Metropolitan Washington Council of Governments
National Capital Region Transportation Planning Board

Use of Feedback Loops Coupled with Nested Logit Mode Choice Models

November 16, 2007

Vanasse Hangen Brustlin, Inc.
8300 Boone Blvd, Suite 700
Vienna, VA 22182
(703) 847-3071

Executive Summary

The Metropolitan Washington Council of Governments Transportation planning Board (TPB) engaged Vanasse Hangen Brustlin (VHB) to review the use of feedback loops coupled with nested logit mode choice models within travel demand models in use at MPOs in the United States. Using a nested logit structure for mode choice modeling has been identified as the State of the Practice, particularly among large MPOs.

Some MPOs using nested logit mode choice also feed the results back into their trip distribution models. There are perceived advantages and disadvantages to this process that TPB needs to understand for its forecasting process. This memo summarizes our review; Table 1 summarizes the responses from individual MPOs.

MPOs employ feedback loops in their travel forecasting tools because it is good modeling practice; yet they acknowledge some issues that can be difficult to understand or explain to decision-makers. Nothing in the literature or heard from MPOs suggests stopping or curtailing the use of feedback in conjunction with nested logit mode choice; rather, it recommends continuing feedback as part of the model chain and acknowledges the role of proper calibration and validation as echoed by a 2003 FSUTMS report. Rigorous examination of the results of each calibration run should identify any unusual model results that necessitate correction before validation and acceptance with a determined optimal number of feedback loop iterations. When examining the results of the feedback process careful attention should be paid to localized impacts as well as regional impacts to assure that unexplainable results in one area are not masked by regional impacts. Further research may be needed to determine an optimal number of feedback iterations to be used with the TPB model.

Table 1: Results of MPO Responses

MPO	Region	Mode Choice Formulation	Feedback	Unusual Results
ARC	Atlanta	Nested Logit	Highway and Transit to Generation; Distribution; Mode Choice	None reported
CTPS	Boston	Nested Logit	Highway and Transit to Distribution and Mode Choice	None reported
NCTCOG	Dallas-Fort Worth	Nested Logit (work trips); Multinomial Logit (non-work)	Highway and Transit to Distribution and Mode Choice	None reported
Metro Council	Minneapolis/ St. Paul	Nested Logit	Highway and Transit to Distribution and Mode Choice	None reported
SANDAG	San Diego	Nested Logit	Highway and Transit to Distribution and Mode Choice	Some VMT dampening; issues upstream and downstream of HOT facility

MPO	Region	Mode Choice Formulation	Feedback	Unusual Results
PSRC	Seattle	Multinomial Logit with non-motorized nest	Highway and Transit to Distribution and Mode Choice (work trips) Highway only to Distribution (non-work trips)	None reported
DRCOG	Denver	Multinomial Logit	Highway and Transit to Distribution and Mode Choice	None reported; but presence of feedback loop makes finding answers "difficult" when checking strange results
MTC	San Francisco	Nested Logit	Highway and Transit to Auto Ownership; Generation; Distribution; Mode Choice (but no logsum interaction between Mode Choice and Distribution)	As much as 50% fluctuation in distribution; unusual effects from introducing multimodal improvements or large single-mode improvements
H-GAC	Houston	Nested Logit (being recalibrated)	Not presently; part of 2007 model improvement will examine use of feedback by other MPOs and consider implementation at H-GAC for either all purposes or just work trips	N/A
MAG	Phoenix	Nested Logit	Highway only to Land Use Model; Distribution; Mode Choice	None reported
WFRC	Salt Lake City	Nested Logit	Highway only to Distribution; Mode Choice run post-convergence	None reported
SCAG	Los Angeles	Nested Logit	Highway only to Generation; micro-loops of auto times and home-based work logsums between distribution and mode choice	None reported
DVRPC	Philadelphia	Binary Logit, nested by mode-of-approach	Full feedback	None reported

Background: Nested Logit and Feedback as State of the Practice and Current TPB Process

The recent TRB survey of MPOs identified the use of a nested logit mode choice structure as the State of the Practice in travel demand forecasting. Nearly 75% of large MPOs (peers to TPB) use a nested logit mode choice model for home-based work trips and nearly 60% use nested logit for other trip purposes.[1] MPOs (such as TPB) that provide forecasts for Federal Transit Administration (FTA) New Starts projects, highway corridor studies, or that model toll lanes are more likely to employ nested logit for mode choice than MPOs that do not engage in these three activities.[2] The use of a feedback loop was also identified as the State of the Practice. Over 80% of large MPOs feedback highway and transit travel times to trip distribution and mode choice.[3] As with the use of nested logit, feeding back travel times to distribution and mode choice is more likely among MPOs that have New Starts/Small Starts programs, that conduct corridor studies, or that model toll lanes.[4]

TPB's current production model (Version 2.1 D #50) uses a sequential multinomial logit structure for mode choice and feeds back peak period and off-peak highway and transit times to trip generation, trip distribution, and mode choice (peak period transit accessibility to jobs is fed back to the demographic submodels; peak and off-peak composite times are fed back to trip distribution).[5] There are six iterations of the feedback loop executed for a typical model run.[6]

A primary component of TPB's model development program for FY 2007 is the development and implementation of a nested logit mode choice model. TPB has been working with AECOM Consult to develop the model. Previously, AECOM had developed a three-purpose, 15-mode nested logit (NL) mode choice model that has been used in project planning studies, and is applied as a post-process to the COG/TPB travel model. Building off AECOM's work, TPB staff has modified this NL mode choice model so that it has four purposes (and still 15 modes). Using the version 2.2 travel model as a base, TPB staff has replaced the existing five-mode multinomial logit (MNL) mode choice model with its four-purpose, 15-mode nested logit mode choice model and is currently working on a year 2002 calibration.

Literature Review

VHB conducted a review of major professional and academic publications and other sources for articles on the issue of feedback and its application with a nested logit mode choice model. Following the feedback requirement of ISTEA, most of the available literature covers the application of speed feedback generally and does not directly address the interaction of feedback with nested logit mode choice specifically; however, nearly all the specific models considered in the literature employ either multinomial logit or nested logit for mode choice.

---

[1] F. Spielberg and P. Shapiro. Metropolitan Planning Organization Travel Forecasting State of the Practice. Presentation to TRB 2007 Annual Meeting. *Note: the Final Report of the TRB Committee has not been published; therefore, minor details of the data are subject to change but the overall findings are valid.*
[2] Ibid.
[3] Ibid.
[4] Ibid.
[5] M. Moran. Memo to VHB 7/19.2007.
[6] R. Milone, TPB Travel Forecasting Model Version 2.1D #50 User's Guide, 2004.

Boyce *et al.* (1994) evaluate a number of feedback algorithms and provides the theoretical basis and proof of the Method of Successive Averages (MSAs) algorithm used for establishing equilibrium across the model components iterated during feedback.[7] TPB employs the MSAs algorithm in its feedback loop implementation. Boyce's algorithms were being introduced while peer review panels funded by USDOT were recommending that MPOs in Atlanta, Cincinnati, and Hartford employ feedback in their models.[8] Johnston and Ceerla (1996), working with the Sacramento regional model, found that with a full feedback loop using the MSAs algorithm a no-build solution appeared more favorable than building HOV lanes.[9] Lan (2003) reviews the feedback process implemented in the standardized model set used by MPOs in Florida and notes that "*proper calibration of the friction factor governing trip length and other important model parameters seems to bear more significance with regard to affecting the model accuracy than the feedback process itself.*"[10] More recently, Boyce (2002 and 2004) has been pushing for a shift away from the sequential modeling paradigm to an integrated model, arguing that 1) the implementation of feedback only partially overcomes the deficiencies inherent in the sequential process and 2) the widespread acceptance and use of the sequential method is largely a result of historical happenstance.[11]

A 2001 TRB report lists implementation of feedback as an improvement for air quality modeling.[12] Previous USDOT guidance notes the use of feedback loops as a best practice.[13] A recent peer review of the San Diego MPO model set noted the use of feedback; the review concluded that the model set was consistent with the state of the practice.[14] A 2003 survey of approximately 30 MPOs (including most of TPB's peers) concluded that 64% of large MPOs fed back congested times to distribution and mode split; that usage was much higher among MPOs in non-attainment areas; and that several MPOs were planning to implement a feedback loop as part of model improvements.[15] The previously noted data from the recent TRB survey shows that this figure has increased for all responding MPOs.

Forecasting work performed in 2005 to model a toll facility in the Minneapolis/St. Paul area necessitated modifying the existing feedback loop in the MPO model after initial tests with the full feedback loop yielded some unusual results: overall network travel times worsened with the implementation of toll lanes when compared with the base case.[16] Similarly, documentation

---

[7] Boyce, D.E., Y-F. Zhang, and M.R. Lupa. "Introducing 'Feedback' into Four-Step Travel Forecasting Procedure Versus Equilibrium Solution of Combined Model", Transportation Research Record 1443, TRB, National Research Council, Washington, D.C., 1994, pp. 65–74.

[8] SG Associates. Summary of Comments Prepared by Travel Forecasting Peer Review Panels, Federal Transit Administration, 1994.

[9] Johnston, R.A. and R. Ceerla. Travel Modeling with and without Feedback to Trip Distribution. UCTC Report Number 431. University of California at Berkeley, Journal of Transportation Engineering, January/February 1996, pp. 83-86.

[10] Lan, C.J. Incorporating Feedback Loop into FSUTMS for Model Consistency, Volume 1. Summary of Final Report BC-791. University of Miami (FL), September 2003.

[11] Boyce, D. "Is the Sequential Travel Forecasting Paradigm Counterproductive?" Journal of Urban Planning and Development, December pp.169-182. See also Boyce, D. Forecasting Travel on Congested Urban Transportation Networks: Review and Prospects for Network Equilibrium Models. Paper for TRISTAN V: the Fifth Triennial Symposium on Transportation Analysis, Le Gosier, Guadeloupe, June 13-18, 2004.

[12] Cambridge Systematics, Inc. National Highway Cooperative Research Program Report 462: Quantifying Air-Quality and Other Benefits and Costs of Transportation Control Measures. TRB, National Research Council, Washington D.C., 2001.

[13] Barton-Aschman Associates, Inc. and Cambridge Systematics, Inc. Model Validation and Reasonableness Checking Manual. Federal Highway Administration, Travel Model Improvement Program. Section 4.1. http://tmip.fhwa.dot.gov/clearinghouse/docs/mvrcm/ch4.stm

[14] Volpe National Transportation Systems Center. Report on Findings of the Peer Review Panel of the San Diego Association of Governments Travel Demand Model. Cambridge, MA, December 2005.

[15] Walker, W.T., A White Paper on Metropolitan Planning Organization Land Use, Transportation, and Air Quality Modeling Needs in the New Federal Transportation Bill. National Association of Regional Councils in association with the Delaware Valley Regional Planning Commission, February 2003. TPB was not one of the participating agencies in this study.

[16] Cambridge Systematics, Inc. with URS Corporation. MnPass System Study, Technical Memorandum #3, Travel Demand Forecasting Approach. Prepared for Minnesota Department of Transportation, Feburary 3, 2005 (revised). The feedback loop was modified to iterate only

from a 2004 corridor study in the Salt Lake City area discusses the effects of adding feedback to distribution and mode choice to the MPO model on the forecasting results.[17]

MPO Contacts

VHB contacted representatives of several MPOs to obtain information about their use of feedback in travel demand forecasting. MPOs were selected primarily because they are peer agencies of TPB in at least one of the following characteristics: size of modeled area; network complexity; similar regional issues; sophistication of modeling approach. Several of the MPOs contacted currently use multinomial logit rather than nested logit for mode choice, but had enough other characteristics in common with the TPB region that their information was useful. Each MPO was specifically asked if they had experienced any usual model results or outcomes, either transit or highway, with the use of their feedback loop. The discussion with each MPO is summarized below.

Atlanta (Atlanta Regional Council [ARC])[18]

ARC uses TP+/Cube as its modeling platform and has a nested logit mode choice model. In its early implementation ARC used “lots” of feedback loop iterations, and the results did not converge. To address this issue, ARC in spring 2004 implemented the MSAs algorithm for its equilibrium assignment and changed the closure criteria, and the results improved. At the same time ARC modified its feedback loop to include an additional midday highway assignment, for a total of two midday assignments within the loop. The midday assignments are performed regardless of the number of loops required for the AM assignment. In winter 2005 ARC corrected its highway skim procedure so the high-occupancy vehicle (HOV) skims for the AM and midday assignments in the feedback loop used congested times rather than uncongested times. At this time the feedback loop closure criteria were modified as well. These changes required recalibration of the HBW gravity model used for trip distribution; the model was updated using gamma functions for each income group.

ARC’s feedback loop includes trip generation as well as distribution and mode choice, and both highway and transit speeds/times are part of the loop; bus speeds are generated by a separate bus speed model that was independently calibrated. A typical model run iterates five to ten feedback loops. The assignment gap tolerance is 0.001 and there are usually 30 iterations, although the number of assignment iterations varies by model year and time period. ARC did not report any issues with its current implementation. ARC considered changing their gap to 0.0001 several years ago during a model upgrade but found that the resulting increase in model run-time did not yield significant improvements to their assignment results; however, they are now again considering this change because of the performance improvements offered by Cube Cluster.

---

through mode choice rather than distribution and mode choice. This resulted in fixed trip tables coming out of distribution, similar to FTA requirements for New Starts forecasts.

[17] Federal Highway Administration and U.S. Army Corps of Engineers. Draft Legacy Parkway Supplemental Environmental Impact Statement/Reevaluation and Draft Section 4(f), 6(f) Evaluation, Appendix B—2020 Travel Demand Analysis, December 2004. The model improvements incorporating the feedback loop were made between the initial draft EIS and the initial final EIS.

[18] Telephone conversation with Guy Rousseau, Atlanta Regional Commission. See also Atlanta Regional Commission, Travel Forecasting Model Set for the 20-County Atlanta Region, 2006 Draft User’s Guide and The Travel Forecasting Model Set for the Atlanta Region, May 2006.

Boston (Central Transportation Planning Staff [CTPS])[19]

CTPS currently uses EMME/2 as its modeling platform but is planning to change software within the next year and is looking at both Cube Voyager and TransCAD. The current model uses a nested logit formulation for mode choice and feeds back composite impedances for all trip purposes back to distribution and mode choice. There are typically one to two feedback loops for a regular application, although more are used during calibration. CTPS did not report any significant issues.

Dallas/Fort Worth (North Central Texas Council of Governments [NCTCOG])[20]

NCTCOG uses TransCAD as its modeling platform and feeds back congested times to trip distribution and mode choice (nested logit for work trips, multinomial logit for non-work trips). Their base model run contains two feedback loops. In the initial iteration and the first feedback iteration trips are assigned for the AM peak period and off-peak. There are 30 assignment iterations for each time-of-day assignment: 15 for the first feedback loop, 15 for the second feedback loop, and 30 for the final iteration (no feedback). A base model run typically takes 13-15 hours using parallel processing and multiple-processor hardware. Large shifts in trip distribution are indicative of problems with the feedback loop; NCTCOG did not report encountering any of these problems.

NCTCOG limits the number of feedback loops both for run-time minimization as well as for "reasonable" convergence. They are able to replicate results between model runs and have not experienced "random" results; the process is designed to encourage consistency without overstated accuracy but while maintaining a "reasonable" level of precision. NCTCOG typically performs four model runs per week, about 200 runs per year. While acknowledging that they currently need terabytes of storage for model space and completed runs, NCTCOG indicated they are likely to run more assignment iterations in the future, although not necessarily more feedback loops.

Minneapolis/ St. Paul (Metropolitan Council of the Twin Cities)[21]

The Twin Cities' MPO uses TP+ as its modeling platform and has a nested logit mode choice model. The Metro Council model usually reaches closure (less than 2% change in AM peak period VMT between iterations) in three feedback iterations; each highway assignment step is capped at 30 iterations (using the TP+ *maxiters* parameter), although staff reports the model reaches equilibrium in 14 to 18 iterations during the most congested hours. The Metro Council uses the TP+ default convergence tests during assignment. The MPO reported no known issues with its feedback loop; see the previously cited MnPass technical memo (Cambridge Systematics [CS] 2005) for feedback loop issues associated with toll modeling.

---

[19] Telephone conversation with Karl Quackenbush, CTPS.

[20] Telephone conversation with Arash Mirzaei, NCTCOG. See also North Central Texas Council of Governments, Dallas-Fort Worth Regional Travel Model Description, Draft, September 2006.

[21] Telephone conversation and follow-up email with Mark Filipi, Metropolitan Council of the Twin Cities.

San Diego (San Diego Association of Governments [SANDAG])[22]

SANDAG uses TransCAD as its modeling platform and has a nested logit mode choice model. The SANDAG model feeds back composite impedances to distribution and mode choice. Initially there was a single feedback loop, now multiple loops are employed. The feedback loops do not start with free-flow conditions; this reduces model run-time and is representative of the observed network – where free-flow conditions are rarely observed. One of the issues SANDAG noted was the selection of the input impedances (logsums). They indicated that the calibration process is tedious, and that the feedback loop is currently disconnected while improvements are being made to the mode choice model. It was also noted that the loop iterations drive up run-time, that they have sometimes experienced VMT dampening, and that they have sometimes noticed unusual results upstream and downstream of their HOT facility. Nonetheless, SANDAG continues the use of its feedback loop because it is consistent with the State of the Practice.

Seattle (Puget Sound Regional Council [PSRC])[23]

PSRC has a multinomial logit mode choice model with a single nest for non-motorized travel. Their feedback loop to distribution and mode choice uses composite impedances from the mode choice logsums for work trips but feeds back auto times only for non-work trips. Their process begins with a free-flow assignment (assignment zero) for the first iteration. Iterations two through four use the full feedback loop and the MSAs algorithm for assignment before updating the skims. The fifth iteration proceeds through distribution and mode choice to the final assignment. PSRC uses a generalized cost assignment with five time-of-day segments; the number of time-of-day assignments plus the feedback loops does increase run-time—a typical model run is about 14 hours. PSRC has found that in their model trip distribution stabilizes fairly well at four feedback loops. Overall, they have found most of their forecasting results to be explainable. The PSRC model has been used by Cambridge Systematics and Mirai Associates to support toll modeling for the Washington State Department of Transportation (WSDOT).

Denver (Denver Regional Council of Governments [DRCOG])[24]

DRCOG uses TransCAD as their modeling platform and has a multinomial logit structure for mode choice. If DRCOG continued to significantly upgrade their trip-based model, they would implement a nested logit structure; however, the focus of model improvement is the development and implementation of an activity-based model. The current Compass trip-based model includes a feedback loop to distribution and mode choice. DRCOG did not report any encountering any unusual issues with their feedback loop; however, they did note that the presence of the loop can make finding "the answer" a complex search when addressing questions about forecasting results, either expected or unusual. DRCOG intends to include a feedback loop in their new activity-based model.

---

[22] Telephone conversation with Bill McFarlane, San Diego Association of Governments. See also Volpe Center (2005) report on SANDAG TMIP Peer Review and associated SANDAG staff presentation.

[23] Telephone conversation with Larry Blain, Puget Sound Regional Council.

[24] Telephone conversation with Erik Sabina, Denver Regional Council of Governments. See also PB Consult and Gallop Corporation, The Integrated Regional Model Project, Vision Phase Final Report. Produced for Denver Regional Council of Governments, March 2005.

San Francisco (Metropolitan Transportation Commission [MTC])[25]

The MTC model uses a nested logit formulation for mode choice and feeds back auto and transit times (zone-to-zone) to their auto ownership model (which drives trip generation) as well as distribution and mode choice; however, there is no interaction between the mode choice logsum and trip distribution. MTC reported that these so-called "grand feedback loops" lead to a lot of fluctuation, and that they have seen as much as a 50 percent fluctuation in work trip distribution from the effects of the feedback loop. Introduction of multimodal or large single-mode improvements (for example, a long BART extension or a new crossing of San Francisco Bay) can create strange, difficult to explain effects. MTC urged looking at the results of feedback applications at a sub-regional level, as problems can be masked by aggregation.

Ultimately, MTC agreed that feedback is useful, but modelers need to pay a lot of attention to what is going on in the forecasting results and the decision whether or not to employ feedback is in part a consideration of whose "rules" are in place for the study (FTA, air quality agencies, etc.). MTC uses fixed trip tables when preparing forecasts for long-range planning studies to avoid bizarre results from the use of full feedback. For shorter studies, MTC sometimes uses their feedback loop, depending on the amount of linkage required with their land use model; for example, is it useful to feed year 2010 travel times to year 2015 land use allocation? They also utilize "micro" feedback loops that iterate three to five times between mode choice and assignment only.

Finally, MTC noted that a major contributor to the issues with feedback to trip distribution is the oversensitivity of the gravity model (used by nearly all MPOs for distribution) to travel time changes. Using a destination choice model rather than a gravity model for distribution may improve the performance of feedback, although k-factors and trip length correction factors may still be needed. In a destination choice model there could be empirical estimation of factors such as crossing impedances for a major travel barrier (e.g., a Potomac River coefficient). Within an existing gravity model, MTC suggested looking at attraction balancing and specifically how tightly closure is forced for non-work trips as these criteria may also contribute to wide shifts during feedback applications.

Houston (Houston-Galveston Area Council [H-GAC])[26]

Although a 2005 review of MPO models for DRCOG indicated that the H-GAC model fed back travel times to trip generation, H-GAC indicated that they currently have no feedback loop in their EMME/2 model. H-GAC is in the process of implementing significant model improvements: converting their software platform to Cube Voyager and recalibrating their nested logit mode choice model. As part of this work H-GAC and their consultants will be evaluating the use of feedback to determine if their model update should feedback all trip purposes or just work trips to distribution and mode choice. H-GAC expects this effort to be concluded by September 2007.

---

[25] Telephone conversation with Chuck Purvis, Metropolitan Transportation Commission.
[26] Telephone conversation with Chris Van Slyke, Houston-Galveston Area Council. See also PB Consult and Gallop for DRCOG (2005).

Phoenix (Maricopa Association of Governments [MAG])[27]

MAG uses EMME/2 for modeling and has a nested logit formulation for mode choice. MAG is considering conversion of its software platform to TransCAD. The MAG model feeds back congested speeds to a separate land use model, as well as to distribution and mode choice. Transit speeds are not fed back due to transit's low regional mode share (less than one percent); however, there is a transit nest and corresponding impedances within mode choice. The feedback loop requires a minimum of five iterations to achieve equilibrium (root mean square error less than or equal to five percent for AM peak period trip table and link volumes). MAG reported that a typical model run executes ten iterations of their feedback loop, depending on the type of applications fewer iterations can be used. MAG also reported very long model run-times (multiple days for one run), which they are hoping to improve with their software conversion (and subsequent hardware upgrade). MAG did not report any unusual model results.

Salt Lake City (Wasatch Front Regional Council [WFRC])[28]

WFRC's model uses nested logit (local bus, express bus, BRT, LRT, commuter rail) mode choice and feeds back highway times to distribution only. WFRC stated that their model iterates only between assignment and distribution to save model run-time. They run a minimum of four iterations but typically require five loops for convergence. Mode choice is run once convergence has been achieved; the final assignment follows mode choice. WFRC did not report any unusual model results.

Los Angeles (Southern California Association of Governments [SCAG])[29]

SCAG's validated year 2000 TRANPLAN model feeds back auto times to trip generation (which includes an accessibility model). There are five "grand" feedback loop iterations; there are also micro-loop feedback iterations of auto times and the HBW logsums between distribution and mode choice. SCAG uses a nested-logit mode choice model. Each assignment step runs thirty iterations. The SCAG model employs a modified MSAs algorithm (average of averages) and reaches stability within three iterations. SCAG is currently undergoing a model conversion to TransCAD, where they will retain the feedback structure but are considering Caliper's new assignment algorithm to improve performance and stability. SCAG did not report any unusual model results.

Philadelphia (Delaware Valley Regional Planning Commission [DVRPC])[30]

DVRPC's TRANPLAN model passes through the full model chain 24 times and uses the Evans algorithm to implement equilibrium assignment. The mode choice model is binary logit with nests by mode-of-access. DVRPC did not report any unusual results.

---

[27] Telephone conversation with Vladimir Livshits, Maricopa Association of Governments. See also Maricopa Association of Governments, Draft Model Documentation, 2007.
[28] Telephone conversation with GuiLin (Andy) Li, Wasatch Front Regional Council.
[29] Telephone conversation with Guoxing Huang, Southern California Association of Governments. See Chapter 4 for further discussion of the SCAG TransCad model.
[30] Walker, W. Thomas and Thomas Rossi. A Practioner's Guide to DVRPC's Evans Congestion-Equilibrium Travel Simulation. Presentation to 2007 TRB Planning Applications Conference, Daytona Beach, FL, and follow-up.

Conclusions

In their technical memo for the 2005 Minnesota toll study, CS provides an excellent summation of both the advantages and disadvantages of the use of feedback:

One of the effects of using composite impedances (or other multimodal feedback mechanisms) in trip distribution/destination choice is that when transportation improvements are made for any mode, the distribution of trips within the region is altered. This is probably more behaviorally accurate than the fixed trip table assumption, but it makes the user and systemwide benefits of the improvements more difficult to understand.[31]

The inability of sponsors to adequately explain the effects of feedback loops on their forecasting results and the desire to easily isolate project user benefits is why FTA requires the "disconnection" of feedback loops (i.e., models must use fixed trip tables) for New Starts forecasts. Nonetheless, the use of feedback can provide forecasting models with a good tool to get closer to modeling the "reality" of travel decision-making – congestion and improvements alter travelers' trip-making behavior. That is why the use of feedback is considered the State of the Practice and why its use is required by law for conformity analysis.

Ultimately, the available literature and comments of the surveyed MPOs using or considering the use of feedback echoes the themes of the CS text – MPOs employ feedback loops in their travel forecasting tools because it is good modeling practice; yet they acknowledge some issues that can be difficult to understand or explain to decision-makers. Nothing in the literature or heard from MPOs suggests stopping or curtailing the use of feedback in conjunction with nested logit mode choice; rather, it recommends continuing feedback as part of the model chain and acknowledges the role of proper calibration and validation as echoed by the 2003 FSUTMS report previously cited. Rigorous examination of the results of each calibration run should identify any unusual model results that necessitate correction before validation and acceptance with a determined optimal number of feedback loop iterations. When examining the results of the feedback process careful attention should be paid to localized impacts as well as regional impacts to assure that unexplainable results in one area are not masked by regional impacts. Further research may be needed to determine an optimal number of feedback iterations to be used with the TPB model.

[31] Cambridge Systematics and URS Corporation 2005, Ibid.