PROCEEDINGS

Twenty-sixth Annual Meeting

Volume XXVI • Number 1 1985

TRANSPORTATION RESEARCH FORUM

PROCEEDINGS—

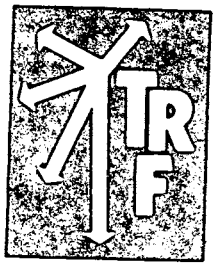
Twenty-sixth Annual Meeting

Theme:

"Markets and Management in an Era of Deregulation"

November 13-15, 1985
Amelia Island Plantation
Jacksonville, Florida

Volume XXVI • Number 1 1985



TRANSPORTATION RESEARCH FORUM
In conjunction with

Forecasting Car Hire Payments Utilizing a Micro Computer

*By George L. Stern and Roger A. Cobb**

ABSTRACT

The body of this paper describes a system used on the Grand Trunk Railroad to forecast and measure car hire payments utilizing the referencing and flexibility of the Lotus Worksheet Management Program on an IBM personal computer. Three files are used. First is an annual and monthly market forecast of carloads in 21 commodity groups and 4 traffic classes. A second file utilizes historical data to explode these 84 cells among 22 equipment types and further into 2 ownership classes. The third file is a record from Car Accounting of the price paid or received for each equipment type. Because prices tend to fluctuate, they are projected utilizing the trend analysis feature of the Visitrend package. Variances are run weekly on carloads; monthly on car type, ownership and price.

Sensitivity analysis measures the effect on net per diem of such actions as incentive pricing to load alternate car types, repair or acquisition of cars to affect loading of system vs. foreign cars or changing train operations to change average car time on the railroad.

I. INTRODUCTION

Car Hire, the rent one railroad pays another for the use of its rail cars, is one of the highest cash flow items in railroad operations. It is not unusual for the total amount paid to, and received from, other railroads and private car owners to approach 25% of revenue.

Car hire, however, remains one of the poorest forecast and controlled items in the rail budget. Most railroads budget only the net difference between payables and receivables and base this forecast solely on total loads handled, modified to some degree by car purchase and repair programs. A Compendium of Railroad Practices compiled by the Association of American Railroads described systems currently in place on several major carriers.[1] While some of these systems have highly desirable features, none fully integrate data flow from Market forecast to Per Diem expense in a manner permitting direct analysis of special capital or operational changes (see insert). While the primary purpose of the AAR study was to describe techniques to measure terminal time related car costs, it is the only investigation we could find which reported rail industry budgeting techniques.

II. HISTORY

The Grand Trunk Railroad is probably no different from most other railroads. Historically, the Finance Department budgeted per diem. It did so based on a regression formula which calculated the carload level at which net car hire would be zero. The budget for any specific year would then be calculated by measuring the variance by the Marketing Department. The results were modified based upon assumptions of the size of the active car fleet. Unfortunately, variances from actual experience (76% in 1982), could not be explained without recourse to other systems and, even then, it was hard to relate monthly activities to the annual budget. it has now been replaced for both 5 year and annual forecasting by the system described in this paper.

While the financial model was being used for annual budgeting, the Finance Department, along with Equipment Management, implemented a different system for monthly booking of net car hire expenses. Because there is several years data available, it is being continued in parallel with the system described herein for the balance of 1985.

This accounting system tracks and projects five journal entries: per diem receivables from foreign railroads for use of GTW cars, reclaims receivable from owning roads for per diem on cars on the GTW not used, per diem payable to owning roads for use of their cars by the GTW, mileage payable to private shippers and car leasing owners, and per diem reclaims payable to foreign railroads for GTW equipment while idle on their railroad.

The main advantage of this accounting model is that it is tied to physical attributes, which can be measured, such as cars and dollars. Empty cars are directly accounted for in this system, whereas they are ordinarily recognized, even in the proposed system, only as a factor in the cost per load. The main disadvantage is that there is still no way of adjusting the car hire forecast directly from the market forecast in order to predict, systematically, any particular element of per diem cost. Nor is the per diem settlement information structured such that variances from budget can be explained. And, since settlements are two months behind, and reclaims four months behind, the current month, only a general direction can be discerned for making adjustments to the budget. For these reasons, it was decided to try to develop a more elaborate model of per diem expense.

A model would be preferred which would respond directly to changes in carload volume, car ownership

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** All tables in this paper contain "test" data which may or may not reflect "actual" conditions.

and the per diem value of the cars used. The Grand Trunk has recently developed a system to do this. Input consists of a load forecast covering 21 commodities in 4 traffic classes, 22 car types, and 2 ownership classes. Each car type and ownership also has a price associated with it. Instead of the three input parameters of the original Finance Department model, or the 12 parameters of the original Equipment Management-Accounting Department model, this system uses 3740 inputs.

When one realizes not only the magnitude of the input assumptions, but also that each parameter is measured each month and the impact upon per diem of any variance in that standard is also measured, you can understand why a micro computer program is needed. In this case Grand Trunk developed this program utilizing the Lotus 1–2–3 spreadsheet program on an IBM personal computer.[2]

III. DATA SOURCES

The source documents are all currently produced for other purposes.

- The Marketing Department issues both its annual forecast and its monthly outlook split into 84 cells. These cells are composed of 21 commodity groups subdivided by four classes of traffic (local, interline forwarded, interline received and bridge).
- Car Accounting maintains its records according to ownership (system, foreign and private line). Within each category (e.g., system), Car Accounting reports car hire received or paid by car type, such as "50' box car" or "jumbo covered hopper".
- Equipment Planning receives a "car count" report each month which shows the number of loads moved by class of traffic, in system and foreign cars, by the same car type.

IV. SYSTEM DESCRIPTION**

The per diem budget system uses assumptions as to the percentage of loads moving in specific car types for each commodity and traffic class. It also assumes a certain percentage of system cars utilized for that car type. Each month, and for the year as a whole, calculations are made using the tables built for the annual budget. These tables have both volumes and percentages to facilitate changes due to proposed acquisitions, car repair programs or retirements.

For ease in manipulation of the various numbers and percentages at budget time, this data is manipulated on a separate worksheet.[3] This separation is particularly useful when preparing a 5 year forecast and plan as each year can be saved easily.

Sample elements from this worksheet are shown as Tables 1, 2 and 3.

Table 1
Actual Carloads

JUNE 1984

		Local		Forward		Receive		Bridge		Total	
Commodity	Car Type	System	Foreign	System	Foreign	System	Foreign	System	Foreign	System	Foreign
16 Chemicals	50' Box	0	6	7	71	0	2	0	33	7	112
	60' Box	0	0	25	11	0	1	0	39	25	51
	Insulated Box	0	0	2	0	0	2	0	10	2	12
	Air Slide Cov Hop	0	0	0	5	0	6	0	44	0	55
	Jumbo Cov Hop	0	27	0	45	0	288	0	160	0	520
	Std Cov Hop	0	12	6	4	0	20	0	25	6	61
	Tank	0	52	0	317	0	364	0	257	0	990

Table 2
Car Type by Traffic Class by Commodity

JUNE 1984

Commodity	Car Type	Local	Forward	Receive	Bridge
16 Chemicals	50' Box	6	16	0	6
	60' Box	0	7	0	7
	Insulated Box	0	0	0	2
	Air Slide Cov Hop	0	1	1	8
	Jumbo Cov Hop	28	9	42	28
	Std Cov Hop	12	2	3	4
	Tank	54	64	53	45

Table 3
Percent of System or Foreign Cars by Traffic Class,
Car Type and Commodity

		Local		Forward		Receive		Bridge	
Commodity	Car Type	System	Foreign	System	Foreign	System	Foreign	System	Foreign
15 Chemicals	50' Box	0	100	9	91	0	100	0	100
	60' Box	0	0	69	31	0	100	0	100
	Insulated Box	0	0	100	0	0	100	0	100
	Air Slide Cov Hop	0	0	0	100	0	100	0	100
	Jumbo Cov Hop	0	100	0	100	0	100	0	100
	Std Cov Hop	0	100	60	40	0	100	0	100
	Tank	0	100	0	100	0	100	0	100

All the remaining per diem and variance calculations discussed in this paper are on a single worksheet.[4]

All of the Grand Trunk's budgeting is driven by Market forecasts. So is this per diem estimate. As you can see from Table 4, the forecast is by commodity by traffic class.

The first step in the calculation process is to explode this carload forecast using the percentages calculated from the car count report (Table 2) into a carload forecast by car type for each commodity (Table 5).

The computer program automatically tallies the total loads projected for each car type within each

Table 4
Carloads by Commmodity and Traffic Class

JUNE 1984

Commodity	Local	Forward	Receive	Bridge	Total
1 Autos					
2 Trucks					
3 Vehicle Parts					
4 Grain					
5 Milled Grain					
6 Cereal					
7 Processed Foods					
8 Perishables					
9 Lumber & Wood					
10 Newsprint					
11 Pulp/Paper					
12 Metals					
13 Scrap Metals					
14 Coal and Coke					
15 Minerals/Sand					
16 Chemicals	100	370	760	660	1890
17 Compressed Gas					
18 Machinery/Equip					
19 Consumer Prod					
20 Miscellaneous					
21 Intermodal					
TOTALS	4150	14970	11380	9890	40390

Table 5
Loads by Car Type by Commodity

JUNE 1984 BUDGET

Commodity	Car Type	Local	Forward	Receive	Bridge	Total
16 Chemicals	50' Box	6	59	2	38	105
	60' Box	0	27	1	45	73
	Insulated Box	0	2	2	12	15
	Air Slide Cov Hop	0	4	7	51	62
	Jumbo Cov Hop	28	34	320	186	568
	Std Cov Hop	12	8	22	29	71
	Tank	54	238	405	299	995

traffic class (Table 6). This is useful to Equipment Management in projecting the number of cars needed to meet shipper requirements. It is also the traditional forecast Marketing supplies Equipment Management as the starting point to predict per diem. The only purpose in this system is to verify the load total to be certain no loads were lost in the explosion process.[5] (Sharp-eyed readers will note

Table 6
Loads by Car Type

JUNE 1984 BUDGET

Car Type	Local	Forward	Receive	Bridge	Total
40' Box	0	1	153	357	511
50' Box	450	2231	2327	3127	8134
60' Box					
86' Box					
Insulated Box					
Reefer					
Air Slide Jumbo CH					
Air Slide Std CH					
Jumbo Cov Hop	67	912	541	601	2120
Std Cov Hop	122	139	199	373	833
Gondolas					
Coil Gondolas					
Open Hoppers					
Bi Level					
Tri Level					
Saddleback					
Short Flat					
Long Flat					
Frame Flat					
Tofc Flat					
Containers	163	411	341	35	950
Trailers	2207	519	299	75	3100
Tank					
TOTALS	6520	15900	12020	9970	44410

Table 7
Loads in System or Foreign Cars by Traffic Class,
Car Type and Commodity

JUNE 1984 BUDGET

		Local		Forward		Receive		Bridge		Total	
Comodity	Car Type	System	Foreign	System	Foreign	System	Foreign	System	Foreign	System	Foreign
16 Chemicals	50' Box	0	6	5	53	0	2	0	38	5	100
	60' Box	0	0	19	8	0	1	0	45	19	55
	Insulated Box	0	0	2	0	0	2	0	12	2	14
	Air Slide Cov Hop	0	0	0	4	0	7	0	51	0	62
	Jumbo Cov Hop	0	28	0	34	0	320	0	186	0	568
	Std Cov Hop	0	12	5	3	0	22	0	29	5	67
	Tank	0	54	0	238	0	405	0	299	0	995

that the totals have increased by the explosion of "Intermodal" into TOFC cars, trailers and containers).

When the ownership assumptions (Table 3) are multiplied by the exploded carload commodity forecast (Table 5), the result is a forecast of loads by commodity, class traffic, car type and ownership (Table 7).

The last step in the basic per diem forecast is to multiply the loads by the appropriate income or cost per car which is called "price" (Table 8). It is recognized that "price", as used here, is actually a combination of car time on line (or off line) and the per diem value of the car. At some time in the future, separate tables may be built for each factor.

The result (Table 9) is an income to per diem in the case of per diem on a system car or a cost in the case of a foreign car. A sum is calculated for each car type and commodity according to whether per diem will be received or paid out. For example, it is assumed that per diem is paid on all loads in foreign cars, but received on system owned cars only when "forwarded". Net per diem is then calculated for each commodity. The sum of the net per diem for all commodities produces the net per diem for the time period.

Table 8
Per Diem by Car Type

JUNE 1984 BUDGET

Car Type	Receive	Pay
40' Box		48
50' Box	275	72
60' Box	239	113
86' Box	213	102
Insulated Box	890	348

V. PRICE

As mentioned above, price as used in this system is a combination of the actual daily value and mileage rates and the time (on or off the railroad) and miles operated. The rates for any individual car are recorded in the Umler file. The problem is to forecast the mix of cars to project an average price and to forecast the average time and mileage to multiply the appropriate rates by. In practice, the portion that is critical differs from receivables and payables.

Per diem is paid on foreign railroad owned and private equipment. For the most part, commodities and thus, freight cars, travel highly repetitive routes. Service is fairly consistent. Most foreign empty cars held for loading are on reclaim (if assigned) or allowance (if free runners). Therefore, the time and mileage portion paid for vary within a fairly narrow range. The assumption we use is that most of the price variance is due to the mix of newer versus older cars. Each month, after the actual settlements are received from Car Accounting, the actual payment for each car type is calculated. These "prices" are accumulated in a separate table, where they can be strategically treated. Because we had so little history in 1984, we simply struck an average for each car type to budget 1985. We did prove that, using the

Table 9
Per Diem Estimate (Receivables and Payables)

JUNE 1984 BUDGET

		Local		Forward		Receive		Bridge		Total		Net
Comodity	Car Type	System	Foreign	System	Foreign	System	Foreign	System	Foreign	Receive	Payable	Per Diem
16 Chemicals	50' Box	0	448	1446	3855	0	161	0	2774	1446	7238	-5792
	60' Box	0	0	4493	935	0	126	0	5133	4493	6194	-1701
	Insulated Box	0	0	1335	0	0	774	0	4039	1335	4813	-3478
	Air Slide Cov Hop	0	0	0	648	0	1152	0	8822	0	10622	-10622
	Jumbo Cov Hop	0	3255	0	3950	0	37481	0	21744	0	66430	-66430
	Std Cov Hop	0	992	1598	241	0	1785	0	2330	1598	5348	-3750
	Tank	0	10702	0	47493	0	90856	0	59614	0	198665	-198665
												-290437

Translation Utility to convert Lotus 1–2–3 files to DIF files, it is possible to load this data into VISITREND/PLOT[6] but we don't intend to do trend or seasonal analysis until we have at least two years of data.

The problem of forecasting receivables is far tougher. Whereas, it is rare for a payable to vary from the average by 15% (and then only $50 per load), it is possible for a receivable to vary from the average by 100%. This is particularly true of insulated box cars and multi-level cars where Grand Trunk's fleet is in national pools. In slow times, the cars are off line, stored on reclaim whereas in busy times, the cars are in continuous use generating receivables. A more flexible budget, recognizing both normal and busy trends, should improve forecast accuracy.

VI. VARIANCES

As you can see, the forecasting of per diem is comprised of many assumptions. A primary advantage of this forecasting system is flexibility in adjusting to changes in those assumptions. Each time one of the input variables changes, a new forecast can be generated quickly and easily. For example, each week the Marketing Department issues a revised carload outlook. Within just a few minutes, a revised per diem forecast is available. As another example, a major utility recently switched from receiving its coal in private cars with no mileage allowance to railroad owned equipment. The impact was enough to change the average cost per load for foreign open hopper cars. The cost table could be changed immediately and, with it, the per diem forecasts. Changes to the input assumptions due to capital investment or operating changes, allows measurement of those changes before they are made.

Another advantage of this system, and possibly the most important, is the ability to recognize and measure variances of the actual results from those used in the forecast. This feedback not only should lead to improved forecasts but, more importantly, should lead to a better understanding of per diem costs, and thus, ways to improve it.

Four variances are currently measured: Carloads by commodity by traffic class, Car Type used within each commodity and Traffic Class, System versus Foreign cars for each commodity, Traffic class and car type, and Car Hire (price) received or paid per load for each car type.

Timeliness of these variances varies greatly, however. Carload commodity information is available the following day. Car type and ownership data is available when the car count report is produced, which is approximately 60 days following the close of the month. Car hire data to calculate "price" per car is not available until reclaims are settled seven or eight months following the close of the month.[7]

Variances are calculated by simply moving the previous per diem estimate to a "work table" in the worksheet; then inserting the new data to automatically calculate the new per diem, calculating and printing the per diem variance by carload and commodity at the same time. All of this is accomplished using the macro capability of the Lotus program. Table 10 shows the macro to produce variances for car type.

VII. RESULTS AND CONCLUSION

An assessment of the program to date would have to rate it a qualified success. Its speed is awesome. Calculation of net per diem for any year of the 5 year plan or any month in the coming year takes about 10 minutes. Calculating the effect on the Grand Trunk of the rate changes proposed by the AAR in Ex Parte 334 didn't take much longer.

The ability to explain variances from budget is also awesome-and overpowering. Care has to be taken not to get enmeshed describing volume and price variances for each car type, commodity and traffic class.

The problem with the program is that these twin advantages also present difficulties. Individual parameters can vary widely on a month to month basis. This is particularly true of ownership (% of cars loaded in system equipment). When the law of large numbers works, and errors offset each other, the resultant forecasts have been remarkably accurate. At other times, all the variances seem to be in the same direction, resulting in horrendous forecasts.

The second problem is that no system, least of all this one, can be used by itself. Further development is needed to integrate this system with other corporate control systems. "Price" needs to be split between a time factor and a pure price factor. The time portion can then be related to the Terminal Management Information system and the Car Movement (quality control) reporting systems. The price portion might lead to individual bi-lateral agreements. Cost per load needs to be systematically compared

Table 10

```
\c        /c~bh8~                    update price variance table date
          /reoldpdest~               erase old estimate
          /fxvpdest~pdest~r          extract pd estimate
          {goto}av43~                insert pd estimate
          /fccapdest~                  into base position
          /recartype~                erase cartype table
          {goto}e44~                 insert cartype from
          /fccecartype~                carcount file
          /pprpdvar~agpq             print cartype variance report
```

with the assumptions in Grand Trunk's customer and commodity profitability reports.

In conclusion, the speed and flexibility of the Lotus spreadsheet program operating on a departmental micro computer has resulted in faster and more flexible detailed forecasts and more detailed analysis of variances. It is a link, previously missing in the Grand Trunk's reporting system, between market forecasts, car maintenance programs, acquisition planning and quality of service.

ENDNOTES

1. "Compendium of Railroad Car Cost Allocation and Budgeting Systems", AAR Report No. %-531, Association of American Railroads, Washington, D.C., August 1982.
2. Lotus 1–2–3 is a product of Lotus Development Corp. It is used on an IBM Model 5150 personal computer, 512K core memory, 720K dual drive disk storage and an Epson FX 100 wide carriage dot matrix printer.
3. The *car count* worksheet is 53 columns by 238 rows. It consumes 184,158 bytes of memory and takes 38 seconds to calculate.
4. The *Perdiem* worksheet is 64 columns by 299 rows. It consumes 290,995 bytes of memory and takes 32 seconds to calculate.
5. Totals are run throughout the worksheet to make sure formulas have not been altered. A master program is kept on a backing disk. The *Spreadsheet Auditor,* a product of Consumers Software, Inc., was used when an error could not be found.
6. VISITREND is a product of Personal Software, Inc.
7. Reclaims and allowances are the primary problem in reconciling physical car measurements to accounting records. They are the primary cause of accounting "adjustments". An effort is underway in the Committee on Car Service to recognize reclaims through the AAR's TRAIN II computer in real time, but it is too early to predict implementation.