

2050 Transportation Scenario Visualization: A human-centered design approach to integrating statewide forecast data and models to improve public understanding of system needs

WA-RD 953.1

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June 2025



Images: mobilitywa2050.org



**Washington State
Department of Transportation**

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WSDOT Research Report

Project Report
Transportation 2050 Visualization
Agreement 1461, Task A1

2050 Transportation Scenario Visualization

A human-centered design approach to integrating statewide forecast data and models to
improve public understanding of system needs

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Prepared for

The State of Washington
Department of Transportation
Julie Meredith, P.E., Secretary

June 2025

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. WA-RD 953.1		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle 2050 Transportation Scenario Visualization: A human-centered design approach to integrating statewide forecast data and models to improve public understanding of system needs				5. Report Date June 30, 2025	
				6. Performing Organization Code Enter any/all unique numbers assigned to the performing organization, if applicable.	
7. Author(s) Barton G. Treece, III, PTP. https://orcid.org/0000-0002-4945-9379 Andrea Figueroa. https://orcid.org/0000-0002-4524-4661 Vishnupriya Ravikumar. https://orcid.org/0009-0003-2455-2328 Susanna Lammervo. https://orcid.org/0000-0001-6027-8715 Ryan P. Avery, P.E., PhD. https://orcid.org/0000-0002-5367-8953 Cecilia Aragon, PhD. https://orcid.org/0000-0002-9502-0965				8. Performing Organization Report No. N/A	
9. Performing Organization Name and Address University of Washington Washington State Transportation Center (TRAC-UW) Box 539446 4333 Brooklyn Avenue Northeast Seattle, WA 98195-9446				10. Work Unit No.	
				11. Contract or Grant No. Agreement 1461, Task A1	
12. Sponsoring Agency Name and Address Washington State Department of Transportation Transportation Building, MS 47372 Olympia, WA 98504-7372 Jon Peterson, Project Manager 360-705-7499				13. Type of Report and Period Covered Final Report (Sept 2024-June 2025)	
				14. Sponsoring Agency Code	
15. Supplementary Notes Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration. Support also provided by King County, WA, with contributions from Challenge Seattle, Boeing, Microsoft and Alaska Airlines.					
16. Abstract This research developed a data-driven public engagement platform to address Washington state's growing transportation challenges. By integrating regional travel forecasts, freight and airport demand, and infrastructure condition data, such as from bridges, into a single, interactive platform, the web-based visual tool makes complex information accessible to both policymakers and the public. Using a human-centered design approach and dynamic storytelling, this work highlights the urgent need for coordinated infrastructure investment and supports decision-making to ensure a resilient, multimodal transportation system to support a growing state population of the future.					
17. Key Words Multimodal transportation, freight and passenger traffic, travel, datasets, forecasting, visualization, metropolitan planning organizations, state of good repair, data visualization			18. Distribution Statement No restrictions. This document is available through the National Technical Information Service, Springfield, VA 22161. Enter any other agency mandated distribution statements. Remove NTIS statement if it does not apply.		
19. Security Classif. (of this report) Not classified		20. Security Classif. (of this page) Not classified		21. No. of Pages 15	
				22. Price N/A	

Acknowledgments

This research was made possible by funding from the Washington State Department of Transportation, King County, Challenge Seattle, with contributions from Alaska Airlines, Boeing, and Microsoft. The authors would like to thank Amy Grotefendt for her work to develop this project and for her collaboration throughout, and also Chris Gregoire and Stephanie Formas for their leadership and support. There are many to thank at WSDOT, including Ron Pate, Clair Leighton, Rob Berman, Travis Phelps, Pasco Bakotich, Dongho Chang, Norene Pen, Matt Versdahl, Sreenath Gangula, Hui Dong, Takahide Aso, and Jon Peterson. From King County, we are grateful to Ashton Allison for his support.

We received much of our data sets from Metropolitan Planning Organizations and appreciate their assistance. Many thanks to Josh Brown and Craig Helmann at Puget Sound Regional Council, Scott Carte at the Thurston Regional Planning Council, Mark Harrington with Southwest Washington Transportation Council, and Hugh Conroy at Whatcom Council of Governments.

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Citation

Treece, B., Figueroa, A., Ravikumar, V., Lammervo, S., Avery, R., Aragon, C. (2025) 2050 Transportation Scenario Visualization: A human-centered design approach to integrating statewide forecast data and models to improve public understanding of system needs. Seattle, WA: Mobility Innovation Center, University of Washington

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Executive Summary: Challenge 2050 – The Future in Motion

The 2050 Transportation Visualization project, with a public-facing title to be called “Challenge 2050: The Future in Motion,” (www.mobilitywa2050.org) is a data visualization and public engagement project developed by the University of Washington’s Mobility Innovation Center to address Washington State’s growing transportation challenges. With the state’s population and freight demand projected to rise sharply by 2050, the project aims to make complex transportation data accessible and actionable for the public and policymakers.

Project Goals

- Integrate disparate transportation data into a single, user-friendly platform.
- Highlight the impacts of population growth on mobility, infrastructure, and freight.
- Support informed decision-making through interactive, human-centered visualizations.

Key Features

- Combines data from regional travel models, airport and freight forecasts, and infrastructure conditions from bridges and structures.
- Uses a storytelling structure to guide users from key insights to interactive exploration.
- Developed with input from technical and non-technical users to ensure clarity and usability.

Challenges

- Difficulty accessing and standardizing data across agencies.
- Lack of centralized, interoperable models for statewide planning.

Recommendations

- Coordinate with key external organizational users to confirm their involvement, align on communication strategies, and define next steps for applying the web-based visualization tool for specific use cases.
- Host the tool, (www.mobilitywa2050.org) at the University of Washington to ensure credibility and public trust.
- Expand data integration and explore AI to enhance planning and infrastructure prioritization.

Introduction

2050 Transportation Scenario Visualization: *A human-centered design approach to integrating statewide forecast data and models to improve public understanding of system needs*

Transportation serves as the backbone of a robust economy to move people and freight across an interconnected, multimodal system. There are several factors that will potentially reduce mobility, economic vitality, and quality of life in Washington state and the greater Cascadia region within the next 25 years. Sufficient data from regional forecasts, state population projections, freight models, planning studies, and state infrastructure assets conditions are available that demonstrates this need. However, the public at-large and decision-makers lack access to this information in a cohesive, easy-to-understand format that is relevant and shows that immediate intervention and infrastructure investment is critical, and the statewide needs cannot be ignored.

By 2050, the Central Puget Sound Region population is expected to grow by 1.5 million people to a total of 5.8 million (PSRC 2020), and the statewide population is forecasted to grow from 8.1 million to 9.8 million (OFM 2025). The growing state population affects the transportation infrastructure, with increased demand for surface travel on roadways, rail, ferries, and air mobility for travelers and freight haulers.

The Washington State Department of Transportation is currently conducting two legislatively funded efforts that are working in tandem: the Interstate 5 Master Plan, which will provide the Legislature with an actionable, comprehensive strategy to prioritize and deliver improvements for the future of the corridor (WSDOT 2024); and the Cascadia Ultra-High-Speed-Ground Transportation (UHS GT) program, which has the potential to increase the transportation network capacity to accommodate future growth and would benefit business and freight movement by improving the reliable transportation of goods and people (WSDOT 2023).

In addition to WSDOT's programs for I-5 and UHS GT, the Puget Sound Region is facing a significant challenge with air mobility, both for commercial air travel and freight cargo. Regional demand for enplanements (passengers boarding for departure) is expected to grow from 24 million in 2018 to between 49.3 million and 55.6 million by 2050 (PSRC 2021). This equates to a need to either construct another Sea-Tac equivalent or add enough capacity at existing airports to meet passenger demand, a gap of about 27 million unmet boardings in the Puget Sound area (PSRC 2021).

Air cargo will also soon be constrained. Eighty-five percent of Puget Sound air cargo is served by Seattle-Tacoma and King County International airports. Demand for air cargo is expected to more than double by 2050, and the region will fall short of on-airport warehouses by about 2027 (PSRC 2021).

As the region grows, congested roads mean it will take longer to access airports – light rail and other multimodal solutions could help increase access. Flights in and out of Sea-Tac may be constrained in the near future with potential controls in place to manage flights similar to other busy airports in the nation such as JFK, LaGuardia, and Reagan National Airport.

There is demand for additional regional air mobility, as well as a vocal opposition for growing capacity especially in the south sound for a new passenger facility; however, the consequences of doing nothing do not seem to be widely understood by the public at large (Gates 2023).

A robust transportation system is vital to statewide economic growth and prosperity. Freight contributes \$14.3 billion to the state gross domestic product, and employs nearly 100,000 people, paid over \$6 billion in wages and salaries (WSDOT 2022). Freight relies on a multimodal system that includes:

- 22,000 centerline miles of truck corridors
- 3,200 active railroad route miles
- 22 deepwater ports
- 22 airports providing cargo service
- A large city-street network for first/last miles deliveries

In 2022, over 600 million tons of freight moved through Washington state, with a total value of just over \$700 billion. (WSDOT 2022). Between 2022 and 2050, freight movements in Washington are forecast to increase 45%, from 603 million tons of cargo to 872 million tons (WSDOT 2022). Increasing freight volumes are likely to further exacerbate many of the challenges the state freight system currently faces (WSDOT 2022). Forecasted truck vehicle miles traveled on the various interstates are expected to increase by 67% from 2022 to 2050 (WSDOT 2022).

Underpinning all the future system needs of a growing state population is aging infrastructure that is showing signs of years of disinvestment for maintenance and preservation, and as a result, is in the “early stages of failure” (Senate Transportation Committee 2024). These manifest in emergency repair work, load restrictions and closures of bridge structures that create disruption, delays, and can be costly for commercial vehicles. WSDOT has a robust inspection program to monitor bridges and tunnels to document issues and prescribe measures to maintain safety for all users. However, the backlog of WSDOT managed assets requiring significant repair or replacement continues to grow with an average \$1.5 billion funding shortfall required to keep transportation investments in a state of good repair (Millar 2024).

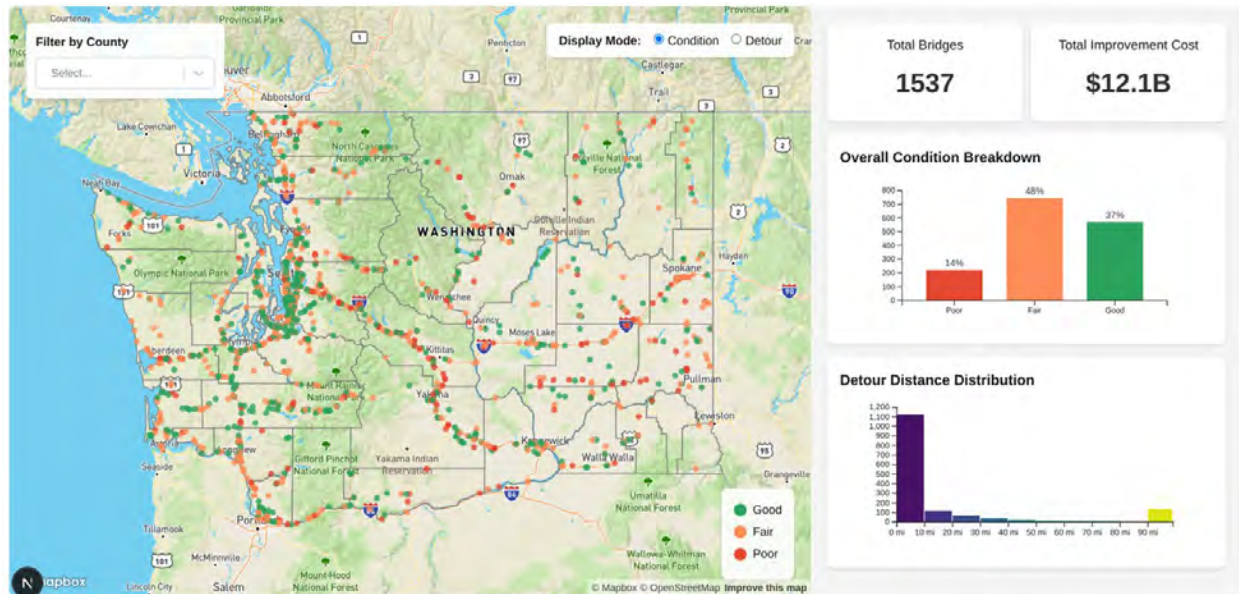


Figure 1 Image of WSDOT bridge conditions from Challenge 2050: The Future in Motion visualization

The Mobility Innovation Center at the University of Washington developed a project to provide clarity and insight into the significant transportation challenges the state is facing by taking existing planning-level data to provide an online website platform to inform and educate the public and decision-makers. These data sets are derived from several sources, such as Metropolitan Planning Organizations (MPOs), WSDOT, and freight mobility data. The project team, led by Professor Cecilia Aragon from the UW Department of Human Centered Design and Engineering, developed a web-based platform that integrated disparate sources into a single resource that shows a broader picture of current and future transportation system challenges, while also using a human-centered approach that creates a personal connection with the data to capture the users' attention and interest.

This aligns with WSDOT's intention to identify broad future trends and uncertainties and to consider the need for different transportation modes to support the growth of the region (WSDOT 2023). As identified in agency reports to the legislature, "scenario planning is, in part, a communication and engagement tool to build awareness, excitement, and curiosity about Cascadia UHSGT" (WSDOT 2023). Scenario planning will enable WSDOT to consider how Cascadia UHSGT will be integrated into the multimodal (highways, airports, rail, transit, etc.) transportation system (WSDOT 2023). This project fits within these aims as it demonstrates the future challenges, constraints, and opportunities of the system with new opportunities to integrate improvements such as UHSGT that could provide greater capacity, redundancy, and reliability for Cascadia.



Figure 2 Image of comparative travel times between Seattle and Vancouver, B.C. from Challenge 2050: The Future in Motion visualization. These figures are reflective of estimated seat time for passengers in each vehicle and does not incorporate airport screening time.

This project is funded in part by WSDOT, King County, and Challenge Seattle, with contributions from Alaska Airlines, Boeing, and Microsoft.

Methodology

Human-centered design (Norman 1988; IDEO 2015) is a creative approach to problem-solving; a large portion of this is communication. Learning what your audience or users want to understand and accomplish is essential. In this case, it's the public at large and policy makers who represent the electorate who should be aware of some of the big challenges we have in Washington related to mobility and what this will mean to our economy and quality of life.

The project team solicited transportation modeling forecasts from the Puget Sound Regional Council (PSRC), Thurston Regional Planning, and Southwest Washington Regional Transportation Council (SWRTC), all established Metropolitan Planning Organizations (MPOs). Each develops a future travel demand model based on population growth projections and assumptions of future planned infrastructure improvements and investments, such as the ST3 package from Sound Transit.

Transportation models gathered were developed by MPOs. Visualization design (Tufte 1990) is an iterative process that requires building a prototype, testing it out, receiving feedback by asking the user, "Does this help you understand what the data is telling you, can it help you make decisions?"

The project employed a visualization approach known as a reverse martini glass (Segel & Heer 2010) as a storytelling structure for developing the end product known as "Challenge 2050: The Future in Motion." This begins with a starting point called the "Kicker" that captures the attention with a compelling hook or key insight to engage the audience. This introduces the audience to the core challenge—a rapidly growing population and its effect on daily life, that highlights the projected population growth of 1.5 million people by 2050, creating an immediate sense of urgency and relevance.

The next portion is an author-driven and explanatory stage. This follows a guided, linear narrative where the author highlights specific insights and explains the data, including:

- Commute impacts
- TSA wait times projections
- State of freight
- Introduce possible solutions

This is followed by a user-driven exploration stage. Interactive visualizations shift control to the user, allowing them to interact with the data, explore details, and discover their own insights with an interactive mobility dashboard.

The project team is conducting user testing with both technical experts and non-technical users to refine the ease of use of the website.

Project Challenges and Opportunities

Gathering the identified data sets for the visualization was the most significant issue this project faced. Various entities would offer assistance, or claimed they had the data needed, but were slow to provide the data as quickly as promised, or the data wasn't in a format that was immediately useful. The project team met with resistance from public entities who were protective of their data sets and would be reluctant to provide requested information out of concern for how it would be used and interpreted.

When connected with a subject-matter expert, or an individual who had led a planning study to request data, the initial result was to share either a web-based document or a presentation with a table. These formats are not suitable for the visualization deliverable. As a result, some tables were recreated by the project team in the necessary file format.

Washington state MPOs are positioned to develop regional travel forecasts within their jurisdictional boundaries. However, there are differences in model development and forecast years. PSRC uses an activity-based model with 2050 as the horizon year, while Thurston Regional Planning and SWRTC use a more traditional four-step model with 2045 as the horizon year. None of these models are integrated with one another and are limited to trips generated within the MPO boundary.

WSDOT staff who have access to system data, which includes highway performance and assets such as bridge conditions, were very helpful and responsive to the project team's requests and usually in the file format requested.

Through this work it is clear that there is no centralized source that incorporates regional travel forecast models with state infrastructure condition, such as bridges. The existing data is not in a common format, nor is it accessible and understandable by the public at large.

Summary of Findings

This project successfully incorporated disparate data sources of travel forecast models from three MPOs along the I-5 corridor, future airport demand, statewide freight demand, and bridge condition data into a platform that can be easily accessed and understood by the traveling public and decision makers. Using a human-centered design approach, users will be able to understand the relevance of future transportation needs and the impending issues related to lack of coordinated infrastructure investment across jurisdictional boundaries.

Recommendations

1. To fully realize the true benefit of Challenge 2050/www.mobilitywa2050.org as a communication tool, a concerted engagement strategy is needed to promote public interest and use. Coordinate with key external organizational users to confirm their involvement, align on communication strategies, and define next steps for applying the tool to specific use cases.
2. Use the University of Washington as the steward of Challenge 2050/www.mobilitywa2050.org on a public-facing website. The university provides objective credibility and should be leveraged for greater public acceptance.
3. Build off the data integration to make Challenge 2050/www.mobilitywa2050.org a more robust tool for statewide transportation planning and public engagement. There is opportunity to incorporate additional data sets and use artificial intelligence as a tool for infrastructure preservation and prioritization to provide a more comprehensive statewide view but also help the information be viewed at a local level.

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