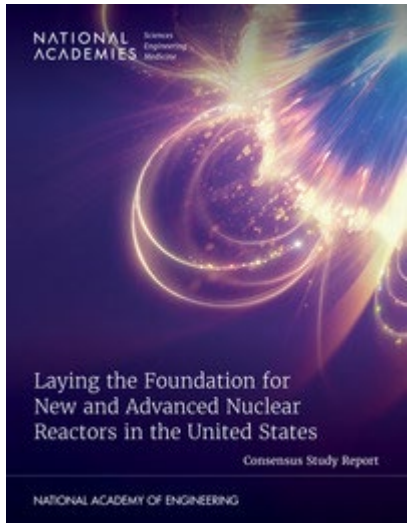
Digital Twins

Opportunities and Challenges for Digital Twins in Engineering: Proceedings of a Workshop—in Brief (2023)

- Opportunities for optimization—in sustainability, decarbonization, and environmental protection
- Value opportunities in digital twins include optimal experimental design, active learning, optimal sensor placement, and dynamic sensor scheduling

Foundational Research Gaps and Future Directions for Digital Twins



Laying the Foundation for New and Advanced Nuclear Reactors in the United States (2023)

- Recommendation for funding for advanced construction technologies R&D to streamline and reduce costs for this work.
- Employment of digital technology and use of the digital twin to provide greater assurance at point of manufacture/fabrication so that required design tolerances are complied with (or being met).

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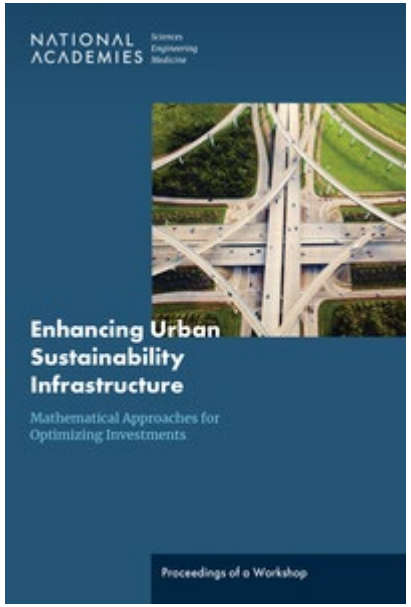
Cyber Security and Privacy

[Challenges in Federal Facility Control System Cyber Security, Including Level 0 and 1 Devices](#) (2023)

- Cybersecurity standards and government organizations have largely ignored process sensor cybersecurity and integrity; and
- Instrument engineers and instrument technicians are not part of cybersecurity programs, have minimal training in cybersecurity, and continue to design cyber insecure sensors and sensor systems.
- Monitoring process sensors in real time would shift control system cybersecurity from a network monitoring issue to an engineering issue.



[Enhancing Urban Sustainability Infrastructure: Mathematical Approaches for Optimizing Investments: Proceedings of a Workshop](#) (2023)

- "Although governments aim to deploy millions of sensors in cities to better understand weather and climate change, cities are growing concerned about privacy issues owing to the information that is collected about individuals."

A more efficient and strategic approach is needed for managing transportation assets, in general, and, in particular, their foundational elements during their service life. This need is exacerbated by uncertainties in the impact of changes to the aging transportation infrastructure assets caused by continued degradation, climate change, unreliable funding, effects of international trade, and possible changes in national policies and priorities—all in the context of almost no information on the condition and service capability of the foundation elements.

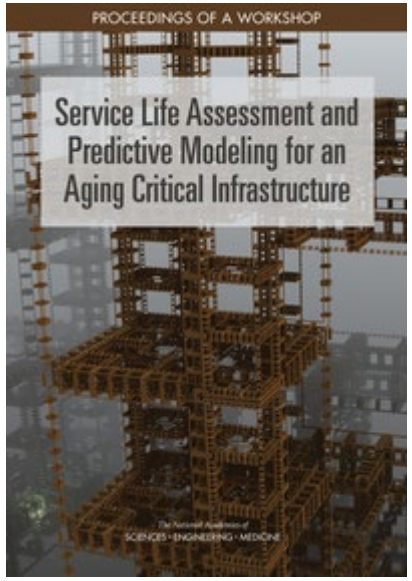
NCHRP Research Report 1041 –

Nondestructive Evaluation of Highway System Asset Foundational Condition and Capability.

Asset Management

[Lifecycle BIM for Infrastructure: A Business Case for Project Delivery and Asset Management](#) (2023)

- Focuses on the development of resources to support the adoption of BIM by highway agencies.



[Service Life Assessment and Predictive Modeling for an Aging Critical Infrastructure: Proceedings of a Workshop](#) (2021)

- Service life prediction and assessment techniques to further improve predictions of (1) highway infrastructure, (2) waterways infrastructure, and (3) railways infrastructure.

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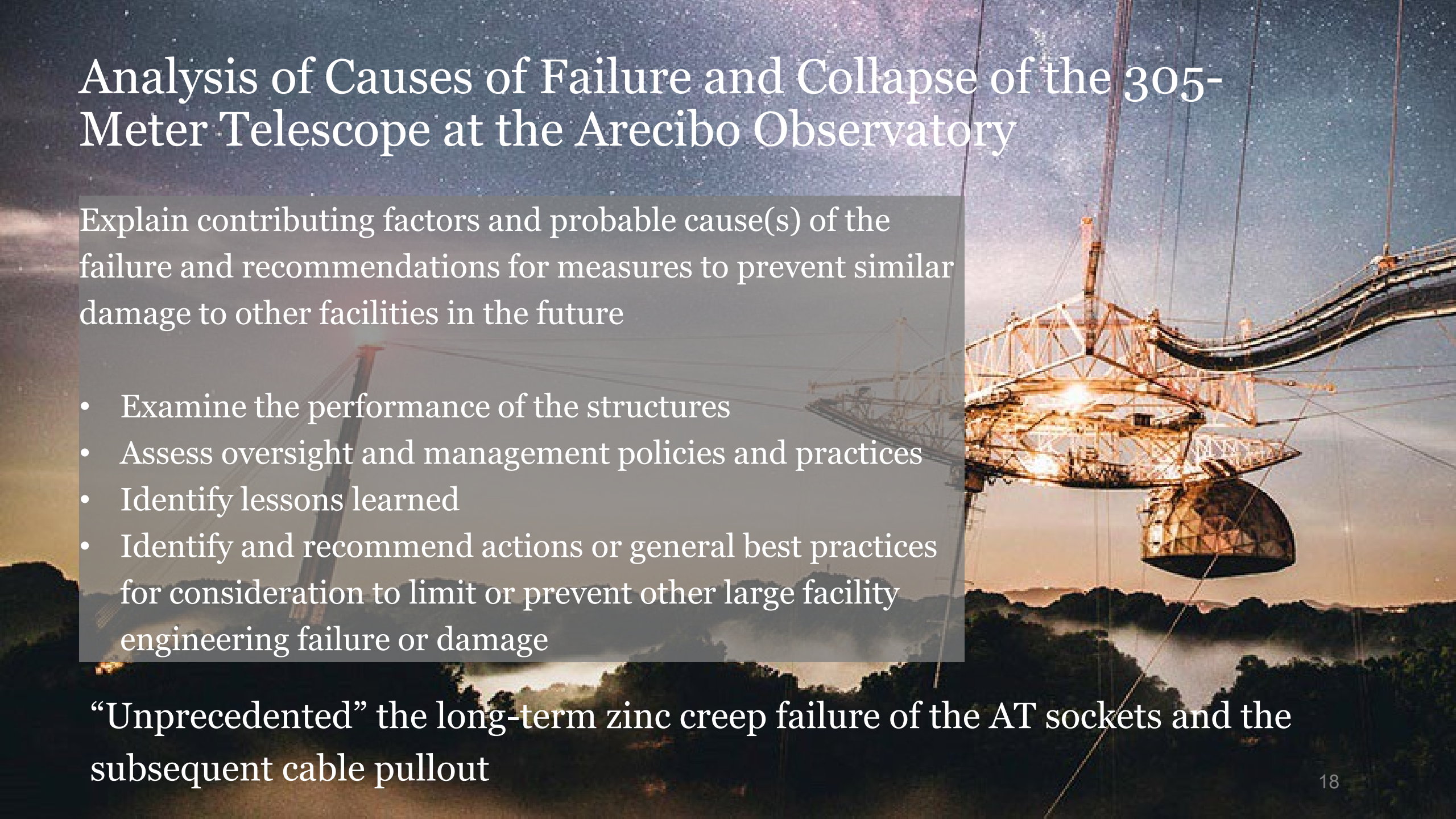
Analysis of Causes of Failure and Collapse of the 305-Meter Telescope at the Arecibo Observatory

Explain contributing factors and probable cause(s) of the failure and recommendations for measures to prevent similar damage to other facilities in the future

- Examine the performance of the structures
- Assess oversight and management policies and practices
- Identify lessons learned
- Identify and recommend actions or general best practices for consideration to limit or prevent other large facility engineering failure or damage



"Unprecedented" the long-term zinc creep failure of the AT sockets and the subsequent cable pullout

Practices and Standards for Plugging Orphaned and Abandoned Hydrocarbon Wells

Support for DOI's Orphaned Wells Program Office on existing practices and standards for plugging orphaned and abandoned hydrocarbon wells.

- *Historic and current well-plugging standards and design and operational practices;*
- *How these standards and practices may differ based on factors*
- *Consideration of cost, technology, or other factors that impact the development of well-plugging plans; and*
- *Environmental and economic benefits to well-plugging and/or mitigation of adverse environmental impacts from well-plugging*

Estimating Facility Renewal Costs and Service Life

Workshop on predicting renewal requirements and estimating facility service life based on “Strategies to Renew Federal Facilities.”

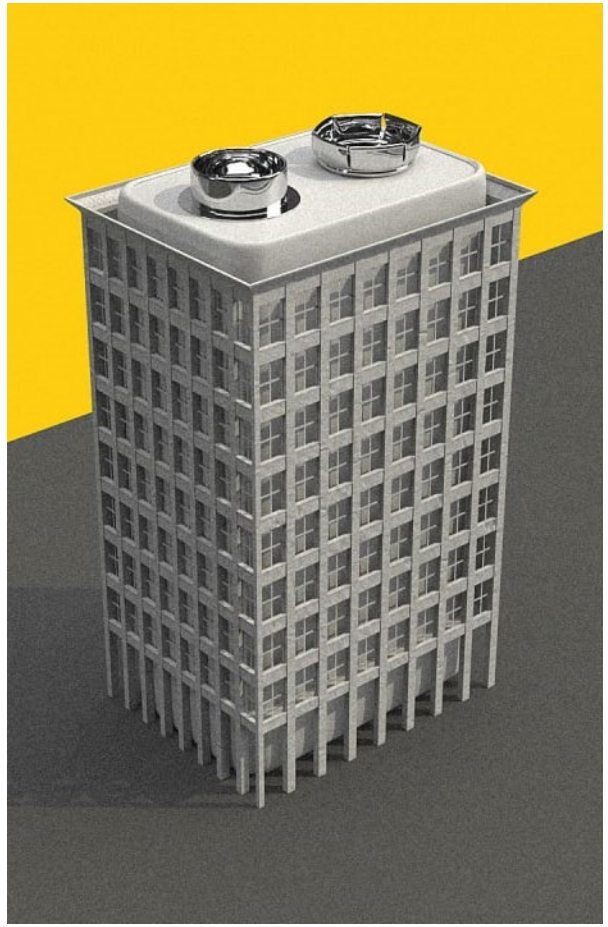
- *Case studies of the estimation of renewal costs and criteria*
- *Geometric depreciation models compared and other estimation models*
- *Depreciation rates for structures and infrastructure*
- *Facility service life for facility planning and budgeting.*
- *Data research*

Safety and Effectiveness of UVC Applications in Built Environments

Examine technical and guidance aspects of UVC (254 and 222 nm) light at different wavelengths and disinfection applications against airborne pathogens in built environments

- *Assess effectiveness of UVC light against airborne pathogens at different wavelengths.*
- *Assess safety of UVC light at different wavelengths and assess potential for formation of ozone or other byproducts.*
- *Advance development of standards for assessing research outcomes and device use.*
- *Address applicable regulatory processes for use of current, emerging, and future UVC light products*

Energy Transition in Buildings and the Constructed Environment



Focuses on technology (materials, design, and IT) and policies that support energy and carbon goals

- *Electrification*
- *Grid-Interactive Efficient Buildings*
- *Buildings in a decentralized and distributed grid*
- *Buildings as Batteries (lift energy storage, innovative and new materials)*
- *Thermal energy storage and off-peak electricity storage*
- *Building-integrated solar energy,*
- *Interface of buildings and electric vehicles in distributed energy,*

THANK YOU

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