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NEW MARKETING PARADIGMS FOR TRUCKLOAD TRUCKING: USING AGILE DEDICATED FLEETS TO REGULARIZE DISTRIBUTION

MBTC FR-1080

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16. Abstract

In an effort to better serve customer requirements, reduce costs, and improve the quality of driver life, truckload trucking companies are turning increasingly to the use of dedicated fleets to sell capacity and to service customer delivery needs. Often, these dedicated fleets make use of engineered delivery lanes established to regularize the driving job. Many tools exist to support the development of such lanes based on aggregate shipment data. What is missing from the literature is evidence that engineered solutions in the form of dedicated lanes or tours are operationally feasible. The authors begin with a discussion regarding the operational feasibility of dedicated fleets based on the findings of preliminary experiments using a simple closed-loop lane tour between two hubs. This preliminary experimentation is then followed by additional experiments using two variations of the simple lane tour. Results of these experiments are subsequently presented and analyzed using standard measures of performance.

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New Marketing Paradigms for Truckload Trucking: Using Agile Dedicated Fleets to Regularize Distribution

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Abstract

In an effort to better serve customer requirements, reduce costs, and improve the quality of driver life, truckload trucking companies are turning increasingly to the use of dedicated fleets to sell capacity and to service customer delivery needs. Often, these dedicated fleets make use of engineered delivery lanes established to regularize the driving job. Many tools exist to support the development of such lanes based on aggregate shipment data. What is missing from the literature is evidence that engineered solutions in the form of dedicated lanes or tours are operationally feasible. The authors begin with a discussion regarding the operational feasibility of dedicated fleets based on the findings of preliminary experiments using a simple closed-loop lane tour between two hubs. This preliminary experimentation is then followed by additional experiments using two variations of the simple lane tour. Results of these experiments are subsequently presented and analyzed using standard measures of performance.

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1. Introduction

As manufacturing becomes more dispersed geographically, inter-facility material handling and distribution for finished goods becomes more challenging. These functions can also become more expensive. One way of dealing with these costs is through the use of dedicated truck fleets and regularized driving lanes. Tools are now emerging that enable large shippers to rapidly determine, from an average freight volume and capacity viewpoint, acceptable driving lanes or tours for dedicated fleets. What is generally missing from these tools is a means of determining operational feasibility of the lanes or tours. Only preliminary work in this area exists. See, for example, Taylor et al. [5].

Operational feasibility is a function of many factors in addition to freight volume. Other critical factors include the availability of return freight (balance), acceptable dock hours for pick-up or delivery, the location of facilities relative to freight markets, the distances between facilities, the size of service areas, and the amount of time in which orders are known in advance.

In this report, the authors examine some of these critical factors via discrete event system simulation to answer some key questions. What is an acceptable level of inter-facility freight density to permit proper dedicated fleet function given a stochastic operating environment? How important is tour length and service area size from an operational and cost viewpoint? How balanced must a lane be in terms of the availability of backhaul freight to make the lane operationally feasible? How much planning time is needed to ensure appropriate operations following the receipt of orders?

Another key issue is that of driver retention through better operational and dispatching strategies. Authors such as Mele [3],[4] have outlined the difficulties associated with driver retention in truckload trucking. Albrecht [1] has described driver retention as a key strategy for this decade. Regular lanes or tours would operationally result in shorter driver tour lengths, thus supporting the strategic objective of driver retention. Evidence of this can be found in Mele [3],[4] in comparing driver turnover rates between random over-the-road (OTR) truckload drivers and less-than-truckload (LTL) drivers. OTR driver turnover rates can range between 85% and 110% per year for some carriers. The more regular LTL driving job results in turnover rates on the order of 4.5% for city drivers and 10% for linehaul drivers. This indicates that appropriately designed lanes may lead to better retention rates and huge cost savings. This can only be achieved if lanes are engineered appropriately for operational feasibility from the standpoint of the driver, the carrier, and the customer.

2. Data Generation

To answer operational questions regarding lanes, two simulators have been developed. The first is designed to generate useful, controlled data. The second is to perform actual experimentation of daily lane operations.

Actual historical lane information has been provided for validation purposes by J.B. Hunt Transport, Inc., the largest publicly held truckload carrier in the United States [2]. Although this data is useful for model development and validation purposes, it is considered to be very

proprietary by J.B. Hunt Transport, Inc., and even more so by her customers. Therefore, all data used in this report has been generated using a simulation model written in the SIMNET II language. In addition to protecting proprietary information, the data generator permits the experimenter to strictly control parameters of interest.

The generator develops random data sets based on experimentally controlled values for freight density, lane length, hub service area size, and freight balance. A preliminary experiment using the simplest type of tour, i.e. a closed loop lane between two hubs (CL2 tour) is conducted to determine the operational feasibility and the experimental parameters of engineered lanes or tours. The freight density is based on an input value for available miles/driver/day for a fixed number of lane drivers (10 in this report). Values ranging from 300 to 800 miles/driver/day for the freight density are examined. Lane lengths ranging from 100 to 1500 miles are examined. Service areas ranging in radius from 10 to 100 miles are examined. Finally, data is developed to examine lane balance ranging from perfect balance to a 4/1 ratio of inbound/outbound freight. As a baseline scenario, it is assumed that 500 miles/driver/day is demanded, the lane length is 500 miles, the service area is 50 miles across, and that perfect balance is achieved on the lane. See Figure 1 for an example of a CL1 tour.

The CL2 tour is then further developed into two different tours; a CL3 tour and a J21 tour. A CL3 tour is a closed loop lane between three hubs instead of two. For experimental purposes, it is assumed that each hub is positioned such that they are equally distanced from one another. A J21 tour is similar to the CL3 tour with a difference in that it has two loaded legs and one unloaded (jump) leg. The unloaded leg represents a 'deadhead' empty movement to reposition the driver for a profitable loaded move. The length of the unloaded leg is some portion of the length of the loaded leg. An experimental design using the baseline scenario mentioned above is performed to see the effect of different lengths of the unloaded leg on the performance metrics. The ratio of the unloaded to loaded legs is varied from 0.3 to 0.7. The J21 baseline scenario assumes that the length of the unloaded leg is half of the length of each loaded leg. Figures 2 and 3 depict CL2 and J21 scenarios, respectively.

3. Simulation System

A very comprehensive simulation system has been developed to test operational feasibility of the lanes. The simulator can handle multiple tours, multiple tour types, and multiple driver domiciles concurrently. This model is also written in the SIMNET II language. It includes many sophisticated features to ensure that the model is representative of realistic dedicated fleet dispatching systems. For example, United States Department of Transportation (DOT) rules regarding driver rest are included. The additional experimental factor of load visibility (the average amount of time after receiving an order that the pick up is scheduled) is specified in this second model. Values range from .5 hours to 16 hours in duration.

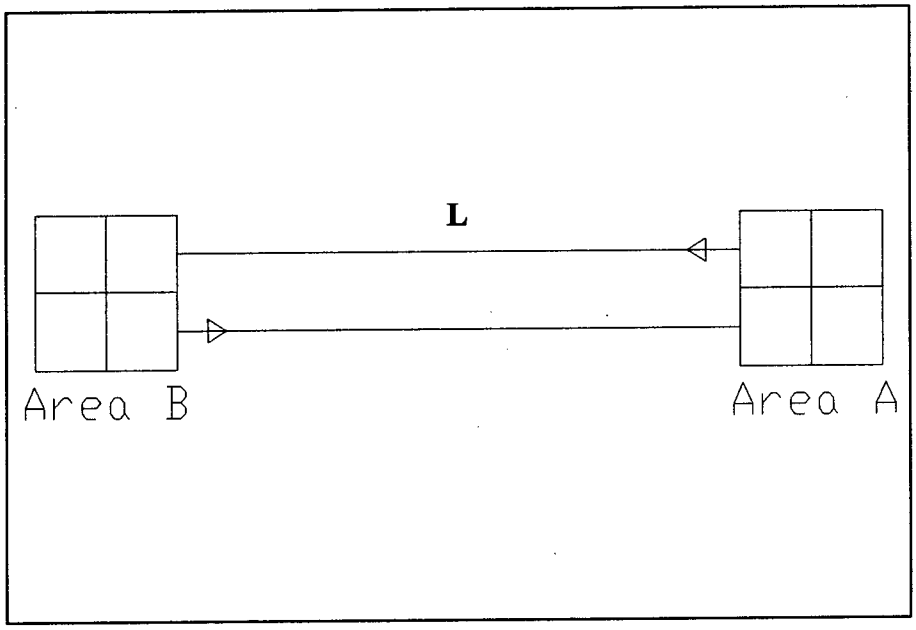


Figure 1. A CL2 tour schema.

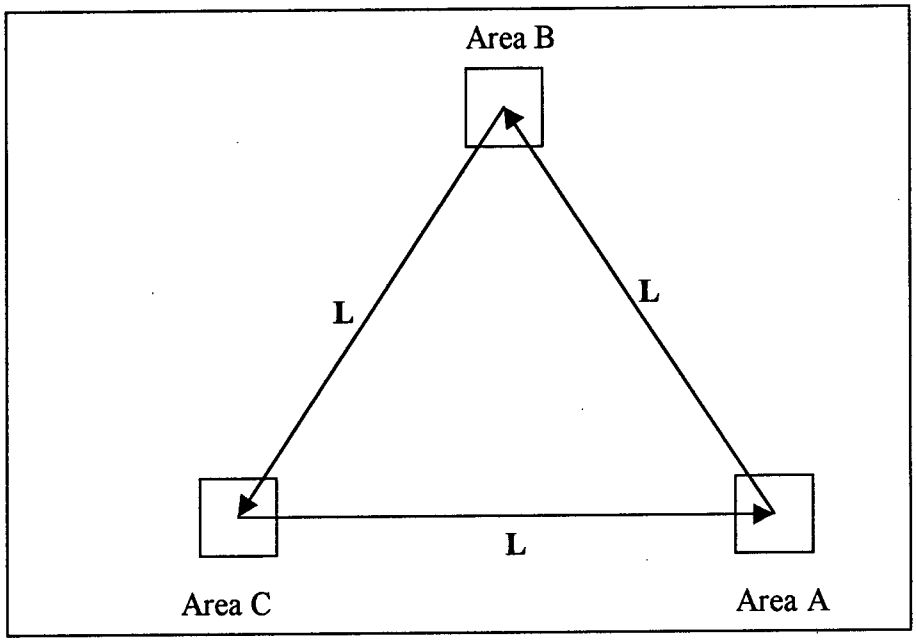


Figure 2. A CL3 tour schema.

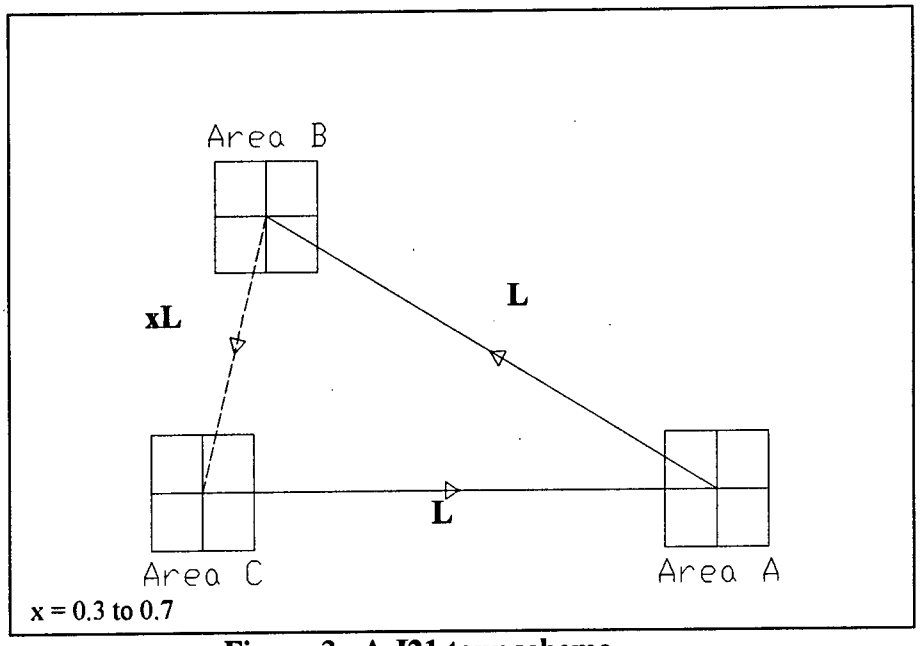


Figure 3. A J21 tour schema.

The data generation model builds driver and load information in such a way that steady state analysis is possible from time zero in the second simulation model. Therefore, no transient period is required. Each scenario is replicated for 10 runs to ensure that independent observations are produced. Experimentation with the model reveals that 10 runs of 2 weeks each is sufficient to produce tight confidence intervals for the selected performance metrics. The SIMNET II trace feature is used to verify all simulation code and validation is achieved using actual data and information supplied by J.B. Hunt Transport, Inc.

4. Design of Experiments

Full factorial designs are used to examine the effects of each of the experimental factors and their interactions with one another. With the exception of the freight balance, all other factors are examined at three experimental levels; low value, baseline value, and high value. The freight balance is examined at two levels only; baseline value and high value (a low value would be experimentally identical to a high one, given that we are interested only in deviation from perfect balance). The values for each level are determined using preliminary experimentation with CL2 tours to determine appropriate extreme values of interest while maintaining operational feasibility. The freight volume is examined at 400, 500, and 600 miles/driver/day. The length of haul is examined at 300, 500, and 700 miles. The service area radius is examined at 30, 50, and 80 miles. The freight balance is examined at a perfect balance and a 3/2 ratio of inbound/outbound freight for the CL2 and J21 tours. For the CL3 tour, the freight balance is examined at a perfect balance, a 4/3/3 ratio, and a 5/3/2 ratio. The load visibility is examined at 2, 8, and 12 hours.

5. Analysis of Results

In this section, we discuss the results of the experimentation described above. We begin with the results from the preliminary experimental design based on the CL2 tour. Subsequently, we present the results of the full factorial design of all three tour types (CL2, CL3, and J21 tours). We include statistical analysis of SIMNET II output via Analysis of Variance (ANOVA) methods and Tukey Multiple Range Comparison Tests.

The performance metrics deemed most important and most interesting for this study are; 1) miles per driver per day, 2) percent loaded miles, 3) percent of loads used, and 4) percent of late loads. The preliminary experimental design used in this report varies each of the five experimental factors (length of haul, service area radius, freight balance, freight volume, and freight visibility) individually to examine main effects in isolation.

5.1 Preliminary Experimental Results

Results of initial experimentation appear in Figures 4-7 for the selected metrics. In each figure, the point in the center of each figure where all lines converge represents the baseline scenario. Lines to the left of center represent decreases in baseline values. Lines to the right of center represent increases in baseline values. For example, the leftmost point on the length line represents a 100-mile length of haul in all four figures. The rightmost point represents a 1500-mile length of haul in all four figures. The other experimental factors vary similarly according to the baseline values and extreme limits discussed above. In this section, the results indicate observed performance when varying each experimental factor individually, while holding the others at baseline values.

Figure 4 reveals that the length of haul should be at least 400 to 500 miles to be a viable candidate lane. Similarly, the expected freight volume (availability) should permit at least 400 miles/driver/day. The miles per driver per day metric appears relatively insensitive to the service area radius and the freight balance. It appears that at least a two-hour visibility into freight availability must exist for viable operations. Interestingly, it appears that an increased visibility window can actually lead to sub-optimal performance. In fact, a 16-hour visibility window produces results that are significantly lower in terms of miles/driver/day in comparison with the 8-hour baseline at a 95% confidence level.

In Figure 5, results for the 'percent loaded miles' metric are presented. This metric is calculated as total miles/driver/day minus first dispatch empty miles. Obviously, this metric is expected to be very sensitive to freight volume. Highly significant differences can be observed as a function of length of haul, freight volume, and load visibility. The figure indicates that the metric is fairly insensitive to freight balance and that the service area radius should be as small as possible. Once again, the results indicate that the length of haul should be at least 400 to 500 miles.

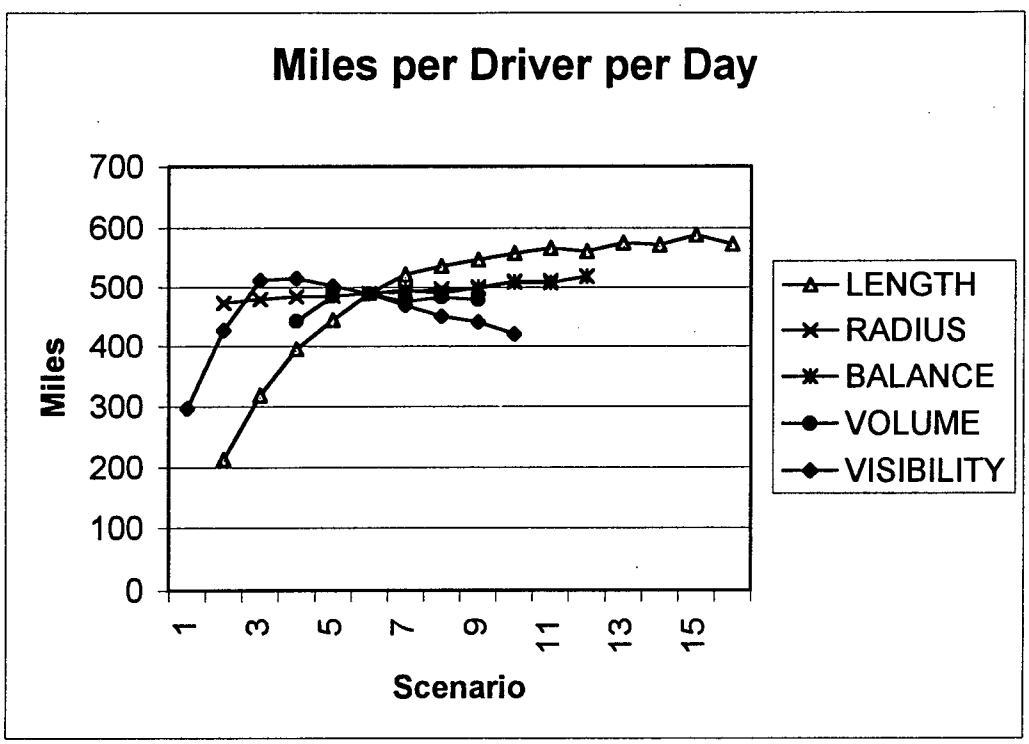


Figure 4. Miles per Driver per Day

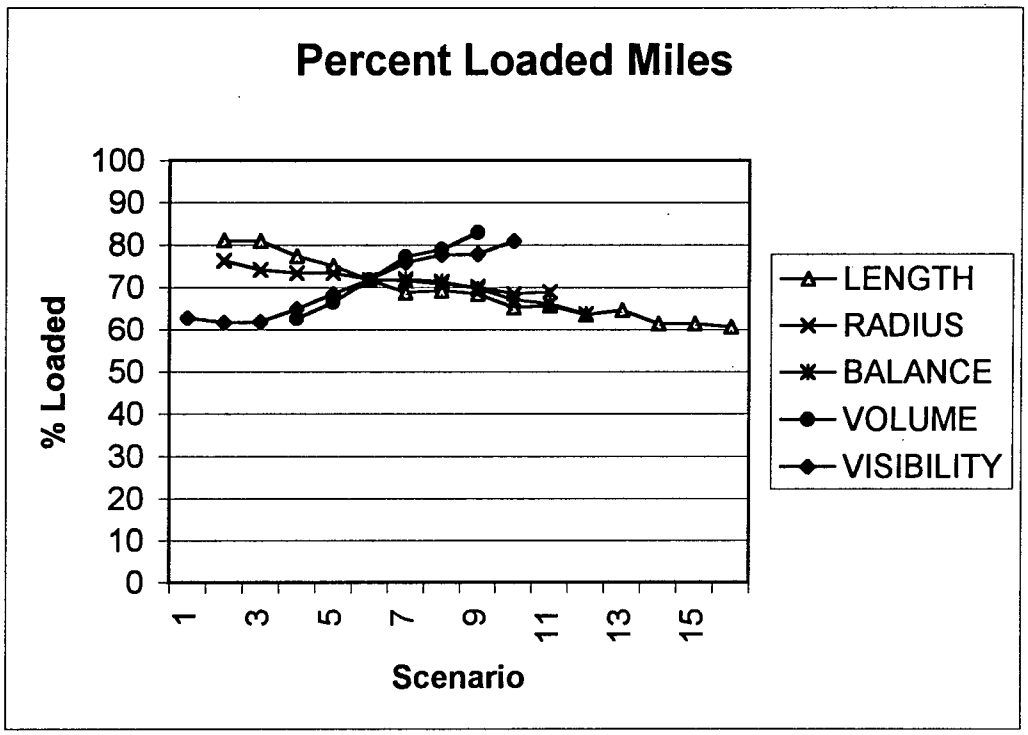


Figure 5. Percent Loaded Miles

Figure 6 reveals some interesting features that make previous results more understandable. The most interesting performance lines in the figure are for freight volume. Figure 6 indicates that excessive and unrealistic volume is simply not picked up for delivery. Although the service area radius values are statistically different from one another in some cases, the 'percent of loads used' metric is insensitive to radius from a practical viewpoint. A great deal of consistency is now starting to emerge relative to length of haul and load visibility. Length of haul should be a minimum of 400 to 500 miles, preferably longer. Load visibility should provide for at least a 2 to 3 hour window.

Figure 7 is perhaps more interesting than all the others. It presents results for the percent of late loads. Load due dates are arbitrarily (but scientifically) assigned in the data generation model. Therefore, the magnitude of the baseline is much less important than the relative differences between scenarios. Four of five experimental factors are 'well behaved' relative to this important customer service metric. A high degree of statistical differences exist relative to all five factors, but four are easily explained. Practically speaking, balance is not important in terms of customer service. Smaller service areas lead to better results and should likely be less than 50 miles. Freight volume should be realistic, i.e. less than 500 miles per driver per day. Visibility should be in the 6 to 12 hour range. The fifth experimental factor, length of haul, provides a great deal of information. Note the extreme low values in three places that correspond to lengths of haul of 100, 500, and 1,000 miles. This occurs because with a 100-mile length of haul, drivers can make several runs along the lane daily. At 500 miles, drivers have a full driving day each direction. At 1,000 miles, drivers can make a convenient two-day drive along the lane. Intermediate lengths of haul result in drivers sleeping on the road instead of in a terminal city where they are likely waiting for their next load anyway.

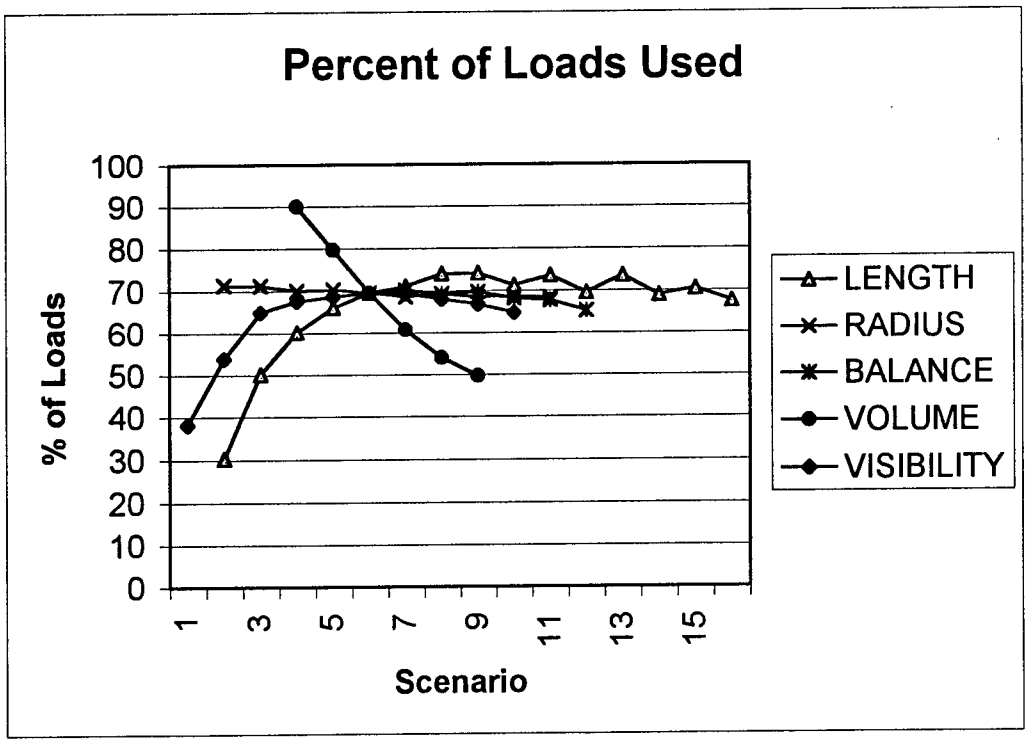


Figure 6. Percent of Loads Used

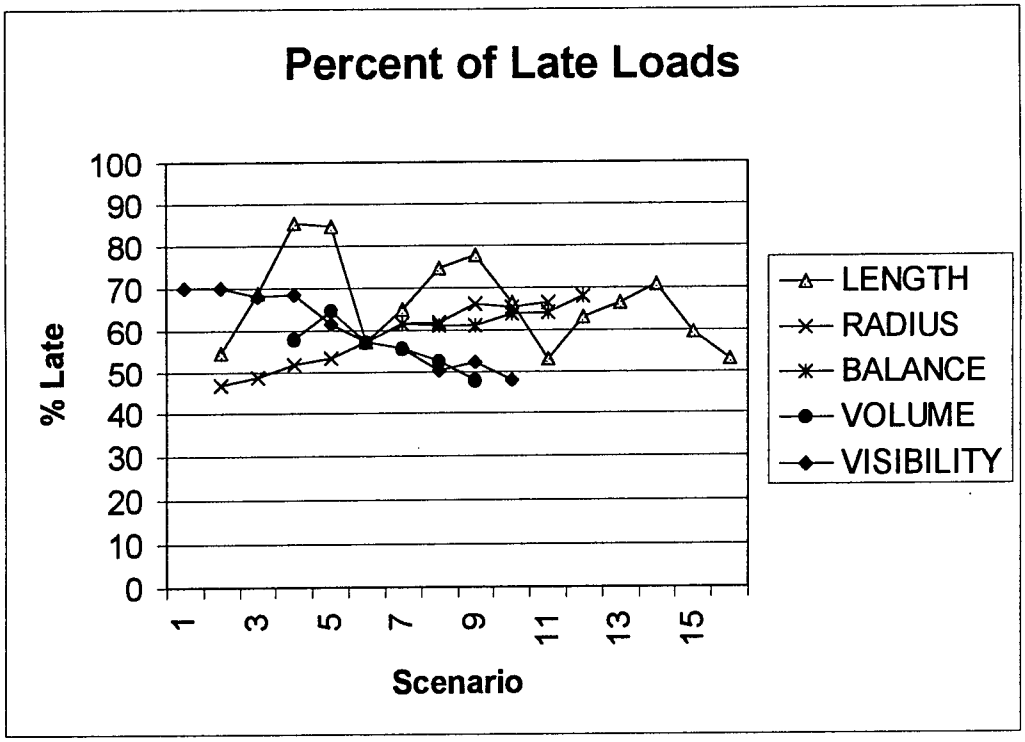


Figure 7. Percent of Late Loads

Similar single-factor experiments have been performed with CL3 and J21 scenarios with very similar results. These experiments provide additional validation for the factors selected for subsequent full-factorial analysis by demonstrating that the extreme values selected are valid not only for CL2 scenarios, but for all scenarios documented in this report.

5.2 Performance Comparison of CL2, CL3, and J21 Tours

Figures 8 through 11 illustrate the overall performance of each tour scenario in terms of the four performance measures (miles/driver/day, percent loaded miles, percent of loads used, and percent of late loads). Figure 8 indicates that CL3 tours seem to be the best tour candidate according to the highest miles/driver/day values. On the other hand, the CL2 tour that does not seem to be very impressive in terms of miles/driver/day, turns out to be the best tour in terms of the other three performance measures (see Figures 9 through 11).

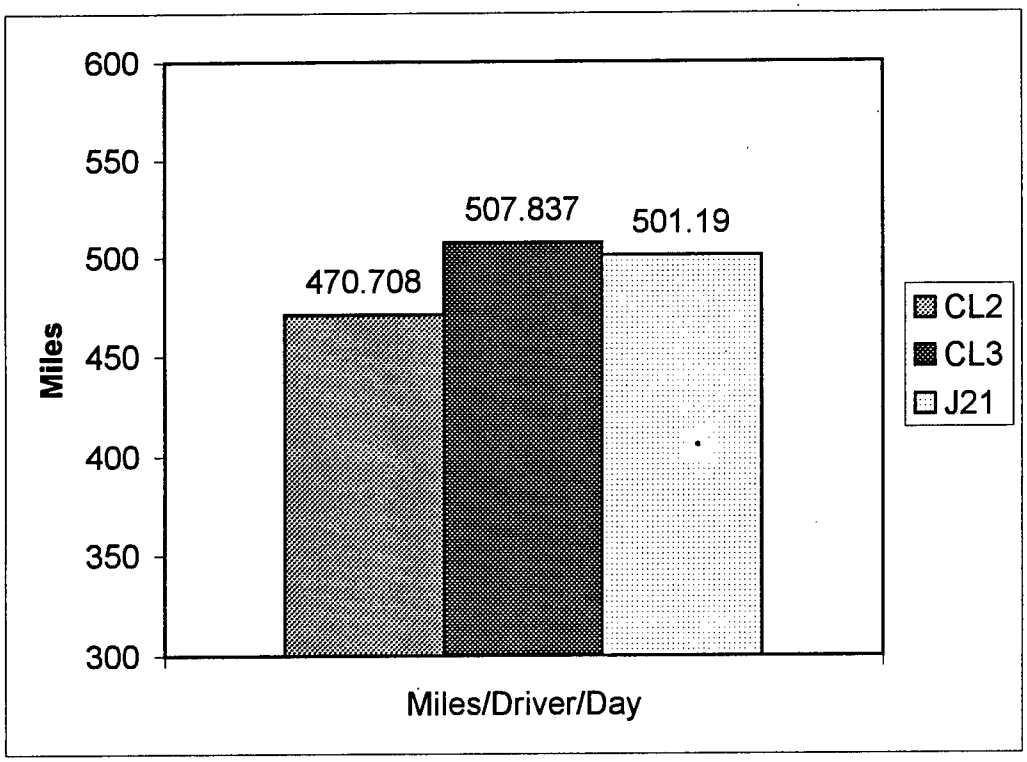


Figure 8. Comparative Performance for 'Miles/driver/day'.

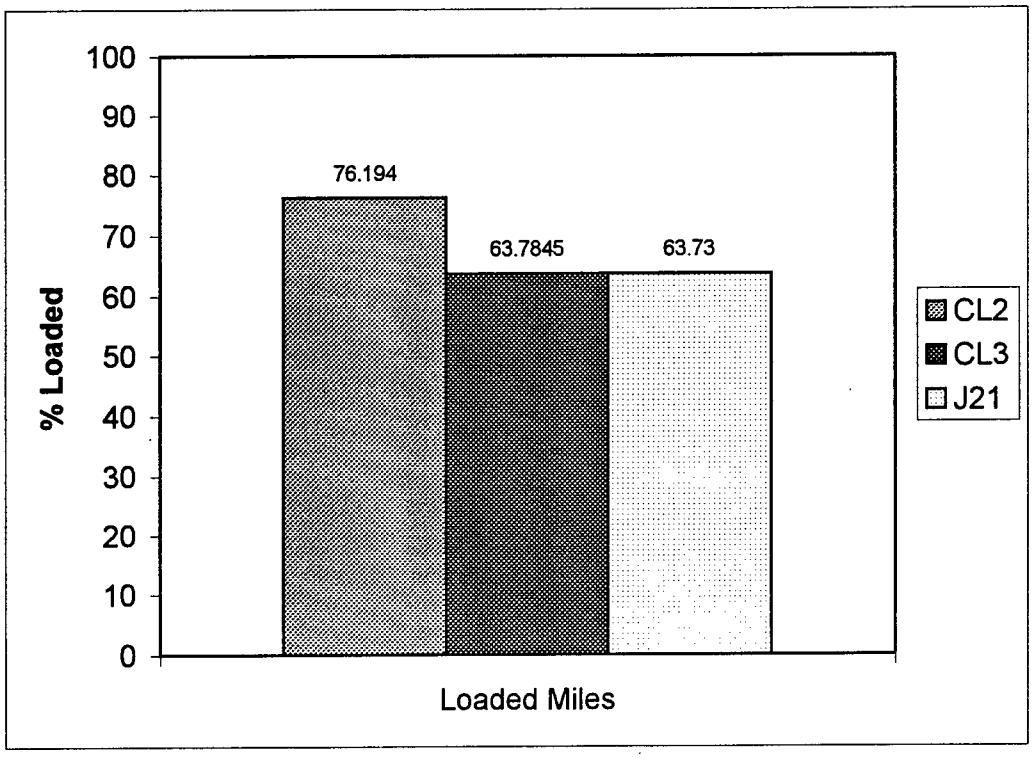


Figure 9. Comparative Performance for 'Percent Loaded Miles'.

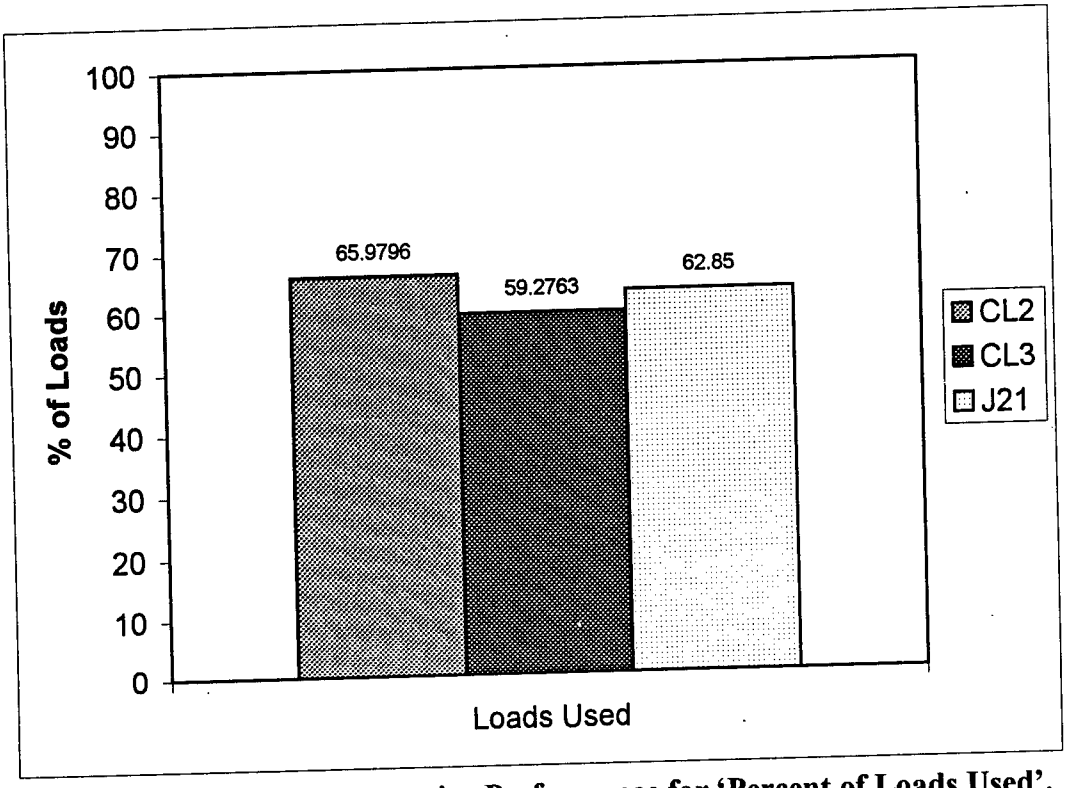


Figure 10. Comparative Performance for 'Percent of Loads Used'.

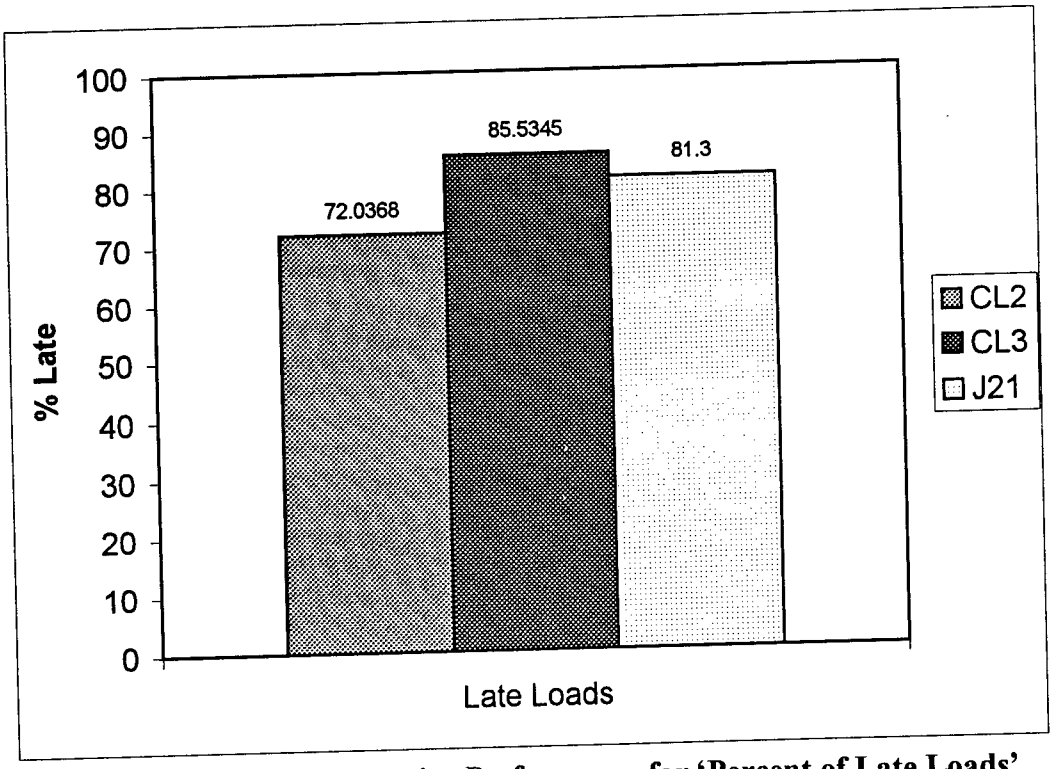


Figure 11. Comparative Performance for 'Percent of Late Loads'.

5.3 ANOVA and Tukey Test Results

ANOVA testing for the 'miles per driver per day' metric for CL2 tour indicates that all of five experimental factors are significant factors at an alpha level of 0.05. In fact, four out of five factors are highly significant at the 0.01 alpha level. Throughout the remainder of this report, a result is said to be statistically significant if found to be significant at the $\alpha = 0.05$ level and highly significant if found to be significant at the $\alpha = 0.01$ level. Load visibility, service area radius, freight volume, and length of haul are found to be highly significant to the 'miles per driver per day' metric. The Tukey test reveals that while volume attains a highly significant level in ANOVA testing, the increase from the baseline value in freight volume in CL2 tour is not statistically significant. The significance is therefore related to decreased freight volumes. Additionally, some higher level interactions demonstrate statistical significance. Appendix 1 provides a summary of ANOVA output as well as Tukey test summary information for the 'miles per driver per day' metric and the CL2 scenario.

The ANOVA results of 'miles/driver/day' metric in CL3 and J21 tour are fairly similar to that of CL2 tour, with an exception that the freight balance factor is found to be not statistically significant in CL3 tour while it is highly significant in J21 tour. The interaction effect of load visibility, freight volume, and length of haul is found to be highly significant to the 'miles/driver/day' metric in CL3 tour while there are no interaction effects above 2-way interactions found to be statistically significant in J21 tours. The Tukey test reveals that the shift from one level to another in each experimental factor is statistically significant for both tour types. See Appendices 2 and 3 for summary information.

ANOVA testing for the 'percent of loaded miles' metric indicates that all of five experimental factors attain a highly significant level for all three tour types. The interaction effect of the load visibility, freight volume, and length of haul is found to be highly significant for all tour types. The interaction effect of the freight volume, length of haul, and freight balance is found to be statistically significant in CL2 tour and highly significant in CL3 tour. Again, the Tukey tests reveal that the shift from one level to another in each experimental factor is statistically significant for all tour types. See Appendices 4, 5, and 6 for summary information for CL2, CL3, and J21 scenarios, respectively.

For the 'percent of loads used' metric, ANOVA testing indicates that freight balance is not a significant factor in CL2 and CL3 tours, while it attains a highly significant level in J21 tour. All other factors are found to be highly significant for all three types of tour. However, the Tukey test reveals that a shift down in service area radius from the baseline value is not statistically significant for the 'percent of loads used' metric in CL2 and J21 tours. On the other hand, a shift up from the baseline value in service area radius is not statistically significant in CL3 tour. The interaction effect of load visibility, freight volume, and length of haul is found to be significant in CL3 tour and highly significant in CL2 and J21 tours. In addition, the interaction effect of freight volume, length of haul, and freight balance is significant in CL3 tour. The interaction effect of load visibility, length of haul, and freight balance is also found to be significant in J21 tour. See Appendices 7 through 9 for summary information relative to the 'percent of loads used' metric.

The freight volume is not found to be statistically significant to the performance of the 'percent of late loads' in CL2 tour, while it is found to be statistically significant in CL3 and J21 tours. From the Tukey test, it is found that freight volume smaller than the baseline value (500 miles/driver/day) does not have a significant effect on the 'percent of late loads' in CL3 tour. The freight balance is found to be statistically significant relative to the 'percent of late loads' metric in CL2 and J21 tours, and is highly significant in CL3 tour. A 3-way interaction of load visibility, freight volume, and length of haul is found to be highly significant in CL2 tour. No interaction effects higher than 2-way interactions are found to be statistically significant in CL3 and J21 tours. See Appendices 10 through 12 for results.

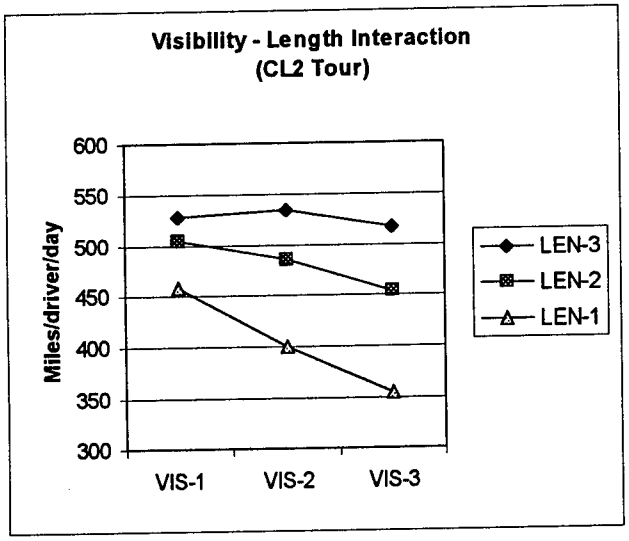
5.4 Analysis of Highly Significant Two-Way Interaction Effects

Figures 12 through 45 illustrate the interaction effects between two factors that are found to have significant interaction effects at two-level or higher interaction levels. An examination of the interaction between load visibility and length of haul (Figures 12 through 14) indicates that an increase in the length of haul results in an increase in the 'miles/driver/day' performance. However, many of these miles are unloaded (deadhead) miles. Figures 15 through 17 confirm this expectation. It is found that an increase in length of haul from the baseline value (500 miles) does not improve the performance of 'percent of loads used' when there is sufficient planning time (8 hours and up of load visibility). See Figures 18 through 20. From Figures 12 through 14, it is also revealed that the miles/driver/day decreases as the load visibility becomes larger. This is largely intuitive because larger load visibility window enables the dispatcher to assign loads more efficiently to the drivers, thus reducing deadhead miles.

These findings are further validated in Figures 21 through 23. These figures also suggest that an optimal result of the performance of 'percent of late loads' is achieved when there is ample planning time (load visibility is 8 hours or more) and the length of haul is closed to the baseline value (500 miles).

An examination of the interaction effect between load visibility and freight volume reveals that an increase in freight volume does not necessarily increase miles/driver/day (Figures 24 through 26). As a matter of fact, the smaller freight volume results in a higher miles/driver/day as the load visibility increases. This result is largely due to the limitation of drivers' availability. The larger load visibility enables dispatcher to make the full use of the drivers. Figures 27 through 29 confirms this finding (see the increase in the 'percent of loaded miles' when the visibility and volume increase). Once the availability limit of the drivers is reached, an excessive in freight volume will not be picked up. It is also noted from Figures 27 through 29 that when the load visibility is small (2 hours), an increase in freight volume does not affect the performance relative to the 'percent loaded miles'. This is largely intuitive because a small visibility window disables the dispatcher to make better dispatching assignments.

A significant interaction effect between load visibility and freight volume for the 'percent of loads used' metric is found in J21 tour only. As it is expected, an excessive in freight volume will not be picked up (Figure 30). Figure 30 also suggests that there is a limit in load visibility in terms of improving the performance of 'percent of loads used'. Again, this finding is due to the limitation of the drivers' availability. Figures 31 through 33 further confirm the anticipation of



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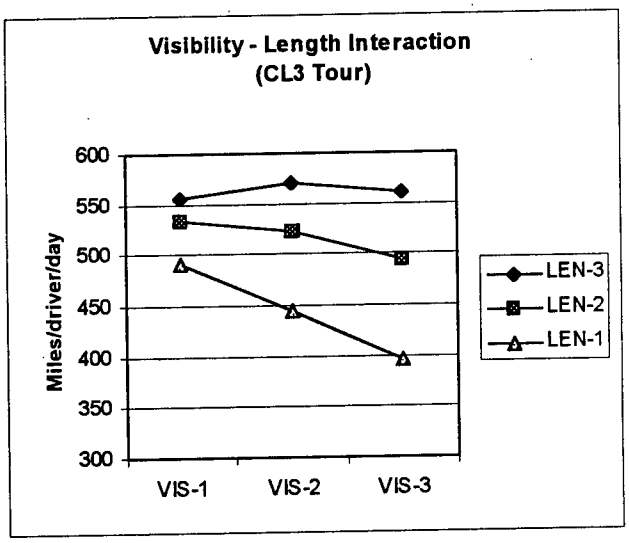

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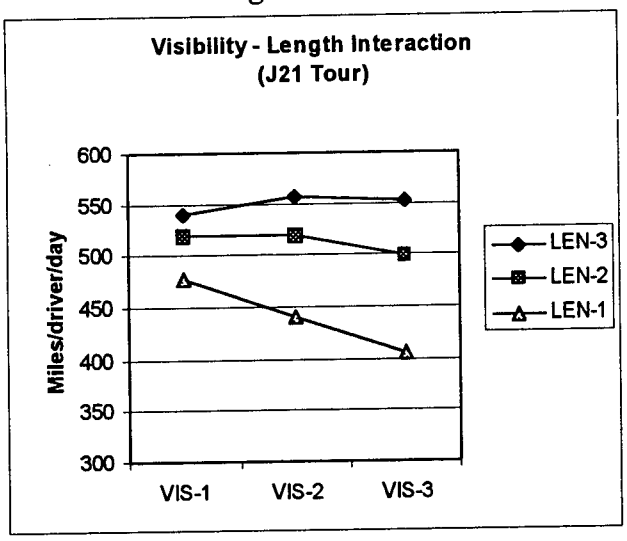

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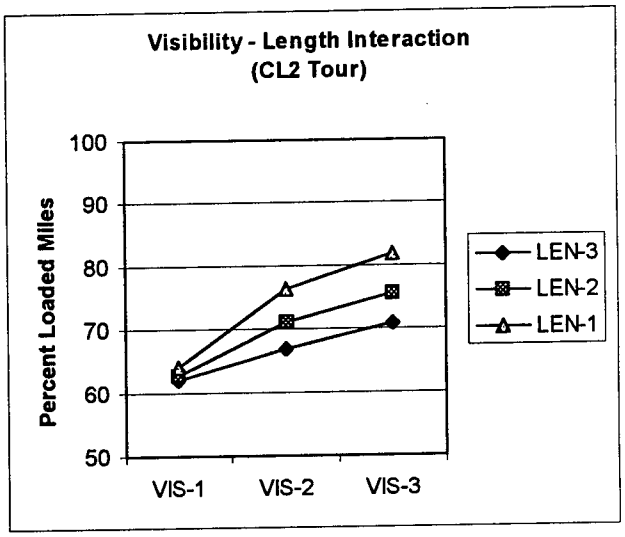

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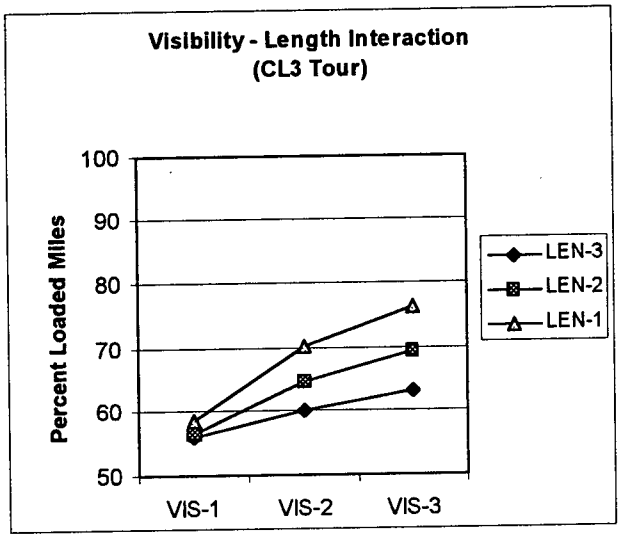

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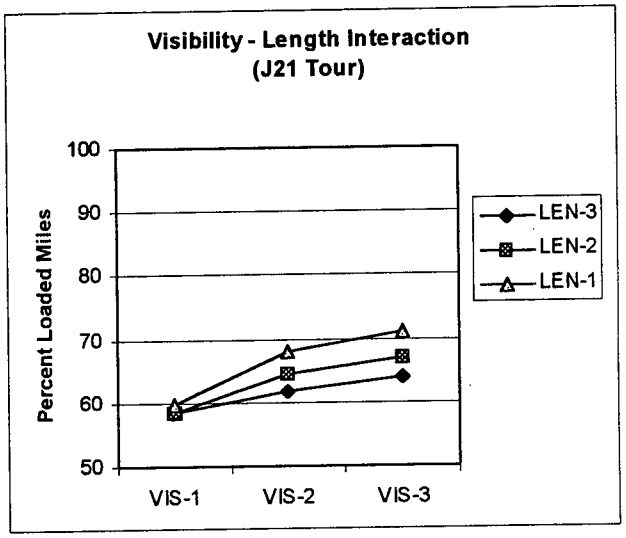

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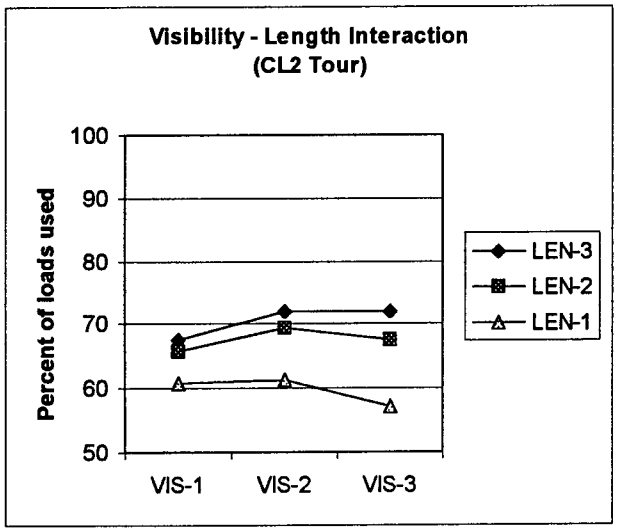

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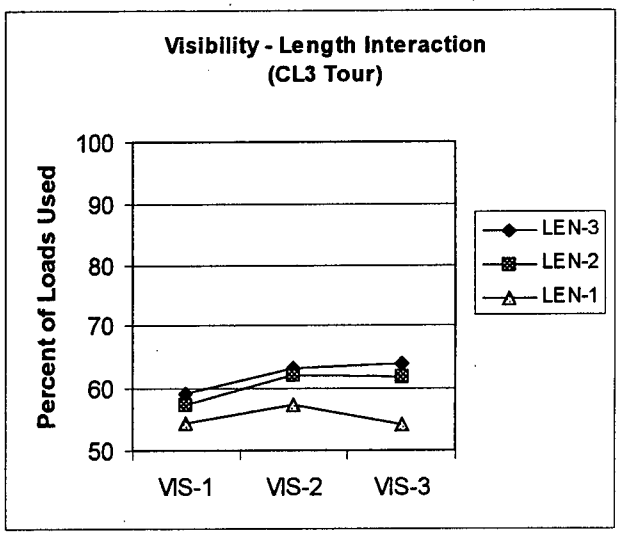

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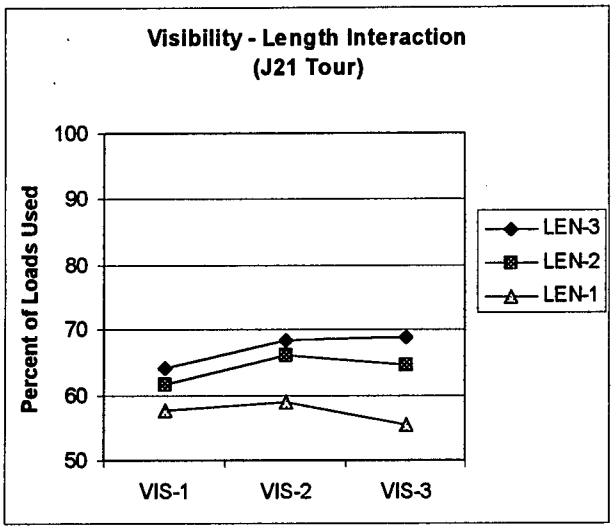


Figure 20.

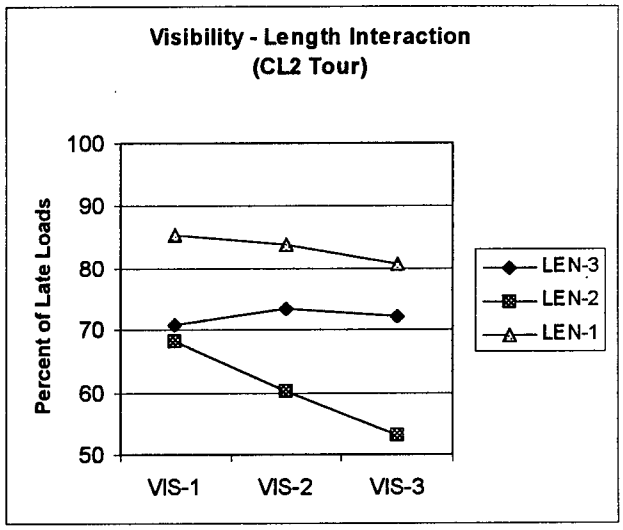
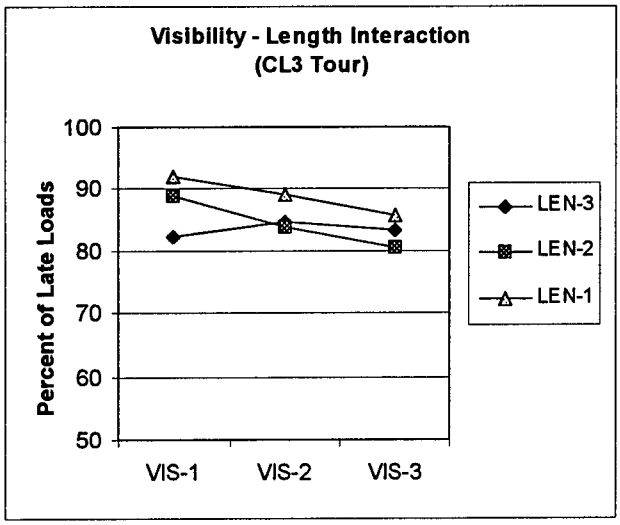


Figure 21.



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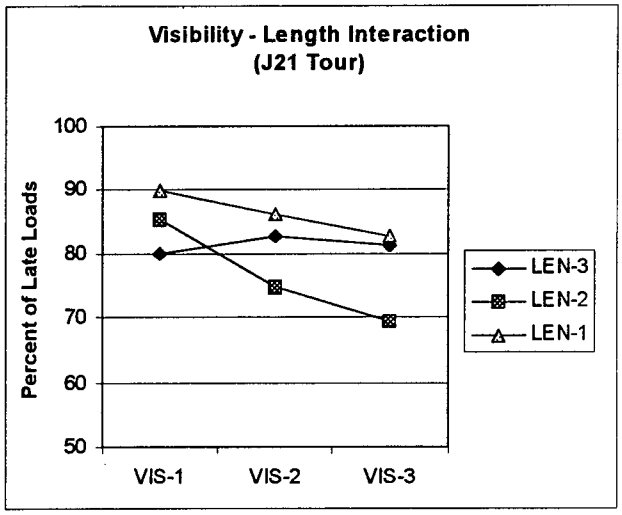

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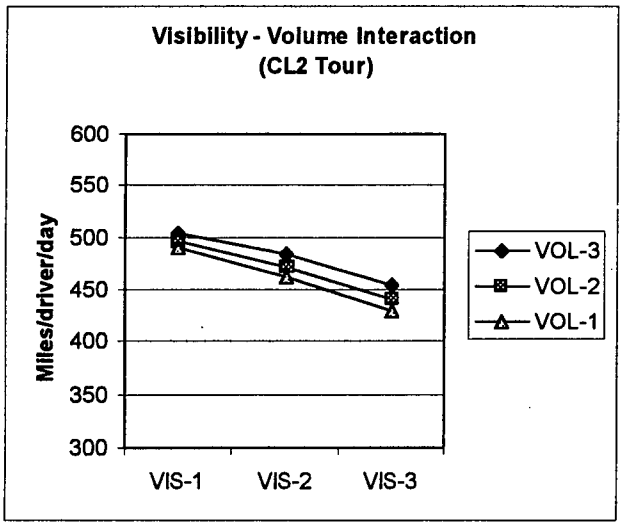

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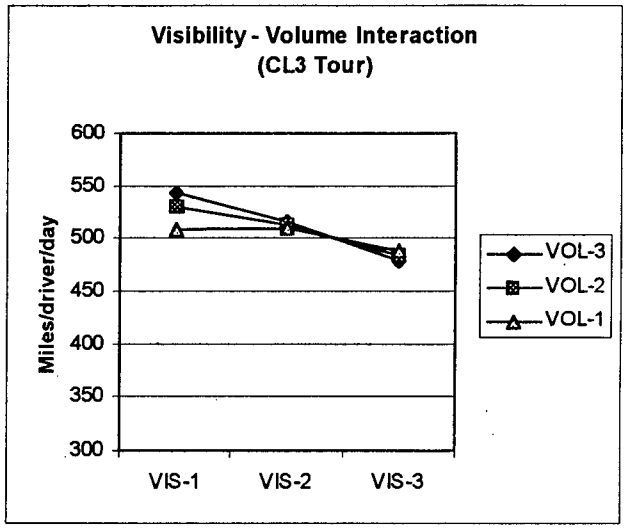

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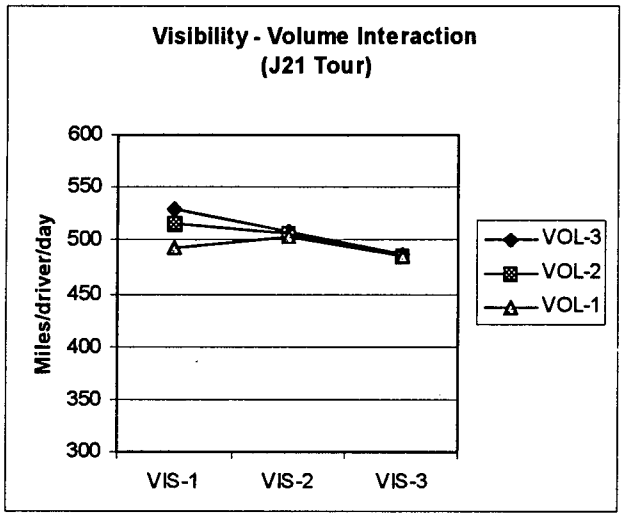

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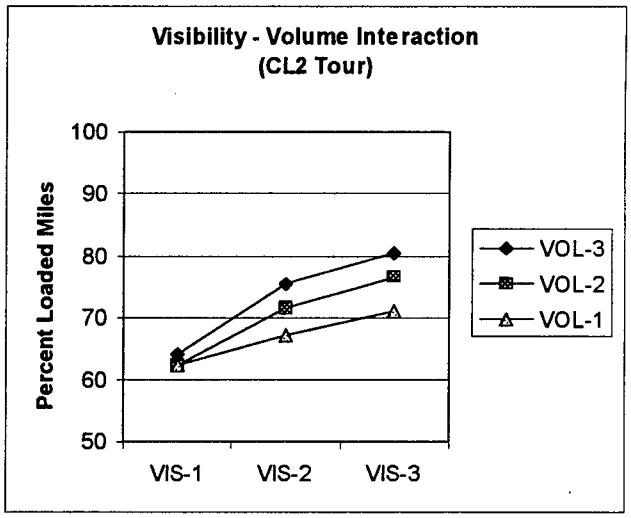
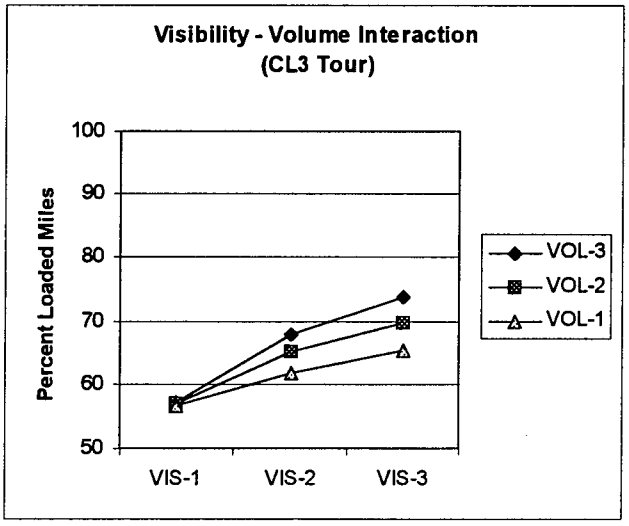


Figure 27.



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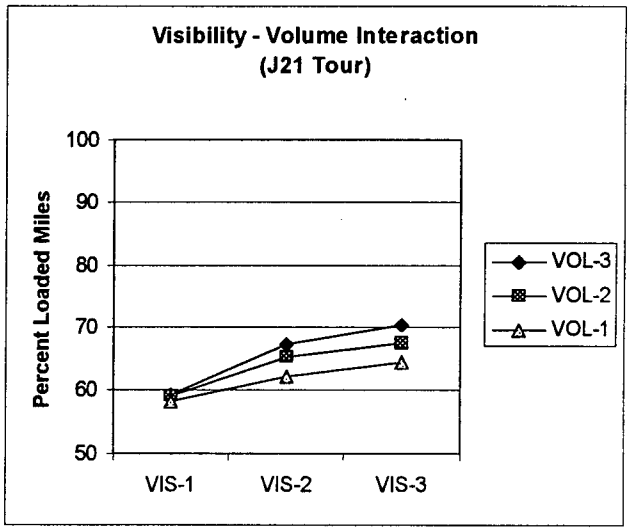

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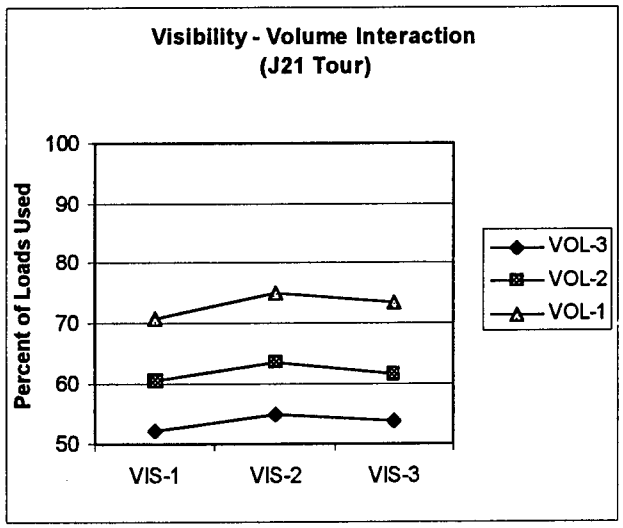

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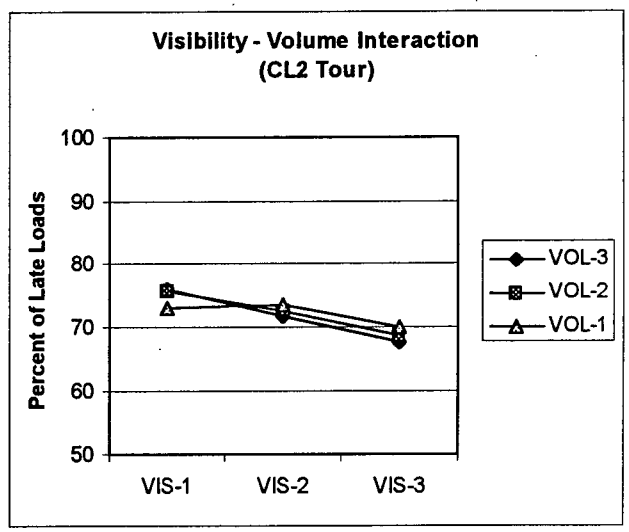

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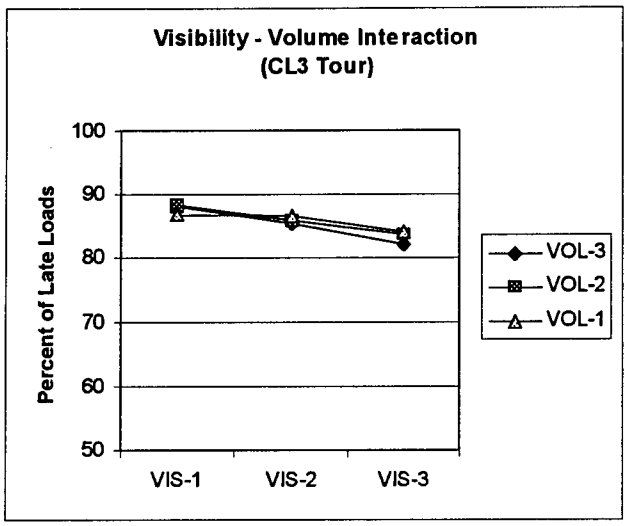


Figure 32.

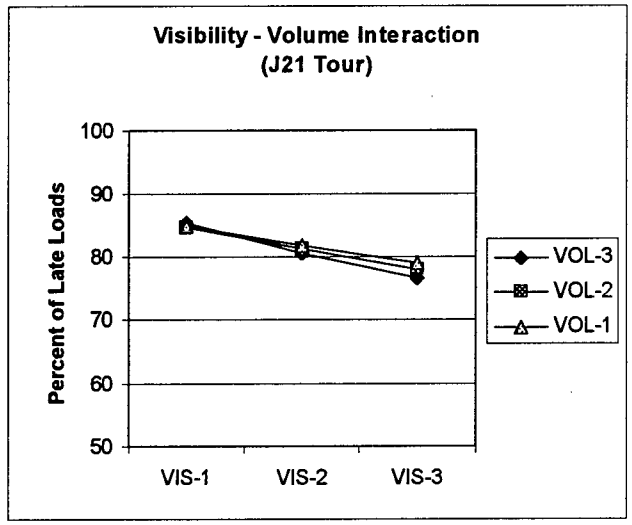


Figure 33.

the benefit in using larger load visibility. These figures also indicate that an increase in the freight volume does not necessarily reduce the percentage of late loads.

Figures 34 through 36 suggest that when there is ample length of haul, 'miles/driver/day' tends to increase as the freight volume increases. In CL2 tour, this phenomenon is achieved when length is at its lowest value (400 miles) while CL3 and J21 tours require length of haul of 500 miles and more to achieve the same effect. A closer examination reveals that the difference in values of lane length and freight volume is very closely related to the performance of 'miles/driver/day. A big gap in the values between freight volume and length of haul tends to decrease 'miles/driver/day. This result is not necessarily bad because when the length of haul is greater than freight volume, many of the miles contributed to the miles/driver/day are deadhead miles. Figure 37 confirms this discovery. This figure reveals that 'percent loaded miles' tends to increase as freight volume increases. However, an increase in length of haul results in a decrease

in 'percent loaded miles' because of the deadhead miles. The interaction effect between freight volume and length of haul is only significant in CL3 tour for the performance metric of 'percent loaded miles' (Figure 37).

An examination of the interaction effect between freight volume and length of haul for 'percent of loads used' metric reveals that an increase in freight volume does not seem to affect the performance of 'percent of loads used' in CL2 tour (Figure 38). However, in CL3 and J21 tours, a sharp decrease in performance value is observed when the volume increases (Figures 39 and 40). This phenomenon results from the form of CL3 and J21 tours. The CL3 and J21 tour schemas require longer travel time of the drivers before he/she can return to his/her point of origin. Figures 41 through 43 suggest that the performance of 'percent of late loads' is at its best when the length of haul is about 500 miles.

The freight volume-lane balance factor is found to be highly significant in CL3 tours. Figure 44 illustrates the interaction between freight volume and balance. It is revealed that an increase in freight volume affects the performance of 'percent of late loads' metric when the balance is not perfect, but is fairly insensitive to the performance value when perfect balance is achieved. However, the magnitude differences in the performance measure due to various balance ratios are fairly negligible.

In Figure 45, we see that there is a tendency of decreasing in the 'percent of late loads' in CL3 tours when the length of haul increases. This phenomenon is strongest for imperfect balance scenarios.

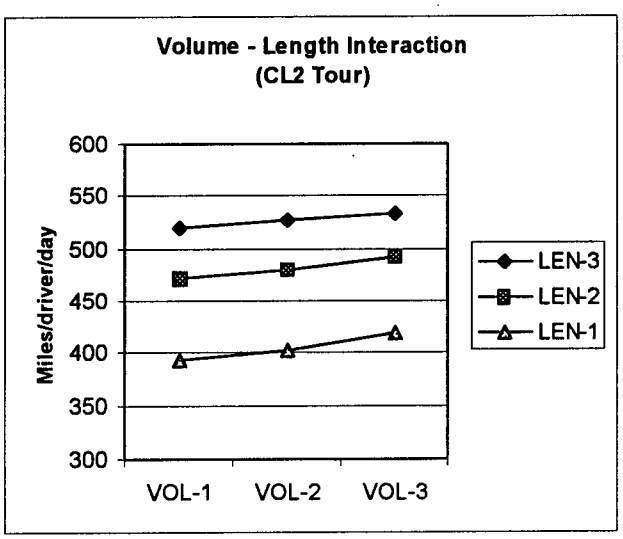


Figure 34.

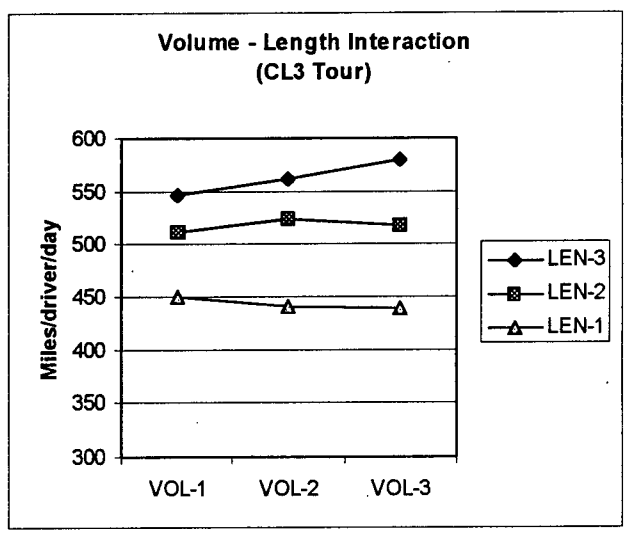
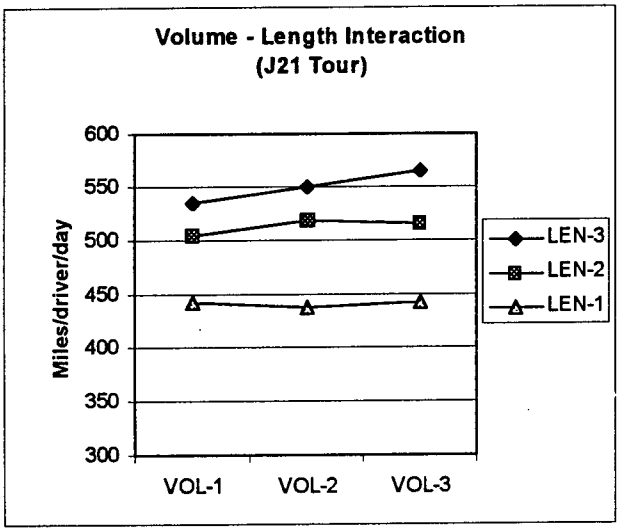


Figure 35.



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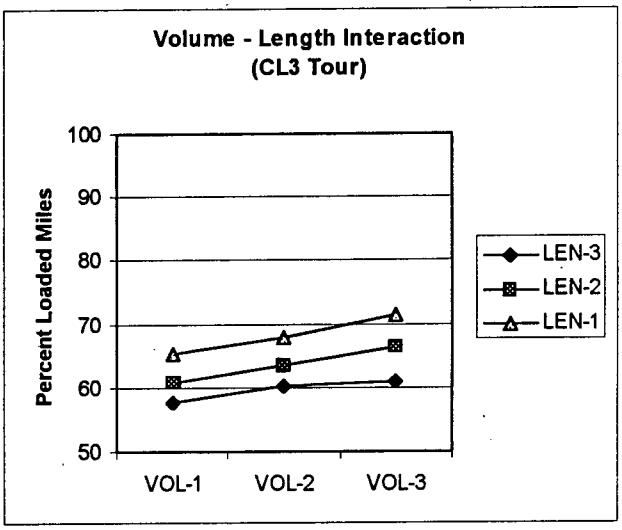

Figure 37.

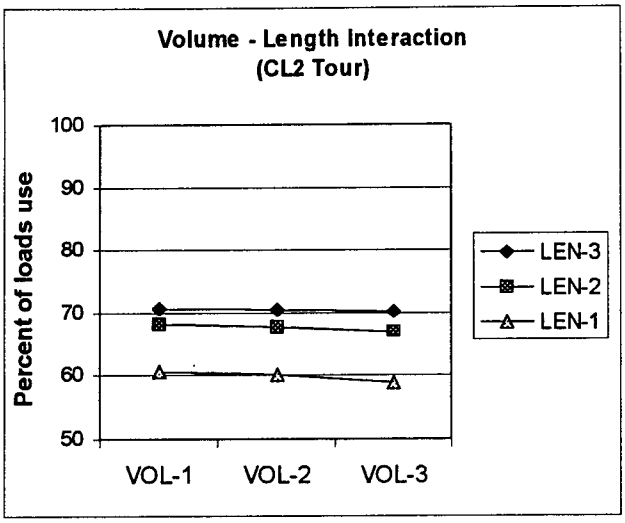

Figure 38.

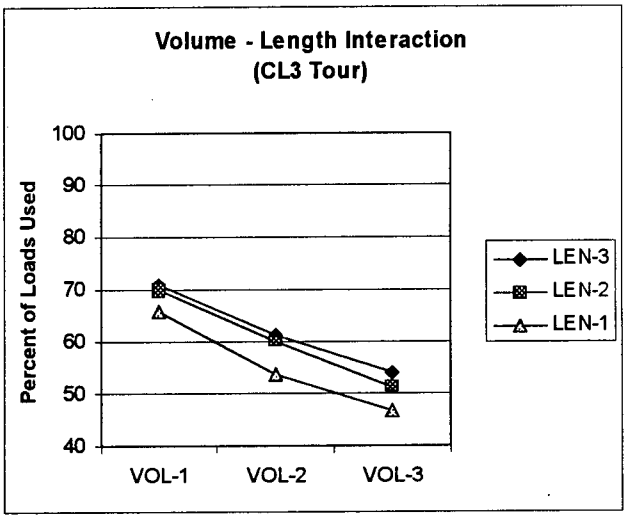

Figure 39.

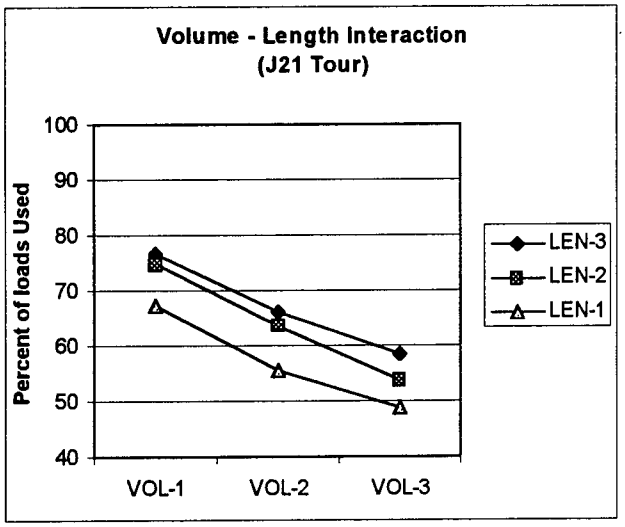

Figure 40.

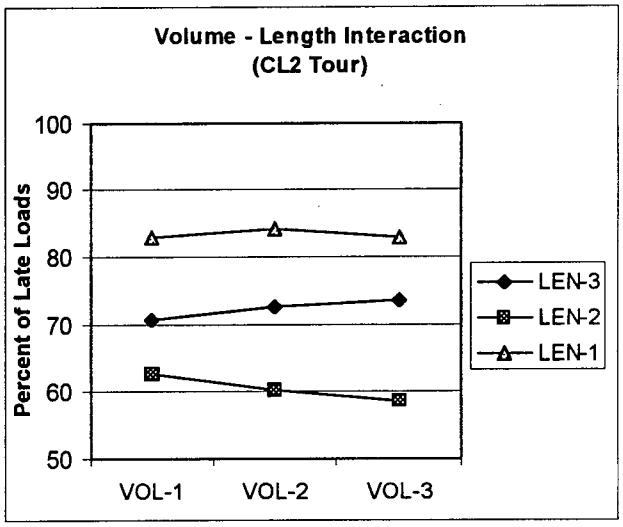

Figure 41.

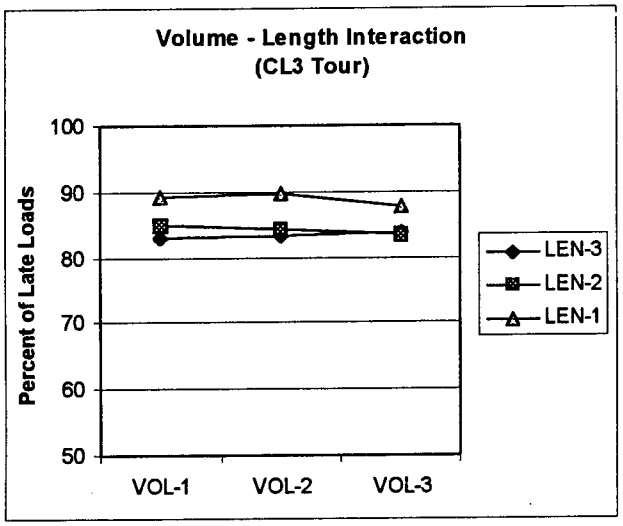

Figure 42.

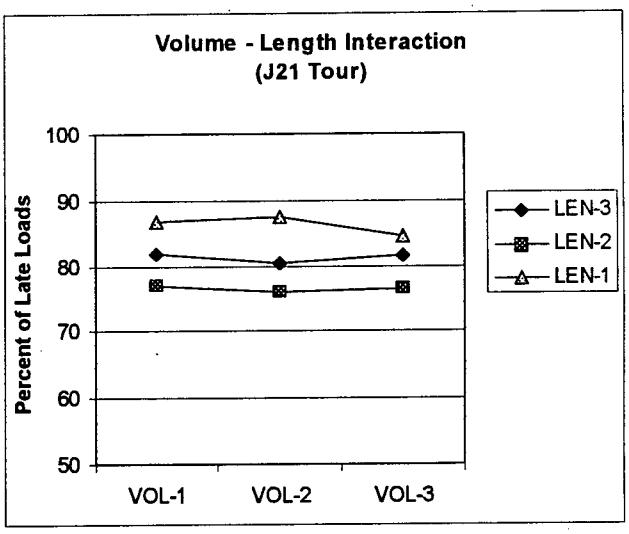

Figure 43.

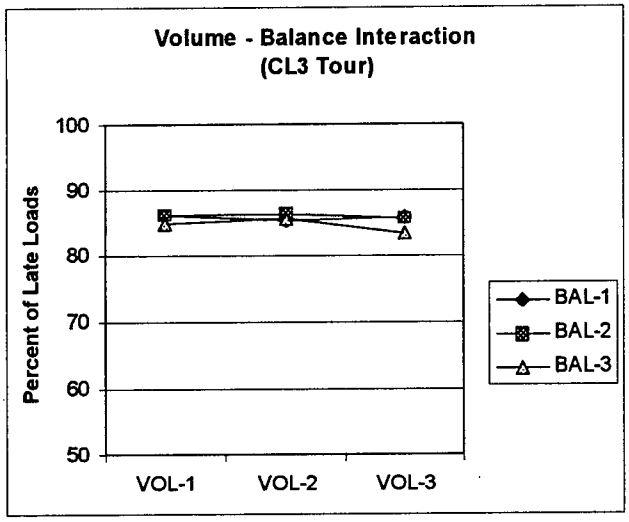

Figure 44.

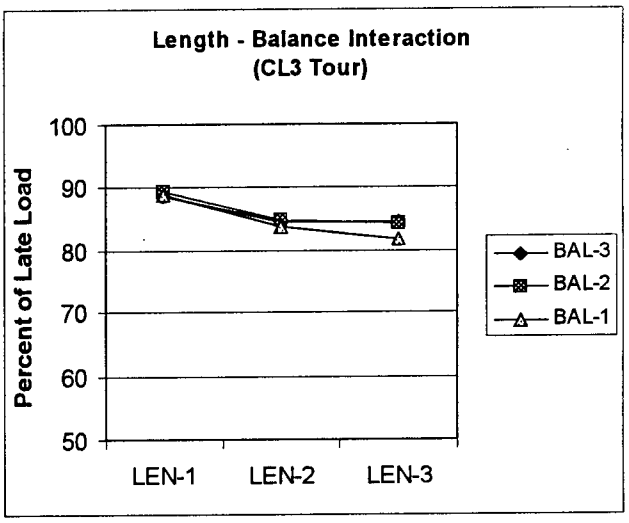

Figure 45.

5.5 J21 Tour Analysis

Figures 46 through 49 present the results of the four performance criteria (miles/driver/day, percent of loaded miles, percent of loads used, and percent of late loads) for the J21 tour with various unloaded to loaded leg ratio values. These figures reveal that the length of the unloaded leg affects all of the performance measures to some degree. The results are largely intuitive. In Figure 46, it is shown that miles/driver/day values increase as the ratio of unloaded/loaded leg length increases. This effect is largely due to the increase in deadhead miles, which results in the lower percentage of loaded miles as shown in Figure 47. Figure 48 further establishes the effect of increasing the percentage of the unloaded leg. When the ratio of unloaded/loaded legs increases beyond 50%, the percentage of loads used starts to decrease rapidly. The largest impact of the unloaded leg length is found on the performance of the 'percent late loads' metric in Figure 49. An average 4.4% increase in the percentage of late loads is found for every 10% increase in the ratio of unloaded/loaded legs.

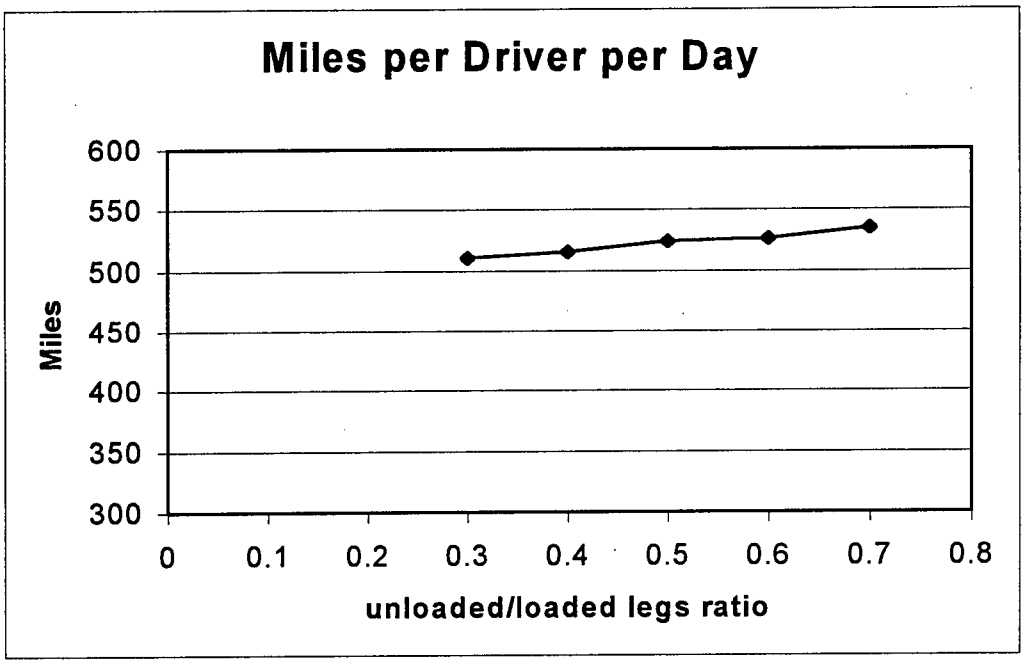

Figure 46. Performance of 'Miles/Driver/Day' in J21 tour.

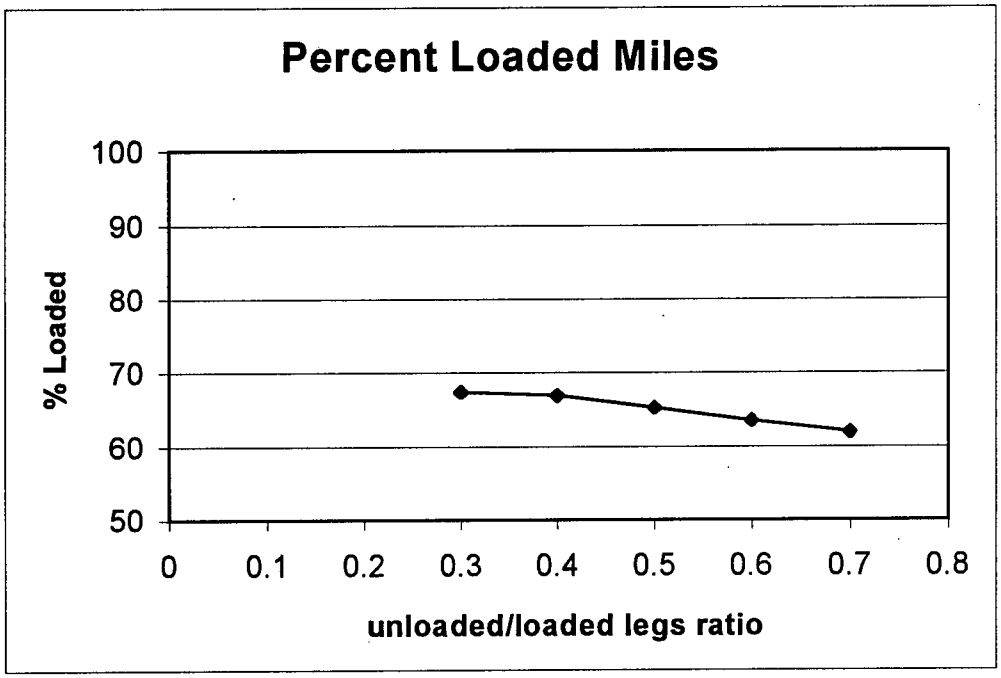

Figure 47. Performance of 'Percent Loaded Miles' in J21 tour.

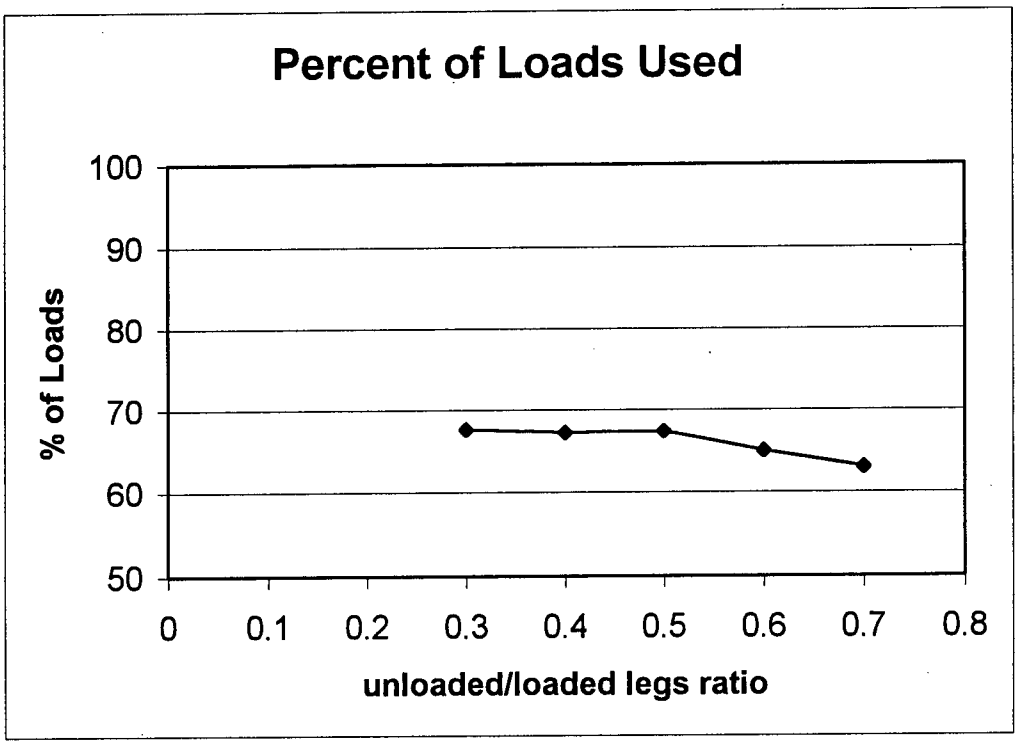

Figure 48. Performance of 'Percent of Loads Used' in J21 tour.

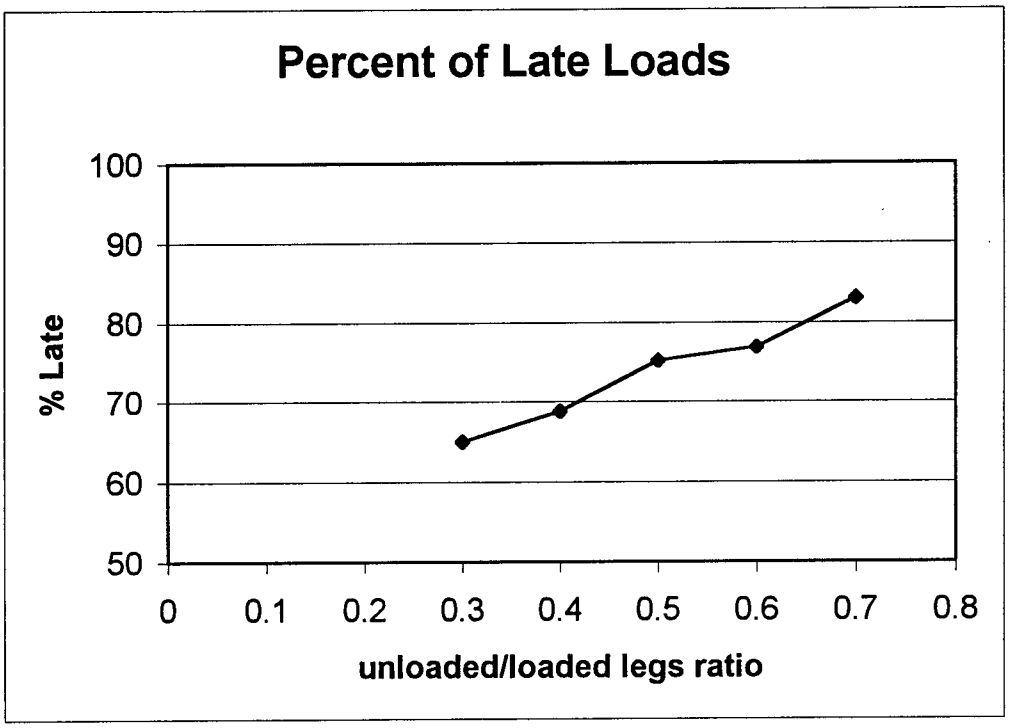

Figure 49. Performance of 'Percent of Late Loads' in J21 tour.

6. Concluding Remarks

The experimentation presented in this report has effectively demonstrated the efficacy of the data generator and lane simulator. The tools are useful from an academic standpoint and from an industry use standpoint. Data supplied by J. B. Hunt Transport, Inc. has helped in the validation process.

The findings of this research verify that delivery lanes can be effective tools for use by truckload carriers. The results of the experimentation indicate that the length of haul, freight volume, lane/tour balance, and load visibility play significant roles in developing an effective dedicated lane. The service area radius, while it attains high statistical differences in some scenarios, is fairly insensitive to the key performance measures. The results of the experimentation also indicate that a combination of dedicated fleet method and point-to-point methods may be needed in order to achieve optimal results.

7. References

1. Albrecht, K. (1994), *Northbound Train*, Amacon, New York, NY.

2. J.B. Hunt Transport, Inc. (1998), *Internet Home Page*, http://www.jbhunt.com/ jbhhome.htm.

3. Mele, J. (1989a), "Carriers Cope With Driver Shortage," *Fleet Owner*, Vol. 84, No. 1, pp. 104-111.

4. Mele, J. (1989b), "Solving Driver Turnover," *Fleet Owner*, Vol. 84, No. 9, pp. 45-52.

5. Taylor, G.D., Meinert, T.S., Killian, R.C., Gangluff, G.E., and English, J.R. (1997), "Development and Analysis of Efficient Delivery Lanes and Zones in Truckload Trucking," *Final Research Report #MBTC-FR-1061*, Mack-Blackwell National Rural Transportation Study Center, Fayetteville, AR, 127 p.

Appendix 1. CL2 Output for Miles/Driver/Day

Anova test results for miles/driver/day at $\alpha = 0.1$.

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VIS	2	827434.99	413717.50	1169.28	0.0001
RAD	2	111478.67	55739.34	157.54	0.0001
VOL	2	22134.01	11067.00	31.28	0.0001
LEN	2	4097543.26	2048771.63	5790.41	0.0001
BAL	1	141.73	141.73	5.99	0.1666
VIS*RAD	4	5894.75	1473.69	4.17	0.0023
VIS*VOL	4	116875.85	29218.96	82.58	0.0001
VIS*LEN	4	403335.42	100833.85	284.98	0.0001
VIS*BAL	2	1569.31	785.16	2.22	0.1158
RAD*VOL	4	370.35	92.59	0.26	0.9026
RAD*LEN	4	7942.34	1985.59	5.61	0.0002
RAD*BAL	2	134.92	67.46	0.19	0.8264
VOL*LEN	4	59366.26	14841.56	41.95	0.0001
VOL*BAL	2	166.08	83.04	0.24	0.7886
LEN*BAL	2	1434.24	717.12	2.03	0.1321
VIS*RAD*VOL	8	1093.16	136.65	0.39	0.9281
VIS*RAD*LEN	8	1705.35	213.17	0.60	0.7764
VIS*RAD*BAL	4	365.40	91.35	0.26	0.9257
RAD*VOL*LEN	8	1743.95	217.99	0.62	0.7654
RAD*VOL*BAL	4	173.9	43.48	0.12	0.9764
VOL*LEN*BAL	4	2793.80	698.45	2.00	0.0980
VIS*VOL*LEN	8	9794.42	1224.30	3.46	0.0006
VIS*VOL*BAL	4	365.84	91.46	0.26	0.9043
RAD*LEN*BAL	4	317.53	79.38	0.22	0.9247
VIS*LEN*BAL	4	477.21	119.30	0.34	0.8536
VIS*RAD*VOL*LEN	16	140.94	87.68	0.25	0.9999
VIS*RAD*VOL*BAL	8	1697.86	212.23	0.60	0.7769
RAD*VOL*LEN*BAL	8	1143.92	142.99	0.40	0.9187
VIS*VOL*LEN*BAL	8	3425.11	428.13	1.21	0.2898
VIS*RAD*VOL*LEN*BAL	24	2061.57	85.90	0.24	0.9999

Tukey's Studentized Range (HSD) Test for variable: MILE

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

Alpha= 0.05 df= 1458 MSE= 353.8216
Critical Value of Studentized Range= 3.318
Minimum Significant Difference= 2.6857

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	VIS
A	497.063	540	1
B	473.188	540	2
C	441.872	540	3

Tukey Grouping	Mean	N	RAD
A	481.407	540	3
B	469.527	540	2
C	461.190	540	1

Tukey Grouping	Mean	N	VOL
A	473.711	540	3
A			
A	472.912	540	2
B	465.501	540	1

Tukey Grouping	Mean	N	LEN
A	526.590	540	3
B	480.871	540	2
C	404.663	540	1

Tukey Grouping	Mean	N	BAL
A	471.6417	810	2
B	469.7740	810	1

Appendix 2. CL3 Output for Miles/Driver/Day

Anova test results for miles/driver/day at $\alpha = 0.1$.

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VIS	2	786181.04	393090.52	1082.85	0.0001
RAD	2	99475.32	49737.66	137.01	0.0001
VOL	2	45117.96	22558.98	62.14	0.0001
LEN	2	5855915.56	2927957.78	8065.70	0.0001
BAL	2	430.19	215.09	0.59	0.5511
VIS*RAD	4	7351.42	1837.86	5.06	0.0005
VIS*VOL	4	144310.66	36077.67	99.38	0.0001
VIS*LEN	4	701169.07	175292.27	482.88	0.0001
VIS*BAL	4	1232.90	308.23	0.85	0.4917
RAD*VOL	4	468.46	117.11	0.32	0.8625
RAD*LEN	4	15225.40	3806.35	10.49	0.0001
RAD*BAL	4	1303.94	325.98	0.90	0.4644
VOL*LEN	4	149784.10	37446.03	103.15	0.0001
VOL*BAL	4	1915.29	478.82	1.32	0.2605
LEN*BAL	4	1220.27	305.09	0.84	0.4934
VIS*RAD*VOL	8	2174.10	271.76	0.75	0.6486
VIS*RAD*LEN	8	1426.40	178.30	0.49	0.8458
VIS*RAD*BAL	8	1020.19	128.77	0.35	0.9440
RAD*VOL*LEN	8	692.46	86.56	0.24	0.9933
RAD*VOL*BAL	8	1361.64	170.20	0.47	0.8787
VOL*LEN*BAL	8	2742.5	342.83	0.94	0.4784
VIS*VOL*LEN	8	9444.40	1180.55	3.25	0.0011
VIS*VOL*BAL	8	1732.59	216.57	0.60	0.7814
RAD*LEN*BAL	8	1068.78	133.60	0.37	0.9277
VIS*LEN*BAL	8	3960.25	495.03	1.36	0.2096
VIS*RAD*VOL*LEN	16	1433.19	89.57	0.25	0.9990
VIS*RAD*VOL*BAL	16	2833.03	177.07	0.49	0.9542
RAD*VOL*LEN*BAL	16	3399.91	212.24	0.58	0.8975
VIS*VOL*LEN*BAL	16	4394.82	274.68	0.76	0.7363
VIS*RAD*VOL*LEN*BAL	40	5139.92	128.50	0.35	1.0000

Tukey's Studentized Range (HSD) Test for variable: MILE

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

Alpha= 0.05 df= 2187 MSE= 363.0137
Critical Value of Studentized Range= 3.317
Minimum Significant Difference= 2.2204

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	BAL
A	508.3762	810	1
A			
A	507.7846	810	2
A			
A	507.3496	810	3

Tukey Grouping	Mean	N	LEN
A	562.6974	810	3
B	517.2508	810	2
C	443.5622	810	1

Tukey Grouping	Mean	N	RAD
A	516.0954	810	3
B	506.9092	810	2
C	500.5058	810	1

Tukey Grouping	Mean	N	VIS
A	527.1270	810	1
B	512.5518	810	2
C	483.8316	810	3

Tukey Grouping	Mean	N	VOL
A	512.4320	810	3
B	509.0053	810	2
C	502.0731	810	1

Appendix 3. J21 Output for Miles/Driver/Day

Anova test results for miles/driver/day at α = 0.1.

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VIS	2	211154.37	105577.18	330.86	0.0001
RAD	2	34958.72	17479.36	54.78	0.0001
VOL	2	49824.60	24912.30	78.07	0.0001
LEN	2	3318112.66	1659056.33	5199.20	0.0001
BAL	1	2482.96	2482.96	7.78	0.0053
VIS*RAD	4	365.75	91.44	0.29	0.8868
VIS*VOL	4	62897.93	15724.48	49.28	0.0001
VIS*LEN	4	328095.50	82023.87	257.05	0.0001
VIS*BAL	2	912.57	456.29	1.43	0.2377
RAD*VOL	4	701.09	175.27	0.55	0.6963
RAD*LEN	4	7711.93	1927.98	6.04	0.0001
RAD*BAL	2	62.65	31.33	0.09	0.9133
VOL*LEN	4	58582.31	14645.58	45.90	0.0001
VOL*BAL	2	1053.02	526.51	1.65	0.1924
LEN*BAL	2	148.33	74.07	0.23	0.7914
VIS*RAD*VOL	8	627.20	78.40	0.25	0.9828
VIS*RAD*LEN	8	1859.43	232.43	0.73	0.6666
VIS*RAD*BAL	4	820.18	205.05	0.64	0.6322
RAD*VOL*LEN	8	1501.98	187.73	0.59	0.7865
RAD*VOL*BAL	4	140.65	35.17	0.11	0.9790
VOL*LEN*BAL	4	1702.92	425.73	1.33	0.2554
VIS*VOL*LEN	8	1965.58	245.70	0.77	0.6234
VIS*VOL*BAL	4	216.29	54.07	0.17	0.9540
RAD*LEN*BAL	4	405.25	101.31	0.32	0.8664
VIS*LEN*BAL	4	663.34	165.83	0.52	0.7213
VIS*RAD*VOL*LEN	16	2337.99	146.12	0.46	0.9661
VIS*RAD*VOL*BAL	8	577.65	72.21	0.23	0.9862
RAD*VOL*LEN*BAL	8	324.08	40.51	0.13	0.9981
VIS*VOL*LEN*BAL	8	539.40	67.43	0.21	0.9890
VIS*RAD*VOL*LEN*BAL	24	2777.96	115.75	0.36	0.9984

Tukey Results: Miles Driven per Driver per Day

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for variable: MILE

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

Alpha= 0.05 df= 1458 MSE= 319.0984
Critical Value of Studentized Range= 2.774
Minimum Significant Difference= 1.7412

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	BAL
A	502.4240	810	2
B	499.9480	810	1

Tukey Grouping	Mean	N	LEN
A	550.089	540	3
B	512.494	540	2
C	440.976	540	1

Tukey Grouping	Mean	N	VOL
A	507.479	540	3
B	502.094	540	2
C	493.986	540	1

Tukey Grouping	Mean	N	RAD
A	507.201	540	3
B	500.465	540	2
C	495.891	540	1

Tukey Grouping	Mean	N	VIS
A	511.847	540	1
B	506.357	540	2
C	485.354	540	3

Appendix 4. CL2 Output for Loaded Miles

Anova test results for percentage of miles loaded at $\alpha = 0.1$.

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VIS	2	46745.9684	23372.9842	2521.14	0.0001
RAD	2	4234.0891	2117.0445	228.36	0.0001
VOL	2	11455.0505	5727.5253	617.80	0.0001
LEN	2	14869.3170	7434.6585	801.94	0.0001
BAL	1	197.7506	197.7506	21.33	0.0001
VIS*RAD	4	122.8770	30.7193	3.31	0.0109
VIS*VOL	4	3108.3992	777.0998	83.82	0.0001
VIS*LEN	4	4008.5218	1002.1304	108.10	0.0001
VIS*BAL	2	120.6196	60.3098	6.51	0.0015
RAD*VOL	4	84.1888	21.0472	2.27	0.0596
RAD*LEN	4	740.5926	185.1482	19.97	0.0001
RAD*BAL	2	9.5429	4.7714	0.51	0.5976
VOL*LEN	4	52.0247	13.0062	1.40	0.2307
VOL*BAL	2	15.8734	7.9367	0.86	0.4250
LEN*BAL	2	92.9517	46.4759	5.01	0.0068
VIS*RAD*VOL	8	43.0077	5.3760	0.58	0.7951
VIS*RAD*LEN	8	104.2667	13.0358	1.41	0.1891
VIS*RAD*BAL	4	7.0925	1.7731	0.19	0.9430
RAD*VOL*LEN	8	34.9450	4.3681	0.47	0.8771
RAD*VOL*BAL	4	20.0296	5.0074	0.54	0.7063
VOL*LEN*BAL	4	93.5841	23.3960	2.52	0.0393
VIS*VOL*LEN	8	672.3174	84.0397	9.06	0.0001
VIS*VOL*BAL	4	33.4525	8.3631	0.90	0.4619
RAD*LEN*BAL	4	8.2276	2.0569	0.22	0.9263
VIS*LEN*BAL	4	27.9655	6.9914	0.75	0.5552
VIS*RAD*VOL*LEN	16	83.1436	5.1965	0.56	0.9141
VIS*RAD*VOL*BAL	8	25.4959	3.1870	0.34	0.9439
RAD*VOL*LEN*BAL	8	30.3206	3.7901	0.41	0.9160
VIS*VOL*LEN*BAL	8	101.1109	12.6389	1.36	0.2081
VIS*RAD*VOL*LEN*BAL	24	122.0984	5.0874	0.55	0.9625

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for variable: PCNT

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

Alpha= 0.05 df= 1458 MSE= 9.270795
Critical Value of Studentized Range= 3.318
Minimum Significant Difference= 0.4347

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	VIS
A	76.0228	540	3
B	71.4988	540	2
C	63.0603	540	1

Tukey Grouping	Mean	N	RAD
A	72.0554	540	1
B	70.4129	540	2
C	68.1136	540	3

Tukey Grouping	Mean	N	VOL
A	73.4264	540	3
B	70.2421	540	2
C	66.9134	540	1

Tukey Grouping	Mean	N	LEN
A	74.0522	540	1
B	69.8783	540	2
C	66.6514	540	3

Tukey Grouping	Mean	N	BAL
A	70.5433	810	1
B	69.8446	810	2

Appendix 5. CL3 Output for Loaded Miles

Anova test results for percentage of miles loaded at $\alpha = 0.1$.

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VIS	2	65997.3494	32998.6747	3562.22	0.0001
RAD	2	2220.1442	1110.0721	119.83	0.0001
VOL	2	10048.7977	5024.3989	542.39	0.0001
LEN	2	30612.7625	15306.3812	1652.33	0.0001
BAL	2	484.7526	242.3763	26.16	0.0001
VIS*RAD	4	206.6515	51.6629	5.58	0.0002
VIS*VOL	4	4371.2695	1092.8174	117.97	0.0001
VIS*LEN	4	8574.1256	2143.5314	231.39	0.0001
VIS*BAL	4	298.2289	74.5572	8.05	0.0001
RAD*VOL	4	59.3739	14.8435	1.60	0.1710
RAD*LEN	4	799.8988	199.9747	21.59	0.0001
RAD*BAL	4	27.7130	6.9282	0.75	0.5593
VOL*LEN	4	690.8213	172.7053	18.64	0.0001
VOL*BAL	4	70.3101	17.5775	1.90	0.1082
LEN*BAL	4	323.3898	80.8474	8.73	0.0001
VIS*RAD*VOL	8	71.5494	8.9437	0.97	0.4612
VIS*RAD*LEN	8	86.6746	10.8343	1.17	0.3137
VIS*RAD*BAL	8	32.4507	4.0563	0.44	0.8988
RAD*VOL*LEN	8	60.8549	7.6069	0.82	0.5838
RAD*VOL*BAL	8	32.6150	4.0769	0.44	0.8974
VOL*LEN*BAL	8	283.6351	35.4544	3.83	0.0002
VIS*VOL*LEN	8	208.7427	26.0928	2.82	0.0041
VIS*VOL*BAL	8	49.5289	6.1911	0.67	0.7199
RAD*LEN*BAL	8	77.6548	9.7069	1.05	0.3974
VIS*LEN*BAL	8	74.0151	9.2519	1.00	0.4348
VIS*RAD*VOL*LEN	16	84.3602	5.2725	0.57	0.9085
VIS*RAD*VOL*BAL	16	52.5258	3.2829	0.35	0.9912
RAD*VOL*LEN*BAL	16	45.7632	2.8602	0.31	0.9960
VIS*VOL*LEN*BAL	16	74.3652	4.6478	0.50	0.9477
VIS*RAD*VOL*LEN*BAL	48	197.0604	4.1054	0.44	0.9997

Tukey's Studentized Range (HSD) Test for variable: PCNT

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

Alpha= 0.05 df= 2187 MSE= 9.263522
Critical Value of Studentized Range= 3.317
Minimum Significant Difference= 0.3547

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	BAL
A	64.2256	810	1
A			
A	63.9556	810	2
B	63.1724	810	3

Tukey Grouping	Mean	N	VOL
A	66.2483	810	3
B	63.8374	810	2
C	61.2680	810	1

Tukey Grouping	Mean	N	LEN
A	68.2732	810	1
B	63.4860	810	2
C	59.5945	810	3

Tukey Grouping	Mean	N	RAD
A	64.9188	810	1
B	63.8543	810	2
C	62.5805	810	3

Tukey Grouping	Mean	N	VIS
A	69.5771	810	3
B	64.8346	810	2
C	56.9419	810	1

Appendix 6. J21 Output for Loaded Miles

Anova test results for miles loaded at $\alpha = 0.1$.

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VIS	2	20693.4330	10346.7165	1604.75	0.0001
RAD	2	668.4792	334.2396	51.84	0.0001
VOL	2	4308.1602	2154.0801	334.09	0.0001
LEN	2	6757.3651	3378.6825	524.03	0.0001
BAL	1	374.9972	374.9972	58.16	0.0001
VIS*RAD	4	5.9962	1.4991	0.23	0.9202
VIS*VOL	4	1269.3036	317.3259	49.22	0.0001
VIS*LEN	4	1971.4460	492.8615	76.44	0.0001
VIS*BAL	2	115.9768	57.9884	8.99	0.0001
RAD*VOL	4	23.6400	5.9100	0.92	0.4533
RAD*LEN	4	71.7161	17.9290	2.78	0.0256
RAD*BAL	2	3.6372	1.8186	0.28	0.7543
VOL*LEN	4	76.9588	19.2397	2.98	0.0181
VOL*BAL	2	40.1886	20.0943	3.12	0.0446
LEN*BAL	2	9.0152	4.5076	0.70	0.4972
VIS*RAD*VOL	8	21.8265	2.7286	0.42	0.9077
VIS*RAD*LEN	8	27.6423	3.4553	0.54	0.8301
VIS*RAD*BAL	4	2.4339	0.6085	0.09	0.9843
RAD*VOL*LEN	8	37.6712	4.7089	0.73	0.6648
RAD*VOL*BAL	4	13.0295	3.2574	0.51	0.7313
VOL*LEN*BAL	4	35.1206	8.7801	1.36	0.2450
VIS*VOL*LEN	8	140.9237	17.6155	2.73	0.0054
VIS*VOL*BAL	4	3.2096	0.8024	0.12	0.9737
RAD*LEN*BAL	4	3.7919	0.9480	0.15	0.9643
VIS*LEN*BAL	4	6.1010	1.5253	0.24	0.9178
VIS*RAD*VOL*LEN	16	24.7616	1.5476	0.24	0.9991
VIS*RAD*VOL*BAL	8	8.1466	1.0186	0.16	0.9959
RAD*VOL*LEN*BAL	8	10.6198	1.3275	0.21	0.9899
VIS*VOL*LEN*BAL	8	14.6410	1.8301	0.28	0.9715
VIS*RAD*VOL*LEN*BAL	24	54.1227	2.2551	0.35	0.9986

Tukey Results: Percent of Miles Driven Loaded

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for variable: PCNT

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

Alpha= 0.05 df= 1458 MSE= 6.447537
Critical Value of Studentized Range= 2.774
Minimum Significant Difference= 0.2475

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	BAL
A	64.2112	810	1
B	63.2490	810	2

Tukey Grouping	Mean	N	LEN
A	66.4045	540	1
B	63.3377	540	2
C	61.4482	540	3

Tukey Grouping	Mean	N	VOL
A	65.6149	540	3
B	63.9387	540	2
C	61.6368	540	1

Tukey Grouping	Mean	N	RAD
A	64.4317	540	1
B	63.8791	540	2
C	62.8795	540	3

Tukey Grouping	Mean	N	VIS
A	67.4594	540	3
B	64.8201	540	2
C	58.9108	540	1

Appendix 7. CL2 Output for Loads Used

Anova test results for percentage of loads used at $\alpha = 0.1$.

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VIS	2	2256.229	1128.114	126.38	0.0001
RAD	2	373.843	186.921	20.94	0.0001
VOL	2	105362.841	52681.421	5901.93	0.0001
LEN	2	32371.786	16185.893	1813.32	0.0001
BAL	1	27.916	27.916	3.13	0.0774
VIS*RAD	4	73.650	18.412	2.06	0.0934
VIS*VOL	4	45.957	11.489	1.29	0.2725
VIS*LEN	4	2987.705	746.926	83.68	0.0001
VIS*BAL	2	27.063	13.532	1.52	0.2198
RAD*VOL	4	14.717	3.679	0.41	0.8008
RAD*LEN	4	66.968	16.742	1.88	0.1144
RAD*BAL	2	5.535	2.767	0.31	0.7335
VOL*LEN	4	515.508	128.877	14.44	0.0001
VOL*BAL	2	1.402	0.701	0.08	0.9245
LEN*BAL	2	25.097	12.548	1.41	0.2456
VIS*RAD*VOL	8	25.136	3.142	0.35	0.9452
VIS*RAD*LEN	8	45.936	5.742	1.63	0.1523
VIS*RAD*BAL	4	3.054	0.764	0.09	0.9869
RAD*VOL*LEN	8	25.185	3.148	0.35	0.9449
RAD*VOL*BAL	4	7.683	1.921	0.22	0.9301
VOL*LEN*BAL	4	28.528	7.132	0.80	0.5258
VIS*VOL*LEN	8	210.936	26.367	2.95	0.0028
VIS*VOL*BAL	4	43.219	10.805	1.21	0.3048
RAD*LEN*BAL	4	37.256	9.314	1.04	0.3834
VIS*LEN*BAL	4	42.254	10.564	1.18	0.3192
VIS*RAD*VOL*LEN	16	43.161	3.073	0.34	0.9525
VIS*RAD*VOL*BAL	8	47.172	5.896	0.66	0.7266
RAD*VOL*LEN*BAL	8	23.583	2.948	0.33	0.9545
VIS*VOL*LEN*BAL	8	25.520	3.190	0.36	0.9417
VIS*RAD*VOL*LEN*BAL	24	139.515	5.396	0.60	0.9333

Tukey's Studentized Range (HSD) Test for variable: PCNT

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

Alpha= 0.05 df= 1458 MSE= 8.926128
Critical Value of Studentized Range= 3.318
Minimum Significant Difference= 0.4266

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	VIS
A	67.5821	540	2
B	65.5821	540	3
C	64.7745	540	1

Tukey Grouping	Mean	N	RAD
A	66.4849	540	1
A			
A	66.1200	540	2
B	65.3337	540	3

Tukey Grouping	Mean	N	VOL
A	76.2786	540	1
B	65.0733	540	2
C	56.5867	540	3

Tukey Grouping	Mean	N	LEN
A	70.4811	540	3
B	67.5727	540	2
C	59.8849	540	1

Tukey Grouping	Mean	N	BAL
A	66.1108	810	1
A			
A	65.8483	810	2

Appendix 8. C13 Output for Loads Used

Anova test results for percentage of loads used at $\alpha = 0.1$.

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VIS	2	6971.882	3485.941	383.85	0.0001
RAD	2	207.721	103.861	11.44	0.0001
VOL	2	135682.499	67841.250	7470.19	0.0001
LEN	2	20143.988	10071.994	1109.06	0.0001
BAL	2	8.704	4.352	0.48	0.6193
VIS*RAD	4	46.981	11.745	1.29	0.2703
VIS*VOL	4	6.835	1.709	0.19	0.9447
VIS*LEN	4	2288.721	572.180	63.00	0.0001
VIS*BAL	4	197.252	49.313	5.43	0.0002
RAD*VOL	4	17.323	4.331	0.48	0.7528
RAD*LEN	4	98.881	24.720	2.72	0.0281
RAD*BAL	4	21.249	5.312	0.58	0.6736
VOL*LEN	4	741.281	185.320	20.41	0.0001
VOL*BAL	4	60.534	15.133	1.67	0.1551
LEN*BAL	4	71.252	17.813	1.96	0.0978
VIS*RAD*VOL	8	51.156	6.394	0.70	0.6882
VIS*RAD*LEN	8	69.190	8.649	0.95	0.4719
VIS*RAD*BAL	8	29.149	3.644	0.40	0.9204
RAD*VOL*LEN	8	59.406	7.426	0.82	0.5869
RAD*VOL*BAL	8	38.510	4.814	0.53	0.8346
VOL*LEN*BAL	8	162.215	20.277	2.23	0.0227
VIS*VOL*LEN	8	142.681	17.835	1.96	0.0473
VIS*VOL*BAL	8	49.174	6.147	0.68	0.7124
RAD*LEN*BAL	8	36.295	4.537	0.50	0.8573
VIS*LEN*BAL	8	118.142	14.768	1.62	0.1123
VIS*RAD*VOL*LEN	16	95.680	5.980	0.66	0.8367
VIS*RAD*VOL*BAL	16	56.606	3.538	0.39	0.9852
RAD*VOL*LEN*BAL	16	28.912	1.807	0.20	0.9997
VIS*VOL*LEN*BAL	16	87.688	5.480	0.60	0.8835
VIS*RAD*VOL*LEN*BAL	48	126.556	2.637	0.29	1.0000

Tukey's Studentized Range (HSD) Test for variable: PCNT

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

Alpha= 0.05 df= 2187 MSE= 9.081597
Critical Value of Studentized Range= 3.317
Minimum Significant Difference= 0.3512

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	BAL
A	59.3550	810	2
A			
A	59.2639	810	3
A			
A	59.2100	810	1

Tukey Grouping	Mean	N	LEN
A	62.0986	810	3
B	60.4068	810	2
C	55.3234	810	1

Tukey Grouping	Mean	N	RAD
A	59.6374	810	1
B	59.2702	810	2
B			
B	58.9213	810	3

Tukey Grouping	Mean	N	VIS
A	60.8801	810	2
B	60.0153	810	3
C	56.9335	810	1

Tukey Grouping	Mean	N	VOL
A	68.8625	810	1
B	58.3345	810	2
C	50.6318	810	3

Appendix 9. J21 Output for Loads Used

Anova test results for percentage of loads used at $\alpha = 0.1$.

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VIS	2	2847.732	1423.866	144.40	0.0001
RAD	2	217.869	108.934	11.05	0.0001
VOL	2	101011.252	50505.626	5121.93	0.0001
LEN	2	27011.070	13505.535	1369.64	0.0001
BAL	1	184.859	184.859	18.75	0.0001
VIS*RAD	4	22.718	5.680	0.58	0.6801
VIS*VOL	4	179.348	44.837	4.55	0.0012
VIS*LEN	4	2478.336	619.584	62.83	0.0001
VIS*BAL	2	5.916	2.908	0.29	0.7446
RAD*VOL	4	145.108	36.277	3.68	0.0055
RAD*LEN	4	43.655	10.914	1.11	0.3517
RAD*BAL	2	26.263	13.132	1.33	0.2643
VOL*LEN	4	589.503	147.376	14.95	0.0001
VOL*BAL	2	15.862	7.931	0.80	0.4478
LEN*BAL	2	8.279	4.139	0.42	0.6573
VIS*RAD*VOL	8	116.661	14.585	1.48	0.1599
VIS*RAD*LEN	8	77.255	9.657	0.98	0.4503
VIS*RAD*BAL	4	69.983	17.496	1.77	0.1315
RAD*VOL*LEN	8	83.689	10.461	1.06	0.3880
RAD*VOL*BAL	4	16.189	4.047	0.41	0.8012
VOL*LEN*BAL	4	15.902	3.975	0.40	0.8065
VIS*VOL*LEN	8	353.574	44.197	4.48	0.0001
VIS*VOL*BAL	4	68.702	17.175	1.74	0.1383
RAD*LEN*BAL	4	15.481	3.870	0.39	0.8141
VIS*LEN*BAL	4	106.088	26.522	2.69	0.0298
VIS*RAD*VOL*LEN	16	221.409	13.838	1.40	0.1311
VIS*RAD*VOL*BAL	8	37.004	4.626	0.47	0.8785
RAD*VOL*LEN*BAL	8	68.320	8.540	0.87	0.5446
VIS*VOL*LEN*BAL	8	75.154	9.394	0.95	0.4717
VIS*RAD*VOL*LEN*BAL	24	194.285	8.095	0.82	0.7127

Tukey Results: Percent of Loads Used

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for variable: PCNT

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

Alpha= 0.05 df= 1458 MSE= 9.860657
Critical Value of Studentized Range= 2.774
Minimum Significant Difference= 0.3061

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	BAL
A	63.1860	810	1
B	62.5104	810	2

Tukey Grouping	Mean	N	LEN
A	67.0579	540	3
B	64.1668	540	2
C	57.3200	540	1

Tukey Grouping	Mean	N	VOL
A	73.0154	540	1
B	61.7647	540	2
C	53.7646	540	3

Tukey Grouping	Mean	N	RAD
A	63.2494	540	1
A A	62.9322	540	2
B	62.3630	540	3

Tukey Grouping	Mean	N	VIS
A	64.4540	540	2
B	62.8838	540	3
C	61.2069	540	1

Appendix 10. CL2 Output for Late Loads

ANOVA test results for percentage of loads delivered late at α=0.1.

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VIS	2	10653.104	5326.552	128.72	0.0001
RAD	2	12299.730	6149.865	148.62	0.0001
VOL	2	133.915	61.458	1.49	0.2268
LEN	2	141519.925	70759.963	1710.02	0.0001
BAL	1	270.750	270.750	6.54	0.0108
VIS*RAD	4	714.496	178.624	4.32	0.0018
VIS*VOL	4	1665.252	416.313	10.06	0.0001
VIS*LEN	4	12897.836	3224.459	77.92	0.0001
VIS*BAL	2	22.675	11.337	0.27	0.7604
RAD*VOL	4	112.119	28.030	0.68	0.6077
RAD*LEN	4	9961.148	2490.287	60.18	0.0001
RAD*BAL	2	33.907	16.953	0.41	0.6639
VOL*LEN	4	2376.367	594.092	14.36	0.0001
VOL*BAL	2	349.666	174.833	4.22	0.0148
LEN*BAL	2	1059.072	529.536	12.80	0.0001
VIS*RAD*VOL	8	90.281	11.285	0.27	0.9748
VIS*RAD*LEN	8	26.539	3.317	0.08	0.9997
VIS*RAD*BAL	4	45.762	11.440	0.28	0.8933
RAD*VOL*LEN	8	188.095	23.612	0.57	0.8027
RAD*VOL*BAL	4	93.913	23.478	0.57	0.6864
VOL*LEN*BAL	4	149.352	37.338	0.90	0.4617
VIS*VOL*LEN	8	1645.575	205.697	4.97	0.0001
VIS*VOL*BAL	4	49.108	12.277	0.30	0.8803
RAD*LEN*BAL	4	43.953	10.988	0.27	0.9003
VIS*LEN*BAL	4	116.822	29.206	0.71	0.5880
VIS*RAD*VOL*LEN	16	261.216	16.326	0.39	0.9841
VIS*RAD*VOL*BAL	8	68.735	8.592	0.21	0.9896
RAD*VOL*LEN*BAL	8	244.518	30.565	0.74	0.6574
VIS*VOL*LEN*BAL	8	153.371	19.171	0.46	0.8823
VIS*RAD*VOL*LEN*BAL	24	352.493	14.687	0.35	0.9984

Note: The highlighted ones do not have significant effects at α = 0.1.

Tukey's Studentized Range (HSD) Test for variable: PCNT

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

Alpha= 0.05 df= 1458 MSE= 41.37953
Critical Value of Studentized Range= 3.318
Minimum Significant Difference= 0.9185

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	VIS
A	74.9026	540	1
B	72.5285	540	2
C	68.6792	540	3

Tukey Grouping	Mean	N	RAD
A	75.4876	540	3
B	71.8789	540	2
C	68.7438	540	1

Tukey Grouping	Mean	N	VOL
A	72.3546	540	2
A			
A	72.0730	540	1
A			
A	71.6828	540	3

Tukey Grouping	Mean	N	LEN
A	83.4025	540	1
B	72.1979	540	3
C	60.5099	540	2

Tukey Grouping	Mean	N	BAL
A	72.4456	810	1
B	71.6280	810	2

Appendix 11. CL3 Output for Late Loads

Anova test results for percentage of loads delivered late at α=0.1.

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VIS	2	7874.6043	3937.3022	116.60	0.0001
RAD	2	2347.2135	1173.6067	34.76	0.0001
VOL	2	308.0829	154.0414	4.56	0.0105
LEN	2	13494.4245	6747.2122	199.82	0.0001
BAL	2	846.4228	423.2114	12.53	0.0001
VIS*RAD	4	249.5513	62.3878	1.85	0.1171
VIS*VOL	4	854.1798	213.5449	6.32	0.0001
VIS*LEN	4	7163.0097	1790.7524	53.03	0.0001
VIS*BAL	4	202.2980	50.5745	1.50	0.2002
RAD*VOL	4	89.8371	22.4593	0.67	0.6162
RAD*LEN	4	184.2024	46.0506	1.36	0.2441
RAD*BAL	4	94.4434	23.6108	0.70	0.5924
VOL*LEN	4	571.8901	142.9725	4.23	0.0020
VOL*BAL	4	450.4889	112.6222	3.34	0.0099
LEN*BAL	4	746.5750	186.6438	5.53	0.0002
VIS*RAD*VOL	8	39.6082	4.9510	0.15	0.9969
VIS*RAD*LEN	8	207.2913	25.9114	0.77	0.6317
VIS*RAD*BAL	8	196.4292	24.5536	0.73	0.6677
RAD*VOL*LEN	8	160.1469	20.0184	0.59	0.7845
RAD*VOL*BAL	8	414.6119	51.8265	1.53	0.1399
VOL*LEN*BAL	8	252.1372	31.5172	0.93	0.4874
VIS*VOL*LEN	8	252.3700	31.5462	0.93	0.4867
VIS*VOL*BAL	8	27.0135	3.3767	0.10	0.9992
RAD*LEN*BAL	8	89.4702	11.1838	0.33	0.9543
VIS*LEN*BAL	8	165.5150	20.6894	0.61	0.7679
VIS*RAD*VOL*LEN	16	303.5225	18.9702	0.56	0.9134
VIS*RAD*VOL*BAL	16	305.3559	19.0847	0.57	0.9112
RAD*VOL*LEN*BAL	16	208.1828	13.0114	0.39	0.9861
VIS*VOL*LEN*BAL	16	378.2537	23.6409	0.70	0.7964
VIS*RAD*VOL*LEN*BAL	48	880.4562	18.3428	0.54	0.9957

Tukey's Studentized Range (HSD) Test for variable: PCNT

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

Alpha= 0.05 df= 2187 MSE= 33.76632
Critical Value of Studentized Range= 3.317
Minimum Significant Difference= 0.6772

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	BAL
A	86.0481	810	2
A			
A	85.8476	810	1
B	84.7080	810	3

Tukey Grouping	Mean	N	LEN
A	88.8263	810	1
B	84.3392	810	2
C	83.4381	810	3

Tukey Grouping	Mean	N	RAD
A	86.7535	810	3
B	85.5035	810	2
C	84.3467	810	1

Tukey Grouping	Mean	N	VIS
A	87.5934	810	1
B	85.8020	810	2
C	83.2083	810	3

Tukey Grouping	Mean	N	VOL
A	85.8043	810	2
A			
A	85.7679	810	1
B	85.0314	810	3

Appendix 12. J21 Output for Late Loads

Anova test results for percentage of loads delivered late at $\alpha = 0.1$.

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VIS	2	14370.7071	7185.3536	190.66	0.0001
RAD	2	3262.6825	1631.3413	43.29	0.0001
VOL	2	270.7545	135.3773	3.59	0.0291
LEN	2	25660.8978	12830.4489	340.45	0.0001
BAL	2	195.1181	97.5591	2.59	0.0758
VIS*RAD	4	179.6445	44.9024	1.19	0.3148
VIS*VOL	4	577.7283	144.4321	3.83	0.0042
VIS*LEN	4	14679.6729	3669.9182	97.38	0.0001
VIS*BAL	2	43.2580	21.6290	0.58	0.5618
RAD*VOL	4	66.6236	16.6559	0.44	0.7766
RAD*LEN	4	1118.0721	279.5180	7.42	0.0001
RAD*BAL	2	22.4287	11.2143	0.30	0.7424
VOL*LEN	4	869.1660	217.2915	5.77	0.0001
VOL*BAL	2	165.4318	82.7159	2.19	0.1118
LEN*BAL	2	200.3464	100.1732	2.66	0.0704
VIS*RAD*VOL	8	100.1588	12.5199	0.33	0.9538
VIS*RAD*LEN	8	84.4349	10.5544	0.28	0.9726
VIS*RAD*BAL	4	28.4795	7.1199	0.19	0.9442
RAD*VOL*LEN	8	147.9143	18.4893	0.49	0.8654
RAD*VOL*BAL	4	11.2964	2.8241	0.07	0.9898
VOL*LEN*BAL	4	240.0114	60.0029	1.59	0.1728
VIS*VOL*LEN	8	369.2599	46.1575	1.22	0.2804
VIS*VOL*BAL	4	139.1109	34.7777	0.92	0.4493
RAD*LEN*BAL	4	7.8443	1.9611	0.05	0.9949
VIS*LEN*BAL	4	61.7446	15.4361	0.41	0.8018
VIS*RAD*VOL*LEN	16	445.3986	27.8412	0.74	0.7356
VIS*RAD*VOL*BAL	8	44.5191	5.5649	0.15	0.9968
RAD*VOL*LEN*BAL	8	90.8970	11.3599	0.30	0.9657
VIS*VOL*LEN*BAL	8	73.7277	9.2159	0.24	0.9773
VIS*RAD*VOL*LEN*BAL	4	97.1714	24.2929	0.64	0.6361

Tukey Results: Percent of Loads Delivered Late

General Linear Models Procedure

Tukey's Studentized Range (HSD) Test for variable: PCNT

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

Alpha= 0.05 df= 1458 MSE= 37.6866
Critical Value of Studentized Range= 2.774
Minimum Significant Difference= 0.5984

Means with the same letter are not significantly different.

Tukey Grouping	Mean	N	BAL
A	81.6496	810	2
B	80.9555	810	1

Tukey Grouping	Mean	N	LEN
A	86.2076	540	1
B	81.2408	540	3
C	76.4593	540	2

Tukey Grouping	Mean	N	VOL
A	81.8470	540	1
A B A	81.2197	540	2
B B	80.8411	540	3

Tukey Grouping	Mean	N	RAD
A	83.1023	540	3
B	81.1721	540	2
C	79.6334	540	1

Tukey Grouping	Mean	N	VIS
A	85.0329	540	1
B	81.1316	540	2
C	77.7434	540	3