Fast Track To Fleet Productivity

Public Transport Scheduling & Rostering

xlerate
fleet productivity solutions

Difficulties and Opportunities

Scheduling is one of the most difficult, complex, misunderstood, and underrated tasks in Public Transport. It also presents, however, one of the greatest opportunities for a bus operator to reduce costs and to improve its operating efficiency.

Improving vehicle utilization means providing the same level of service with fewer vehicles. Improving driver schedules means that drivers are spending more time actually driving those vehicles. Both these improvements can directly and dramatically lower capital and operating expenses.

Better schedules show instant results. They do not require expensive purchases or unproven technology. They immediately assist you in doing more with your current equipment and staff.

Finding a solution to Public Transport scheduling is a daunting task. The first step is to break it down into a number of smaller problems.

Rostering is one of the final steps of Public Transport Scheduling. After vehicle assignment (blocking) and crew assignment (run cutting), rostering is the process of combining daily runs to create complete weeks of work for drivers.

In New Zealand, rostering has often been left to the drivers, where each driver picks his or her runs and days off in order of seniority. This practice often leads to "leftover" runs that cannot be legally combined and require costly part-time or overtime work. It can also lead to an excessive number of runs with non-consecutive days off.

In Europe, rostering is much more complex where the goal is to minimize the difference between individual driver's workweeks.

For these reasons, is can be highly beneficial the Transport scheduler to create all the rosters at once to minimize leftovers, and then let the drivers choose a roster from this set. In addition to minimizing leftovers, powerful software now exists that allows the schedule a great degree of control over the type of rosters created. The scheduler can easily choose to maximize driver convenience or minimize the difference in work for all rosters or only for rosters of a certain type.

This paper also outlines these cost-effective rostering techniques and how Xlerate software can help achieve those goals.

How do we manage our data?

It's easy to lose opportunities by getting lost in the volume of Public Transport trip information. Each Transport system provides of a set of runs during the day, and each run is further composed of a series of trips, some on multiple routes. The time it takes to drive a trip can vary during the day due to the traffic, and the frequency of trips can increase during rush hours. Of course, the requirements of weekend, holiday, and special event services can alter the number of trips.

Customized and accurate trip patterns are the key to providing better customer service. Vehicles are also better utilized by trip patterns that match the requirements of the riders. Even for small and medium sized agencies, the number of distinct trips can become quite large - often into the several thousands. Although all these trips need to be considered, they can usually be derived from a few simple rules based on the time of day, and the level of service required. It is far easier to change the rules and have the trips generated and stored automatically by a computer system then it is to maintain the trips separately. Real street level maps showing the routes can be as essential to detecting errors and inconsistencies in the route specifications.

Generating trips quickly and efficiently is the key to keeping up with route changes and the needs of a dynamic ridership.

How many vehicles are needed?

Once we have determined all the trips that need to be driven, the second step is to figure out how vehicles should be assigned so that all the trips are covered. Doing this so that the minimum numbers of vehicles are used is a surprisingly complex problem.

After driving a trip, a vehicle usually drives the next trip in the route. It is at the end of the route, however, it can go back on the return route, change to a different route starting from the same location, or drive to the beginning of a different route. If we assign vehicles to trips all at the same time, we maximize the opportunity to take advantage of this flexibility. Unfortunately, all of these combinations can create millions of possibilities. We also want to minimize the amount of waiting and deadheading time for each vehicle. With this added requirement, this problem becomes even more complex.

This problem is known as "the vehicle blocking problem". At small and medium bus operators, vehicle blocking is usually done manually. This technique can yield a good solution that avoids the most glaring inefficiencies. However, a computer based scheduling system can consider all of the possibilities and find the best solution.

Computers are particularly good at this type of number crunching, and can do it automatically in minutes. Unlike human schedulers, they blindly consider alternatives that might look bad at the beginning, but sometimes work out in the end.

The result of this exercise can be surprising, and sometimes dramatic. Our solution at a medium-sized bus operation is a case in point. The operation was using over 320 buses to cover their trips, and all the vehicle blocks looked quite reasonable. As good as those blocks were, the computer found another solution that used just under 250 buses, and reduced the peak vehicle requirement by 23.

When you stop to think of the capital costs of acquiring just one vehicle and the operating costs of maintaining it, reducing the number of vehicles (and improving their utilization) represents a significant cost savings opportunity for every Transport operator.

How do we assign drivers?

After utilizing the vehicles as to minimize capital and operating expenses, we need to assign drivers to those vehicles. The problem starts with meeting all the rules for how drivers work in a day. We need to keep drivers' work days an acceptable length. We would like to minimize the number of drivers that need to work split shifts during the day. We would like each driver to work as close to a full day as possible. We need to respect union rules regarding overtime, report and travel times, and any number of other "unwritten rules" that govern the runcut. Of course, we would also like to ensure that drivers are actually driving. We also occasionally need to keep certain runs exactly the same.

Since each vehicle is fully utilized from the blocking step, it may be in use for the whole day - longer than one driver could work. This means that a number of drivers may drive a given vehicle during the day, relieving one another at different locations within the system.

Relief points do not always need to be at the beginning and end of a route or even a trip - they could occur at intersections or other passing points. The possible valid ways drivers can be deployed using all possible relief points can be astronomical. Some solutions lead to overall efficiency, while some of them lead to excess waiting time.
Again, the power of the computer can be used to sift through these possibilities in minutes and help find the best answer. As it proceeds, the machine constantly checks the rules for each run, and ensures that the final result is always valid.

How do we assign day off?

For the most part, Public Transport operates six or seven days a week. Typically, drivers need two days off each week, and this means that some drivers will have to share routes. Days off need to be scheduled so that drivers work the same route as often as possible, work roughly the same hours each day and have as many consecutive days off as possible. Additionally, they need to report for work at roughly the same time each day. Drivers are better scheduled if we minimize the number of part-time work assignments. Often, collective employment agreements require a minimum percentage of full-time drivers.

Because of these restrictions, it is not always possible to have a driver work two given runs on consecutive days, and respect report time or minimum time off between days. All of the many combinations need to be explored carefully, or undesirable rosters will result. Again, a computer-based scheduling system can consider far more possibilities in seconds than can be considered by hand. It goes about this in an efficient way that avoids getting "painted into a corner". The computer meticulously checks all the rules so that no unacceptable rosters are ever released.

Goals of Rostering

There are a number of basic goals that are always considered at each Bus operator, some are required, and some are optional. These goals have different degrees of importance at a given operation.

- Required: Respect required days off in a week. If drivers work a 5-day week, then they need 2 days off per week. If drivers work a 4-day week, then they need 3 days off per week.

- Required: Respect minimum off time between consecutive working days. Drivers need a minimum amount of time off when one day ends before work on the next day begins.

- Optional: Maximize driver convenience. This includes maximizing consecutive days off, minimizing the difference in start time from day to day and minimizing combinations of straight and split runs (at some operations, this is not allowed at all).

- Optional: Maximize driver stability. Here the goal is to try to minimize the number of different routes a driver has to work in the week. The idea is that this will result in higher customer service as the drivers do each run more often and learn how to drive it better.

- Optional: Minimize part-time and leftover work. At some operations, part-time work weeks must be paid for at a full-time rate and/or leftover work must be paid at an overtime rate.

- Optional: Minimize the weekly work variance between drivers. Especially, some operations have to pay a premium for drivers who work over and under the average week. It is sometimes desirable to make certain classes of rosters "roughly" equal in duration (for example, make all rosters with non-consecutive days off roughly the same amount of work).

Rostering Strategies

As is usual with problems in Public Transport scheduling, the optional rostering goals conflict, and it is usually impossible find a solution that satisfies all simultaneously.

Another issue is to determine whether driver convenience should be considered in order of seniority (for example, the most senior drivers get first pick at the most convenient rosters). Alternatively, it could be considered across the board for all drivers (for example, all drivers could start the next day's work within one hour of the previous day's start time). Practically, both strategies could apply in different situations at the same property.

The first step in finding a good roster is to decide which the most important goals are, and which are the goals that can be sacrificed for the important ones. There are a number of techniques that can be used:

1. Let the Drivers Pick their Runs and Days Off

This technique is very common. Drivers meet with the scheduler - in order of decreasing seniority - and pick desired days off as well as the runs that they want to work. The remaining runs are left for drivers with lower seniority and the process repeats until all runs have been chosen. This allows the most senior drivers to get the best work weeks, and the first work weeks can be stable. However, it can lead to problems:

Many incompatible work days left over at the end. A number of work days cannot be combined together because they would violate the restriction of minimum time off. This does not mean that there is no solution that incorporates those work days; it just means what the drivers picked did not lead to that solution.

Many "ugly" rosters at the end for low seniority drivers. For example, a high variance of start time between work days or a lot of mixing between run types in the same roster. This can contribute to driver dissatisfaction and higher absenteeism.

A high degree of inequity in the number of hours worked per week between drivers. Some may be too short to pass as "regular", and others may be too long to be worked without overtime. This can also lead to driver dissatisfaction if the inequities are too great.

Rostering Strategies

2. Let the Drivers Pick from a set of SCHEDULED Work Weeks

This requires the scheduler to create a set of feasible and complete rosters first, and then allows the drivers choose those given rosters in order of seniority. This allows the scheduler to plan the roster cleverly so that the problems of letting the drivers choose their own days off can be avoided. Of course, this means that some of the driver convenience be sacrificed, as the rosters will be designed without each driver's direct input on desired days off and runs.

In the past, many operations did not use this strategy because there was no way to create a good set of rosters quickly. All this changes with computerized scheduling. There are a number of ways that operations may want to create rosters to maximize consecutive days off and minimize any leftover work.

3. Maximize Driver Convenience

Here the goal is to minimize the variance in daily work start-time for each individual roster. This can lead to more variation in the week's work between rosters. However, since there is more stability in each driver's roster, this may be preferable.

4. Minimize Variance between Work Weeks

Here it is desirable to equalize the total work time between rosters. This makes all the work done in a week as equitable as possible for all rosters, but may cause more variance between start time on each day of a roster. Although this makes the rosters as "fair" as possible from a total work perspective, it may decrease the driver convenience. Again, in some situations, this may be preferable.

5. Blend Driver Convenience and Minimized Work Variance

The ultimate solution would be to be able to choose between convenience and equality, and Xlerate Scheduler allows this too. The scheduler can choose along a sliding scale to indicate the level of preference for driver convenience or equality.

Conclusion

What counts in the end is the quality and cost of the Transport schedule. By managing the data, we can quickly keep up with the needs of our customers. By minimizing the number of vehicles, we reduce capital and maintenance costs. By effectively scheduling our drivers, we improve employee relations and reduce operating costs.

Xlerate Scheduler is a software package by Xlerate Technologies Limited which combines all these capabilities into a complete Managed Services offering. The system was specifically designed to meet the needs of small to large-sized Transport agencies. Its point and click user interface uses menus and dialogs to quickly define trips from simple rules. Its state-of-the-art scheduling blocking techniques ensures that the fewest vehicles are used. Its run-cutting and rostering procedures help create the best schedules possible. Its powerful yet user-friendly design puts the scheduler in control of all the features and solutions. Schedulers can be fully productive on the system in only a few days.

We integrate with our mapping data application to show and edit street level maps of routes on the screen, and the Crystal Reports report writer to produce professional and customizable reports of any data or solution in the system. Crystal can create output in just about any Windows application format including Excel, Word, and can send information directly by email.

These features allow solutions to be put into effect quickly and efficiently. Data from the system can be automatically formatted in-house to produce professional route descriptions and trip times for the public. All of these features are immediately available right out of the box in the standard package.

The Xlerate Scheduler supports a wide range of techniques for rostering to meet the needs of many operations. By allowing the scheduler to choose the technique dynamically, the software allows "what-if" scenarios to be tested quickly without the need of costly additional consulting. This ensures that schedulers using Xlerate Scheduler will continue to meet the rostering needs of their transport operations today as well as in the future.

Xlerate Technologies provides complete turnkey services, as well as installation, upgrade and data conversion.

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