The Oregon Modeling Improvement Program: An Overview

prepared by

Oregon Department of Transportation -
Transportation Planning Analysis Unit
MW Consulting
PB Consult, Inc.

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For copies or more information about this report contact:
William J. Upton
Transportation Modeling Program Manager
Oregon Department of Transportation
555 13th Street N.E., Suite 2
Salem, Oregon 97301-4178
Telephone: (503) 986-4106
Fax: (503) 986-4174
E-mail: william.j.upton@odot.state.or.us

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List of Abbreviations and Symbols

ALD	Aggregate Land Development Model in SWIM2
ATF	Alternative Transportation Futures Study by the Willamette Valley Livability Forum
BMPO	Bend Metropolitan Planning Organization
CAAA	Clean Air Act as Amended
CAMPO	Corvallis Area Metropolitan Planning Organization
CSS	Cross-Sectional Survey
CT	Commercial Transport Model in SWIM2
CTPP	Census Transportation Planning Package
DASH	Dynamic Activity Simulator for Households
DEIS	Draft Environmental Impact Statement
DEQ	Oregon Department of Environmental Quality
DLCD	Oregon Department of Land Conservation and Development
DTA	Dynamic Traffic Assignment
ED	Regional Economic Model in SWIM2
EIS	Environmental Impact Statement
ET	External Truck Transport Model in SWIM2
FHWA	US Federal Highway Administration
FTA	US Federal Transit Administration
GIS	Geographic Information System
GreenSTEP	Greenhouse gas Statewide Transportation Emissions Planning Model
FHWA	Federal Highway Administration
GHG	Greenhouse Gas
GreenSTEP	Greenhouse gas Statewide Transportation Emissions Planning Model
GPS	Global positioning system
HERS	Highway Economic Requirement System software
HH	Household
HPMS-AP	Highway Performance Monitoring System-Analytical Package
IMPLAN	System of software and data sets for policy analysis
I-O Model	Input-Output Model
ISTEA	Intermodal Surface Transportation Efficiency Act
JEMnR	Joint Estimation Model in R Code
LANL	Los Alamos National Laboratory
LCOG	Lane Council of Governments
LPS	Longitudinal Panel Survey
LUSDR	Land Use Scenario DevelopeR Model
Metro	Portland Metropolitan Area Metropolitan Planning Organization
MWVCOG	Mid-Willamette Valley Council of Governments
MPO	Metropolitan Planning Organization
OCMS	Oregon Congestino Management System
O-D	Origin-destination
ODOE	Oregon Department of Energy
ODOT	Oregon Department of Transportation

OEA	Oregon Office of Economic Analysis
OECD	Oregon Department of Economic & Community Development
OHAS	Oregon Household Activity Survey
OHCS	Oregon Department of Housing & Community Services
OMC	Oregon Modeling Center
OMIP	Oregon Modeling Improvement Program
OMUG	Oregon Modeling Users Group
OMSC	Oregon Modeling Steering Committee
OSUM	Oregon Small Urban Models
OTC	Oregon Transportation Commission
OTP	Oregon Transportation Plan
OTREC	Oregon Transportation Research & Education Consortium
PECAS	Production, Exchange and Consumption Allocation System Model
PI	Production allocations & Interactions Model in SWIM2
PT	Personal Travel Model in SWIM2
RPS	Regional Problem-Solving Program
RTC	SW Washington Regional Transportation Council
RTP	Regional Transportation Plan
RVCOG	Rogue Valley Council of Governments
SIP	Strategic Implementation Plan
SPG1	Synthetic Population Synthesizer (sample) used in SWIM2
SPG2	Synthetic Population Synthesizer (locate) used in SWIM2
SPR	State Planning and Research Program
STEAM	FHWA Surface Transportation Efficiency Analysis Model
PSU	Portland State University
PUMS	Public Use Microdata Sample
RTC	Southwest Washington Regional Transportation Council
RVCOG	Rogue Valley Council of Governments
SWIM1	First generation of the Oregon Statewide Integrated Model
SWIM2	Second generation of the Oregon Statewide Integrated Model
TAZ	Transportation Analysis Zone
TCSP	Transportation and Community System Preservation USDOT grant program
TDM	Transportation Demand Management
TLUMIP	Transportation and Land Use Model Integration Program
TOD	Transit-oriented development
TPR	Oregon Transportation Planning Rule
TRANSIMS	TRANSportation SIMulationS model framework by USDOT
TRANUS	Modeling package for land use and transportation policies
TS	Transport Supply Assignment in SWIM2
TSP	Transportation System Plan
UrbanSim	Urban land use-transportation model
USDOT	U.S. Department of Transportation
VMT	Vehicle miles travelled
WSDOT	Washington State Department of Transportation
WVLF	Willamette Valley Livability Forum

EXECUTIVE SUMMARY

BACKGROUND

State highway departments historically responded to the broad public view that roads are fundamental to a mobile, accessible and prosperous America. Beginning in the 1970s, several mandates dealing with how projects are selected and designed resulted from public concerns about the environmental and social impacts of road construction. Generally, they require an open public process, agency coordination, and alternative solutions. The mandates prescribed the process of considering how transportation infrastructure investments are decided and designed, and specified measures to ensure compliance and coordination.

To address these mandates, changing how to think about providing transportation services is important. Recognizing that land use, economic and transportation decisions and investments are related and interdependent is a big step towards addressing the intent of the mandates. The historic mathematical models used by engineers and planners are inadequate to analyze and predict the multi-dimensional environment of today. New methods that analyze travel behavior, location preferences, market forces, transportation infrastructure, and policies and how they interact with one another are needed.

The Oregon Department of Transportation (ODOT) embarked upon a comprehensive Oregon Modeling Improvement Program (OMIP) in 1994. OMIP was developed to consider how to meet the new rules and regulations. It includes three primary areas of focus:

- It is important to bring together all stakeholders and to provide forums for information exchange and development of new ideas.
- New and expanded modeling tools are required to provide information for efficient and effective-decision making. These tools need to address the number and type of interactions involved to allow analysis of complex relationships of land use, transportation and economics. Results need to be presented in a manner that can easily be understood by a wide variety of users.
- Formal education and training on the need for and application of these tools is an ongoing program.

The Oregon program developed with a five-track approach that is intended to make the modeling program useful and accessible to decision-makers, stakeholders, and practitioners. The five OMIP tracks include Resources, Outreach, Development, Implementation, and Data.

RESOURCES

Establishing and maintaining adequate funding is critical to the overall success of the program. This track is intended to ensure the availability of adequate staffing and resources to implement OMIP and to provide the necessary modeling support to customers at the federal, state, metropolitan planning organization (MPO), and local levels. A large part of the OMIP program is to maximize resources across agency lines. This is accomplished in several ways, including sharing staff, joint contracting and partnership agreements. OMIP is also working to create career ladders within the agencies for modelers and to bring about comparable pay between agencies. Creating an attractive environment for recruiting and retaining employees is one of the most important functions of the OMIP program.

The Oregon Transportation Research and Education Consortium (OTREC) provides an excellent opportunity for collaboration and cooperation among Oregon universities and the Oregon modeling program. Development of an Oregon Transportation Modeling Center at Portland State University will complement and support activities of OTREC, ODOT, the MPOs and others involved in transportation modeling in Oregon.

OUTREACH

A major component to the success of the Oregon program comes from the collaboration and cooperation among everyone involved in program development and application. Several cooperative forums meet regularly to discuss and provide direction on OMIP.

The Oregon Modeling Steering Committee (OMSC) is a consortium of federal, state, and local agencies that provides oversight to the Oregon program. The OMSC regularly provides peer review for a variety of models and model applications. An internationally prominent Peer Review Panel meets regularly to review progress on the Transportation and Land Use Model Integration Program (TLUMIP) and to recommend improvements or modifications. Local peer panels review new model applications around the state. A statewide Modeling Users Group meets regularly to exchange information, solve problems, and provide training. This group includes technical staff from local jurisdictions and state agencies, consultants, and others involved in the day-to-day application of the tools.

Training and formal education are important OMSC activities to develop and implement the OMIP. Training stresses the multi-dimensional nature and connections between land use, transportation, economics and the environment when developing community solutions to transportation issues. Thinking in an integrated manner using integrated tools requires a new level of technical and policy competency. OTREC and the Oregon Modeling Center are emerging as significant opportunities for research, formal education and collaboration to meet the needs of the modeling community. Coordination with academia will provide the necessary skills to implement fully the OMIP initiatives and to assist the evolution of simulation and modeling into public policy analysis.

Information sharing and good communication are important to engage decision-makers and staff to define needs and opportunities. ODOT and the OMSC regularly sponsor an international symposium on Integrated Land Use-Transportation modeling, and modelers throughout Oregon regularly publish papers, make presentations, and meet with interested groups to discuss the Oregon program. Every project that uses transportation analysis is an opportunity to improve communication and understanding of the Oregon modeling program and how it can be used to support good decision-making.

DEVELOPMENT

Modeling in Oregon occurs primarily at two levels - at the local and statewide levels. Locally, most MPOs develop models and provide analysis for their member jurisdictions. ODOT develops models and provides analysis for non-MPO areas and MPOs that require assistance. ODOT also addresses the need for regional and statewide complex integrated models.

The integrated statewide transportation modeling concept was introduced in 1995. Research, clear development and implementation best practices, and documentation are important activities to support development of interactive and integrated modeling tools. Continuing research is also important to expand the Oregon program. Over the past several years, cooperative OMSC efforts resulted in funding for several research projects. The OMSC Applications Subcommittee maintains a list of research topics of interest to OMSC members.

Modeling development and application practices at the MPO and local levels continue to be upgraded and standardized throughout the state. Several documents guide model development and application in Oregon, including:

- Travel Demand Model Development and Applications Guidelines
- Strategic Plan for Development of new Modeling Tools
- Modeling Protocol
- Model Documentation Guidelines

Clear and timely documentation of development of all models in Oregon is a goal of OMIP. It is the intent to conduct peer review of all models developed in Oregon.

A major component of the OMIP program is to have analysis tools available at the statewide, regional, and local levels. Several model development and enhancement programs are on-going to provide the broadest analysis capabilities that are required to support the many levels of decision-making around the state.

The Transportation and Land Use Model Integration Project (TLUMIP) is a significant component of the OMIP. In 1996, TLUMIP was begun to develop and refine interactive statewide and urban transportation and land use models for use in planning and policy analyses at varying scales of geography. The design of the first generation models began with an assessment of the policy and investment issues they should be able to address. The initial model vision was to operate at three geographic levels: statewide, substate and urban area.

The first generation of the statewide integrated model (SWIM1) was completed for application in 2001. It has been used to examine a variety of transportation and land use policy actions, investments and their interactions through time.

Building on the experiences with SWIM1, ODOT embarked on a more extensive second generation model (SWIM2). It uses the PECAS economic input-output activity allocation framework, an aggregate model of spatial development and micro-simulation models of freight and person transport. SWIM2 is a modular, component-based modeling system developed in an open source environment, enabling others to use and contribute to the development of the software. The initial results from calibration of SWIM2 have demonstrated reasonable behavior, consistent with expectations. Further scenario testing will be conducted to increase confidence in the model but the initial indications are positive.

The Joint Model Estimation in R code (JEMnR) is an estimated travel demand model using combined data for all Oregon MPOs. It has been calibrated and is available for use in the MPO areas. Similarly, an Oregon Small Urban Models (OSUM) program is a joint model estimation for urban non-MPO areas in Oregon. OSUM uses data from eight rural counties to do estimation and calibration. Local social and demographic data is used in the joint estimation model structures for both MPO and urban non-MPO areas to create locally validated models. This method has proven to be very cost-effective while providing more robust models for all areas, including Portland Metro.

With the success of TLUMIP, JEMnR and OSUM, planners and decision-makers in Oregon are recognizing the usefulness of modeling tools and analysis to understand the complex interactions of transportation, land use and economics. ODOT staff continues to expand modeling capabilities to meet customer needs. Building on the JEMnR structure, regional models are being developed in Deschutes and Marion Counties. Specialty models are also being developed to respond to special requests. The Land Use Scenario DevelopeR (LUSDR) model is a land use model that was developed to provide modeling support for a long-range urban growth study of a small metropolitan area in Jackson County. The Greenhouse gas Statewide Transportation Emissions Planning (GreenSTEP) model is being developed to support the Oregon Global Warming Commission to develop a statewide strategy for managing greenhouse gas emissions from transportation sources.

IMPLEMENTATION

The Oregon modeling efforts have succeeded because of the cooperative and collaborative efforts of policy-makers and technical staff in Oregon and with developers from around the world. The OMSC provides a unique forum for intergovernmental discussion and debate on federal, state and local issues. Training and education programs cross agency and jurisdictional boundaries and further integrate staff understanding and awareness of land use, economic and transportation interactions. OTREC and the Oregon Modeling Center will be important for formal and continuing education and research to support OMIP.

Decision- and policy-makers are regularly faced with more difficult and complex issues. Traditionally, decision-making occurred in a linear process. Today's analysis tools support and encourage a more iterative decision-making process. An iterative decision-making process encourages policy and technical people to work together to define and address how these complex interactions respond to different policy choices.

Case studies provide an opportunity to test methodologies and technical capabilities of the models, and to provide results. Several case studies are described to show the wide range of applications and how modeling tools and analysis can support decision-making. Consistently, case studies demonstrate the importance of presenting analysis results in clear, non-technical terms in a manner that can be easily understood by a wide and varied audience. Presenting modeling and analysis results as a logical "story" helps users understand the assumptions used in the application and the potential impacts of results.

DATA

Improved data collection and analysis methods are needed to provide coordinated, complete and reliable date for the improved models. A household activity and travel survey was conducted in 1994 by ODOT and the five Oregon and SW Washington MPOs. This resulted in a rich database of activity and travel information for almost 12,000 households. In 1997, ODOT sponsored a recreational/tourism activity survey to address information gaps in recreational/tourism travel and to provide a better picture of recreational travel behavior within the state. Additional data was collected in 2000 for an eight-county area in Oregon to support small-scale regional transportation models being built outside the MPOs.

To consider new data collection methods for behavioral and demographic information, a panel of survey and modeling experts convened in May 2002 to help determine the best method of updating data for the Oregon models. This panel helped set direction for Oregon in establishing new methods of collecting time series data for continued improvements to model development. A major Oregon Household Activity Survey (OHAS) was initiated by the OMSC in 2007 and a comprehensive survey will be conducted from 2008-2011 throughout the state. OHAS will use a core survey with common data elements for all participating jurisdictions, including questions unique to a region. Supplemental surveys can be done for data elements unique to a region.

Several research and data collection projects have been conducted to better assess ways to support freight movement within and through the Oregon economy. These include freight data collection in the Portland area, commodity flow data collection, freight shipper and carrier survey, and a truck intercept survey.

THE FUTURE OF OMIP

With the broad "family of analysis tools" that was developed under OMIP, a major focus for the next several years is to identify new opportunities and ways to apply these tools to address important policy and project development issues. A continued aggressive outreach and communications program, combined with a broad formal education and training program, informs customers and other model users of the tools available and how to use them. The intent continues to be to move decision-makers and practitioners to a new way of thinking about and evaluating public policy and infrastructure investment decisions and to provide the tools to help make increasingly difficult and complex tradeoffs and decisions.

An increased level of understanding and comfort with OMIP tools and processes will maximize their value and ensure their use as the way we do business in Oregon. High profile projects, an aggressive outreach and communications program, combined with formal education and training, will bring the tools and processes of the OMIP to decision-makers and practitioners throughout Oregon. It will also provide a new generation of skilled practitioners to continue to develop and use these new and sophisticated analysis tools.

International symposia will continue to be held to disseminate and discuss the most current advances in integrated modeling. OMIP is also exploring opportunities for European and North American collaborative efforts. Coordination between OTREC and the OMSC will be important to continue research and education in transportation planning, simulation and modeling. An Oregon Modeling Center at Portland State University will coordinate research on integrated and regional models, provide a resource for interns and collaborative projects, and be a focus for distance learning and formal education, communication and a data repository.

The OMIP has been very successful since its inception. The foundation of the program has been that everything is done in a non-mandatory and cooperative environment. Because of the level of coordination and cooperation that has been developed, Oregon has made remarkable strides in all areas of modeling in a very short time period. The cooperative nature of the OMSC is the foundation that will continue to support future growth of OMIP. OMIP will continue to move forward relying on its three components to continued success: frequent and clear communication, consistency, and broad cooperation.

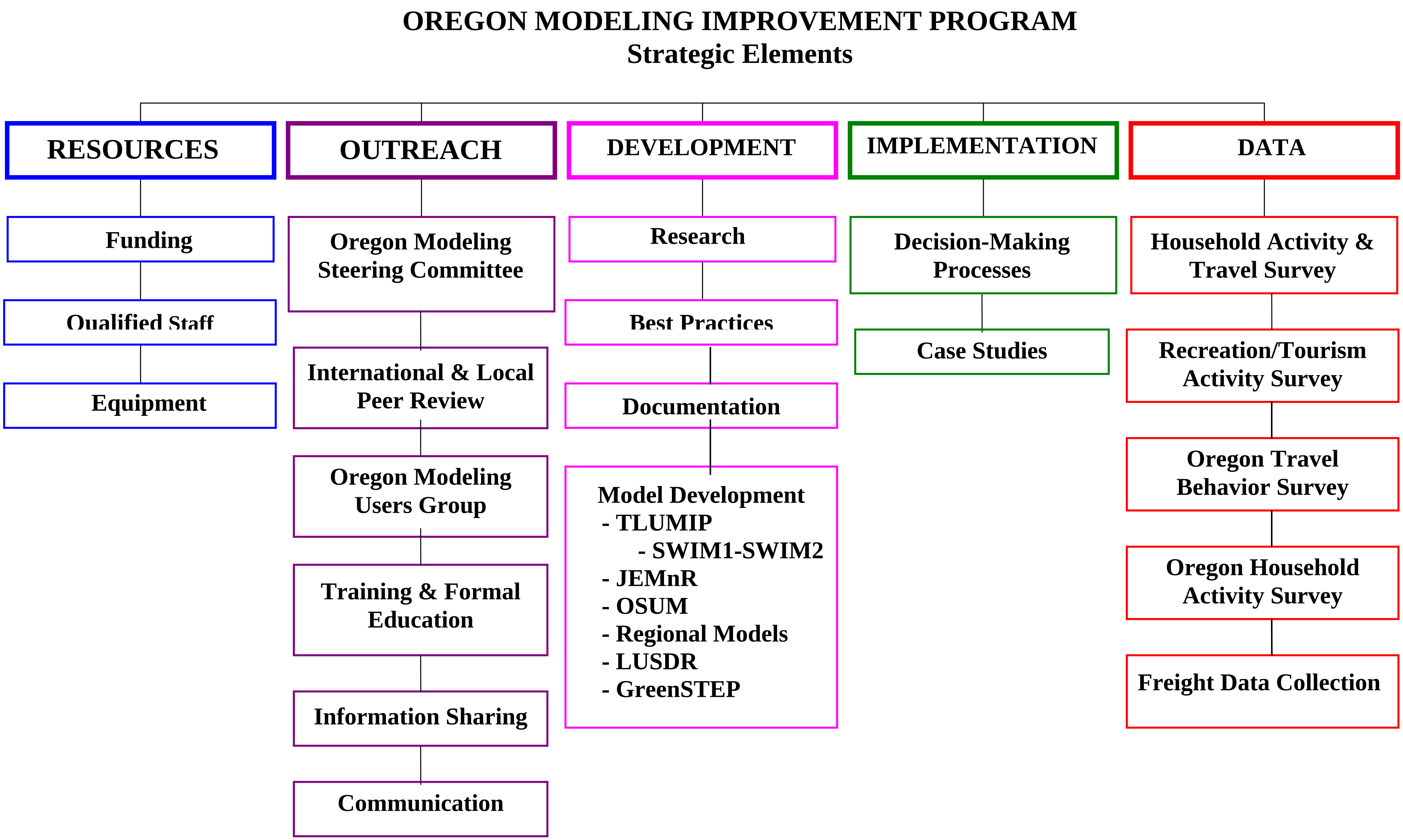


Figure 11. OMIP Strategic Elements

INTRODUCTION

An overview of the Oregon Modeling Improvement Program (OMIP) was prepared in 2002 to document the development and implementation of the OMIP program. This update of the 2002 publication includes the progress of the OMIP program through 2008.

HISTORICAL PERSPECTIVE

Originally, travel demand modeling was performed within the Highway Division of the Oregon Department of Transportation (ODOT). The principal effort was geared toward forecasting demand and testing highway project impacts relative to average daily travel patterns of automobiles. This standard practice is referred to as the Quick Response methodology, or "Black Box" approach. Travel modeling continued this way through the Surface Transportation Act era and the building of the national highway infrastructure.

In the early 1990s, the federal government was interested in integrating land use, transportation, economics and environmental issues. The Federal Intermodal Surface Transportation Efficiency Act (ISTEA) and the 1990 Clean Air Act Amendments (CAAA) were enacted to encourage local and state agencies to do a better job of integrating land use and transportation decisions. The level of analysis and type of information requested from modeling changed nationally in response to these acts. Oregon responded to ISTEA and the CAAA with the adoption of policy documents and regulations, including the Oregon Transportation Plan (OTP), the Transportation Planning Rule (TPR) and the Oregon Clean Air Conformity Rule. The demand on modeling results no longer focused on building roadways, but rather on analysis and discussion of the total system, linking land use and transportation.

Methods to analyze the complex ways in which travel behavior, location preferences, market forces, infrastructure and policies interact have become important to inform policy-makers and to maximize private and public investments. Through regulation, public policies affect land prices and the distribution of uses. Infrastructure investments likewise drive private investment and business location decisions. The ability to simulate land use and travel behavior and to correlate the economic impacts is important for better growth management and more efficient, cost-effective investment in the transportation system.

Like other states, Oregon faces two issues for public policy decision-making for transportation investments. First is the issue of how to evolve the thought process of decision-makers and practitioners into a comprehensive, multi-dimensional manner integrating transportation investments, community values, economic opportunities and livability. Second, modeling practitioners recognize that the standard practices and modeling tools of the past decades are no longer adequate to support an interactive problem solving approach.

Average daily automobile models based on national averages are no longer adequate tools to address these policy issues. Peak hour mode choice models, based on local trip behavior integrated with land use, is the new standard. Consistency in model development is required and it is clear that no one agency can develop a comprehensive program on its own. The key to a successful program is one that involves and maximizes resources across public agency, jurisdictional and private business lines.

OREGON MODELING IMPROVEMENT PROGRAM

ODOT embarked upon the OMIP in 1994. It was developed considering how to meet the new rules and regulations and includes three primary areas of focus. First, it is important to bring together all stakeholders and to provide forums for information exchange and development of new ideas. Second, new and expanded modeling tools are required to provide information for efficient and effective decision-making. These tools need to address the number and type of interactions involved to allow analysis of complex relationships of land use, transportation, the environment, and economics. Third, formal education and training on the need for and application of these tools is an ongoing program. This includes education and training for policy- and decision-makers, as well as improving and expanding staff skills and providing new and expanded career opportunities.

OMIP has a five-track approach intended to make the modeling program useful and accessible to decision-makers, stakeholders, and practitioners. The five OMIP tracks include:

- Resources
- Outreach
- Development
- Implementation
- Data

This report documents the work completed through 2008 in the OMIP under each of the five tracks. Each track is equally important to the overall success of the Oregon program.

RESOURCES

Each metropolitan planning organization (MPO) and ODOT provide transportation modeling services to local jurisdictions and other clients to meet federal requirements and for planning and project development. Each MPO has the responsibility for providing this technical capability to its constituent jurisdictions. In addition to Portland Metro, Mid-Willamette Valley Council of Governments (MWVCOG), Lane Council of Governments (LCOG), and Rogue Valley Council of Governments (RVCOG), Bend and Corvallis were designated MPOs in 2003. Albany is expected to become an MPO after the 2010 Census.

ODOT is charged with coordinating statewide transportation programs to ensure consistency and compatibility of model development and application. It has the responsibility to provide technical assistance to jurisdictions not included in an MPO. ODOT worked closely with the Bend MPO (BMPO) and the Corvallis area MPO (CAMPO) to develop fully functional transportation modeling and analysis capabilities to support the planning activities of these new MPOs.

Agreements are frequent between ODOT and individual MPOs and among the MPOs (especially Metro) to supplement staff or to provide specialized assistance as necessary. All of these programs are coordinated independently with the Federal Highway Administration (FHWA). The relationships among ODOT, the MPOs, and FHWA, especially through the Oregon Modeling Steering Committee (OMSC) umbrella, are excellent and many joint and cooperative programs are undertaken as a result of these relationships. Discussions are ongoing on how other state agencies can make better use of the Oregon range of modeling tools through the OMSC.

Closer coordination among jurisdictions, MPOs, ODOT and other state agencies is also dictated by the expansion of areas of interest. Traditional modeling boundaries are no longer appropriate. Areas of influence have broadened outside of MPO boundaries and many projects cover a broader area than the MPO boundary, including commuter and high speed rail, urban growth boundary analyses, and regional analysis and problem-solving. Statewide and MPO modeling efforts are starting to merge and overlap, requiring greater coordination at the boundary interface. ODOT also works closely with MPOs to analyze regional issues beyond a single city or county boundary. A regional approach to solving complex problems is becoming more commonplace, requiring more sophisticated and specialty analysis tools to assist decision-makers in evaluating future policy options and impacts.

Opportunities for improving the state of transportation analysis in Oregon and maximizing resources are becoming evident. These include:

- Better data collection mechanisms to limit duplication of efforts.
- Compatible and coordinated model development throughout the state.
- Streamlining contracting to ODOT for modeling assistance.
- More comprehensive and complete analyses that cover broader jurisdictional areas.
- Better consistency of data collection and maintenance, and model development and application.

- Integrated efforts to help gain grants or other funding.
- Broader technical and talent base available to all jurisdictions and agencies.
- Larger, more diverse staff that attracts more qualified people and encourages staff synergy.
- Senior and specialized experience spread among modeling groups.
- Better integration of land use and transportation issues statewide.
- More efficient and broader based problem-solving.
- Expanded formal education to build a future generation of skilled practitioners.

Greater cooperation and resource efficiencies have resulted in cost-effectiveness and more integrated programs throughout Oregon. As closer cooperation and coordination continues through the OMSC and among modeling partners, several issues must be kept in mind:

- Local control of modeling is important and must be maintained, in both actuality and perception.
- Different agency and jurisdiction missions and priorities can conflict.
- With management and technical turnover in agencies and local jurisdictions, effort is required to maintain management understanding and continuous support for this complex, multi-year program.
- Close coordination between decision-makers and practitioners is paramount to effective use of analysis tools.

Despite the cooperation among agencies and jurisdictions, resources are a major concern for implementation of OMIP. ODOT and Metro closely coordinate their activities and, through different management structures, work to apply staff and funding resources as efficiently and effectively as they can to address their separate work programs and to support other MPOs. ODOT provides additional support to MPOs through annual agreements. Work loads and staffing in the MPOs and ODOT, however, are often subject to changing local priorities. For example, the focus by ODOT on maintenance and preservation of the existing highway system is greatly reducing the monies available for corridor and other system planning. This directly affects the amount of money available to the ODOT modeling program and MPOs and makes it difficult to manage a long-term program and maintain qualified staff. Budgets are routinely affected by non-modeling issues, such as funding shifts, unforeseen special projects, and projects delayed to address environmental issues. With fewer large planning projects (environmental impact statements, corridor planning) base loads for several MPOs are changing, affecting the core modeling group.

Demand has increased for transportation modeling and analysis as awareness of the value and availability of the broad analysis tools has increased. It has been a goal of OMIP to help jurisdictions throughout Oregon to develop reasonable and effective transportation models, and to provide the technical staff to develop specialty models that address such issues as regional land use and transportation, and climate change. However, with the success in these areas comes greater demand for resources to develop and apply analysis tools. Although demand for these services has increased significantly since 2002, no additional resources have been added to ODOT or MPO programs.

Travel demand modeling, and integrated modeling in particular, are increasingly the way business is done, not only in Oregon but also nationally and internationally. This trend creates an increased demand for experienced technical staff and it is difficult to attract and retain qualified employees to ODOT and Oregon MPOs. To address this staffing need, the OMSC is working with Oregon universities and MPOs to develop programs for internships, distance learning, and degree programs to produce the new modelers and analysts that will develop and apply the wide range of sophisticated tools available to support local, state and federal decision- and policy-makers. Development of an Oregon Modeling Center (OMC) at Portland State University (PSU) will be an important step in producing the resources and coordination necessary for this important statewide program to continue to grow and expand.

Resources continue to be a major focus of OMIP as it strives to build partnerships and to provide adequate technical resources for development and implementation of a wide range of analysis tools.

OUTREACH

An important component of the success of the Oregon program is the collaboration and cooperation among everyone involved in program development and application. Several cooperative forums meet regularly to provide direction and discussion on OMIP. In addition, education and training, information sharing and general communication occurs regularly to ensure the highest levels of understanding and collaboration.

THE OREGON MODELING STEERING COMMITTEE

The success of the Oregon modeling program is attributable to an uncommon level of collaboration and cooperation facilitated by the OMSC. The OMSC mission is to:

- Improve the state-of-the-practice and promote state-of-the-art land use and transportation modeling in the state of Oregon.
- Serve as a consensus forum and support group to coordinate the land use-transportation modeling efforts of federal, state, regional and local agencies.

Five goals guide the OMSC in meeting its mission:

1. Support to Decision-makers: Provide technical information and analyses to support informed decision-making.
2. Communication and Coordination: provide a forum for exchange of ideas, and encourage use of and share current and future technology.
3. Technical Excellence: Support research, development and application of models at the local, regional and statewide level, to improve and expand capabilities, integration and use of transportation models statewide.
4. Education and Training: Proactively promote and educate modelers on the capabilities of transportation modeling as an analytical tool to support decision-making, through coursework, training, symposiums and case studies. Inform policy-makers of analysis as an objective technical support for decision-making.
5. Peer coordination and Support: Serve as a technical and professional support group to members, agencies, local governments, consultants and others to further transportation modeling knowledge and expertise, and to maximize resources.

The OMSC is a voluntary consortium comprised of representatives of local, state, and federal agencies and all Oregon MPOs. Membership includes the key state agencies responsible for land use, transportation, economic and environmental policy development and implementation. The Southwest Washington MPO is a member of the OMSC because of the mutual issues between Vancouver and Portland for transportation and community development.

Membership has evolved over time as agency missions and technical staff interests or capabilities change. In 2008, members of the OMSC include:

- Federal Highway Administration (FHWA)
- Oregon Department of Transportation (ODOT)
- Oregon Department of Land Conservation and Development (DLCD)

- Oregon Department of Environmental Quality (DEQ)
- Oregon Department of Administrative Services-Office of Economic Analysis (OEA)
- Oregon Department of Energy (ODOE)
- Portland Metro (Metro)
- Mid-Willamette Valley Council of Governments (MWVCOG)
- Corvallis Area Metropolitan Planning Organization (CAMPO)
- Lane Council of Governments (LCOG)
- Rogue Valley Council of Governments (RVCOG)
- Bend Metropolitan Planning Organization (BMPO)
- Southwest Washington Regional Transportation Council (RTC)
- Oregon Transportation Research & Education Consortium (OTREC)
- Port of Portland (POP)

The MPOs have been important partners in the program since its inception. In addition to their participation in the OMSC, some have an active role in the Transportation and Land Use Model Integration Program (TLUMIP). LCOG in Eugene hosted the application and testing of the first generation urban area model. Portland Metro contributes substantial experience and results from its pioneering work in activity-based travel modeling.

Among OMSC state agency members, information sharing, education, and opportunities to develop joint projects and integrate agency programs occur regularly. Metro and ODOT work closely with the Port of Portland on freight planning issues, and they coordinate their efforts with parallel work in the Metro and statewide freight models. ODOT and OEA discuss how the statewide model can be used for comprehensive planning and to define how local and state agencies can work together to use it effectively. The DLCD and ODOE have interests in how analysis can support Oregon decision-makers as they grapple with the complex issue of climate change. With OMSC oversight, a major statewide joint data collection effort is underway to update the Oregon Household Activity Survey (OHAS). Metro and PSU are working together on several development projects, including dynamic traffic assignments (DTA) and the Dynamic Activity Simulator for Households (DASH).

The OMSC meets quarterly and encourages presentations to keep members up-to-date on significant statewide projects and topics of interest. Speakers are invited to talk about their programs, and to learn more about the OMSC. Ad hoc subcommittees are formed when major issues or opportunities require oversight or direction, such as the OHAS and climate change subcommittees. The OMSC continues to work to expand capabilities in modeling transportation, land use, economic and environmental issues.

PEER REVIEW

International Peer Review Panel

An internationally prominent Peer Review Panel maintains a significant role in the TLUMIP program. This panel meets regularly to review progress on the models and to recommend improvements and modifications. Their invaluable contributions shaped the TLUMIP work program and heavily influenced the design of the models. TLUMIP has been fortunate to have the same Panel members throughout the program. Members of the Peer Review Panel include:

- David Simmonds, David Simmonds Consulting, Inc., Cambridge, England
- Michael Wegener, Spiekermann & Wegener, Dortmund, Germany
- Frank Koppelman, Northwestern University, Evanston, IL
- Keith Lawton, Keith Lawton Consulting, Newberg, Oregon
- Julie Dunbar, Dunbar Transportation Consulting, Bloomington, IL
- Kim Fisher, Transportation Research Board, Washington, DC

OMSC Peer Review

As ODOT develops models for a variety of clients, it intends to have all models peer reviewed. The OMSC Applications Subcommittee coordinates peer review of models as requested and has organized peer review for the Corvallis, Bend and Rogue Valley MPO models. The expectation is that all models used in Oregon will be peer reviewed to ensure compliance with best practices and adopted procedures.

OREGON MODELING USERS GROUP (OMUG)

A statewide users group includes technical staff from local and state agencies and jurisdictions, consultants, and others involved in the day-to-day application of these modeling tools. Participation on the users group is open to everyone in private business or public agencies to encourage understanding, cooperation, and technical excellence. This group of practitioners from throughout Oregon meets regularly to exchange knowledge and information, solve problems, and provide training. OMUG is an important part of the OMSC program and it is coordinated and managed by the OMSC Professional Development Subcommittee.

TRAINING AND FORMAL EDUCATION

It was recognized in 1994 that Oregon MPOs, counties, and individual cities would require technical assistance and guidance in developing and applying travel demand models to the wide spectrum of their planning and design study needs. Several training programs were developed to impart the necessary modeling skills. Early training focused on the theoretical underpinnings of integrated land use-transportation modeling, while more recent sessions focus on software implementation and data requirements. Education and training on the OMIP program helps staff from diverse agencies and jurisdictions understand the integrated nature of their programs, and the importance of considering the broader range of impacts in analysis and decision-making. On-going training on modeling and modeling applications is provided as credit curriculum and to agencies as cooperative efforts with state universities. Because modeling and analysis are continuing to evolve and improve, on-the-job training is important – both to develop staff and to continue to advance the state of modeling and analysis.

Training and formal education are fundamental activities of the OMSC in the development and implementation of the OMIP. Training stresses a different way of thinking about and solving community and transportation issues, considering the multi-dimensional nature and interconnectedness of land use, transportation, economics, and the environment. Training and education is part of every project, helping policy- and decision-makers understand and effectively apply new approaches to community and infrastructure planning and development.

TLUMIP has expanded beyond the theoretical and practical limitations of current transportation planning practices. The innovative program attempts to create consistent and connected models of land use, transportation, the economy, and the environment. The current generation of TLUMIP models is based upon stochastic simulations of travel and land use in Oregon. The transportation components of these models are based upon innovative research into activity-based travel modeling, as well as unique extensions to freight modeling. The software implementation for such models was built from scratch, and employs a cluster of microcomputers to address the problem.

TLUMIP drew from numerous disciplines not normally encountered in travel demand forecasting. The unique skills are required for almost any scientific or engineering pursuit. Recent advances and techniques from other large scale simulations in meteorology, operations research, natural resources modeling, and logistics are integral parts of the current work. The project team has expanded its skill set and exposure to parallel works in related disciplines, in effect creating a new niche within the larger realm of simulation and modeling.

Much of this same theoretical and practical knowledge is needed to maintain and use the TLUMIP models. Their successful implementation requires an expanded academic foundation. Users of the TLUMIP models will clearly require a diverse skill set and capabilities not presently developed in the transportation planning profession. The emerging Oregon Modeling Center, jointly sponsored and supported by Portland State University and the OMSC, will provide the opportunity to develop appropriate creative academic programs to provide the necessary skills to engineers and planners to fully implement the OMIP initiatives. This joint program will provide internships, distance learning, formal classes, and seminars on emerging technologies and applications. It will continue the simulation and modeling in public policy analysis evolution.

INFORMATION SHARING

ODOT's website (http://www.odot.state.or.us/tddtpau/modeling.html) provides information on OMSC meetings, key contacts throughout the state, research methodologies and findings, and related studies and reports. Technical reports on model development and research are also regularly posted on the website. Minutes of OMSC meetings are posted to share information beyond the OMSC membership.

ODOT and the OMSC sponsored five Symposiums on Integrated Land Use-Transportation Modeling in 1998, 2000, 2002, 2005 and 2008. These Symposia emphasized OMIP and TLUMIP, and related international research and development. These Portland conferences draw a worldwide attendance, and have evolved from presentations on the theory of TLUMIP, through development and applications, and most recently on the next generation of TLUMIP.

Agency staff and consultants involved in OMIP and the TLUMIP programs regularly publish papers, make presentations at professional meetings and conferences, and conduct small group discussions with interested groups. Interest in OMIP and TLUMIP were expressed by the Japanese Ministry of Land, Infrastructure and Transport and the Tokyo Institute of Behavioral Sciences, and by The World Bank East Asia and Pacific Region for modeling in China. Presentations and small group discussions are available for those interested in learning more about the Oregon program.

COMMUNICATION

To make OMIP more than a technical exercise, it has been important to communicate effectively on the availability and value of Oregon analysis tools and applications. The Oregon modeling program has increased awareness of modeling and analysis tools and their capabilities through small- and large-scale applications, general presentations, conferences, publications and brochures. This communication benefits those in Oregon who will use the models for planning and project development, and those outside Oregon who can benefit from the Oregon program's research and documentation. Every modeling and analysis project is an opportunity to improve communication and understanding of the modeling program, and how analysis tools can be used to support good decision-making.

Consistently, the most important lesson learned from the application of Oregon analysis tools is the importance of clear, non-technical information presented in a manner that can be easily understood by a wide and varied audience. Modeling and analysis results must be a logical "story" that helps users understand the assumptions used in the application and the potential impacts of results. The OMIP program provides the Oregon technical community, policy- and decision-makers with new tools and processes that help redefine ways of thinking and problem-solving to be more comprehensive and collaborative. The on-going success of OMIP is its acceptance as the way business is conducted in Oregon.

DEVELOPMENT

Modeling in Oregon occurs primarily at two levels - at the local and statewide levels. Locally, MPOs develop models and provide analysis for their member jurisdictions, and ODOT develops models and provides analysis for non-MPO areas and MPOs that require assistance. ODOT also addresses the overall, statewide need for more complex integrated and regional models.

The integrated statewide transportation modeling concept was introduced in 1995. It is intended to have all Oregon cities, counties, MPOs and state agencies working together, using state-of-the-art transportation analysis tools. These range from sophisticated statewide and MPO models to representative small urban community models. Through the OMSC partnership, the analytical integrity and data consistency of model development and analysis is maintained at all levels. Research, documentation, and clear best practices are all important elements of model development.

RESEARCH

Continuing research is important to expand the Oregon program. Over the past several years, cooperative OMSC efforts resulted in funding for several projects under the Federal Transportation and Community and System Preservation (TCSP) program and the State Planning and Research (SPR) program. The OMSC Applications Subcommittee maintains a list of research topics of interest to OMSC members.

Examples of research projects funded or developed through cooperative OMSC efforts include:

- *Performance Measurements:* Difficulties were identified with how different state policy documents use performance measures. For example, all MPOs have used alternatives to the TPR vehicle miles traveled requirements. Several state documents provide policy direction, such as maintaining the state's economic viability, but reliable and consistent performance measures dealing with policies are generally unavailable. Decision-makers need better performance measures to improve public policy and investments. This research incorporated and built upon recent studies in land use and transportation system multi-modal accessibility measures; economic system sensitivity changes in accessibility; the interactions among land use, transport, and ecological systems; and environmental justice. This research identified and tested transportation plan performance measures that could potentially augment or replace the current TPR requirements. Specific plan performance measures to evaluate transportation systems plans (TSPs) and other policy documents were recommended.
- *Freight survey:* More detailed information on freight movement in Oregon is critical for the statewide model to reflect actual use of the transportation system for this critical economic component. This effort was to obtain information about the quantity and type of goods handled, where goods are going regionally, how they are being carried, and what are the key business factors considered in making shipment decisions.
- *Statistical Analysis of Urban Design Variables and Their Use in Travel Demand Models:* A subcommittee of the OMSC conducted research to understand how aspects of urban design influence transportation choices. From over 100 urban design variables considered, nine

quantifiable aspects of urban design were identified and analyzed. The design variables were evaluated for such things as explanatory power (e.g., auto ownership, mode choice), development difficulty, and ease of data collection. Three co-linear accessibility-related variables were successfully integrated into a single statistically significant variable. The composite variable was tested in both auto ownership and mode choice models. Sensitivity tests were conducted to see how changes in the urban design variable would affect the predicted use of non-automobile travel modes. There were two important results of this research: it defined a way to design variables so that the relative significance of each component is preserved in the composite urban design variable; and it demonstrated that it takes a very large density change to effect even a small change in auto use - only extreme changes have any significant impact. A report was prepared to document the process and findings.

- *Bicycle use and route choice:* PSU Professor Jennifer Dill conducted research into bicycle use and route choice in Portland. Metro and LCOG intend to use data from this research to develop improvements to mode choice and route choice models for the bike mode.

ODOT routinely works with universities to conduct research to support OMIP:

- ODOT funded research at the University of Texas at Austin titled *Towards Behaviorally Consistent Integrated Transport/Land Use Models In Support of Infrastructure Systems Decisions.* The goal of this research was significant behavioral and statistical improvements in integrated transportation/land use modeling methods. The proposed framework incorporated travel demand, location choice, and transport supply decisions in a way that is both accurate and comprehensive.
- ODOT and Metro have several contracts in process or programmed with PSU to:
  - Make improvements to the LUSDR model.
  - Conduct a literature review on how large land use applications are evaluated relative to transportation system impacts. This information will be used as background to develop a manual for modeling procedures for land use changes that impact transportation systems.
  - Update the commercial transport module of the second generation of the Oregon statewide model.
  - Develop a dynamic traffic assignment model.
  - Develop a Dynamic Activity Simulator for Households

BEST PRACTICES

The *Travel Demand Model Development and Applications Guidelines* are intended to support best practice as the yardstick of acceptable practice in Oregon, while simultaneously supporting extending the methodology to advanced or state-of-the-art practices. The specification of model development and application guidelines is formulated in the context of a two-dimensional framework -- region size and model capability.

These guidelines recognize the proper level of complexity of mathematical formulation and level of detail required for a range of sizes. These range from Portland Metro, a region diverse in transportation infrastructure, to the five other Oregon MPOs (with populations exceeding 50,000), and entire regions with population less than 50,000. These are stratified into those in air quality non-attainment and those who are in attainment. Similarly, the level of complexity considers the full range of model complexity from typical or common practice (generally found in most MPOs) through acceptable practice, "best" practice, advanced practice, and finally "state-of-the-art", which often borders on academic research. The travel demand modeling capabilities within the Portland region generally represent advanced practice, with some of its initiatives considered "state-of-the-art".

Modeling practices at all levels continue to be upgraded and standardized throughout the state. The following documents guide model development and application in Oregon:

- *Strategic Plan for Development of Modeling Tools.* The purpose of this plan is to lay the groundwork for the coordinated development of modeling tools at the statewide, MPO and local levels. It promotes cost-effective expenditure of modeling resources by matching the development of new modeling tools with prioritized needs.
- *Modeling Protocol.* The protocol sets requirements for the development and use of the statewide, MPO and local urban area models to ensure that these activities are performed at acceptable professional levels and that modeling products conform to federal and state requirements.
- *Model Documentation Guidelines*. These guidelines respond to the need for clear, thorough documentation to be prepared in a standardized format as a part of all model development projects. The intent is for models to be reviewed for compliance with specific modeling requirements, such as those for air quality conformity analysis.

DOCUMENTATION

Clear and timely documentation of development of all models in Oregon is a goal of OMIP. It is also the intent of OMIP to have peer review of all models developed in Oregon. *Travel Demand Model Development and Applications Guidelines,* developed in June 1995, is under contract to be updated to define the process and documentation for development and application of transportation models in Oregon.

MODEL DEVELOPMENT

A major component of the OMIP program is to have analysis tools available at the statewide, regional, and local levels. Several model development and enhancement programs are on-going to provide the broadest analysis capabilities that are required to support the many levels of decision-making around the state.

Transportation and Land Use Model Integration Project (TLUMIP)

In 1996, ODOT embarked upon TLUMIP to develop analytical tools to help policy makers better understand the complex relationships of transportation, land use, the economy and the environment. TLUMIP was intended to develop and refine an interactive statewide transportation and land use model for use in transportation planning and policy analyses at varying scales of geography. Goals and objectives identified to guide the initial TLUMIP program are included in Appendix A.

Design of First Generation Statewide Integrated Models

The design of the first generation models began with an assessment of the policy and investment issues they should be able to address. The need to evaluate unique Oregon issues, such as urban growth boundaries, influenced the design of the model. Key Oregon policy makers were interviewed to define important issues that the model should address. The study team, with help from the International Peer Review Panel and OMSC members, identified eleven key issues that the candidate models should assess. Table 1 lists these key policy issues and the level of modeling analysis.

The initial model vision was to operate at three geographic levels: statewide, substate and urban area. The statewide model assesses broad policy options and intercity travel and provides the basis for the substate model. The regional substate model gives a finer level of analysis along the major transportation corridors. Finally, the urban model handles the high-resolution analysis of the local impacts of policy decisions and investments. All three model levels address the first five issues identified in Table 1. The next four issues are germane to the substate and urban levels, while the last two issues are considered only in the urban model context.

The program began by assessing the existing integrated land use and transportation models in the United States and abroad. Consensus that existing models were not suited to examine many of the identified key issues was quickly reached. Most existing models operated at the extremes of geographic detail – they were either too abstract or only suited to small area studies. The study team concluded that a series of nested models of activity, location, and travel choice offered the most promise, since it held the best possibility to operate at the various specified geographic levels, as well as reflecting current literature. Unfortunately, no existing model possessed the desired characteristics, so the team decided to pursue parallel model development efforts.

The first of these efforts, UrbanSim, was a dynamic, non-balanced framework of individual choice at the urban level. UrbanSim was designed to operate in tandem with the urban travel models already in use in Oregon. Since developing the urban and statewide geography levels of models overstressed resources, the UrbanSim program was set aside so the team could concentrate on the statewide effort.

After considerable discussion and research, it was decided to build the statewide and substate models using the TRANUS package, an existing modeling framework task. Some functions were carried out in Excel spreadsheets and R.

Table 11. OR Integrated Model – Desired Capabilities to Address Policy Issues

Analysis Issue	Applicable Scale			Required Data	Modeled Response(s)[1]
	Statewide	Substate	Local		
Effect of land supply on land use and location decisions	ν	ν	ν	Zonal area, employment and housing by type, network travel times by mode, exogenous constraints on growth (non-movable businesses, urban growth boundaries).	Changes in residential and commercial land prices, changes in land consumption by category of use, migration of employment.[2]
Effect of congestion on land use and location decisions	☐	ν	ν		Changes in zonal accessibility and its indirect effect on residential and business location choice.
Cumulative effects of retail location choice		☐	ν		Current and lagged changes in land prices and land use in the target and adjacent zones, increased infrastructure cost as a function of increased travel demand, changes in zonal accessibility and destination choice.
Effect of large commercial development on periphery of the growth boundaries	☐	ν	ν		
Effect of land supply on travel behavior	ν	ν	ν	Employment and household supply by zone, network travel times and cost by mode, estimates of the elasticity of trip generation by trip purpose	Changes in trip generation as a function of zonal accessibility and congestion[3], changes in destination choice as a function of changes in residential and business location choice.
Effect of highway capacity increases on travel behavior[4]	ν	ν	ν		Changes in trip generation and destination choice by trip purpose, changes in corridor and systemic network measures[5], changes in travel disutility by trip purpose and area (county, zone group, etc.).
Effect of network connectivity on travel behavior		☐	ν		Changes in trip generation and destination choice as a function of zonal accessibility, changes in network measures for the study area.

[1]Some measures of effectiveness will be applicable for all analyses, such as changes in consumer surplus (for persons) or aggregate changes in transport cost (for freight).
[2]Zonal accessibility is a derived output of the travel model that is fed back into the land use model until user-defined equilibrium occurs; it is primarily a function of zonal density and the level of congestion on the network serving it.
[3]These changes can be measured both in terms of changes for a single zone or group of zones, or systemwide using measures such as changes in vehicle miles and house of travel by area, corridor, trip purpose, mode of transport, etc.
[4]These effects are still not well understood; see TRB Special Report 245.
[5]Includes but not limited to changes in vehicle miles and houses of travel by mode and trip purpose (under congested conditions and total) for the corridor under study, a buffer zone around it, and for the state or substate area as a whole.

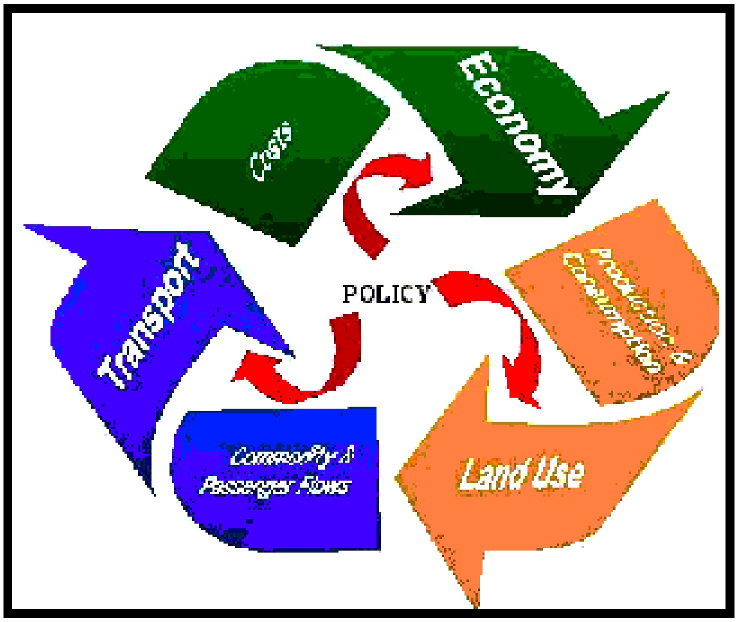
Table 1. OR Integrated Model – Desired Capabilities to Address Policy Issues (continued)

Analysis Issue	Applicable Scale			Required Data	Modeled Response(s)[6]
	Statewide	Substate	Local		
Effect of parking supply on travel behavior		□	ν	Total travel time and cost by mode, employment and household supply by zone, exogenous forecast of parking cost and supply by zone.	Changes In mode choice as a function of parking cost at the destination, lagged residential and business location choices as a function of decreased accessibility and changes in land prices.
Effect of urban form on mode choice		□	ν	Zonal area and density, parking cost and supply by zone, travel cost and time by mode.	Changes in mode choice as a function of destination parking costs and differential travel times and costs, lagged changes in residential and business location choice and attendant changes in trip generation and destination choice.
Effect of rail investment on highway use	ν	□		Rail service and network attributes, rail passenger and freight origin-destination data by mode of access and trip purpose (persons) or commodity family (freight), zonal accessibility.	Truck-rail diversion by commodity group as a function of current and lagged cost and travel time differentials, changes in unit transport cost by mode, passenger mode choice as a function of travel time and cost differential and changes in consumer surplus.[7]
Effect of changes in the demographic composition of Oregon	ν	ν	□	Changes in household composition by time period, estimates of trip generation elasticity by household type.	Changes in trip generation by area and household type[8], changes in the demand for employment by businesses, inducement

[6]Some measures of effectiveness will be applicable for all analyses, such as changes in consumer surplus (for persons) or aggregate changes in transport cost (for freight).
[7]Estimation of passenger patronage will not be possible using the Phase II model. Exogenous estimates of modal shifts can be accommodated but not explicitly modeled in the statewide model.
[8]Three household classifications based on income (low, medium and high) have been specified for the statewide model, based upon data availability.

The first generation of the Statewide Integrated Model (SWIM1) simulated land use and travel behavior mathematically and relied on various data, from business sector exports to transportation operator characteristics. This statewide model was a valuable complement to regionally focused MPO models. Figure 2 represents the complexity of the interactions and the interdependence of economics, land use and transportation.

Figure 22. Schematic Representation of the First Generation Statewide Model



In Figure 2, the model starts with an input-output economic model of commodities by standard industrial code in dollars. The amounts correspond to the production and consumption of goods and services. As the model distributes these goods and services regionally, it looks for available land or locations for the production (industry) and consumption (households) of goods and services. This is the land use or land allocation portion of the model. After the production and consumption of goods and services are located within the model area, it then generates the travel required for production and consumption of these goods and services. This generation of movement represents vehicle and freight trips on the system. These trips are assigned to travel the system via the shortest path possible. As the number of vehicles and roadway congestion increases, so does the cost of using the roadways. These cost increases are then fed back into the economic model where the model reiterates until there is little change in these costs. At this point, the model advances to the next time period and continues operating until it reaches a predetermined forecast year. Policies can be introduced at any point for testing.

SWIM1 was used in five major state and regional policy applications within Oregon since 2001 (see Implementation). It demonstrated the overall concept validity and has been a useful tool for planners and policy-makers.

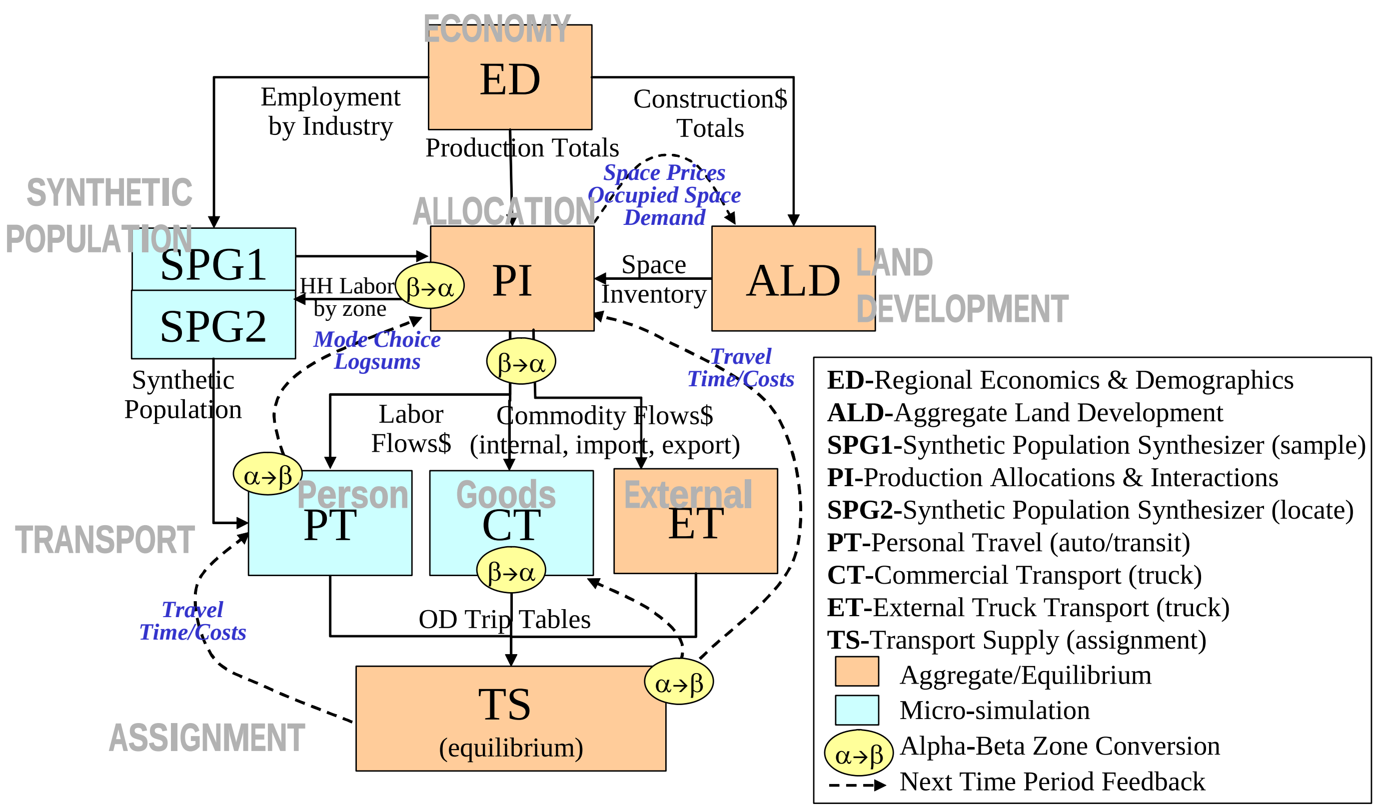
Second Generation Statewide Integrated Model

Building on the experiences with SWIM1, ODOT embarked on a more extensive second generation model (SWIM2). The goals and objectives established for the second-generation model are included in Appendix B.

Modeling requirements for SWIM2 were thoroughly reviewed and a new model specification developed. This underwent extensive revision through the peer review process. The original plans for the second generation model were very ambitious and eventually were scaled back to meet the timelines for anticipated analysis.

SWIM2 is a modular, component-based modeling system developed in an open source environment, enabling others to use and contribute to the development of the software. The model structure is shown in Figure 3. It uses the PECAS economic input-output activity allocation framework, an aggregate model of spatial development and micro-simulation models of freight and person transport.

Figure 33. SWIM2 Model Structure

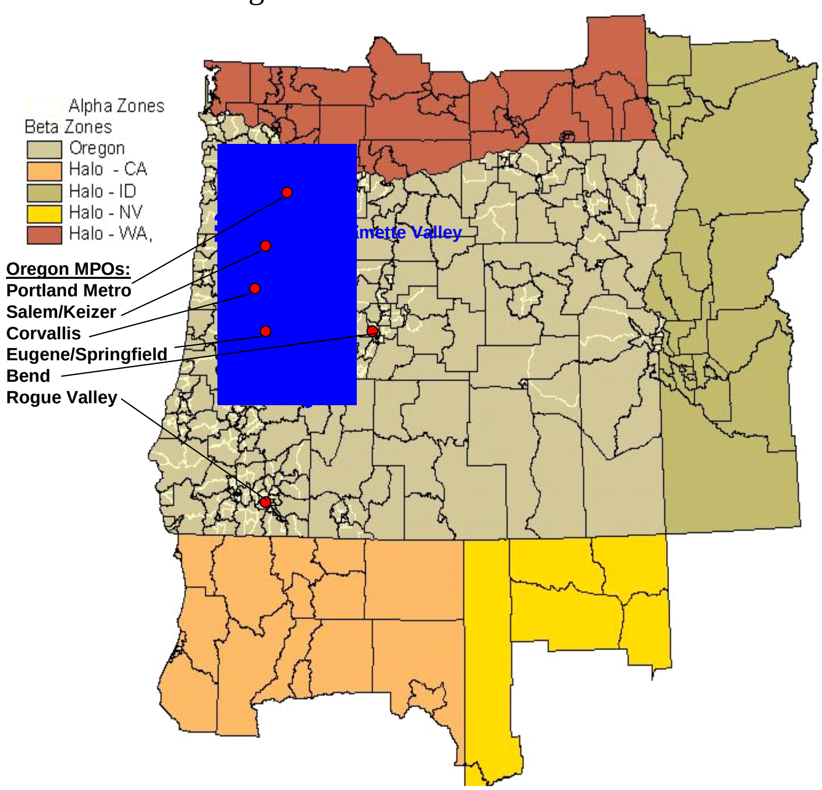


The top half of Figure 3 shows a spatial activity model, which starts with a regional economic model (ED). The model-wide construction and industry activity totals are then allocated to zones using a spatial input-output model that respects economic relationships among businesses and households, and responds to price signals and travel costs. This includes 3000 zones in Oregon and surrounding counties in adjacent states. Floor space development is allocated in the Aggregate Land Development (ALD) model and industry activity is allocated in the Production Allocations & Interactions (PI) model. PI is an earlier version of the PECAS model, while ALD is an aggregate land use model. A synthetic population is then developed in the Synthetic Population Synthesizer (SPG) consistent with the employment totals. The assigned home and work locations are assigned consistent with labor flow patterns from PI. It should be noted that there is currently no feedback to the economic model. Therefore, the regional economic activity is not impacted by changes in land use and commodity prices resulting from location decisions and travel costs in the rest of the model.

The bottom half of Figure 3 shows the transportation components of the SWIM2 model. They include micro-simulation tour-based models of personal travel (PT) and commercial/goods movement (CT), and a simple model of external truck travel (ET). PT simulates daily activity patterns and resulting trips for over five million people in the study area (from SPG's synthetic population). CT translates the flow of goods (in dollars from PI) into vehicle trips, combining shipments for a typical weekday. The resulting vehicle trips are assigned to the network using a standard equilibrium approach.

SWIM2 operates using a system of geographic zones that cover the entire state of Oregon and a 'halo' of about 50 miles, including counties immediately adjacent to the state boundaries. This system is shown in Figure 4.

Figure 44. SWIM2 Model Area



Calibration Process. Calibration of an integrated model is significantly more challenging than a standard transportation model. The addition of components covering the economic and land use dimensions lead to a large number of potential calibration targets, not all of which are consistent and typically do not fall on a single year. Some inputs, such as base-year floor space inventory, are not available in the real world so must be synthesized for use in the model. Integrated model calibration is an iterative development process, where all models are incrementally increased to a mutual level of accuracy in each cycle, avoiding throwing any one module and its downstream effects too askew.

Given these issues, more emphasis was placed on testing the model's overall behavioral response through sensitivity tests of likely policy applications rather than focusing on a tight match to any set of static target data. As an extension of the formal calibration of SWIM2, two policy sensitivity tests were made to assess the model's behavioral response to increasing highway capacity and increasing travel costs. The input in each scenario consisted of an unrealistically large change to delineate clearly the direction of the impact on the rest of the system resulting from this type of action. These "proof-of-concept" tests will reveal how the model responds to changes in policy levers built within the model.

Preparation for Model Application. The sensitivity testing and final phases of model calibration occurred at the ODOT offices as part of the transition of SWIM2 from the development team to the Agency staff. Once the model was ready for performance evaluation, a strategy was formed to move from the development phase to model application. Several tasks were identified as necessary preparation for real-world policy applications:

- **Training**. Agency staff needs to be trained on how to use the model. Scenario set-up and familiarity with the graphic user interface is necessary for staff to run the model independently. This training will be provided as the team works through the evaluation scenarios. Continuing support will be needed once the model is in use.
- **File Management**. File organization and archiving are very important aspects of modeling. The model produces 60 gigabytes of data with a 30-year run, so efficient management of disk space is important. As issues are identified, improvements will be made to the folder structure while conducting the scenario tests to improve user-interface.
- **Model Variability**. A solid understanding of the model responsiveness to specific policy-levers and variability due to the micro-simulation modules is important before starting policy application. The test scenarios are designed to reveal model responsiveness, identify performance issues and push the model beyond likely real-world changes to understand the limits to the performance of the model.
- **Output Processing**. Given the large amount of output data, a major task associated with the test scenarios is creating automated scripts to summarize model output and produce tables and graphs in a form useful for reviewing, interpreting and reporting model results. This should also allow disk space savings if the summaries can replace the need to keep full model outputs. It currently requires 5-10 megabytes for a 30-year model run. At this point, most of the output is processed using the R programming language. Some functionality and use of other data processing tools will be added to the model in the future.

Calibration Results. Development and calibration of SWIM2 is judged a success based on the testing done so far. The direction of predicted changes as well as relative magnitude pass the initial test of reasonableness, but further investigation is needed. Several successes have been realized in this modeling work.

- The model runs over time covering 30 years and accommodating "extreme" changes in the system.
- Including a model halo area around the state border takes on a useful role in representing the regions surrounding Oregon, as was intended.
- The effort needed to obtain computing capability was worth the time and expense to the state.
- Careful consideration and effort spent on sound file structure, naming conventions, and strategic organization was helpful to making progress throughout the scenario test phase.

Key to the successful use of the model was conducting analysis by using a base reference scenario. It is much easier to interpret and communicate analytical results by comparisons with a constant base scenario. Creating a valid reference scenario requires a lot of time and data collection, but saves resources in the long-run.

Clearly, there are many challenges that remain. In addition to evaluating and refining the model through evaluation of additional sensitivity tests, there are several implementation challenges:

- Model runtimes are longer than desired. A 30-year run takes nearly five days to complete and outputs consume 60 gigabyte of disk space.
- Added to the run time is time required to process the model output into summary tables and graphs, taking an additional eight hours.
- Convergence became more time consuming in the later years in the more extreme high cost scenario, revealing the potential for longer runtimes for some analyses.
- The model produces a large quantity of information. This must be reviewed and analytical conclusions made quickly to meet the deadlines of policy analysis. A methodical, careful approach to automating the production of data summaries from the model is critical to building an understandable, descriptive story of what the model is forecasting in a timely manner.

Overall, the SWIM2 model has demonstrated reasonable behavior, consistent with expectations. The reasons for confidence in the results and the appropriateness of some further adjustments were identified in this testing as intended in a calibration exercise. This is judged to have been essential as part of taking SWIM2 from development into use in forecasting and assessment. Further scenario testing will be important to increased confidence in the model, but the initial indications are positive.

Joint Estimation Model in R Code (JEMnR)

ODOT, Metro, LCOG, MWVCOG and RVCOG used information from the *1994/1995 Travel Activity Survey* to jointly estimate a travel demand model for all MPO areas within Oregon. JEMnR incorporates the unique characteristics of each MPO into data sets that others can use. Localized data reflects how Oregonians respond in Oregon situations – Eugene/Springfield for bicycle/pedestrian data, Salem for government data, and Portland for high-density urban area data. This effort combines the best of all models into a model more robust than any single existing model.

JEMnR includes destination-choice considerations, e.g., certain income levels are more likely to go to job A than job B. Bringing in mode choice allows pricing considerations. Various income levels value time differently, so this can be considered in road pricing analyses. The explicit value of multi-modal accessibility is included in the model. Other models have depended on auto accessibility but this uses all modes, weighs them, and the value of these modes becomes part of destination choice.

The joint estimation was developed in the R open source dynamic code language. It brings best modeling practices to all areas of the state and saves development cost and effort by eliminating duplication of efforts. Because the model structures are all consistent, peer review efforts are simplified. The JEMnR was validated in 2001.

Building on the JEMnR structure, ODOT developed fully operational integrated models for the new MPOs of Bend and Corvallis areas.

Oregon Small Urban Models (OSUM)

Most of Oregon is outside an MPO and many local jurisdictions cannot afford to build models to analyze their infrastructure needs and opportunities. To address this need, a joint estimation model was developed for urban non-MPO areas. It uses local data from eight Oregon rural counties to do estimation and calibration. This process is broadly applied to replace individual city models in rural areas. It provides an effective and more efficient method of modeling with greater sensitivity for smaller jurisdictions. Several prototype rural models were also estimated to provide cost-effective modeling tools for areas outside MPOs.

Regional Models

Deschutes County Model

TPAU is working with Deschutes County to develop a new travel demand model to be used in preparing an update of its TSP. The outcome of the project will be a travel demand forecasting model for the County that can be used to support the TSP update. The County model is being developed by TPAU, with the County and ODOT Region 4 staff providing data support. The model uses the JEMnR structure, extending the Bend MPO structure to the rest of the County. A total of 972 zones are used in the model structure. The Bend MPO model and the Redmond model structures are mirrored in the County model. Part of Crook County to the east and Jefferson County to the north is included in the model.

Marion County Model

Initial work on the Marion County Model started in 2003. The goal of the project was to develop an intercity vehicle travel model for Marion County that has all the components needed for transportation planning for Marion County, the Mid-Willamette Valley Council of Governments, and cities in the County. The model was to take advantage of local household travel data and origin-destination data from the 1994-1995 survey, thus minimizing the use of aggregated and synthesized factors and parameters. The model was to be built so that forecasts would be sensitive to the transportation and land use policy questions of interest to the County. This includes how growth of the cities in the County will affect traffic volumes and how road and highway projects would affect travel patterns. The model infrastructure was developed in 2003 but further development was set aside until 2004. TPAU is in the process of updating the modeling structure and moving forward with development of the Marion County model.

Specialty Models

With the success of TLUMIP, JEMnR and OSUM, planners and decision-makers in Oregon are recognizing the usefulness of modeling tools and analysis to understand the complex interactions of transportation, land use and economics. ODOT staff continues to expand modeling capabilities to meet customer needs, and specialty models are being developed to respond to special requests.

Land Use Scenario DevelopeR (LUSDR)

The impetus for the development of LUSDR was to provide modeling support for a long-range urban growth study of a small metropolitan area in southern Oregon. Land use models are generally recognized as useful tools for forecasting land use inputs to transportation models and for analyzing the land use effects of transportation projects. Unfortunately, the complexity of most land use models gets in the way of their widespread use by planning agencies. LUSDR is a land use model that incorporates most of the land use behavior and policy sensitivity desired in a land use model and yet has a simple structure and manageable data requirements.

LUSDR operates at the level of individual households and employment establishments and microsimulates location decisions of land developments. The model produces a synthetic population of households having the attributes of size, workers, age-of-household-head, income, dwelling tenure, and dwelling type. Households are packaged into residential developments. Employment is calculated from workers and allocated to economic sectors, employment establishments, and business developments (e.g. shopping centers, office parks, etc.). Residential and business developments are allocated to zones using an iterative process that identifies candidate zones based on land availability and plan compatibility, chooses zones using a location model, and reconciles land supply and demand in each zone through a bidding process.

Although the model application influenced the design of the model, it did not establish constraints limiting the applicability of the model to urban growth studies. LUSDR may be used to provide land use forecasts for transportation modeling studies, and may be run in a connected manner with a transportation model to support a variety of integrated modeling studies.

What sets LUSDR apart from other land use models is its support for strategic planning and the assessment of uncertainty and risk. LUSDR demonstrates the value and practicality of implementing land use models as stochastic microsimulations. The model explicitly addresses uncertainty and supports a more realistic strategic planning approach. Consideration of the tradeoffs between modeling completeness and model comprehensiveness resulted in a model that runs quickly and addresses the most important land use behavioral elements. The approach also permits land use models to be built with a modest amount of data.

LUSDR is on the way to becoming a standard model in Oregon's toolbox of models. It will enable modelers to improve land use forecasts for transportation modeling and will provide useful modeling support for land use and transportation planning studies. In the simplest applications, it will assist local planners with developing the long-range forecasts that are used for transportation modeling and other studies. Even if a consensus process is used to get agreement on a final forecast, LUSDR can help by producing a set of plausible alternatives that are consistent with comprehensive plan regulations and market behavior as a starting point for discussions.

For more complex integrated land use and transport studies, LUSDR will be coupled with an urban travel model to assess the effects of proposed transportation system changes on urban development patterns. LUSDR produces the transportation analysis zone (TAZ)-level population and employment inputs required by transportation models, and it uses transportation model outputs to calculate the accessibility and travel exposure variables used in its location model component. LUSDR and the transportation model can be run iteratively through time, passing this information back and forth to simulate the effects of land use and transport interactions.

LUSDR will also be used to support a risk-assessment approach to transportation and land use planning. It is helpful in identifying the magnitude of transportation problems and the relationship between land use patterns and transportation problems.

The following enhancements are planned for LUSDR:

- Develop housing compositions for each interim model year from demographic forecasts.
- Keep track of an inventory of developed space over time - allocating household and employment establishment demand to existing space and then creating new developments to accommodate the excess demand.
- Run LUSDR and the regional transportation model in a connected fashion through time.
- Incorporate densification and redevelopment into the model.
- Model the additions to urban growth boundaries incrementally rather than as long-range aggregate amounts.

Greenhouse Gas Statewide Transportation Emissions Planning Model (GreenSTEP)

ODOT is developing the GreenSTEP model for use by the Land Use and Transportation Subcommittee of Oregon's Global Warming Commission to develop a statewide strategy for managing greenhouse gas (GHG) emissions from transportation sources. The existing set of transportation, land use, and emissions models used in Oregon cannot address the range of scenarios that need to be tested in the amount of time available. Existing models can address transportation and land use interactions more thoroughly than GreenSTEP will be able to do, but these models take too long to run and do not address all the factors of interest to the Subcommittee.

GreenSTEP will be used to estimate the effects of a number of factors on GHG emissions, including relative amounts of urban and rural development, metropolitan and other urban area densities, amounts of metropolitan area transit service, highway capacity, vehicle fuel efficiency, use of electric vehicles, fuel costs, other vehicle charges that may be levied, carbon content of fuels, and carbon production from electrical power generation. Design objectives include making travel forecasts be sensitive to forecasted changes in age demographics. It is expected that the rate of future travel growth will be affected by the aging of the population. For example, travel of the baby-boom generation will decline as they retire and leave the work force. GreenSTEP must also address the entire state but do so on a regional basis to be responsive to regional differences. Because it is expected that the strategies developed for metropolitan areas will be different from those developed for other urban and rural areas, the model needs to be able to distinguish between these types of areas.

The model needs to be able to be run in minutes rather than hours so that a number of iterations of scenario development, modeling, and analysis can be accomplished in a short timeframe. It needs to be operational quickly so that a number of strategies can be evaluated to help develop recommendations. The Commission has about six-months to develop recommendations to be considered in the 2009 Oregon Legislative Session.

The OMSC established a subcommittee to serve as a resource/peer review panel for development of the GreenSTEP model. Following the 2009 Legislative Session, this subcommittee will begin to address how to incorporate elements of the GreenSTEP model into all Oregon models to make them more sensitive to address GHG issues at all levels of planning.

IMPLEMENTATION

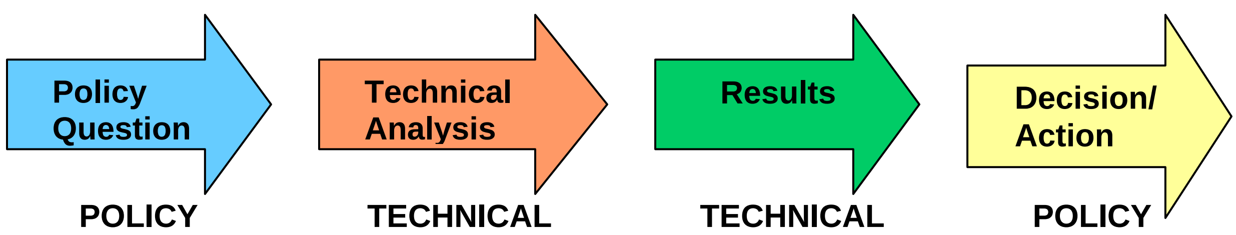
The Oregon modeling efforts have succeeded because of the cooperative and collaborative efforts of policy-makers and technical staff in Oregon and with developers from around the world. The OMSC provides a unique forum for intergovernmental discussion and debate on federal, state and local issues. Through model application projects, policy-makers and technical staff work together and with the broader public to develop and define the complex questions, evaluate the probable results of different alternatives and actions, and make difficult choices and decisions to maintain a livable Oregon. Lessons learned from application of the modeling tools and analyses enable OMIP to continue to refine and improve the overall program.

DECISION-MAKING PROCESSES

Decision- and policy-makers are regularly faced with difficult and complex issues. Elements are integrated and there is often a complex interaction of issues. They must balance among land use, economic development, housing, transportation and other issues. Their constituents are often sophisticated, and consistency and legal sufficiency are becoming more important. The process of decision-making has become as important as the data upon which the decision is based.

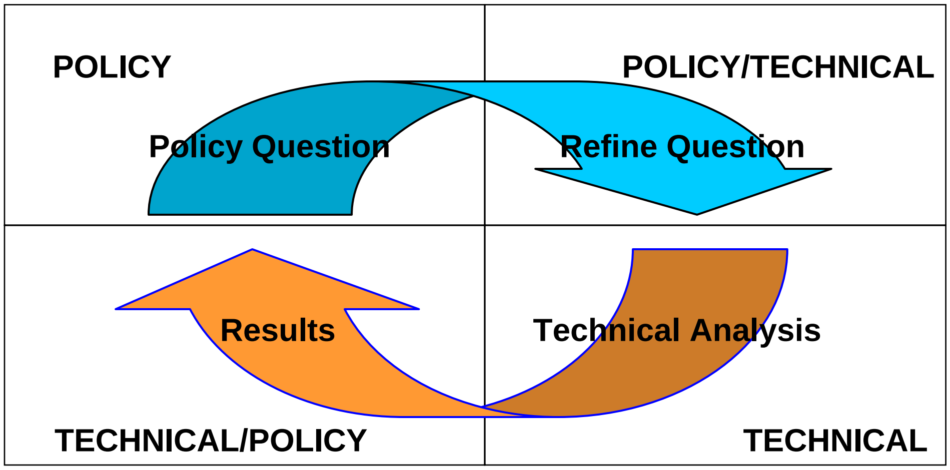
Traditionally, decision-making occurred in a linear process. The policy or decision-maker asked the question, technical staff conducted analysis and provided results, and the decision-maker took action or made a decision (Figure 5).

Figure 55. Linear Decision-Making Process



Today's analysis tools support and encourage a more iterative decision-making process. During applications of the analysis tools, how the question is asked is important. What decision-makers really are interested in is often different than the question they ask. It is important for technical staff and decision-makers to work together to clearly define the question. Technical staff can then decide the appropriate analysis tools to provide analysis and information. Results must be presented in a simple and easy to understand manner, and the technical staff and decision-makers again work together to analyze the results. If the results raise additional questions, the process is repeated to provide additional information (Figure 6).

Figure 66. Iterative Decision-Making Process



The analysis tools developed in OMIP help decision-makers consider and evaluate how issues interact. They help answer complex questions, such as:

- How do investments affect development patterns?
- How do investments disperse population and jobs?
- How do people respond to different policies?
- What futures will result from the decisions made today?

CASE STUDIES

Case studies provide an opportunity to test methodologies and technical capabilities of the models, and to present results. They also provide a public forum for discussions on policy issues and how these tools can help decision-makers in the future. It is important that modeling tools be developed that provide accurate and reliable information. It is just as important that decision-makers understand the potential of these tools and use them to explore public policy issues in a multi-dimensional and comprehensive manner. The importance of presenting analysis results in clear, non-technical terms in a manner that can be easily understood by a wide and varied audience cannot be overstated. Presenting modeling and analysis results as a logical "story" helps users understand the assumptions used in the application and the potential impacts of results.

UrbanSim

The UrbanSim prototype model was applied to a case study in Eugene-Springfield, Oregon. The case study was designed to test the model for performance (longitudinal calibration) and to assess how it worked over time. A simulation was conducted from 1980 through 1994. Considerable work went into the development of the dataset and associated calibration targets. Developing the 1980 dataset almost two decades later proved to be a formidable challenge.

While LCOG could provide some GIS coverage from that period, a large amount of manual data processing was required. Most parcel data did not contain the year the buildings were built or their commercial square footage. There was some mismatch between parcel boundaries between 1980 and 1994. Most of these data problems were overcome using manually generated data.

The case study results provided useful insights into the model behavior over the historical period of the calibration. The simulated 1994 values of key variables of population and employment achieved fairly high correlation and goodness-of-fit measures. On the other hand, the model results showed considerably lower ability to reproduce the observed changes from 1980 to 1994. The corresponding correlation and goodness-of-fit measures were quite low. Extensive sensitivity testing of the model was performed to evaluate the behavior of the model. Simulated annealing techniques (smoothing results to compensate for variability in raw data) were used to search for coefficient and parameter values capable of matching the calibration targets. A detailed review of the longitudinal calibration results can be found in *Waddell, et al*. (2000).

SWIM1 Model

Willamette Valley Livability Forum

The Willamette Valley Livability Forum (WVLF) facilitated and coordinated a long-range look at the future of land use and transportation in Oregon's Willamette Valley. The WVLF is a voluntary organization of local governments, MPOs, business and citizen groups, and state agencies formed to promote dialog and recommend actions on regional land use and transportation issues. In 1999, the Forum initiated a long-range, comprehensive, regional look at the future of land use and transportation in the Willamette Valley. This effort brought together the following three innovative analytical modeling efforts. The leaders of these studies were partners in the WVLF project:

- Environmental effects of alternative land use futures by the Pacific Northwest Ecosystem Research Consortium, a consortium of the U.S. Environmental Protection Agency, Oregon State University, University of Oregon, and University of Washington.
- Economic effects of alternative land use futures on the farming and forestry industries and public infrastructure by the Willamette Valley Alternative Futures project, a collaborative research study coordinated by the 1000 Friends of Oregon.
- Economic, land use and transportation effects of alternative land use and transportation policies by ODOT and the OMSC for the Alternative Transportation Futures (ATF) project.

The ODOT/OMSC modeling project was the first application of the integrated statewide transportation and land use model. The ATF project was funded by a TCSP grant from the U.S. Department of Transportation. An ATF Steering Committee provided direction for development of scenarios to be modeled. Eight transportation and land use scenarios were modeled. The scenarios with their respective policy variables are summarized in Table 2.

Table 22. Willamette Valley Livability Forum Scenarios with Policy Variables

Scenario	**Policy Variables**			
	Road Network	**Transit Network**	**Mileage Tax (TDM)**	**Land Use**
No Action (reference scenario)	No major improvements	No major improvements	No major programs	***Historical Trend***
Highway Emphasis	***Major improvements***	No major improvements	No major programs	***Historical Trend***
Transit Emphasis	No major improvements	***Major improvements***	No major programs	***Historical Trend***
Mileage Tax Emphasis	No major improvements	No major improvements	***Major program***	***Historical Trend***
Compact Development Emphasis	No major improvements	No major improvements	No major programs	Plan Trend
Hybrid 1	***Only rural improvements***	***Major improvements***	***Graduated Mileage tax- 10¢ to 20¢***	***Plan Trend***
Hybrid 2	***Moderate improvements-urban & rural***	***Moderate improvements***	***Graduated mileage tax-5¢ to 10¢***	***Plan Trend***
Hybrid 3	***Moderate improvements - urban & rural***	***Moderate improvements***	No Major Programs	***Historical Trend***

The scenarios vary by land use, road networks, public transit networks and mileage tax (transportation demand management). Five scenarios were chosen to test the responsiveness of land use and transportation patterns to various public policies. The scenarios do not represent proposals but were chosen to represent a range of possible policy types. The objective was to identify scenarios with clear differences and variance from the reference scenario in only one respect to facilitate the evaluation. After evaluating the five scenarios, the ATF Steering Committee defined two additional scenarios that blended elements of the five policies to assess their aggregate effects. An eighth scenario was defined as part of a separate project and blended policies in a third hybrid combination.

To focus the statewide model outputs, the WVLF ATF Steering Committee identified the following evaluation measures:

- Distribution of growth in households within the Willamette Valley and surrounding regions.
- Distribution of growth in jobs within the Willamette Valley and surrounding regions.
- Changes in per capita passenger and vehicle miles traveled in the Willamette Valley.
- Changes in per capita passenger and vehicle hours traveled in the Willamette Valley.
- Changes in passenger and vehicle travel times in the Willamette Valley.
- Changes in auto and truck speeds on urban and rural freeways and arterials in the Valley.
- Changes in auto travel times between selected Willamette Valley cities.
- Emissions from vehicles in motion in the Willamette Valley.
- Changes in residential and industrial/commercial land prices in the Willamette Valley.

A summary of the more significant modeling results from this analysis includes:

- Congestion will increase and vehicle miles traveled per person will decrease.
- The model assumed that the Willamette Valley population would double by 2050. With this projected population increase, even if major investments are made in highways and public transit, travel delay and traffic congestion will increase. Passenger vehicle miles traveled decreases for all scenarios because of this increased congestion. Even so, the transportation policies chosen today can make a difference in how the transportation system works in the years ahead. For example, the increase in travel time is significantly less for the three hybrids.
- Of the policy choices modeled, city-to-city traffic congestion increases the least when the highway and transit infrastructure expansion is coupled with taxes to reduce demand. Over the 50-year period, Hybrids 1 and 2 result in the smallest increases in average travel time. Hybrid 3, which excludes the mileage tax, results in a significantly greater increase in average travel time over the other Hybrid scenarios. The Highway scenario, with no public transit expansion, has the greatest increase in travel time of all scenarios tested.
- The policy effects are different for trucks than for passenger vehicles. Truck travel times increase more under all scenarios. Moreover, truck travel time increases are mitigated more by highway improvements than are passenger vehicle travel time increases.
- There is much inertia in the current system.
- Regional growth varies little among scenarios. It takes major policy shifts over a long time period to effect significant change because development patterns and travel behavior change very slowly. Modeling shows that, even after projects are constructed and in use, it takes years for them to manifest themselves into different land use patterns and travel levels.
- Substantial policy shifts can alter overall growth of the Willamette Valley, but due to geographic circumstances and local policies, impacts are greater at the local level than at a regional level.
- The hybrids show more pronounced differences because of the combined economic, land use and transportation elements. It should be noted that the future year population was fixed, constraining the distribution around the state responding to the various economic, land use and transportation variables. Realistically, some population migration out of the study area would occur, responding to the policy variables applied.
- Where people and jobs locate is affected by several elements:
    - Transportation improvements and location - Highway expansion decentralizes both jobs and housing, while transit expansion centralizes jobs and decentralizes housing. Highway expansion tends to keep growth within the Willamette Valley, while transit expansion and a mileage tax tend to move some growth to areas outside the Valley. Increased mobility by any mode increases the population of metropolitan fringe areas and neighboring cities.
    - Supply of land, which affects land price - Strong urban growth boundaries influence land use more than they do travel. The Compact scenario constrains the availability of land to develop, increasing land prices. As a result, land prices within metropolitan areas increase, directing more development to smaller cities and outside the Willamette Valley. This scenario also increases city-to-city and longer distance travel. Hybrid scenarios increase the compact scenario effects - the land price push combined with the city-to-city mobility pull increases the population shift to smaller cities.

- Transportation costs - Mileage tax increases private vehicle costs in the Willamette Valley and decreases the overall amount of travel in the Valley. It shifts more development outside of the Valley where there is no tax, offsetting some travel reductions within the Willamette Valley.

- Growth in areas outside the Willamette Valley is greatest for scenarios that restrict land supply and impose taxes in the Valley (Hybrids 1 and 2). Adding improved mobility further reinforces movement out of the Valley. The area south of the Willamette Valley in the I-5 corridor experiences the greatest growth as a result of Hybrid scenarios 1 or 2.
- Transit ridership increases with increases in transit infrastructure, mileage taxes, and restrictions on highway expansion. Transit service as a percentage of total trips increases most significantly relative to strong investment in public transportation and mileage taxes.

It is clear that different policy choices will have different impacts for the future and that combinations of policies will provide the most significant change. This project provided several scenarios with very different results. By modeling various combinations of land use, economic and transportation policy options, decision-makers can anticipate events and adopt policies to help shape the Willamette Valley for future generations.

House Bill 3090

The 1999 Oregon Legislature asked ODOT to look at the results of designating a north-south freeway in Central or Eastern Oregon, from the Washington to California borders. The objectives of House Bill 3090 were to:

- Define a better north-south connection to I-82 in Eastern Oregon.
- Increase growth of Central/Eastern Oregon.
- Decrease growth in the Willamette Valley.
- Decrease travel and congestion on I-5 in the Willamette Valley.

SWIM1 was used to identify and evaluate three alternative alignments to connect with existing freeways in Washington and California. The same parameters were used for this study as for the WVLF ATF model runs. Results of this model run concluded that a new freeway from Washington to California through Central or Eastern Oregon would:

- Significantly reduce travel time from Washington to California.
- Improve market accessibility to both Central Oregon and the Willamette Valley.
- Result in minimal differences in growth in Central and Eastern Oregon.
- The US 97 improvement could slightly increase growth of the Willamette Valley.

Overall, the proposal did not meet the objectives of transferring growth from the Willamette Valley to Central or Eastern Oregon and the project did not go forward. The results of this model run were also used as one of the hybrid alternatives considered for the ATF project.

Newberg-Dundee Bypass Induced Growth Analysis

The Newberg-Dundee Bypass is proposed to bypass Highway 99W, a major recreation route through rural Yamhill County. Yamhill County is within commuting distance of the Portland metropolitan area. In 2002, as part of the draft environmental impact statement (DEIS), the project was modeled to assess the potential for induced growth on small communities in Yamhill County as a result of building and not building the bypass. The modeling effort provided information to decision-makers and helped withstand legal challenges to the DEIS.

Economic and Transportation Modeling and Analysis of Bridge Options

When it identified a growing number of structural deficiencies in Oregon bridges, ODOT used its state-of-the-art integrated economic, land use and transport model to analyze the effects of different courses of action on the Oregon transportation system, its economy, local roads and communities. In the absence of sufficient funding for repair or replacement, many of these bridges would be subject to weight restrictions. These weight-restricted bridges could reduce freight mobility on major roadways, potentially disrupting local and regional livability and the Oregon economy.

Using SWIM1 and supplementary information, ODOT assessed the possible ramifications of several investment strategies to highway users, Oregon communities and the Oregon economy. These strategies ranged from no new investment, the repair or replacement of certain bridges, to fixing all bridges. Modeling information was combined with information from Motor Carrier Division, Bridge Section and others to develop a recommended investment strategy to address the bridge problem.

The interstates I-5 and I-84 support commerce throughout Oregon. The Portland metropolitan area and the Willamette Valley represent the economic heart of the state and rely heavily on the interstate system for movement of goods and services. Their connection to ports and markets within Oregon, with neighboring states, and overseas is vital to the state's economic health. The backbone of that connection is the interstate system. Two-thirds of the state's economic benefit can be derived by connecting I-84 and I-5 to Portland. The Interstate and U.S. highway systems in Oregon not only facilitate trade within Oregon, but also are an integral part of the North American trade network. Therefore, restoration of I-5 and I-84 as unrestricted freight routes needed to be the ultimate goal of a bridge replacement strategy.

At the same time, it was imperative that other areas of the state continue to have unrestricted access for movement of goods and services. Deteriorating bridges in these areas, far from the interstate highways, were a serious threat because businesses in rural and coastal Oregon tend to rely more on goods typically shipped in heavy trucks, such as wood and agricultural products. Such heavy commodities and remote area businesses already demand high transportation costs. Any increased cost brought about by truck detours or load limits would erode what is in many cases a slim profit margin. Heavy loads that cannot be divided into smaller loads are essentially "landlocked" if they cannot cross load-restricted bridges. Given the nature of the heavy goods moved in rural Oregon and the importance of these goods to the local economy, it was critical to maintain key freight routes across the state.

Modeling results showed that Oregon's bridge problem had the potential to cost the state economy as much as $123 billion in lost production and 88,000 lost jobs over the next 25 years.

In addition to the potential economic cost, the bridge problem posed a threat to the livability and safety of many communities throughout Oregon. Weight limits lead to truck detours, which put trucks on city streets and other roadways that often have inadequate maintenance funding and were not built for these loads. In addition to safety concerns with increased traffic detours through local communities, deterioration of local bridges could impede the response time of emergency personnel to reach citizens and forest fires. As bridges continue to age and crack, communities increasingly experience these impacts. Without significant investment, 30 percent of Oregon's bridges were expected to be weight-limited, with associated heavy truck detours, by 2010.

Expenditures to repair or replace components of the transportation infrastructure serve two purposes. An investment in state and local bridges maintains accessibility, avoiding loss of jobs and productivity growth in the long term. Money spent on bridges throughout Oregon sustains family-wage construction jobs in the short-term. These jobs, in turn, generate income that is spent on goods, services, and income taxes for the Oregon General Fund. This issue was important to the Governor and the 2003 Oregon Legislature, facing one of the highest unemployment rates in the nation.

The bridge improvement strategy needed to balance these issues in a timely manner. Because half of the critical bridges are on the interstate system, the time and the cost (over $1 billion) required to address them made them problematic as a first step.

In January 2003, ODOT submitted a report to the Oregon Transportation Commission (OTC), outlining a recommended 10-year $2 billion bridge investment strategy. The strategy restored heavy haul access to a skeletal freight system extending to all parts of the state. It strategically restored detour routes for the major interstate routes first to accommodate heavy truck traffic during the 10-year construction period and unexpected emergency bridge failures. SWIM1 provided information to support the dialogue of tradeoffs, particularly state versus regional economic impacts under various investment scenarios. This discussion of tradeoffs framed the ODOT recommendation to the OTC and ultimately shaped state legislature funding discussions. This recommendation was accepted by the Oregon Legislature and it approved the largest public infrastructure investment in Oregon since World War II.

Oregon Transportation Plan

The OTP was originally adopted by ODOT in 1992. The Plan was updated in 2005 to address the future from 2005-2030. This statewide multi-model plan provides umbrella policies and investment strategies for modal, facility, regional and local plans.

SWIM1 was used to provide a reference case for alternative scenarios. It showed that modernization projects do not necessarily improve mobility and provided data to support what was suspected but not confirmed. It reinforced and supported other analysis processes and tools.

The OTP received the Transportation Research Board's 2008 Transportation Planning Excellence Award. This biennial awards program was developed by FHWA and FTA to recognize outstanding initiatives across the country to develop, plan and implement innovative transportation planning practices. SWIM1 was an important element of the award recognition.

Regional Models

Rogue Valley MPO

The Greater Bear Creek Valley in Jackson County, Oregon, is a relatively small but rapidly growing metropolitan area. A Regional Problem-Solving (RPS) study was conducted to identify additional lands needed for urban development to accommodate a doubling of the region's population. The RPS process will create a coordinated urban expansion plan for Jackson County and the cities of Ashland, Central Point, Eagle Point, Jacksonville, Medford, Phoenix and Talent.

The jurisdictions involved in the RPS process agreed upon and adopted a set of goals and policies to guide the outcome of the process. These policies identify a number of issues of concern regarding land utilization, public facilities and services, resource lands, housing, jobs, and community identity. A number of analyses were commissioned in order to determine how growth proposals might affect these concerns.

ODOT was requested to help evaluate transportation effects of the growth proposals. LUSDR was developed to provide the land use inputs required by the Rogue Valley MPO regional transportation model to evaluate the potential transportation consequences of alternative land use patterns and transportation system additions that might occur given the proposed urban reserve areas. The modeling objectives were to:

- Develop a set of plausible future land use patterns consistent with the study goals.
- Test the effects of this set of future land use patterns on the transportation system.
- Identify the features of land use patterns that most affect transportation performance.
- Assist in identifying additions to the transportation network needed to serve future development of the urban reserves.

The modeling proceeded in the following stages:

- Model the transportation performance of the adopted regional transportation plan (RTP) for a range of land use futures that could plausibly occur given the proposed urban growth areas.
- Model the transportation performance of this same set of plausible land use futures on a road network with additional capacity expansion (beyond what is addressed by the RTP).
- Model the transportation performance for different land use and transportation policy scenarios. The land use scenarios include growth with no change in policy, growth according to a policy that concentrates mixed use development in nodes, and growth according to a policy that creates regional employment centers. The transportation scenarios include different levels of road and public transportation network expansion.

Modeling provided the following information to assist the RPS decision-making process and subsequent planning.

- By the time the region's population doubles, the road system will have to be expanded substantially in order to avoid extensive and severe congestion. Making the road improvements identified in the current regional transportation plan will be insufficient to avoid congestion. Enhancing the RTP road network with more capacity and road connections will do much to reduce congestion but major new roads may be needed as well. None of the model scenarios was able to eliminate all severe congestion on the road system. The analysis was not designed to determine what would be necessary to do so.

- The analysis showed that travel patterns, amounts of travel, congestion, and travel times will be significantly affected by the way in which the region grows. This is seen most clearly in the third stage results. The results showed that a nodal development pattern, where higher density mixed development is clustered in nodes, would significantly reduce travel distances, congestion, and average travel time relative to the other land use scenarios. The regional attractor scenario, which simulates the development of major employment centers, produces more vehicle miles travelled (VMT) and less benefit from road improvements than the no-policy-change scenario.
- Planning should consider the effects of uncertainty in how land in the region will develop over time. There are many ways that land could be developed that are consistent with the growth area proposals, comprehensive plans, and market tendencies. Overall travel is unlikely to be affected, but individual portions of the road system will be affected. The results revealed that congestion on freeway ramps is most sensitive to how land development proceeds.
- The results for congestion on the I-5 mainline showed predictable growth of congestion. The second stage of modeling showed large increases in I-5 congestion and only small differences among the land use scenarios.
- Development of all of the growth areas will result in increased travel on congested roadway sections. The high capacity scenario would eliminate most, but not all of the affected congested roadway sections. This information can be used to help identify where road improvements will be needed. Determining what should be done in these areas to accommodate development will require more detailed analysis that is beyond the scope of this study.

DATA

Data to support the Oregon modeling program can consume a significant amount of resources, both for collection and analysis. Historically, data has been collected independently by different jurisdictions and agencies, using different methodologies for data collection and recording. This has made it difficult to compare or transfer data from one jurisdiction or one model to another. As Oregon modeling and analysis tools continue to evolve, they place increasing demands on the data upon which they are built. To conduct meaningful policy analysis for decision-makers, it is necessary to collect consistent and current information regarding household choices, such as activities, automobile acquisition and travel behavior. The OMSC has undertaken several collaborative data collection efforts to ensure consistent collection methodologies and model applications.

HOUSEHOLD ACTIVITY AND TRAVEL SURVEY

In spring 1994, a household activity and travel survey was conducted in the Willamette Valley in Oregon and in Southwest Washington. This cooperative research project was sponsored by ODOT and the five MPOs in Oregon and SW Washington - Metro, MWVCOG, LCOG, RVCOG, and RTC. This cross-sectional survey provided Oregon data to support OMIP activity-based models. The result was a rich database of activity and travel information for almost 12,000 households.

Each of the MPOs was considered as a distinct universe for the purposes of sampling. The same design was customized to meet the needs of each MPO and they helped to define the geographic areas to be included in the sample universe. In four of the five MPOs, the sampling strategy was a stratified sample based on location categories of the immediate environment or situation, such as inner urban, satellite cities, suburban areas. In one of the MPOs, a random sampling design was used.

The survey was conducted in three phases: survey design and implementation, revealed preference survey implementation, and stated preference survey implementation. In addition to traditional travel data, the MWVCOG survey collected time-use activity data for a 48-hour period to capture day-to-day variation in personal travel behavior. The survey also included an enrichment sample of public transit users.

RECREATION/TOURISM ACTIVITY SURVEY

Recreation and tourism play a significant role in the Oregon economy. In-state and out-of-state visitors to Oregon recreation and tourist attractions contributed more than $4 billion to the state economy in 1995, a 52 percent increase over 1990.

In 1997, ODOT sponsored a recreational/tourism activity survey to address information gaps in recreational/tourism travel and to provide a better picture of recreational travel behavior within the state. Between April and June 1997, demographic data and 48-hour travel data were collected from two separate sources. One source was the guests of 95 lodgings in Multnomah, Lane, Hood River, Deschutes and Lincoln Counties who were provided with self-administering surveys that were returned to the lodging staff. The second was visitors to recreational attractions who were interviewed by survey teams at eight key Oregon attractions. The response rate for the lodging surveys yielded 355 completed surveys for the five counties. The intercept surveys at recreational attractions collected data from 1329 visitors.

OREGON TRAVEL BEHAVIOR SURVEY FOR 8 COUNTIES

Using the 1994 household activity and travel survey instrument as a base, ODOT collected data in eight rural Oregon counties in 1996 to examine travel behavior and trip generation by households in the small rural areas of Oregon (non-MPOs). This analysis estimated trip-making characteristics to support small-scale regional transportation models being built outside the four MPO areas in Oregon. The data for this analysis came from approximately 3200 two-day household activity surveys.

Small rural areas account for about 31 percent of the population and 86 percent of the area of Oregon. Since most of this area is sparsely populated, the eight counties were selected to provide a good cross-section of Oregon's rural areas, and surveys were conducted in the more populous parts of those counties. The surveyed counties included Clatsop, Coos, Deschutes, Josephine, Klamath, Lincoln, Malheur and Umatilla. The data collected from this survey is the data base for the Oregon Small Urban Models (OSUM) developed in non-MPO areas.

OREGON HOUSEHOLD ACTIVITY SURVEY

In 2001, the OMSC began discussions on updating the 1994 household activity and travel survey. A panel of experts was convened to discuss the merits of a longitudinal panel survey (LPS) vs. a cross-sectional survey (CSS). There is evidence that LPS data can significantly enhance the ability to understand and forecast travel behavior. A panel survey is one of the few methods available to the analyst to understand how traveler behavior is influenced by information acquisition, experimentation, and learning. It provides an opportunity to identify behavioral change over time. In effect, the LPS provides information to understand cause and effect relationships and the process of change. A pilot survey was developed and conducted to test specific survey methods and data collection approaches.

Following the pilot study, each Oregon MPO and ODOT was interviewed to define specific data needs unique to each region of the state. A stakeholder meeting was held in June 2007 and the main issues that drive modeling were discussed. In 2008, ODOT entered into a contract with a consultant team to perform survey design, data collection and database preparation for the Oregon Household Activity Survey (OHAS). The overall process to define the next household activity and travel survey and to secure funding took time, but the methodical approach allowed the OMSC to work through several issues and define a solid process and cooperative funding program.

The OHAS project is intended to expand coverage to include seasonal and possibly weekend (Saturday) information. Operationally, it is hoped that a continuous survey program can be funded as an annual expense and the survey process and data storage can be institutionalized in a centrally accessible location(s). OMSC members, including MPOs, multiple government agencies and OTREC universities, are partners in developing and funding this survey. ODOT is managing the overall program, with oversight by a subcommittee of the OMSC and local management by MPOs for their parts of the survey. ODOT entered into Intergovernmental Agreements with all participants to define terms of cooperation and financial participation.

OHAS will use a core survey with common data elements for all participating jurisdictions, including up to four questions unique to a region. Supplemental surveys can be done for data elements unique to a region. This could include additional surveys, special deliverables, region-specific data elements, a specialized sampling approach such as for a special population, or unique data collection methods, such as non-typical global positioning systems (GPS). The core survey design, covering most needs that are common across all participants, will determine the base cost per survey. The additional costs associated with tailoring the core survey to meet regional needs will be paid by the jurisdiction requesting the changes.

A pilot project for the core survey was conducted in summer 2008. The first survey will be conducted in fall 2008, with additional surveys conducted according to funding commitments in 2009, 2010 and 2011.

FREIGHT DATA COLLECTION

With increasing demands on the transportation system and a reduction in financing for new major transportation facilities, movement of goods and services throughout the state of Oregon is becoming a bigger challenge. The Portland metropolitan area has succeeded in establishing a market as a regional distribution and transshipment center for international commerce. The combination of the four “R’s” -- rivers, rail, roads and runways -- and the available transportation services help the region build on this historically competitive advantage. The economy of Portland and the rest of Oregon depend on the ability to move freight through this regional and multi-state hub.

Commodity Flow Data Collection

Metro, in cooperation with the Port of Portland and ODOT, conducted a commodity flow data collection and analysis project in 1997 to understand how commodities move in and through the region. This effort obtained information about the amount and type of goods being handled, where they are headed within the region, how they are being carried, and what factors businesses consider in making shipment decisions. The study resulted in several work products: commodity scoping and 2040 projection refinement, truck/commodity origin-destination data collection, design and implementation of a stated preference survey to determine the elasticities of factors influencing shipping decisions, and development of a commodity carrier forecasting model. This information is currently being updated.

Freight Shipper and Carrier Survey

At the same time as the Commodity Flow Data Collection project, ODOT conducted a freight shipper and carrier survey to obtain better freight movement information throughout the state. This survey focused on identifying concerns, bottlenecks and other problems with moving freight over the Oregon transportation system.

Truck Intercept Survey

In 1998, ODOT sponsored a statewide commodity flow survey to support statewide travel model development. Using an intercept survey of freight trucks, data was collected at Oregon ports of entry. Data collected included weight, vehicle and commodity classification, and origin-destination information. Over 16,000 truck drivers were interviewed, providing an extensive database on goods movement by freight trucks within Oregon. The survey focused on long-haul truck movements on the Interstate and U.S. highway system. The data was analyzed to determine the flow of goods by truck volumes, payload weight and cargo value between three general regions within Oregon. Diurnal distribution and fleet ownership attributes by commodity group were also defined. This study tried to understand the economic and transportation relationships between Oregon regions and the degree to which highways help facilitate these movements.

Freight Data Collection Project

The Freight Data Collection Project was a joint project with the Port of Portland, Metro, Multnomah County, WSDOT and ODOT. Concluded in 2007, it was conducted in the Portland area to identify freight flows around the region and to fill in other data needs.

The project was conducted in two phases. Phase I defined freight data questions on goods movement and the economy, land use and goods movement, truck routes and utilization, relationship of trucking to other modes, and corridor/project specific data needs. Phase II was the freight data collection program. Sources of data included road intercept, terminal gate and motor carrier surveys, a truck following study, and vehicle classification counts. Data types included origin-destination (O-D) data, freight facility flow information, transportation network information, truck count data, commodity information, routing information, temporal variability of freight flows, and truck classification and carrier information.

Hourly vehicle classification counts helped with understanding patterns by truck type, facility type and trip type, and validated analytical tools. Collecting vehicle classification data for the first 15 minutes every hour maximized project resources. Roadside truck O-D surveys provided a detailed understanding of interregional trip patterns and an understanding of land use relationships. Routing information should be useful for future planning. Roadside truck O-D surveys at port terminals and intermodal yards should allow for better modeling of gateway facilities. The truck-following survey was well-suited for collecting truck O-D data for a small subregion and provided useful routing information.

THE FUTURE OF OMIP

With the broad "family of analysis tools" that was developed under OMIP, a major focus for the next several years is to identify new opportunities and ways to apply these tools to address important policy and project development issues. A continued aggressive outreach and communications program, combined with a broad education and training program, informs customers and other model users of the tools available and how to use them. It also provides skilled practitioners to work for local governments and agencies to develop and use the tools effectively. The intent continues to be to move decision-makers and practitioners to a new way of thinking about and evaluating public policy and infrastructure investment decisions and to provide the tools to help make increasingly difficult and complex tradeoffs and decisions. An increased level of understanding and comfort with OMIP tools and processes will maximize their value and ensure their use as the way we do business in Oregon.

OMIP will continue to see high profile projects. The fact that specialized models are being developed to address issues of local land use/transportation interactions and greenhouse gas impacts means that the value of the Oregon modeling program is well recognized. Policy-makers and communities continue to request assistance that challenges the technical capabilities and skills of the program.

OMIP has made substantial gains in large-scale integrated models and urban level transport models but these efforts need to be brought together to provide advances in urban level integrated modeling. As the statewide integrated model continues to be refined, interactive links must be built between the statewide, local urban and rural models. Visualization and animation of modeling and analysis results will be necessary to engage users and the general public and to help them understand analysis results. The importance of presenting analysis results in clear, non-technical terms in a manner that can be easily understood by a wide and varied audience cannot be overstated. Presenting modeling and analysis results as a logical "story" helps users understand the assumptions used in the application and the potential impacts of results.

From a practical perspective, best practices and guidelines will continue to be updated and refined as model development, applications, and refinement occurs. Clearly defined processes and good documentation are increasingly important for consistency and legal sufficiency. Peer review of all models developed in Oregon should become common practice.

The international symposia held in Portland every few years continue to be good forums to disseminate the most current advances in integrated modeling. OMIP continues to explore opportunities for European and North American collaborative efforts. Bringing together resources from both Europe and North America will accelerate advances in the industry. The interest of Japanese and Chinese government modelers in the Oregon program provides opportunities to share and expand the knowledge and application of OMIP.

With the creation of OTREC and expanded collaborative programs with OTREC universities, the opportunity to develop a multi-disciplined advanced degree program in transportation planning and/or simulation and modeling is within reach. To support this goal, the OMSC has initiated discussions to establish an Oregon Modeling Center at Portland State University. This Center will coordinate research on integrated and regional models, and provide a resource for interns and collaborative projects. As the Center becomes well established, it can be a focus for distance learning, communication, and can serve as a data repository. The Oregon Modeling Center and the OMSC will become partners to expand the educational program in Oregon to provide new and experienced staff to meet the needs of the increasingly complex modeling community.

The key to the successful OMIP program has been that everything is done in a non-mandatory environment. All participating agencies and jurisdictions agree that this type of working environment is preferred because it offers the most latitude to perform within the local political environment while maintaining the ability to influence the big picture of modeling in Oregon. Individual ownership to the program has created a healthy working relationship among agencies and jurisdictions that previously had little contact or communication. These agencies and jurisdictions are now communicating regularly and are building work plans together, assisting each other to raise the level of performance of modeling in Oregon. Because of this coordination and cooperation, Oregon has made remarkable strides in all areas of modeling in a very short time period.

The cooperative nature of the OMSC is the foundation that will continue to support future growth of OMIP. As the program moves forward, three fundamental elements will ensure continued success: frequent and clear communication, consistency, and broad cooperation.

APPENDIXES

APPENDIX A: MAY 1996-TLUMIP GOALS & OBJECTIVES

OREGON DEPARTMENT OF TRANSPORTATION
TRANSPORTATION AND LAND USE MODEL INTEGRATION PROGRAM
Original Goals and Objectives - May 1996

TLUMIP Goals

The Oregon Transportation and Land Use Model Integration Program (TLUMIP) has four important goals. These goals are designed to provide the basis for a truly statewide system of land use and transportation analysis that is comprehensive, consistent and coordinated and that address key elements of ODOT's mission in the areas of statewide transportation planning and statewide planning.

Goal #1: Develop long-term economic, demographic, passenger and commodity flow forecasts for statewide and substate regions, and maintain databases needed for periodic updates.

The State should provide long range forecasts (i.e., for a minimum of twenty years) of sufficient detail to support travel demand modeling, land use allocation models, and policy analysis as required under ISTEA, the Statewide Planning Program and the TPR. These data bases and forecasts should directly support statewide planning for intrastate commodity flow analysis and freight and goods movement, and should provide the level of detail necessary to provide control totals to metropolitan, city and county planning agencies for use in developing and applying land use allocation models and travel demand models. Forecasts and databases available at the substate level should include interregional commodity, freight and passenger flows.

Goal #2: Integrate statewide and metropolitan level land use data bases, land use modeling, and spatial analysis methods to support transportation and statewide planning in the state of Oregon.

In addition to providing the data bases and forecasts needed for planning and evaluation of transportation facilities and long term assessment of land use patterns, ODOT, in conjunction with metropolitan, city and county planning organizations, should provide a lead role in establishing the administrative procedures and planning processes necessary to develop, coordinate and review data bases, forecasts and models produced under this program. This effort will be designed to be integrated into the work programs of both ODOT and participating agencies, and will be designed to foster and provide a sustainable, long term commitment by all study participants.

Goal #3: Establish methods for evaluating key policies in the Oregon Transportation Plan, implementing the Statewide Transportation Planning Rules and assessing progress made toward achieving goals implicit in Oregon's Statewide Benchmarks.

A significant goal for ODOT, other state agencies, and the metropolitan and local planning organizations participating in this program, is preparing a comprehensive inventory of the policies and plan elements that must be addressed by the models and data bases developed under this work program. This goal will be addressed by preparing a formal inventory of statewide policies and developing evaluation methods that relate these policies to the data and models required to analyze them. Emphasis will be placed on the relationship between policy evaluation and the modeling processes, the relationship of policies to data and forecasts, and the ability of modeling process(es) developed through this program to aid in evaluating the effectiveness of pubic policy as they apply to the OTP and the TPR.

The Oregon Statewide Benchmark program has established a comprehensive catalogue of measures designed to show the progress being made in attaining the goals and objectives of the Statewide Planning Program and the relationship of planning goals to the overall quality of life throughout the state. Many of the benchmarks in this program affect and are affected by elements of the OTP and requirements in the TPR. Evaluation procedures, databases, and forecasts related to key benchmark data will be identified through this program. Recommendations will be developed and periodically reviewed to assess whether the goals stated in the Oregon benchmarks program are being attained as they relate to the OTP and the TPR.

Goal #4: Develop the tools, guidelines and institutional support necessary for ODOT and other planning agencies to sustain the models and data bases needed for integrated land use and transportation facility analysis.

The investment in developing the data and models needed to analyze the implications of statewide policies and track information necessary to evaluate the success of these policies needs to be supported and sustained as efficiently and cost-effectively as possible. To achieve these goals, written guidelines will be developed under the Transportation and Land Use Model Integration Program describing the best practices for applying the models developed under this program. Interagency cooperative agreements and protocols for sustaining the databases and models will also be developed through this program. A long-term strategy for maintaining and updating the analytic processes, models, forecasts and databases developed through this program will be prepared.

These four broad goals form the basis that policymakers and senior staff of ODOT and participating state, metropolitan, city and county organizations will use to evaluate the effectiveness and continuing viability of the Transportation and Land Use Model Integration Program.

As the Transportation and Land Use Model Integration Program is implemented and applied to transportation and statewide planning policy analysis and decision making, ODOT and participating governmental agencies will be using the processes and data bases developed through the program to meet several of the primary objectives of their respective agencies. These objectives may be modified over time, but include:

TLUMIP Objectives

Objective #1: Provide a framework for improving land use forecasting methods and developing true integration and feedback between travel demand models and land use allocation models at the substate and metropolitan level.

Developing models that include meaningful feedback between traditional travel demand models and the advanced land use allocation models developed through this work program is one of the most important technical requirements of this work program. Such feedback should go well beyond the integration of composite impedance functions used in typical adaptations of existing land use models and include interrelationships that are reflective of statewide and local planning policy.

Feedback and the integration of land use and travel demand models should also fully reflect planning guidelines included in rules and regulations implemented under federal guidance in ISTEA and state guidelines in the TPR. The modeling effort should be designed to be conducted in an environment that leads to significantly improved methods for forecasting future land use, and supports a process of evaluating the consequences of implementing alternative transportation plans and evaluating the implications of current and proposed changes in policy on the pattern of future land use and development. These processes should also reflect recommendations for advanced state-of-the-art and state-of-the-practice as identified by, among others, the National Association of Regional Councils and the federally sponsored Travel Model Improvement Program.

Objective #2: Improve and enhance growth management, corridor planning and congestion management system studies that rely on long range economic forecasting, land use allocation models and data that can be generated by the Land Use Model Integration Program.

The work program will support TSP development and MPO/urban area modeling programs in Oregon by providing consistent statewide demographic and employment forecasts, improving external passenger and commodity flow forecasts at the metropolitan, city and county level and improving the data and analysis that supports the Oregon Congestion Management System (OCMS).

Objective #3: Improve and enhance the Oregon Highway Monitoring System's analytical processes (OHMS).

The OHMS is a key contributor of data and information to the OCMS, the Statewide Highway Plan, and Statewide Corridor Planning. Key elements of the OHMS include:

- √ Improving traffic forecasting methods;

- √ Providing the necessary sensitivity of travel demand models to land uses and land use related variables;
- √ Integration of statewide travel demand with urban area modeling;
- √ Improving land use and travel demand modeling in urban areas of the state; and
- √ Improving the ability to model, display and analyze travel demand, land use and policy sensitive information.

Objective #4: Provide technical support for the Highway Plan update, reengineering of Project Selection and Development, and special projects (such as the Willamette Valley Strategy) that advance comprehensive transportation planning in the State of Oregon.

Future updates of the Oregon Highway Plan will be based on policies in the OTP and on a comprehensive assessment of transportation facilities and system needs. Statewide modeling and databases, as developed for this program, will support analysis of alternative policies and strategies for meeting the objectives of the plan. The reengineering of the Project Selection and Development process will be supported by this program by enabling ODOT to identify transportation needs in a timely manner and evaluate prospective alternatives taking into account the effect of an individual project on land use and other transportation facilities in the same corridor or transportation "market". Finally, several corridor level studies and initiatives are either underway or contemplated by ODOT for the future. Among those already underway is the Willamette Valley Strategy. Development of statewide travel demand forecasts and integrated land use models are expected to improve the quality and level of analysis available to ODOT and participating agencies as they develop and refine corridor level studies in other parts of the State.

From Request for Proposals, May 9, 1996

APPENDIX B: JUNE 1998-TLUMIP GOALS & OBJECTIVES

OREGON DEPARTMENT OF TRANSPORTATION
TRANSPORTATION AND LAND USE MODEL
INTEGRATION PROGRAM
Updated Goals & Objectives - June 1998

<u>TLUMIP Goals</u>

Goal #1: Develop a set of integrated land use and transportation models that will enable ODOT and the MPOs to do analysis needed to support land use and transportation decision making.

The goal is to produce models that:

- Can be used to analyze the potential effects of transportation and land use policies, plans, programs and projects on travel behavior and location choices.
- Are integrated at the statewide and substate levels and are connected with metropolitan transportation models.
- Are connected by a consistent theoretical framework, automated linkages for passing data, and procedures for coordinating between ODOT, MPOs and local governments.
- Are built on platforms that can be modified and extended as necessary to implement improved analysis methods.
- Produce outputs that can be used in other analysis packages for assessing transportation system performance.

Goal #2: Develop and maintain databases needed to make periodic long-term economic, demographic, passenger and commodity flow forecasts for statewide and substate regions.

The State should work with the MPOs to develop and maintain the databases needed to produce twenty-year forecasts of sufficient detail to support travel demand modeling, land use allocation models, and policy analysis as required under ISTEA, the Statewide Planning Program and the TPR. These databases and forecasts should directly support statewide planning for intrastate freight and passenger movements and distribution of population and employment growth. The forecasts should provide the level of detail necessary to provide control totals to metropolitan, city and county planning agencies for use in developing and applying land use allocation models and travel demand models.

Goal #3: Develop the expertise, guidelines and institutional support necessary to sustain the models and data bases needed for integrated land use and transportation facility analysis.

The investment in developing the data and models needed to analyze the implications of statewide policies and track information necessary to evaluate the success of these policies needs to be supported and sustained as efficiently and cost-effectively as possible. To achieve these goals, written guidelines will be developed under the Transportation and Land Use Model Integration Program describing the best practices for applying the models developed under this program. Interagency cooperative agreements and protocols for sustaining the databases and models will also be developed through this program. A long-term strategy for maintaining and updating the analytic processes, models, forecasts and databases developed through this program will be prepared.

These program goals form the basis that policymakers and senior staff of ODOT and participating state, metropolitan, city and county organizations will use to evaluate the effectiveness and continuing viability of TLUMIP.

TLUMIP Objectives

Objective #1: Provide training on the integrated transportation and land use models.

The models need to be presented to a wide technical audience. This will be done through a statewide conference and model documentation. Selected ODOT staff and MPO staff will be trained so they may acquire a working knowledge of the theory of the models, how the models work, the data used in the development and updating of the models, the procedures for calibration and validation of models, and methods for applying the models.

Objective #2: Connect the statewide and substate models with the metropolitan area models.

The first generation work began with a vision of a nested model framework for the metropolitan, substate and statewide components. The 1st generation statewide and substate models do nest, but the metropolitan model does not. Although it now appears that a fully nesting structure may not be possible, the models should be built on consistent frameworks, produce consistent results and efficiently pass information between one another.

Objective #3: Transfer the statewide and substate model to a platform that is extensible and can be modified by ODOT in the future.

The first generation model was developed using TRANUS. This off-the-shelf modeling application was chosen because it appeared to be able to accomplish the objectives of fully integrating transportation and land use modeling, being affordable and being open. The state and substate models are large implementations of integrated models using TRANUS and have revealed some limitations of the application. Furthermore, the application has not been as open as had been anticipated. It is ODOT's desire to have the models implemented using applications that ODOT can extend and modify as necessary to make future model improvements.

Objective #4: Integrate rail transportation into the statewide and substate model.

The 1st generation models do not model rail transportation. The 2nd generation models should include this component so that ODOT may assess passenger and freight mode choices.

Objective #5: Develop a working metropolitan model that integrates transportation and land use components.

The metropolitan area prototype model does not fully integrate transportation and land use components. The model connects the simulation of residential and business locations with the existing metropolitan travel demand model implemented with the EMME/2 software. The transportation model feeds accessibility parameters to the land use model. The land use model in turn feeds the transportation model land use allocation information that then is used for trip generation and distribution. The objective is to develop the prototype into a working model and create logical and efficient connections between land use and transportation components.

Objective #6: Establish data linkages between the statewide, substate and metropolitan models and analytical software for assessing highway system performance.

ODOT periodically evaluates highway system performance for updates of the state Congestion Management System, Highway Plan, Oregon Transportation Plan, Corridor Plans and STIP. The primary analysis tools have been the Highway Performance Monitoring System-Analytical Package (HPMS-AP) and the Highway Economic Requirement System software (HERS). In the future, ODOT may be using the FHWA Surface Transportation Efficiency Analysis Model (STEAM) and other similar software. Presently ODOT does not have effective methods for combining the results of metropolitan transportation models with ODOT data to produce a combined dataset that can be used in these analysis packages. Therefore, one objective of the second stage work is to develop efficient methods for combining the outputs of models at all geographic scales to produce the needed datasets.

Objective #7: Establish university research linkages.

ODOT believes that research links with universities are an important part of a continuing program to develop good and practical models. University research has always been important to the development of modeling practice. ODOT would like to support university research that uses Oregon data so that the results will have practical applications for the Department.

From Request for Proposals, June 22, 1998

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