Chapter 14: Patterns for "selected floors"

Summary: Patterns for "selected floors" are the basis of the Comparative Performance Tables (CPT's) that have been used in previous chapters to demonstrate the performance potential of intelligent destination elevators for UP traffic. This chapter proves with "selected floors" patterns that a group can vary transport capacities and distribute transport capacities evenly over all floors whilst maintaining a best-possible balance between transport capacities and time-dependent service qualities. Time-dependent service qualities are improved by the "First come first served" method of service call assignments to specific cars.

Introduction

In previous chapters the inherently poor service qualities of traditional groups have been explained. During periods of heavy traffic the large and full cars of existing traditional groups cause the cars to make many stops. This implies long average RTT's and travel times in the cars for passengers. Particularly during simultaneous UP and DOWN traffic the service qualities of traditional groups are often unacceptable. Unfortunately traditional group controls cannot be intelligent and cannot control their efficiency or service qualities. The random destinations of passengers are in control.

Intelligent destination groups can control and coordinate car operations, i.e. control efficiency and all service qualities, by selecting a specific "selected floors" pattern **or** numbers for permitted stops on the basis of anticipated traffic conditions.

As mentioned in Chapter 7: **efficient UP traffic is the basis for the efficiency of all traffic conditions.** This chapter proves that UP traffic efficiency can be controlled by the use of "selected floors" patterns. These patterns form the logical basis of the calculated data structures and the Comparative Performance Tables that disclose the inherent relativity of the performance parameters of groups.

The relativity of group transport capacities and time-dependent service qualities provides the mathematical basis for best-possible planning and performance of groups with intelligent destination controls.

Patterns for "selected floors"

The basic pattern for service to upper floors is **all cars serve all floors**. This is the one and only pattern of groups with "collective selective" controls and the reason why they cannot influence their efficiency and service qualities. In the past it was not unusual to divide a group of "collective selective" elevators into cars serving a Low- and a High Zone during UP PEAK traffic. This mode of car operation was not always understood or appreciated by passengers and it seems this practice has been abandoned.

Intelligent destination elevators can gradually reduce (vary) the number of “selected floors“. These changes do not affect call entry by passengers nor the group's method of response to call entry.

Chapter 14: Patterns for "selected floors"

Chapter 7: “Why intelligent destination elevators perform better” shows the pattern for "selected floors" = 11 for a group serving 12 floors. When a group serves 13 floors its pattern "selected floors" = 12 is identical except that the number of trips to complete a full Cycle increases to 13.

Patterns for high numbers of "selected floors" are called **omitted floors patterns**. Patterns for serving consecutively ONE or few "selected floors" with direct trips are called **direct trip patterns**. Omitted floor patterns assure service to all floors by TWO cars. Direct trip patterns assure service to all floors by TWO or THREE or more cars.

The common characteristic of all patterns is that **each floor is served the same number of times during all trips of a pattern.** The patterns below for "selected floors" = 11 and 10 demonstrate how <u>groups with odd numbers</u> of floors can assure regular service to all floors by **consecutively departing cars**.

Trip number	1	2	3	4	5	6	7	8	9	10	11	12	13
	Number of "selected floors" = 11												
Floors served													
13		X	X	X	X	X		X	X	X	X	X	X
12		X	X	X	X	X	X		X	X	X	X	X
11	X		X	X	X	X	X		X	X	X	X	X
10	X		X	X	X	X	X	X		X	X	X	X
9	X	X		X	X	X	X	X		X	X	X	X
8	X	X		X	X	X	X	X	X		X	X	X
7	X	X	X		X	X	X	X	X		X	X	X
6	X	X	X		X	X	X	X	X	X		X	X
5	X	X	X	X		X	X	X	X	X		X	X
4	X	X	X	X		X	X	X	X	X	X		X
3	X	X	X	X	X		X	X	X	X	X		X
2	X	X	X	X	X		X	X	X	X	X	X	
1	X	X	X	X	X	X		X	X	X	X	X	
0	X	X	X	X	X	X	X	X	X	X	X	X	X

Trip number	1	2	3	4	5	6	7	8	9	10	11	12	13
	Number of "selected floors" = 10												
Floors served													
13		X	X	X		X	X	X		X	X	X	X
12		X	X	X		X	X	X	X		X	X	X
11		X	X	X	X		X	X	X		X	X	X
10	X		X	X	X		X	X	X		X	X	X
9	X		X	X	X		X	X	X	X		X	X
8	X		X	X	X	X		X	X	X		X	X
7	X	X		X	X	X		X	X	X		X	X
6	X	X		X	X	X		X	X	X	X		X
5	X	X		X	X	X	X		X	X	X		X
4	X	X	X		X	X	X		X	X	X		X
3	X	X	X		X	X	X		X	X	X	X	
2	X	X	X		X	X	X	X		X	X	X	
1	X	X	X	X		X	X	X		X	X	X	
0	X	X	X	X	X	X	X	X	X	X	X	X	X

X "selected floors" — (yellow) omitted floors — Ch14dia1

When cars are operating in accordance with a specific pattern each floor can be served a specific number of times during the trips that make up the pattern. The number of floors served identifies the pattern.

Trips that include service to the top floor are called **High trips**. All other trips are called **Low trips**. The RTT of each trip can be calculated for any number of passengers. The average RTT of all trips Low and High with a specific number of passengers is the **<u>Average RTT L & H</u>.**

The number of trips in a pattern that will serve all floors the same number of times varies with the number of floors served by the group and the number of "selected floors". The maximum number of trips required to evenly distribute elevator service over all upper floors equals the number of floors served by a specific group.

<u>The total time to complete all trips of a pattern is by itself not important</u>, however, this **total time** divided by the <u>number of times each floor is served</u> yields the average **<u>Cycle RTT</u>**, i.e. the average time required to serve each floor once.

Chapter 14: Patterns for "selected floors"

The **<u>Cycle INTERVAL</u>** is the Cycle RTT divided by the number of cars in the group. The Cycle INTERVAL **enables calculation of the theoretical minimum AWT =** the average Cycle INTERVAL divided by TWO.

The **<u>Departure INTERVAL</u>** between cars leaving floor zero is the average RTT L & H divided by the number of cars in the group.

For a <u>specific anticipated UP traffic density</u> the relevant Comparative Performance Table (CPT) shows the range of "selected floors" patterns that can satisfy this traffic density.

To appreciate why and how all floors get equal service during each Cycle RTT please envisage a 4-car group with cars A, B, C and D serving 13 floors with either one of the above patterns. Car A makes trip number 1 starting from floor zero. The **next car** starting from floor zero will make trip number 2. **The trip of the next car includes the omitted floors of the previous trip**. When car A returns to floor zero trips numbers 2, 3 and 4 probably have already been started and car A continues with trip number 5. If the "brains" had decided a change of pattern car A would continue the next trip of the new pattern.

Service to all floors is accomplished by TWO cars. Each time car A or any other car departs from floor zero it can serve all "selected floors", however, passengers that want to go to the omitted floors are **denied service by the first departing car (NEXT 1) and are assigned to the second next departing car NEXT 2.**

For high numbers of "selected floors" the majority of passengers will enjoy short waiting times that will average at half of the <u>Departure INTERVAL</u>. The passengers that are denied service by the first departing car have to wait for car NEXT 2 and experience longer waiting times. All passengers benefit from shorter ATTC's.

Direct trip patterns

A well designed group will not require the use of direct trip patterns for normal traffic conditions. However, for emergencies or to solve problems of <u>existing under-elevatored buildings</u> the use of direct trip patterns may be required.

The patterns below show how a group serving 13 floors can efficiently serve 7/6 and 5/4/4 upper floors if required for high traffic densities.

Trip number	1	2	3	4
Number of "selected floors" = 7/6 (6.5)				
Floors served				
13		X		X
12		X		X
11		X		X
10		X		X
9		X		X
8		X		X
7	X			X
6	X		X	
5	X		X	
4	X		X	
3	X		X	
2	X		X	
1	X		X	
0	X	X	X	X
	X	"selected floors"		

Trip number	1	2	3	4	5	6	7	8	9
Number of "selected floors" = 5/4/4 (4.33)									
Floors served									
13			X			X			X
12			X			X			X
11			X			X			X
10			X			X			X
9		X			X				X
8		X			X			X	
7		X			X			X	
6		X			X			X	
5	X				X			X	
4	X			X			X		
3	X			X			X		
2	X			X			X		
1	X			X			X		
0	X	X	X	X	X	X	X	X	X
	(yellow)	omitted floors					Ch14dia2		

Chapter 14: Patterns for "selected floors"

As for all patterns the common characteristic is that **each floor is served the same number of times during all trips of a pattern**. An alternative pattern for 7/6 above might be a TWO-trip pattern with trip 1 serving the 6 top floors and trip 2 serving the 7 lowest floors.

Pattern 5/4/4 consecutively serves all floors with THREE cars. This implies that some passengers may have to wait for car NEXT 3.

Please note that the 5/4/4 pattern above serves all floors once with a trip to 5 "selected floors" and twice with trips to 4 "selected floors". This mode of car operation assures equivalent service qualities for all floors. If the 5/4/4 pattern is inadequate to satisfy the demand for transportation the pattern 4/3/3/3 is the next option. The ultimate pattern will be direct consecutive trips to each single floor.

Direct trip patterns enable a group to satisfy extremely heavy simultaneous UP and/or DOWN traffic conditions. For the direct trip modes of car operations rigorous adherence to patterns will be required for the UP and the DOWN trip. Chapter 16 gives an example of how and why direct trip patterns provide both UP and DOWN passengers with equivalent service qualities.

It is obvious that direct trip patterns are very efficient and combine high transport capacities with shortest possible ATTC's and for most options shortest possible ATTD's as well. In CPT's the patterns 7/6, 5/4/4 etc. are identified by the average number of floors served 6.5, 4.33 etc.

The purpose of "selected floors" patterns

"Selected floors" patterns serve several purposes. The most important are:

1. To **calculate and evaluate** data for UP traffic performance and the efficiency of groups on the basis of **rigid adherence to patterns**.
2. To create the calculated data structures that **prove and disclose the relativity of group transport capacities and time-dependent service qualities**.
3. To enable extraction of Comparative Performance Tables (CPT's) for specific traffic conditions.

The "selected floors" patterns, the calculation methods and the calculated data structures that were developed for this book prove the interdependence of group transport capacities and time-dependent service qualities. These systems make service quality data transparent and prove that smaller cars are inherently more efficient. The calculated data structures disclose that the Average Travel Time in the Car (ATTC) and the Average Time To Destination (ATTD) are the most important time-dependent service qualities of groups.

Modes of car operations

The **"selected floors" mode of car operation** is characterized by rigid adherence to "selected floors" patterns for UP and DOWN traffic. This implies that UP passengers on floor zero are assigned to specific cars on the basis of floors served by car NEXT 1, NEXT 2 and so on. Consequently waiting times for some unlucky UP passengers can be more than ONE Departure INTERVAL. This mode of car operation for UP traffic and assuming DOWN traffic is NIL has been used as the basis for calculation of the data in the Comparative Performance Tables (CPT's) of this book.

During operation on the basis of rigid adherence to patterns all passengers will benefit from shorter ATTC's, ATTD's and lower average car loads. Pro rata to the number of "selected floors" some passengers will have to wait for the NEXT departing car and consequently the theoretical minimum Average Waiting Time (AWT) increases accordingly. This implies that the calculated data provide a **conservative** evaluation of the AWT. The calculations on the basis of rigid adherence to patterns disclose that the calculated ATTC reductions exceed the AWT increases, i.e. ATTD's are reduced. Exception: Direct trip mode of car operation to low numbers of "selected floors".

The "direct trip" modes of car operation enable a group to maximize transportation capacities by rigid adherence to patterns for the UP and DOWN passengers. In case of emergencies or extremely heavy simultaneous UP and/or DOWN traffic the direct trip mode of car operation will be able to solve any transport capacity problem. Chapter 16 explains with an example how and why direct trip patterns will provide both UP and DOWN passengers with equivalent service qualities during extremely heavy simultaneous UP and DOWN traffic.

"First come first served" mode of car operation

For medium to heavy traffic conditions that do not require "direct trip" modes of car operation, i.e. traffic conditions that do not dictate the use of "direct trip" patterns, a much better method for assignment of passengers to specific cars is possible.

The **"First come first served" mode of car operations** will be able to satisfy all traffic conditions of well planned groups. Less well planned groups may need to use direct trip patterns for extremely heavy simultaneous UP and DOWN traffic. The "first come first served" mode of car operation is characterized by the assignment of passengers to the next departing car (NEXT 1) till a maximum number for permitted UP destinations and/or DOWN stops is reached. This way **service denial, if any, is delayed till the last possible moment**. A denied passenger will be assigned to car NEXT 2.

This method of passenger assignment implies that for most or all passengers the theoretical minimum Average Waiting Time (AWT) will be the shorter Departure INTERVAL divided by TWO. The calculated AWT of Comparative Performance Table's is based on the longer Cycle Interval divided by TWO.

The above implies that **the permitted number of destinations/stops for UP and DOWN trips** determines the efficiency and all service qualities of any group for specific traffic conditions. The essential ability of intelligent destination elevators is control of the average Round Trip Time (RTT) for each and every round trip and for all traffic conditions. Intelligent destination controls permanently concentrate on minimizing and equalizing RTT's. These methods assure that Departure- and Cycle Intervals and Average Waiting Times are at all times minimized and equalized. This means that the bandwidth of all time-dependent service qualities of groups with intelligent destination controls are minimized under all traffic conditions in relation to the traffic densities during bandwidth evaluation periods.

For light to medium traffic conditions high transport capacities are not required and cars will usually be allowed to **serve all floors.** For these traffic conditions best possible time-dependent service qualities is the one and only objective of intelligent destination group controls. Chapter 17: “Module for moderate traffic conditions” reviews this mode of car operation in detail.

Advantages of the "First come first served" mode of car operation

The greatest advantages of the "First come first served" method of passenger assignment are: **flexibility and simplicity**. The number of permitted UP destinations for car NEXT 1 and the total number of stops during each round trip are at all times under control to assure **consistent and shortest possible RTT’s, AWT’s, ATTC’s, ATTD’s and lowest average car loads at all times**.

Control of the efficiency of UP traffic from floor zero to upper floors is an important task of any group control because passengers may have any upper floor as their destination. DOWN traffic is unproblematic because the great majority of passengers go to floor zero. The "First come first served" mode of car operation in combination with the control of DOWN and INTERFLOOR stops enables full control of the RTT of each and every round-trip. Consequently the efficiency of a group and all time-dependent service qualities can be controlled under all traffic conditions.

Probable number of stops

The mathematical formula for "probable stops" assumes that all floor populations are identical and that any passenger may go to any destination. In a real building floor populations are **not identical** and these differences reduce the theoretical number of "probable stops". Differences in the working hours of different companies likely to further reduce the number of "probable destinations" of passengers. We can say the formula for the calculation of "probable stops" is conservative because it is based on worst case assumptions. This implies the performance data of real groups are likely to be better.

Please note that if we use the number of "probable stops" to set the number for the permitted number of UP destinations the relevant car load provides information about the probable number of passengers for anticipated traffic conditions. In the next chapter this reversal of interpretation of Comparative Performance Tables receives further attention.

"Intelligent destination" group controls will learn all performance data, including probable / permitted stops / destinations", from analysis of car operations. These data will form the basis of their operational data structure, i.e. the group’s memory. The combination of the operational- and the calculated data structures form the basis of the "brain power" of groups with intelligent destination controls.