One of the most important components of the TRB summer meeting was the development of break-out sessions. Attendees were assigned to groups, composed of ten to twelve attendees selected at random. After each presentation session, each break-out group met to discuss critical issues that were raised by speakers, and to develop a list of what they believed to be critical research needs associated with the topic of each session.

All six of the discussion groups clearly reached consensus that determining the cause-effect relationships between vehicle activity and emission rates was a top priority. The groups all indicated that mobile source emission inventories and emission modeling capabilities are critical for a number of reasons. The most prevalent reason appeared to be the need to use these models in State Implementation Plan (SIP) preparation, including the development of effective transportation control measures in transportation and air quality conformity analysis. Second, models are needed to accurately evaluate the local impacts of transportation projects. The third reason for improved modeling methods appeared to be the need to accurately assess the effectiveness of proposed transportation control measures in many urban areas.

The five general topics for break-out sessions included: mobile source emissions estimates; transportation control measure (TCM) and transportation demand management (TDM) effectiveness analysis and monitoring; land use, travel patterns, and air quality; transportation demand modeling for air quality plans and control strategy analysis; and top-down approaches to obtaining data for air quality analysis. In essence, each of the break-out sessions focused upon a different aspect of the transportation/air quality puzzle, including aspects of theoretical modeling as well as practical application. The needs that were identified by the six groups for each session topic were both short term and long term in nature. The specific issues that were raised by nearly every group are summarized as follows:

**Mobile Source Emissions Estimates**

One major concern is that new emission rates are needed to better quantify the impacts of transportation control measures. Hence, improved emission rates related to engine starts and changes in traffic flow are needed for evaluation of policy options. Creation of new emission testing cycles that are more representative of on-road operations, perhaps by time of day or trip purpose, was recommended. But with or without new cycles, development of real-world
emission rates for emission-producing vehicle activities (especially for activity under different vehicle operating modes, such as acceleration, deceleration, idle, etc.) was clearly established as the highest priority. All of the groups indicated that quantification of off-cycle emissions should be vigorously pursued. Some groups indicated that potentially significant explanatory variables, such as cycle work and speed variability should also be investigated. One group also suggested that the investigation of these critical emission parameters be prioritized by potential emissions impact.

Nearly all of the groups indicated that improving our capability to estimate PM$_{10}$ emissions and emission impacts was important. Currently, it is difficult to determine what fraction of PM$_{10}$ concentrations are transportation-related, and it is very difficult to determine what PM$_{10}$ fractions are associated with vehicle emissions vs. re-entrainment of road dust.

Expanding research programs that will improve estimates of heavy-duty vehicle emission rates and vehicle activity was listed as a high priority by most groups. Some groups also indicated that we should improve our ability to identify and quantify emissions of toxic air contaminants from motor vehicles. Finally, addressing uncertainty inherent in emissions data and emission factors was mentioned as a priority. By making uncertainty more explicit, policymakers can better evaluate the emission reduction potential of proposed policies.

TCM and TDM Effectiveness Analysis and Monitoring

The primary focus of group discussions was upon the need to develop tools to evaluate TCM impacts and improve our ability to analyze non-work trips. The general consensus was that existing TCM analysis tools need to be significantly improved. To this end, the collection of new data associated with tripmaking behavior (for discretionary and non-discretionary trips) was noted as a high priority by most groups. Further investigation of potential barriers to participation in TCMs, such as geographic, social, personal safety, or economic constraints, was recommended.

Examining public acceptance of TCMs, in terms of TCM effectiveness and longevity, was a primary need identified. Evaluating the leverage and synergistic effects of TCMs was also noted as an important research area. Groups noted that the focus of most TCM research has been upon those TCMs designed to affect commute trips. Given the ongoing increase in non-work trips, groups indicated that TCMs affecting non-work trips deserve more attention.

The evaluation of consumer response to market-based strategies, the TCM approach usually considered to have the greatest potential for modifying transportation demand, was a very high priority. The development of "total social cost" analysis tools that could account for the presence or absence of SOV and alternative transportation mode subsidies was important to some. The evaluation of TCM side effects and equity impacts that may result from the implementation of these strategies was critical to some groups. Development of monitoring methods, designed to evaluate TCM effectiveness, was proposed. Finally, further investigation of the feasibility of substituting telecommunications for vehicle trips was an important issue for some groups.
Land Use, Travel Patterns, and Air Quality

Basic research designed to evaluate the effects of numerous land use characteristics on tripmaking behavior and on the effectiveness of transportation control measures was deemed paramount. Collection of more detailed data related to trip generation rates is critical to this end. The development of a more detailed "offspring" of the ITE trip generation manual was suggested by one group. Policy impact studies, based upon new research and improved models should be conducted, and should also focus upon evaluation of consumer response to land use policies. In addition, many groups indicated that the impacts of land use/transportation policies on various socioeconomic groups (e.g. housing affordability, distance to employment, access to services, transportation costs, etc.) should be evaluated. Better defining the role of government in land use decision-making was also noted as a high priority.

Developing feedback loops between land use, transportation demand, motor vehicle emission, and air quality models was deemed necessary by all groups. Utilizing GIS capabilities that provide spatial resolution in land use, transportation demand, and vehicle emissions was recommended, and most groups suggested that GIS capabilities be introduced into the overall land use/transportation/air quality modeling framework. A number of groups also noted that existing and future data will be used most efficiently if land use/transportation models are developed with a built-in compatibility for the GIS-based systems used (or being developed) in other branches of government.

Transportation Demand Modeling for Air Quality Plans and Control Strategy Analysis

The outputs of transportation activity models, both regional demand models and microscale traffic simulation models, often do not produce data/information necessary to answer important policy questions. Currently, it is difficult to assess the potential impacts of TCMs, market-based incentives, special events, and traffic flow changes using existing models. The clear consensus reached by the break-out session groups was that transportation activity models need to provide the important information needed to make these kinds of policy decisions. This implies that the cause-effect relationships between vehicle activities and their emission rates must be known. Thus, the emission rate research described above must progress in concert with the enhancement of existing activity models or the development of new models.

Discussion groups put a great deal of weight upon improving the accuracy of activity models, so that accurate outputs can be coupled with emission models and emission results can be used in air quality planning. However, there was no clear consensus on whether research should focus on upgrading existing models and improving integration between transportation and air quality models, or if the focus should be upon developing completely new modeling approaches. Nevertheless, as group number four indicated, "research for enhancements to models must consider land use/travel/emissions model sets as a continuum." The modeling approach debate deserves much additional attention and is likely to continue well into the future.
With either general approach to improving activity models, enhancement of existing models or wholesale development of new models, the break-out session groups all noted that the collection of additional vehicle activity data is critical. Of course, data related to emission-producing activities (e.g. cold starts and high acceleration activities) should be a focus of data collection. But even the general data associated with vehicle trips, vehicle miles traveled, and vehicle speeds need to be enhanced in most areas. To this end, some groups recommended the preparation of "strategic data collection plans" designed to gather necessary data.

The discussion groups also noted that the majority of transportation activity models are not user-friendly. The operational characteristics of the models are complex, limiting the scope of individuals that can participate in the activity modeling process. Plus, when model documentation is unavailable, the outputs of the models cannot be examined in light of the assumptions that inherently limit the use of the outputs. Thus, accountability associated with using model outputs is often lacking. The majority of groups indicated that new or improved models should provide simplified user interfaces and should be supported by documentation enabling users to better interpret modeling results and establish ranges of uncertainty around their findings.

**Top-Down Approaches to Obtaining Data for Air Quality Analysis**

The long term needs discussed by the groups were generally related to data enhancement. Collection of pertinent emission-producing vehicle activity data, and improving the estimates for activity-specific emission rates was the focus of most groups research agendas. Development of strategic data collection plans is of paramount importance. Collection of important data that can be employed in various modeling routines should be a priority and should be shared when possible. Data sharing necessitates good communication between agencies so that data can be formatted for use by multiple parties. Investigating the capabilities of high-tech approaches to data acquisition should be explored; many of the IVHS technologies can be implemented to collect useful transportation/air quality analysis data. For example, a Nielsen family of cars could be implemented to collect "typical" tripmaking and traffic flow data. Privacy issues were also broached by two of the groups as a research need with respect to data acquisition and sharing.

**Additional Discussion Points of Consensus**

Incorporating uncertainty into transportation/air quality analyses was a critical research need, as well as incorporating the concept of the total social costs in evaluating planning decisions. All of the groups indicated that agencies and industry need to improve communication related to modeling and research. Sharing of data is critical, but sharing of research results is even more so. The development of a research clearinghouse was also recommended (perhaps with the Federal Transportation Data Center taking the lead and the TRB committee serving a role in disseminating research results). The development of research consortiums capable of undertaking major research efforts and sharing data and results, through combined public and private funding, was recommended as a high priority by some groups.
Finally, all groups recommended that steps aimed at improving the understanding of transportation/air quality relationships, in terms of education of researchers, government agents, and the general public, should be undertaken. The public needs to know how transportation behavior effects air quality. An informed public will help to make transportation and air quality programs both politically supportable and ultimately successful.

Detailed Break-out Session Summaries

During the break-out sessions, groups worked with flip chart paper to record research brainstorming results and research priorities. The remainder of this section of the meeting proceedings is dedicated to summarizing the research recommendations made by each of the discussion groups. For each session, the individual research priorities determined by each group are presented. After the research priorities section, additional detailed notes from group brainstorming are provided for each topic session (many of the issues raised in the brainstorming sessions already appear in the research priority section). Many of the brainstorming issues are broken into subtopics that provide specific research focus. In other words, it is recommended that interested policy-makers and researchers examine both the research priority and brainstorming sections of these notes.

The membership of each group is provided on the following page. In general, each group was well represented by members of local, state, and federal government agencies from the land use, transportation, and air quality disciplines. In addition, a number of research universities were represented and one vehicle manufacturer. The depth and breadth of focused presentations and discussions should provide a reasonable spectrum of the research needs faced by transportation/air quality planners. The research priorities outlined by attendees of this conference might be supplemented through future research working groups that entail even broader-based participation of industry and public interest groups.

Conclusions

The organizers of this summer meeting hope that the research summaries will aid in the development of a comprehensive transportation/air quality research plan. Hopefully, this plan will be arrived at with direct participation and support of government agencies, affected private industry, and public interest groups. The development of an efficient research plan that avoids duplicity of effort and is directed at solving common problems should be a primary goal of future efforts.

The majority of the working groups at the summer meeting indicated that broad-based research consortia should be established on a nationwide basis to pursue research in the air quality arena. Peer reviewed research coupled with the efficient sharing of data and research findings will move us quickly toward a greater understanding of how we can best assess the impacts of land use and transportation on air quality, as well as how we can best mitigate potential impacts. Active participation of industry, government and the private sector, are necessary if
research is to progress efficiently. Of course, this means the participation of technical experts from the individual coalitions as well as overall fiscal participation. Hence, the next steps associated with developing a detailed working agenda for land use, transportation, and air quality research should probably entail the development of a consortium process. Given the need for a national research agenda, the new Administration may wish to coordinate the consortium process to ensure active participation of industry, state and local governments, academia, and public interest groups. The development of research consortiums that provide adequate funding, technical expertise, peer review, and information dissemination services will enhance our ability to make rational decisions regarding future land use, transportation, and air quality policies.
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<td>Mike Clifford</td>
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<td>Karen Heidel (Tuscon)</td>
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<td>Terry Parker</td>
<td>Shawna Mulhall</td>
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SESSION 1
MOBILE SOURCE EMISSIONS ESTIMATES
PRIORITY RESEARCH NEEDS

GROUP 1

1. Consider LEV and reformulated gasoline emission characteristics, and market penetration, in mobile source emission models (include reformulated gasoline, flexible fueled vehicles, and electric vehicles)

2. Develop an improved linkage between transportation and air quality models (both macro- and microscale models)

3. Identify transportation contribution to PM$_{10}$ by species through receptor models and characterization of PM$_{10}$ monitoring data

4. Evaluate existing bag emissions data using cycle work and speed variability (e.g. standard deviation of speed) as independent variables

5. Compare systems operation characteristics and determine system effect upon emissions (e.g. impacts of 3-hour and 24-hour HOV lanes and speed correction factors)

6. Develop an inventory of transportation-related toxic air contaminants from existing data bases

GROUP 2

1. Assess implications of current research findings on SIP preparation:
   (i.e. model changes and impacts on control strategy selection)

2. Account for uncertainty (explicitly if possible) in policy/planning decisions:
   Models need to be made “decision-oriented”

3. Solve technology transfer problems for emission rate research findings:
   Implement a consortia/teamwork process

4. Recognize that developing new data/models takes time:
   Coordinate research and policy development
   Develop reasonable and specific technical guidelines

5. Develop strategic data collection plans:
   Identify critical emission parameters
   Prioritize
   Collect appropriate activity data
GROUP 3

1. Make speed correction factors reflect the real world:
   Account for frequency of acceleration/deceleration within cycle
   Investigate developing different cycles for:
   time of day, trip purpose, trip length, vehicle type, etc.

2. Evaluate emissions from heavy-duty vehicles:
   Real emission rates
   Modes of operation (real cycles)
   Idling characteristics

3. Develop real world emission rates:
   Determine what factors are important
   Determine what factors can be measured
   Evaluate validity of testing procedures and results

GROUP 4

1. Develop emission rates that can be employed in evaluating the emission reduction potential of TCMs

2. Research emissions factors related to engine load (e.g. uphill load and acceleration)

3. Develop improved methods for speed-related emissions profiles (especially for high speed emissions)

4. Evaluate the impacts of outside air quality on indoor air quality:
   Determine if buildings near freeways are prone to indoor air quality problems
   Specifically look at employment locations near major transportation corridors

5. PM$_{10}$ issues:
   Identify relative contribution of exhaust and entrainment of PM$_{10}$
   Identify origins of transportation-related PM$_{10}$
   Develop methods for controlling PM$_{10}$
   PM$_{10}$ Hotspots:
   Improve transportation source modeling
   Compare highway contribution to other sources
   Investigate means to eliminating hot spots

6. Improve the interface between Mobile5 and UTPS 4-step demand modeling processes

7. Conduct primary data collection of real-time, on-road emission data (with air quality concentrations)
8. Toxic air contaminants (TACs):
A link is needed between EPA regulation process and transportation industry
EPA standards should be based on concentration and probability of human exposure
Evaluate TAC emissions related to transportation corridors and congestion hotspots

GROUP 5

1. PM$_{10}$ issues:
   Collect more data on trucks/buses, and evaluate PM$_{10}$ control technologies
   Determine priority for emissions control (particulates vs. NOx)
   Determine if alternate fuel vehicles will meet NOx controls
   Quantify re-entrained road dust

2. Cold start issues:
   Test different cars, catalytic and non-catalytic, under different temperatures
   Evaluate time effects (i.e. how long a vehicle has been sitting)
   Quantify typical numbers of trips
   Determine if technologies will likely reduce problems for new cars

3. Acceleration issues:
   Identify behavior of typical group of drivers
   Note variations by geographic area (LA, San Francisco, Atlanta, etc.)
   Collect more data from more cities
   Note acceleration variations on the roadway:
   Terrain, freeway on-ramps, level of service, driving styles, events
   Analyze acceleration using on-board computers in cars
   Evaluate acceleration-related emissions from alternative fuel vehicles
   Improve cooperation with traffic systems folks

4. Evaluate the accuracy of travel log surveys

GROUP 6

1. Expand off-cycle analysis

2. Address transportation data and emission factor uncertainties
3. Ensure that activity data are consistent with emission factors:
   Investigate the use of automatic vehicle location (AVL) and automatic vehicle
   identification (AVI) technologies to gather emissions-related data
   Characterize typical links

4. Determine relationships between roadway level of service and emissions (facility type):
SESSION 2
TCM AND TDM EFFECTIVENESS ANALYSIS AND MONITORING

GROUP 1

1. Research related to TCM effects:
   Improve methods to assess behavioral changes and to quantify TCM impacts on vehicle trips and vehicle miles traveled
   Structure TCMs so they work (based upon noted behavioral changes)
   Develop methodologies for discreet choice analysis of untested TCMs
   Assess car-pool collection behavior:
      One point pick up versus residence pick up (e.g. VMT differences)
      Assess actual efficiency (carpool average vehicle ridership)
   Quantify HOV effectiveness (operational)
      Persons per vehicle to get number of trips reduced
   Assess TCM impacts on VHT and VMT (include consideration of cold starts)
   Quantify air quality benefits:
      Compare modeled and measured (monitored air quality) benefits
   Quantify effectiveness of TCMs in areas where congestion is not an issue
   Measurement of compliance (develop compliance monitoring methods)
   Assess synergy of TCMs

2. Research related to economic effects:
   Quantify the effectiveness of economic incentives and disincentives
   Develop price elasticities for parking charges and gas price increases
   Quantify current subsidies of SOVs
   Assess the potential of economic incentives to increase effectiveness of TCMs

3. Research related to non-traditional TCMs:
   Assess feasibility of TCMs that reduce non-work trips
   Develop TCMs for seasonal or episodic air pollution

4. Research related to travel behavior:
   Characterize discretionary and non-discretionary trips
      O/D survey for 24 hour period, rather than peak period
      By trip type and trip length with geography
   Examine the effects of personal safety and security issues on TCMs
      Vandalism in park and ride lots
      Personal safety in subways
GROUP 2

1. Develop TCM monitoring techniques:
   Determine if standardized facility and aggregate data are analytically sufficient

2. Evaluate market incentives:
   Include total social cost analyses
   Analyze extent of incentives necessary to change behavior
   Tie incentives/mechanisms into demand models

3. Consider TCM end users and determine if tripmakers can and will adapt:
   Include TCM effectiveness limits (e.g. single parents, low income, rural areas)

4. Include traffic impact analysis in models (i.e. microscale impacts):
   Small changes in demand can yield large changes in total congestion delay

5. Evaluate socioeconomic impacts and equity considerations

GROUP 3

1. TCM implementation method issues:
   Develop prototype regulations
   Estimate emission credits
   Develop procedures for monitoring

2. Link TCMs to Transportation/air quality modeling

3. TCM evaluation/quantification issues:
   Determine how to evaluate at regional, local, and site, levels
   Examine comparative effects
   Assess implementation over time
   Evaluate net effects of mode shift

4. Evaluate peripheral TCM effects:
   Quantify positive and negative side effects
   Evaluate cost/benefit
   Evaluate cost effectiveness of TCMs

5. Evaluate leverage and synergistic effects:
   Assess the role of TCMs as catalysts for other TCMs

6. Evaluate and improve marketing and public education strategies:
   Determine what TCM strategies work and what strategies do not
   Quantify effectiveness
GROUP 4

1. Determine methods for incorporating TCMs into UTPS, so that their effectiveness as air quality control measures can be evaluated at the micro- and macroscale levels

2. Research and develop standardized approaches to TCM monitoring and evaluation. Develop standardized evaluation procedures for TCMs and evaluate the effectiveness and acceptability of TCMs, and develop method to prioritize TCMs based on various scenarios of local applications. Define appropriate mechanisms for data acquisition and evaluation roles

3. Quantify synergistic effects of TCMs

4. Develop comparative, apportioned cost analysis for TCMs

5. Develop a resource document for identifying effective TCM strategies based on community characteristics (similar to travel response measures guidance)

6. Evaluate (quantify) the potential for marketing TCM strategies to improve TCM effectiveness

7. Establish a TCM clearinghouse and/or computer bulletin board

GROUP 5

1. Examine interaction effects of transportation control measures:
   Determine which TCM combinations work well together and which do not

2. Develop TCM evaluation criteria:
   Determine TCM emission reduction effectiveness
   Develop standardized evaluation procedures (cookbook, lists, models)
   Effectiveness of TCMs in urban, suburban and rural areas

3. Implementation of TCMs:
   Evaluate public acceptability
   Evaluate incentives and disincentives

4. Economics issues:
   Evaluate economic incentives
   Develop cost-effectiveness guidelines

5. Intermodal issues:
   Determine why transit works elsewhere in the world
   Determine why people don't use transit in the United States
GROUP 6

1. Identify specific populations of people amenable to different types of TCMs:
   - Include analysis of TCM barriers (social, economic, geographic, mobility, etc.)
   - Identify data needed to evaluate TCM response
   - Determine the circumstances and incentives to which travel is responsive
   - Identify the variables that affect trip-chaining
   - Evaluate the extent of incentives necessary
   - Better characterize secondary TCM effects

2. Determine the relationships among and between TCMs:
   - Evaluate synergistic effects and competition between TCMs
   - Improve means of quantifying the effects of various measurers

3. Address total TCM cost issues:
   - Identify the costs that need to be measured
   - Identify the groups that incur these costs
   - Ensure consistency in measuring cost effectiveness across measures
   - Develop means to quantify social costs

4. Analyze the practical feasibility and enforceability of TCMs:
   - Develop methods to quantify the effectiveness of TCMs

5. Pursue non-employer based TCMs
SESSION 3
LAND USE, TRAVEL PATTERNS, AND AIR QUALITY
PRIORITY RESEARCH NEEDS

GROUP 1

1. Compare historical development in planned and unplanned communities (mixed use issues):
   - Jobs/housing balance
   - Double income family issues
   - New developer claims
   - Housing affordability

2. Examine the role of government in infrastructure approvals and funding

3. Remove institutional barriers preventing agencies from talking to each other and move toward an integrated approach in land use/transportation/air quality decisions

4. Improve our understanding of trip-making characteristics:
   - Collect more data related to trip generation rates
   - Population density and transit use
   - Family income and transit use
   - Non-traditional transit patterns and trip patterns
   - Commute length effects on health, social well-being, and productivity

5. Evaluate land use effects on TCM effectiveness:
   - 24-hour VMT study of full service linear city design (non-work trip savings)
   - Evaluate use and financing of shuttle for daily non-work trips from home and effects on changing commute mode

6. Determine if an indirect source permit program will work:
   - California program applicability
   - Emission density zoning
   - Effects on land use

7. Explore feedback loops between models based upon data collected and results of new studies proposed above

8. Conduct analyses of GIS systems applications for land use, transportation, and air quality modeling
GROUP 2

1. Improve economic analysis techniques:
   Develop guidelines for, and undertake total social cost analysis
   Develop mechanisms to internalize hidden costs, subsidies, and cross-subsidies
   provided to the gasoline-powered single occupant vehicle (perhaps as market-based TCMs)

2. Improve modeling techniques:
   Data collection
   Integration with GIS
   Automation of data collection
   Connectivity of land use and transportation models
   Sharing information and modeling techniques across regions
   Increase coordination between experts

3. Address land use impacts on TCMs and mode choice:
   Catalysis of TCM effectiveness
   More data on walking/alternative modes
   Impacts on traffic flow

4. Address the issue of property rights:
   Determine what rights and distribution of rights exist in the region
   Explore transferable development credits
   Determine which approaches are successful

GROUP 3

1. Develop an offspring of the ITE trip generation manual
   Quantify emissions by land-use (and trip type)

2. Evaluate the pros and cons of TCMs based on land use scenarios

3. Assess implications of changes in parking policy:
   Pricing/phasing
   Land use/zoning
   Equity

4. Evaluate infill versus sprawl, and impacts upon: air quality, VMT, congestion, average speed, infrastructure cost, energy use, etc.

5. Optimize land use alternatives for transportation/price sensitive population groups

6. Assess the synergistic effects of land use/transit/transportation:
   Mixed use and other patterns
GROUP 4

1. Establish and promote the use of consistent definitions of density, land use types and other parameters which are variables in both land use and transportation models

2. Research use of models and policy options for regions characterized by sprawl but not growth

3. Research the applicability of local government development incentives and controls in land use models

4. Research the need for considering factors such as quality of life, land cost, crime, etc., should be considered in land use/transportation planning models or in conjunction with land use/transportation planning models

5. Define appropriate applications of GIS for supporting land use/transportation modeling

GROUP 5

1. Investigate relationships between land uses and alternative transportation modes:
   Evaluate the ability of higher densities, mixed use, and pedestrian/transit orientation to attract transit
   Determine which comes first ... land use changes or transit access
   Timing for development and transit - same time vs. sequential
   Investigate using credits to local governments for land use changes undertaken if transit is not provided
   Evaluate the impacts of higher density, mixed use projects on travel patterns and emissions

2. Continue land use/transportation/air quality modeling studies:
   Improve coordination of various modeling activities
   Support incorporation of land use into transportation models
   Collect data on relationships between density, mixed use, intensity of use, and the transportation system
   Update earlier land use and transit studies
   (e.g. BART, Washington DC metro system studies)
   Evaluate differences between city, size and geographic area
   Develop local agency guidelines for data collection, modeling, updating

3. Address marketability/public acceptability of land use measures:
   Address the NIMBY (not in my backyard) syndrome
   Evaluate public acceptability of density increases
   Research residential location and housing price issues
   Evaluate the real costs of alternative development patterns
   Assess the political acceptability of density by elected officials
4. Provide appropriate tools to local land use agencies:
   GIS
   Bring regional data to local level
   Provide training on and maintenance of existing systems
   Ensure adequate funding

5. Investigate land use balance:
   Optimal mix to reduce VMT/Emissions
   Find appropriate density for geographic locations (urban suburban/rural)
   Evaluate infill development
   Tools to evaluate residential location decision-making

GROUP 6

1. Evaluate locational decision making:
   Research the values that affect locational decision making, including:
   crime, life-stage mobility needs, school locations, and density
   (currently not included in transportation or land use modeling)
   Identify the tradeoffs that play a role in locational decision making

2. Conduct research on trip generation rates (by mode) for non-traditional and neo-traditional land uses

3. Research tax policy effects on land use

4. Research the interactions between land use and TCMs

5. Develop an integrated land use, transportation, emissions, air quality modeling framework which integrates GIS

6. Ensure that research addresses non-California issues
SESSION 4
TRANSPORTATION DEMAND MODELING
FOR AIR QUALITY PLANS AND CONTROL STRATEGY ANALYSIS

GROUP 1

1. Investigate uniformity of peak hour factors within regions and between regions
   Explore inexpensive approaches to handling peak hour issues

2. Improve and integrate cost effective techniques for monitoring/collecting data related to
   traffic counts, vehicle classification, and speeds:
   Interface with GIS
   Maintain data by time of day, season, etc.
   Collect data during ozone episodes

3. Develop an easily implemented method to obtain cold start percentages at link level by
   trip purpose, time of day, temperature regimes, and mode split (i.e. goods movement)

4. Characterize typical trip cycles by trip purpose, facility type, and V/C ratio:
   Include speed, speed variation, acceleration, idle, etc.

5. Undertake uncertainty analysis for all land use, transportation and air quality models:
   Determine how accurate existing models are
   Evaluate error in individual models
   Define how accurate we expect these models to be
   Optimize data gathering efforts based upon uncertainty analyses

6. Examine mode split component of transportation demand models:
   Optimize urban mobility while minimizing emissions
   Account for fiscal, psychological, behavioral constraints

GROUP 2

1. Identify air quality-related parameters that are significant when they are missing from
   demand model outputs

2. Improve model sensitivity and capability to address planning and TCM needs

3. Close the loop between land-use and UTPS-type 4.-step demand models

4. Integrate GIS systems into modeling approaches

5. Undertake speed monitoring studies
6. Improve HPMS (Highway Performance Monitoring System)

7. Explore the implementation of a Nielsen family of cars and perhaps a random sample of production line cars equipped for collecting data

8. Identify what data we really need and how much data must be collected:
   Don't collect data that will never be used

9. Determine if it makes more sense to upgrade existing UTPS-type 4-step demand models or to start over with a new approach

GROUP 3

1. Establish performance standards for travel demand models used in conformity:
   Price sensitivity
   Congestion/time factors
   Speed/vehicle mode
   Clearly defined assumptions
   Ability to test alternatives quickly

2. Establish protocol for delineation of input assumptions to provide accountability to non-modelers

3. Evaluate the feasibility of modeling commercial vehicles:
   Difficulty of collecting data
   Access to private data

4. Data needs:
   Accurate traffic counts
   Real-time system evaluation
   Actual speeds under varying conditions
   Spatial/temporal factors of emissions

5. Improve models:
   Incorporate TCMs
   Include peak vs. non-peak
   Include trip chaining
   Include topographic factors
   Investigate operating cycles by facility type

GROUP 4

Preamble: Research for enhancements to models must consider land use/travel emissions model sets as a continuum
1. Reevaluate the mode choice parameters of the trip generation component, to better account for TCMs, mode of access, and non-motorized travel

2. Research existing techniques of model calibration and validation and suggest methods for improving these processes

3. Determine critical characteristics (link, zone, corridor) to which emissions results are most responsive

4. Develop guidelines on valid alternatives to large scale travel surveys for model calibration (e.g. origin-destination surveys, census-like effort)

5. Evaluate expeditious implementation of TCMs so that their actual impacts can be determined

6. Research methods for more reliable goods movement modeling (commercial vehicles)

GROUPS 5 & 6

1. Modeling research issues:
   Develop a GIS-based model for air quality and transportation planning
   Encourage transportation, emission, and air quality modelers to develop common set of definitions and data collection requirements and costs
   Develop sub-area/corridor modeling capabilities (i.e. for TCM evaluation)

2. Data issues:
   Assess trip ends by time of day (real world hot and cold starts)
   Special events
   Non-recurring incidents
   Special activity centers
   Better define actual link speeds and emission characteristics (by time of day)

3. Improve capabilities to assess microscale emission impacts (e.g. traffic flow changes):
   Assess emissions benefits of ramp metering
   Assess emission benefits of incident management/traffic flow improvement
   Assess emissions from parking lots

4. Evaluate and document the capability of existing air quality/emissions transportation models to predict noted historical episodes

5. Conduct research on heavy-duty truck emissions
SESSION 5
TOP-DOWN APPROACHES
TO OBTAINING DATA FOR AIR QUALITY ANALYSIS

GROUP 1

1. Census data:
   Use 1990 census data
   Develop a cookbook, short form, index, application matrix to allow user-
   friendly extraction of census data
   Provide air quality input in development of the year 2000 census questionnaire

2. Develop a work statement/mission to establish a centralized office to serve as a
   clearinghouse of transportation data at state, local, and air quality district levels:
   Develop automatic data transfer techniques

4. Design of traffic management systems to include air quality related information:
   Include speeds, acceleration/deceleration rates, vehicle class, cold/hot starts, etc.
   Explore automated vehicle identification and/or global positioning system uses

5. Develop a compendium of state practices regarding privacy issues:
   Determine the kind of information that can be shared with public
   Establish the role of public agencies
   Investigate vehicle registration data by UTM or latitude/longitude

6. Determine if it is feasible or necessary to do traffic monitoring at local street level

7. Determine travel characteristics of new and converted alternate fueled vehicles:
   Compare alternate fueled vehicle use to use of conventional vehicles

8. Analyze heavy-duty vehicle, delivery vehicle, and taxi activity:
   Evaluate contribution to congestion and emissions
   Examine feasibility of use restrictions

9. Investigate the feasibility of reporting vehicle class by MOBILE weight class, rather
   than by number of axles (under the Highway Performance Monitoring System)

GROUP 2

1. Evaluate existing data:
   Data may already exist that are currently not being used

2. Develop strategic data collection plans
3. Identify specific data collection and analysis projects
4. Develop data that can be used to assess socioeconomic impacts
5. Undertake additional behavioral analysis projects
6. Collect data needed to analyze emissions and activity for heavy-duty vehicles

GROUP 3

1. Establish professional standards for data accessibility:
   Assumptions
   Disclaimers
   Ethical standards
   Timeliness

2. Ensure compatibility of data
   Data should serve multiple purposes
   Develop data standards
   Design data collection for multiple applications
   Institute similar data formats across information systems
   Provide user-friendly PC data sets
   Eliminate institutional barriers

3. Collect comprehensive truck/commercial fleet data for transportation/air quality

4. Assess feasibility and methods of using journey to work census data to estimate VMT reductions of trip reduction strategies

5. Develop a directory of state and regional reports on scarce data:
   Establish a clearinghouse
   Incorporate report standardization elements
   Provide report abstracts
   Provide information regarding data source, contact, and cost

GROUP 4

1. Research ways of putting collected data to better use through data sharing and enhanced use of existing systems (e.g. sharing GIS databases).

2. Research the implications of under-counted groups (e.g. military, tourists, students, specific socioeconomic groups) in data collection on air emissions modeling, and provide factoring methods to compensate.
3. Quantify illegally certified and unregistered vehicles if they exhibit higher emissions

3. Research legal aspects and restrictions of data collection at national and state levels (i.e. confidentiality)

4. Determine emissions characteristics of heavy-duty vehicles in activity centers and develop guidelines for mitigating impacts

5. Investigate innovative ways (e.g. remote sensors, transponders, etc.) of acquiring speed, VMT, air quality, and emissions data (e.g. long path monitoring of pollutant concentrations along roadways to evaluate TCM impacts).

6. Conduct research on changing household characteristics and the impact on travel and air quality

7. Research ways to collect and incorporate local street network data into air emissions modeling (pay special attention to reliability and accuracy of traffic count methods)

**GROUPS 5 & 6**

1. Conduct research to more clearly identify the average and range of vehicle use, emissions rates, and total emissions

2. Focus research on uncontrolled and early-controlled vehicles:
   - Examine patterns of use
   - Examine distribution of vehicles, with a policy perspective
   - Demographics of ownership

3. Conduct household surveys of non-work travel specifically in non-attainment-areas

4. Evaluate the highway performance monitoring system (HPMS) in non-attainment areas

5. Research potential uses of IVHS technologies:
   - Routinely collect travel and congestion data with hour by hour resolution
   - Monitor external trips (e.g. confirm accuracy of screenline counts)
   - Must address privacy issues related to IVHS technology

6. Analyze how agencies can use currently available operational data (e.g. traffic control, inspection and maintenance, transit, etc.)
SESSION 1
MOBILE SOURCE EMISSIONS ESTIMATES
AREAS OF CONCERN - BRAINSTORM NOTES
VARIOUS GROUPS

Users versus researchers:
- Software-PCs and mainframes, data collection, methodologies

Improve transferability of California research to other states:
- California vehicles and California congestion/operation
- Market penetration of future LEV technologies for adopted California programs
- Assess market penetration and emission characteristics of California reformulated gasoline
- Include LEV emission characteristics in emission models (EMFAC/MOBILE)

What ozone precursors should we focus upon (HC vs. NOx)

Develop comparisons between gasoline and alternative fuel vehicles

Linking transportation, emission, and air quality (i.e. airshed) models
- (e.g. linking TRAFCOM or DTIM to MOBILE5 or EMFAC)

Grid the transportation/emission models to improve input to air quality models

Develop guidance for use of transportation and emission models

Develop PC-based linkages where possible

Recognize that there is an immediate need for modeling tools (1993 SIP due dates) as well as a long-term need

Take a national focus on pollutants rather than the current specific focus on CO & O3
- (e.g. PM$_{10}$ is a major issue for some areas)

Assess re-entrained PM$_{10}$ source strength for freeways
- Need to separate out natural PM$_{10}$ sources

Use historical data to find out where weaknesses and data gaps are
- Identify gaps where emissions are not "real-world" (e.g. speed emissions)

Conformity process:
- Determine if research findings are consistent with conformity findings (e.g. new speed correction factors)
- Improve guidelines
- Undertake research linking system improvements to reduced emissions
- Undertake research linking behavioral TCM effectiveness to reduced emissions

Vehicle activity data acquisition for TCMs
- Operational lane miles, 24-hour lane use activity, etc.

Better quantify emissions of toxic air contaminants from tailpipes

Technology transfer problems
- A disconnected research process exists - independent finding without coordination
- Improve our ability to turn research results into policy
- Timeframe conflict: SIP calls without guidance, policy requirement vs. reality, etc.
- Uncertainty needs to be made explicitly known and included in analyses
- Research findings are not translated into policy quickly enough
- Data availability/accessibility issues must be addressed
Research design often ignores policy needs or user needs
Improve communication between researchers, policy makers, and implementers
Coordination/teamwork approaches should be taken
Improve dissemination of information and findings to the public
Industry and government
Trust is an issue
Develop consortiums
Develop model user and policy maker guidelines (assumptions, methods, etc.)

Model Robustness
Assess usefulness over time
Recognize lack of data quality
Identifying true cause-effect relationships:
Vehicle activities that cause emissions
Assess if we will have needed activity data
Determine what local level data will be needed
Quantify the costs that will be entailed
Recognize that uncertainty exists but that we must move forward
Don't hide uncertainty

Strategic Data Collection
Determine what data are needed
Determine what money is available and how it can be transferred to the local level
Remember that vehicle testing is costly
Identify the activity data that are needed
Develop modal emission rate and/or engine map approaches

Decision Oriented Models
Determine if relative comparisons can be developed
Assess model complexities and determine if model complexities interfere
Evaluate regional versus corridor level analyses
(VMT, engine starts, evaporative, inspection & maintenance)
Develop user/policymaker guidelines (including assumptions and methods)

High speed, acceleration, and deceleration
Potential changes for modeling
Modal estimates
Number of cars
Location of acceleration and deceleration operational modes
Modal-transition to real world
"Modal emissions/traffic model"
Account for modal emissions in emissions inventory
Develop an inventory that includes modal information
Relationship between testing schedules and inventory procedures/models
Temporal effects of congestion
Effects of heavy-duty vehicles
Comprehensive database
Modal mix definition
Analysis of SCF (reflect the real world)
Modal trip definition
  Fit to TDM modeling
  Cycles by trip type
Modeling effects of acceleration frequency on emissions
  Real-world congestion
  Emissions/mode
  Real world/mode
Modeling: Which factors affect emissions
  Is the set complete
  Which are important
Idle conditions/effects
  Auto - idle versus stop versus queue
  Heavy-duty vehicles - duration
Improved data for heavy-duty vehicle emissions
Effects of ramp metering on:
  Idle time
  Acceleration and deceleration (ramp versus flow)
  PM$_{10}$
Acceleration rates and trip characteristics
Improved evaporative tests
Macro versus micro modeling
  Determine what is important at each analytical level
SESSION 2
TCM AND TDM EFFECTIVENESS ANALYSIS AND MONITORING
AREAS OF CONCERN - BRAINSTORM NOTES
VARIOUS GROUPS

Implementation Methodology
  Develop prototype state regulations
  Estimate emission credits
  Develop procedures for monitoring
Linking TCMs to transportation/air quality modeling
TCM evaluation/quantification and determine how to analyze
  Comparative effects
  Implementation over time
  Mode shift effects
Determine how to quantify multiple entity/regional TCMs
  Cost effectiveness
  Additivity
What are short/long term effects of:
  Cost/benefit
  For/to whom
Identify Most effective TCMs
Congestion pricing/SOVs
Other peripheral effects
  Quantification
  Cost/Benefit and cost effectiveness
  Implementation monitoring (reporting versus doing) and quantify impacts
  Incremental effects
  TCMs versus capital investment
Research on incentives
  Most effective employer based trip reduction measures
Methods/criteria for average vehicle ridership targets for different areas
  Access to transit
  Parking supply
Leverage and synergistic effects - role of TCMs as catalysts for other TCMs
Home-based rideshare analysis and possible incentives
Effectiveness of marketing and public education: (i.e. what works/doesn't)
  Quantify effectiveness
Air quality effectiveness of "split mode" travel response (e.g. park and ride)
Relationship between SOV rate and employee numbers
How to effectively package transportation control measures

Evaluate the potential effectiveness of implementing a gas tax as a means to reducing VMT
Collect data on modes used to access HOVs (park-n-ride cold start issue)
Identify relationship between TCMs and congestion management
Identify institutional and policy inconsistencies which adversely impact TCM utility and
  identify means for overcoming these obstacles
SESSION 3
LAND USE, TRAVEL PATTERNS, AND AIR QUALITY
AREAS OF CONCERN - BRAINSTORM NOTES
VARIOUS GROUPS

Offspring (son) of ITE
  Quantify emissions by land-use (and trip type)
Transit accessibility criteria
Synergistic effects of land use/transit/transportation
  Mix use
  Other patterns
Electric Vehicles:
  Quantify penetration
  Charging patterns/efficiency
Land use modeling protocols and definitions
Parameters for land use inventory:
  Accessibility/price
  Range of options/synergy
Remote sensing
  Resolution necessary for land use modeling
Effect of local parking control on regional land use
Pros/Cons of TCMs based on land use scenarios
Effects of disaggregation of electric vehicle
  Data on: emissions, travel patterns, energy use, dispatch, etc.
Telecommuting and land use patterns
Optimizing land use alternatives for transportation-price-sensitive population groups
Increased sensitivity in land use alternatives analyses
Implications of changes in parking policy: pricing/phasing, land use/zoning, equity, etc.
Infill versus sprawl, and impacts upon: air quality, VMT, congestion, average speed,
  infrastructure cost, energy use
SESSION 4
TRANSPORTATION DEMAND MODELING
FOR AIR QUALITY PLANS AND CONTROL STRATEGY ANALYSIS
AREAS OF CONCERN - BRAINSTORM NOTES
VARIOUS GROUPS

How to make traffic counts more accurate
Performance standards for travel demand models for conformity:
   TCM-sensitive
   Price sensitive
   Congestion/Time
   Speed/Vehicle mode
   Assumptions clearly defined
   Ability to test alternatives quickly
Potential for real-time system evaluation and use of embedded loop experiments
Focus on output
   Basis for TCM evaluation
   Peak versus off-peak
Develop models of trip-chaining and park time (cold/warm starts)
More data on actual speeds as they relate to emissions
Feasibility of developing a goods movement model (heavy-duty vehicles) for air quality purposes:
   Difficulty of collecting data
   Access to private data
Spatial/temporal factors of emissions critical to control strategies
Factor geography into model
   Effect of terrain
   Extended acceleration/deceleration
Protocols for delineation of input assumptions to provide accountability to non-modelers
Means to establish modal activity (operational cycle) by average speed, facility type,
   intersection or ramp
Modal emission tools for transportation engineers to test/estimate micro-scale link characteristics
Need to model micro-scale hot spots i.e., intersections, street canyons
Pilot projects to develop statistical TDM models
SESSION 5
TOP-DOWN APPROACHES
TO OBTAINING DATA FOR AIR QUALITY ANALYSIS
AREAS OF CONCERN - BRAINSTORM NOTES
VARIOUS GROUPS

Comprehensive truck/commercial fleet data for transportation/air quality
Marketing data:
  To users
  To collectors
  To victims
Improve reliability of vehicle use data
  Odometer
  Testing
  Connect with other data
Develop universal multi-modal database
Feasibility and methods of using journey to work census data to estimate VMT reductions of
trip reduction strategies
Prototype legislation to permit/safeguard sharing of state data including addresses
  Veh/driver
  Employer
Increase use of technology in data
Reporting in PC data user sets that is user friendly
Reporting other than averages
Find means to track goods as well as modes (perhaps with bar codes)
Compatibility of data
  Serve multiple purposes
  Standards
  Design for multiple applications
  Format:
    Across information systems
    User-friendly PC data sets
Institutional barriers
Directory of state and regional reports on scarce data:
  Clearinghouse
  Standard elements
  Abstracts
  Source/contact/cost
Professional standards for data accessibility
  Assumptions
  Disclaimers
  Ethical standards
  Timeliness
Need better data on commercial vehicle fleets