Effective Modeling Analysis: A Case Study Using the Oregon Statewide Integrated Model for the Oregon Freight Plan

Abstract

The Oregon Department of Transportation (ODOT) recently completed its first statewide long-range Freight Plan. Given the uncertainty of future economic conditions, the second generation Oregon StateWide Integrated Model (SWIM2) was used to evaluate the implications of uncertain economic conditions to long range freight planning. Several lessons learned from past analyses prompted changes to the analysis process followed for this particular project. The Oregon Freight Plan analysis enabled us to identify ways modeling services can be more effective in supporting long range planning. While having sophisticated tools to conduct the analysis is important, other aspects of the planning analysis process appear to be just as important, in some cases perhaps even more important than the tools themselves. This paper aims to share some of the strategies Oregon has identified as key to providing effective modeling services to our planning peers.

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Introduction

The Oregon Department of Transportation (ODOT) recently completed its first statewide long-range Freight Plan. Given the uncertain economy, the second generation Oregon StateWide Integrated Model (SWIM2)[1] was used to evaluate the implications of uncertain economic conditions to long range freight planning. Oregon has an accomplished program in transportation model development. However, many lessons remain as we move forward implementing the use of our models, especially in the case of the StateWide Integrated Model. The analysis conducted for the Oregon Freight Plan represented the first full model application for the second generation version of SWIM.

Several lessons learned from past analyses prompted changes to the analysis process followed for this particular project. The Oregon Freight Plan analysis enabled us to identify ways modeling services can be more effective in supporting long range planning projects. While having sophisticated tools to conduct the analysis are important, other aspects of the planning analysis process appear to be just as important, in some cases perhaps even more important than the tools themselves. This paper aims to share some of the strategies Oregon has identified to providing effective modeling services to our planning peers.

The purpose of this paper is to suggest to the modeling community that conscious effort to improve outreach to our planning partners will result in more effective modeling analysis and generate support to enhance our modeling programs. An overview of the Oregon StateWide Integrated Model is presented, as well as a description of the analysis conducted for the Oregon Freight Plan. A summary of strategies related to providing effective modeling services is also provided.

Overview of the Oregon Statewide Model

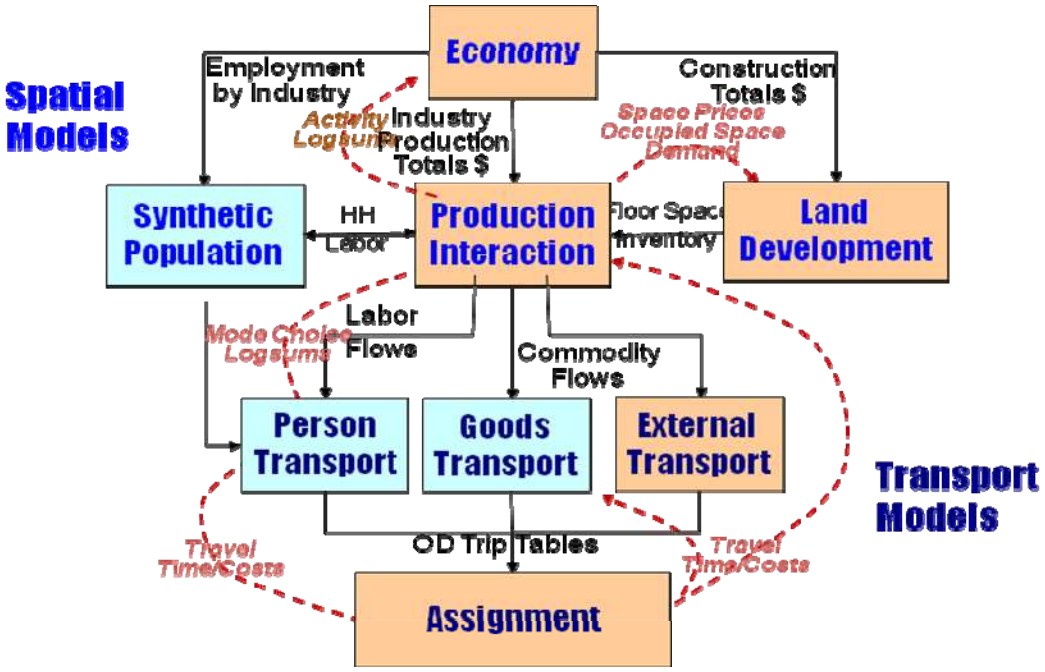
The second generation StateWide Integrated Model (SWIM2) was used for the Oregon Freight Plan analysis to evaluate future conditions and reveal implications for freight movement in Oregon. SWIM2 is an integrated model, incorporating land use, the economy and the transportation system into one dynamic environment. This tool supports analysis that accounts for the intricate connections and feedbacks amongst these three areas of activity. SWIM2's integrated framework, where land use and travel result from economic transactions, makes it ideal for tracing the impact of economic conditions at the state and regional level.

SWIM2 was developed between 2004 and 2007, with calibration and data improvements implemented until late 2009. Oregon is divided into 2950 "alpha" zones, which can be aggregated into 519 "beta" zones (used in the economic components). The structure is modular, allowing for updates and improvements to be made with minimal disruption to the full model. Some modules operated at the alpha zone level, while others do so at the beta zone level.

SWIM2 includes a roughly fifty-mile halo around the state of Oregon consisting of 39 counties in neighboring states of Washington, Idaho, Nevada, and California. **Figure 1** illustrates the structure of SWIM2. The modules of interest to the Freight Plan analysis were:

- Economy – economic and demographic module in which alternative economic forecasts are generated
- Production Interaction – production allocations and interactions from which commodities flow between zones and industry production is located
- Goods Transport – commercial vehicle transport, which "loads" cargo into trucks and sends them to destinations via the assignment module

Figure 1. Structure of the Oregon StateWide Integrated Model 2



SWIM2 includes twenty industry sectors; eighteen household income/size categories; forty-one SCTG commodity groups; eight labor and fifteen service occupations; and nineteen floorspace types. This complex model provides a rich dataset to support the Oregon Freight Plan, with analysis on commodity flow by value and weight, describing regional economies within the state and linking them to freight movement, as well as truck tours and use of state corridors.

Analysis Approach

The schedule for the Fright Plan was very aggressive. Given the time needed to set-up and run each scenario, including time needed to trouble shoot unanticipated problems which is common when using a new model, analysis scenarios had to be carefully designed to serve the needs of the plan in a timely manner. ODOT staff proposed a set of modeled scenarios to the Freight Plan Steering Committee for approval after listening to many topic discussions early in the planning process. Revisions were made to the scenario designs after further discussion and recommendations from the Committee.

The analysis began with a Reference scenario, which produced a forecast based on "business-as-usual" for Oregon and represents a likely future given current trends and policies. The Reference scenario represents activity consistent with the most recent state forecasts of economic conditions,[2] land use patterns, and transportation system investment. This scenario serves as a reasonable and understandable basis of comparison for the alternative analysis scenarios.

Three hypothetical scenarios were produced using SWIM2, in addition to the Reference scenario: [3]

- Optimistic economic forecast
- Pessimistic economic forecast
- High transport costs

The Optimistic and Pessimistic forecasts provide a reasonable range of economic conditions Oregon could experience over the next twenty-five years. Oregon industries rely on the transportation system for obtaining production materials and labor needed to do business and get their goods to market. When economic activity changes, so do the demands placed on the transportation system. The High Cost scenario includes additional transportation costs to the Pessimistic scenario to reveal the long-range implications associated with this area of risk.

Several evaluation metrics were formulated to reveal the effects of changing underlying economic conditions at the statewide and regional level. These metrics were used to compare conditions in the analysis scenarios relative to the Reference scenario. Performance was evaluated with respect to:

- Transportation System – miles traveled, hours traveled, trip costs, commodity flow
- Economic Welfare – industry output, commodity value, and production costs

Analysis results were evaluated statewide as well as regionally, based on twelve Oregon Area Commissions on Transportation (ACT) geographic boundaries. Variations in national and statewide economic conditions result in different regional impacts. Such differences arise from unique regional industry mix and commodity flow patterns, which can be obscured when conditions are evaluated at the statewide level. Results at the regional level are of great interest to decision-makers, who typically represent specific regions of the State.

The Optimistic and Pessimistic economic scenarios were presented as "bookends" with which to consider the range of possible futures. This information will be used to evaluate alternative Freight Plan strategies and support formulation of policies that preserve the economic resilience of Oregon's freight system. Decision makers will be able to better assess the robustness of freight strategies and avoid creation of barriers that may inhibit the freight industry from reacting nimbly to economic change. The analysis showed a common high demand on core freight routes under any economy while highlighting select locations of variation under alternative economic futures.

The high fuel prices experienced in 2008, unknown greenhouse gas mandates, and future energy costs combined to create the impetus to evaluate the impact of higher transportation costs, in

addition to alternative economic forecasts. A three-fold increase in transportation costs was added to the Pessimistic scenario. This cost increase was modeled in a generic fashion, to avoid association with a specific cause, such as rising fuel prices, rising taxes, tolls, or a new carbon tax. Although SWIM2's freight mode choice model was unable to capture shifts to alternate freight modes, significant realistic changes in freight logistics were observed under the high transport cost scenario. For example, congestion and workday limitations led to more truck tours to serve a given set of freight flows.

Techniques For Effective Modeling

Beyond the technical discussion, the effort provided opportunities for the consulting and agency modeling staff to forge new ways in making use of their modeling tools and analysis to effectively serve the project effort.

The planning process takes time. Committees of stakeholders commit a significant amount of time to work through the formulation of long range plans such as the Oregon Freight Plan. Analysis also takes time, even more time when a large-scale sophisticated model is used, such as the SWIM2. With runtimes of three to four days, model runs must be carefully designed to meet the needs of the project in a timely manner. It is inevitable there will be glitches that set back progress, so time for such unknowns should be included in the modeling schedule.

The ambitious schedule for the Oregon Freight Plan left modeling staff with less time than typically allotted for projects of this scope. As a result, the ODOT modeling staff approached the project a little differently. In addition, ODOT was in the process of shifting model application skills and responsibilities to in-house staff and away from the model development consultant team. This project served as an opportunity for ODOT to gain application knowledge, yet continue to develop model enhancements in the background using the consultant team.

Three distinct changes were made to the Oregon Freight Plan modeling analysis approach and found to be key factors relating to effective modeling:

1. Agency modeling staff worked as a distinct partner in the Oregon Freight Plan project team, playing the role of an internal consultant alongside ODOT planning staff and their project consultant team.
2. Agency modeling staff attended meetings with the project steering committee and stakeholder sub-committees in order to gain a first-hand understanding of issues of interest to stakeholders.
3. Agency modeling staff communicated and interacted directly with stakeholders rather than receiving and sending information via a second party.

The effects of these techniques are discussed in the remainder of this paper.

Serving the Role as an Internal Consultant

Serving as a project partner, agency modeling analysts are allowed the opportunity to have a say in how the analysis is conducted. They can design an analysis approach that utilizes the strengths of the modeling tools and avoids the weaknesses. They can manage expectations throughout the

life of the project. Modeling staff has specialized knowledge and skills related to the tools and data available within their agency. They bring a distinct aspect of the work no other staff members or consultant team can provide. This knowledge and expertise can best be exploited when agency modeling staff is brought in as partners in the project. This is the most effective analysis design to serve the needs of the project given the unique tools and skill mix of the agency.

Modeling staff is often isolated from the planning process and committees they ultimately serve. This disconnect reduces the effectiveness of analysis. Without a clear understanding of the goals and objectives of the committee, internal conflicts or sense of risk, modelers chance designing an analysis that falls short of meeting the needs or timing of the project, thus being ineffective and reducing the chances of being asked to participate in the future. Clear understanding of the goals and objectives of a steering committee, in addition to awareness of participant perception of project risk and political conflict, is essential to developing a robust analysis. Lack of such awareness may result in ineffective modeling and reduce the chances of being ask to contribute to future projects.

Agency modelers learn about the political and planning processes, as well as impart information on analysis tools and data available to inform decision makers. This kind of interaction provides an awareness of modeling and analysis services, builds credibility, and generates support of future model enhancement, such as developing better input data.

Agency planners and external planning consultants are not as familiar with the modeling tools available as the agency modeling team. Thus, it is very important agency modeling staff are given the opportunity to design and recommend the analysis approach to take advantage of the analysis tools strengths as they relate to the planning project. If not given a strong voice in the project, there is an increased risk of ineffective analysis. This approach is important for the success of the project, not only the modeling analysis.

Attending Project Meetings

Having the authority to design the analysis methodology will not guarantee effective modeling services. It is important that the analysis serve the needs of the planning process. The best way to do this is to have agency modeling staff participating in stakeholder and project meetings from the start of the project. This allows the analyst direct access to information related to the project. Conversations among stakeholders and planning staff reveal a lot of information affecting the analysis design. Information pertinent to the analysis may or may not be relayed to the modelers by others, especially if they are not familiar with the nuances associated with agency modeling tools and techniques. First-hand exposure to the conversations and concerns of project participants greatly contributes to the formulation of effective modeling analysis. It is fairly common to leave modelers out of these meetings, but ODOT has found it to be very helpful to plan for participation in the project meetings.

Interacting and Communicating Directly with Stakeholders

Attending project meetings is not only beneficial to the modeling analysis. It also serves the informational needs of the project team members and stakeholders. As topics are discussed and questions arise, an analyst can suggest methods to explore the areas of interest to project participants that may supplement the core model runs. Instead of focusing on addressing specific questions asked by stakeholders, it is more productive to identify the root concerns and issues people wish to address through discussion and interaction. This information can be used to formulate an effective analysis procedure to address the core issues. For example, the risk and uncertainty associated with the Oregon economy appeared to be a major impediment to moving ahead with analysis. Identifying ways to accommodate the unknown economic conditions supported the formulation of strategic freight policies within an uncertain economic environment.

It is common for technical questions to pop up in committee meetings and other project meetings. Access to an analyst who can address these questions immediately avoids delay, misinformation and uncertainty generated by unanswered inquiries. One of the main challenges for modeling staff is communicating technical information in plain language for all to understand. Using simple graphics, avoiding jargon, and relating the information to the goals and objectives of the project are techniques that have served ODOT well.

ODOT has invested considerable time and resources to improve how we communicate with our customers, especially in the area of visualization of model data. The SWIM2 generates a phenomenal amount of information. A twenty year, 3-day model run generates fifty to eighty gigabytes of data. In order to evaluate and report results from a model run, a systematic approach was taken to organize and visualize data. Given experience from past analyses, the SWIM2 analysts had a strong sense of what information needed to be evaluated from a given model run. A preliminary list of model data elements, both input and output data, was the starting point for creating a user-friendly database and tool to view model results. After each model run, a standardized summary database was generated. This database serves as the source of data for a visualization tool developed for viewing SWIM2 outputs over time for a forecast scenario and comparison among scenarios. The visualization tool is a flexible interactive tool that can be used to run queries and produces maps, charts, line graphs and tables. The underlying database can also be used directly to create specialized graphs and charts unique to specific questions or analyses.

The SWIM VIZ database and visualization tool was in the process of development when the Freight Plan analysis began. It was used through out the analysis process and proved to be an invaluable tool for interpreting and digesting results from the scenario model runs. The lessons learned while using this tool served as a guide to building new SWIM VIZ features. **Figure 2** provides a few examples of the variety of visualization provided by this tool. At this stage, the visualization tool is primarily used by modeling analysts and has proven to be a powerful means to gain information quickly.

Some graphics for public presentation were developed to address the specific areas of interest of the Oregon Freight Plan Steering Committee. One particular plot stands out as a well received way to quickly assess the extent of economic risk to the freight system. **Figure 3** illustrates the total commodity flows for year 2027 for the Optimistic economic scenario compared to the Reference scenario. The reference scenario flows are represented in blue with the additional flows from the Optimistic scenario displayed in green. **Figure 4** provides the same for the Pessimistic economic scenario. Commodity flows were plotted on the roadway network in terms of value and tonnage to illustrate regional flow patterns. It is clear from this plot that freight flows will increase, regardless of economic conditions. Specific patterns by mode were reported using other graphs and tables. Flow plots illustrating patterns for individual commodity groups were also presented to reveal differences among commodity groups. These delineated the stability (or instability) of the major commodities and associated industries under various economic conditions. Plots revealing regional patterns were also used to reveal differences by part of the state.

Figure 2. Example Visualization From the SWIM2 VizTool

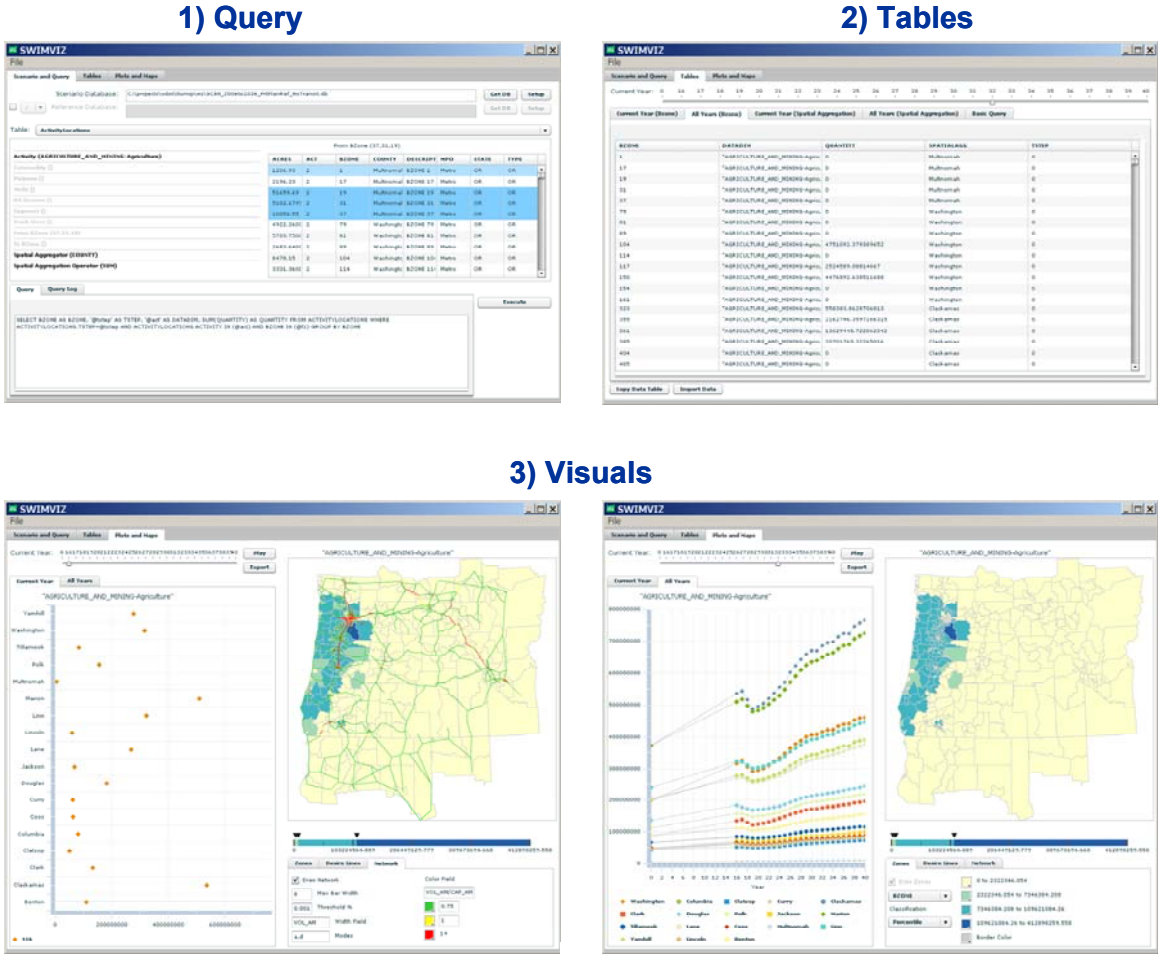


Figure 3. Commodity Flows for Optimistic Scenario Relative to Reference Scenario by Value and Tonnage Year 2027

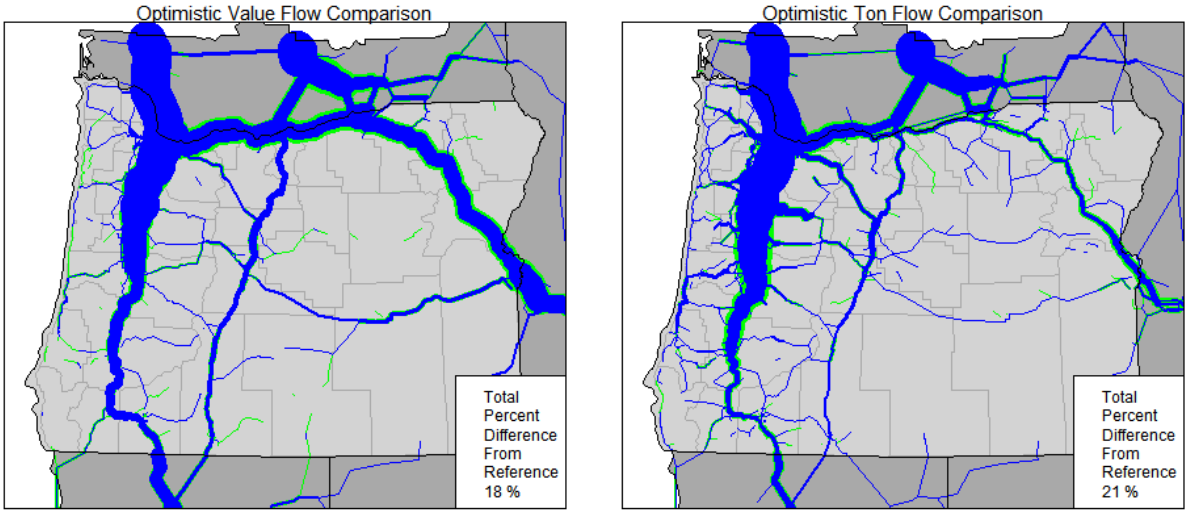
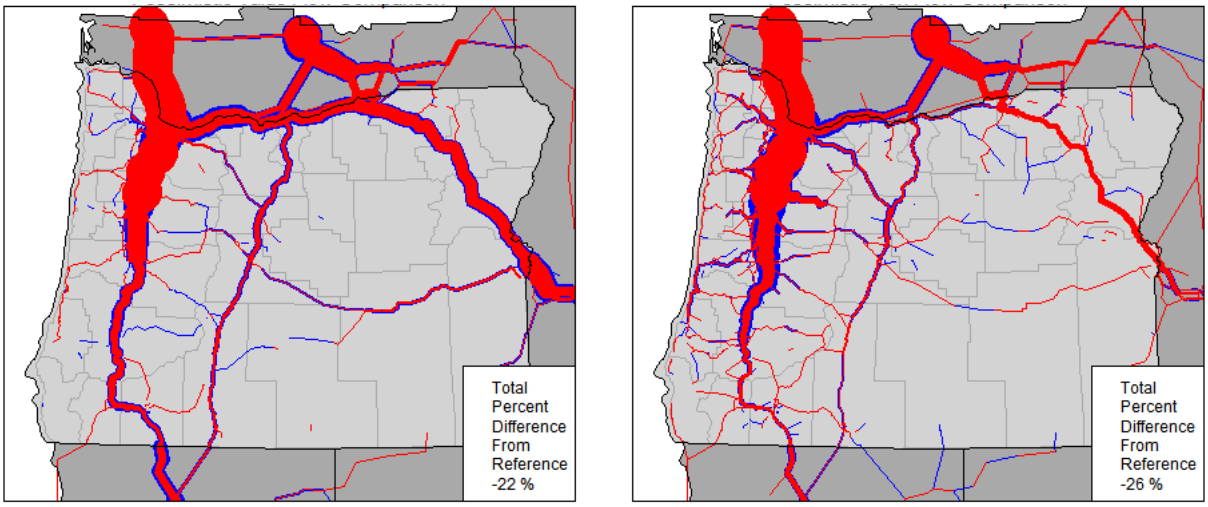


Figure 4. Commodity Flows for Pessimistic Scenario Relative to Reference Scenario by Value and Tonnage Year 2027



Conclusion

Using models to provide information to decision makers is the fundamental driver of model development and application programs across the nation. Modeling programs tend to focus on improving models and obtaining better data. However, if models are not used effectively, they will not be relevant nor gain the support needed for future improvements. Greater attention should be invested in learning how models can be used effectively in order to assist decision makers and garner support and justification for further data and model enhancements.

The analysis conducted for the Oregon Freight Plan serves as an example of effective modeling for the Oregon Department of Transportation (ODOT). Several aspects of this work were approached differently than in past studies. First, modeling staff served as internal consultants on the project team with the authority to develop and recommend the analysis approach, having the familiarity and experience with the analysis tools available in Oregon. Second, modeling staff attended all project meetings, both project staff and stakeholder meetings. This provided the full context and breadth of issues of interest to the project participants. This information was used to develop an analysis approach designed to utilize the strengths of the tools available, informing the Freight Plan Steering Committee, while serving the aggressive timelines of the project. Finally, direct interaction between agency modeling staff and stakeholders provides an effective way to relay information quickly and clearly in order to support the planning process.

Oregon has a rich set of modeling and analysis tools to serve the needs of long range transportation planning. In order to effective, modelers must not rely solely on the sophistication of their tools. Significant time and effort must be dedicated to actively participating in the planning process with agency staff, consultant staff, and stakeholders. This approach is proving to be very effective in Oregon.

Endnotes

1 PB, HBA Specto, EcoNorthwest, "SWIM2, Model Description," submitted to the Oregon Department of Transportation, Version 25. (June 2010)

2 http://www.oregon.gov/DAS/OEA/

3 A fourth scenario to evaluate growth in key Oregon industries was requested for this analysis. However, after reviewing the Optimistic forecast data, the differences between the planned industry scenario and the Optimistic scenario were too slight to warrant a separate SWIM2 scenario run. The information desired for the industry scenario is provided by the Optimistic scenario.