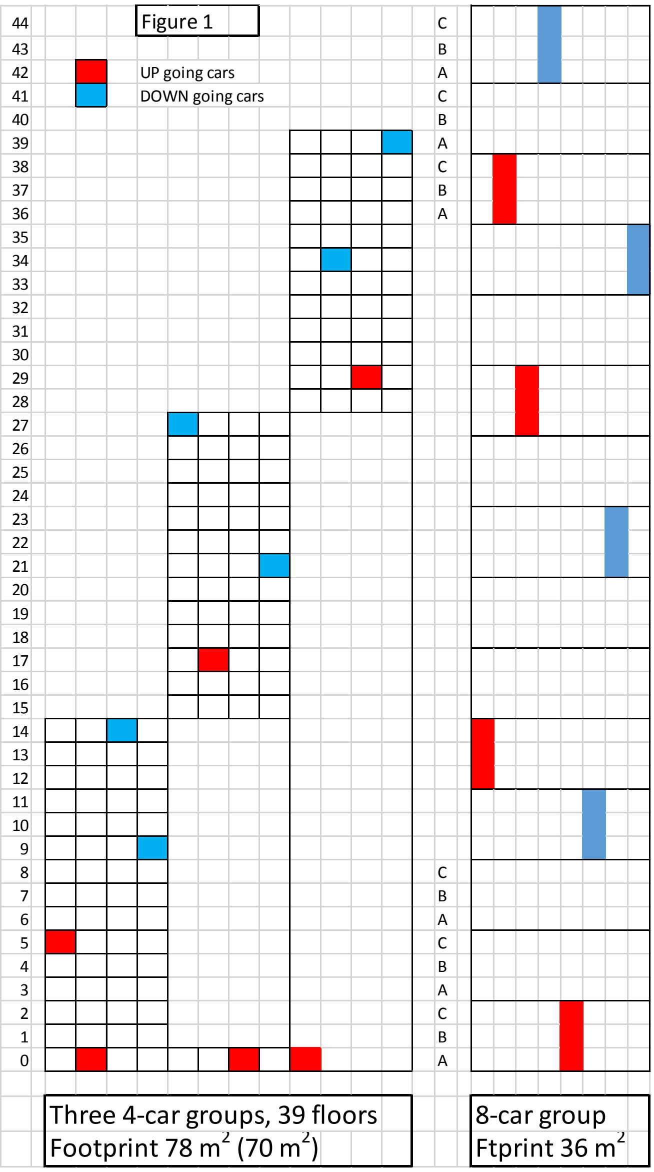
Chapter C: Layered Zoning

Introduction

Vertical zoning of tall buildings with a Low Rise, High Rise, and in-between zones, is the well-known planning concept of existing tall buildings. This type of zoning was the only possible zoning option for traditional groups controlled by passengers and floor buttons in the cars. This chapter will demonstrate that intelligent groups facilitate different zoning options.

Triple-deck group serving three Layered Zones A, B, and C

Figure 1 compares a 39-floor building served by THREE 4-car groups with single-deck cars, with a 44-floor building served by ONE group with eight triple-deck cars.



The single-deck 4-car groups have contract loads of 1600 KG and serve 14, 13, and 12 floors. Their total net footprint, i.e. without allowance for separating beams, hoist way enclosures, and lobby areas, is approximately 78 m^2. Alternatively, single-deck groups, with intelligent controls and contract loads of 1200 KG, could have a footprint of approximately 70 m^2. The 4-car single-deck groups serve 14/13/12 upper floors and should have contract speeds of 2.5, 6, and 8 m/s, to equalize group transport capacities.

The 8-car triple-deck group has a contract load per deck of 800 KG, a contract speed of 6 m/s, and a footprint of approximately 36 m^2. This group simultaneously serves three zones. Each zone consists of 14 A, B, and C floors. The total number of upper floors served is 42. The assumed population per floor is 75 persons, i.e. the total building population is 3150 persons.

Each block of A, B, and C floors, served by the triple-deck group, forms ONE destination, because the A decks of the triple-deck cars serve only A floors, the B decks only B floors, and the C deck only C floors. Consequently, the floor distances between A, B, and C floors must be identical, and equal the distances between the A, B, and C car decks. The floor distances between a C floor and an A floor above can be flexible. Escalators connect the building entrance levels 0, 1, and 2. The large number of cars and the short distances between cars, *in terms of numbers of destinations between cars*, i.e. possible stops, promise short intervals, waiting times, and high service frequencies. Average deck loads will be low.

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Performance of triple deck groups

The cars of triple-deck group can accommodate 3 X 8 = 24 passengers and serve three building zones simultaneously. Table 1 states the Door to Door Flight Times (DDFT's) for all possible travel distances of the triple deck group for the assumed contract speed of 6 m/s. As for single-deck groups Table 1 is the basis of the data structures of the intelligent triple-deck group of Figure 1.

Table 1		
Door to Door Flight Times		
(DDFT's) for all travel distances.		
Destination Numbers	Destination levels in meters	DDFT in seconds
0	0	0.0
1	12	12.5
2	24	15.4
3	36	17.5
4	48	19.5
5	60	21.5
6	72	23.5
7	84	25.5
8	96	27.5
9	108	29.5
10	120	31.5
11	132	33.5
12	144	35.5
13	156	37.5
14	168	39.5

The triple-deck group benefits from high average car speeds because the travel distances between stops are long. For example: The DDFT over the shortest travel distance of 12 meter is 12.5 seconds, i.e. only 2.9 s. longer than the DDFT of 9.6 s. over a 4 meter floor distance of single-deck cars. The slightly longer DDFT between adjacent destinations of the triple-deck group is over-compensates by the much shorter average waiting times of the 8-car group. This implies the average time to destination (average waiting + travel time) for trips between floors of A, B, or C zones are shorter in comparison with trips between floors of zones served by the single-deck groups.

Comparison of Table 1 data of this chapter with Table 1 of Chapter B demonstrates the major advantages of the triple-deck group. The high service frequency potential, i.e. short average waiting times, contribute to and explain why service qualities of the triple-deck group will be superior to those of the single-deck groups.

The total numbers of passengers on three decks defines the number of probable stops (at destinations) of the triple-deck group. Consequently, triple-deck groups make extensive us of performance data provided by "selected floors" patterns, i.e. strict control numbers of permitted stops under all traffic conditions.

Evacuation Capacity

To demonstrate the extremely high transport capacities of the triple-deck group we review its **evacuation** capacity, which is an important safety aspect of groups for tall buildings. In an emergency, the cars of the triple-deck group can evacuate a maximum of 10 persons per deck, i.e. eight cars can evacuate 240 persons, the entire population of three floors, in a single round trip. The average DDFT of direct up or down trips is 26 seconds. If we assume the loading and disembarkation of 10 passengers at each deck has a time "cost" of 20 seconds the average time to evacuate 240 persons will be 52 + 20 = 72 seconds. The triple-deck group can evacuate he entire population of zones A, B, and C in 14 roundtrips to all destinations, i.e. 14 * 72 = 1008 seconds or 17 minutes. During emergencies, intelligent triple-deck groups can focus their evacuation capacity as required by circumstances.

Heaviest simultaneous up and down traffic

The huge evacuation capacity of the triple-deck group demonstrates that in respect of up or down transport capacities, this group exceeds the maximum possible demands of 42 upper floors.

The performance calculation in the Appendix of this chapter demonstrates the same is true in respect of demands for heaviest simultaneous up and down traffic. This calculation assumes that during heavy simultaneous up and down traffic each consecutively departing car will be permitted to serve a maximum of 7 random floors during the up trip and to make 6 additional random stops during the down trip. A further assumption is that all deck loads will be 8 passengers.

The average deck load of 8 passengers is assumed to consist of 4 of the 8 incoming passengers during the momentary departure interval. The other 4 passengers were assigned to the second departing car during the previous departure interval, i.e. incoming passengers during heavy simultaneous up/down traffic are served by two consecutively departing cars.

The calculation proves that the intelligent triple-deck group of Figure 1 can transport 7.43 % of the population up and down during a period of 5 minutes and deliver an average waiting time of 27 seconds. These performance data are very good, particularly if we take into consideration the exaggerated assumptions for this calculation. In existing buildings simultaneous up and down traffic, in excess of 5 % of the population is rare. All traffic conditions will be less sever in comparison with those assumed in the Appendix, because numbers of stops will be less. The calculated data indicate that the triple-deck group of our example can probably serve 15 destinations, i.e. 3 additional floors. When intelligent group controls become available, the performance of triple-deck groups will be proved independently by traffic simulation.

The random destinations and stops for each round trip derive from the first come first served (FCFS) demands of passengers. During heavy traffic conditions, the coincidence of other passengers having the same destinations determines average deck loads.

During all traffic conditions, it can happen that when a car stops a specific deck may not have passengers leaving or entering. Complete avoidance of these occurrences is not possible. Direct communication with passengers enables explanation, however, this is probably superfluous because intelligent groups minimize stops; passengers will understand and appreciate its mode of car operations. Passengers are aware that making stops for passengers in other cars is a common feature of public transport systems. It is unlikely that this minor aspect of triple-deck groups will prevent the realization of tall buildings with triple-deck groups. The advantages of intelligent triple-deck groups are probably irresistible.

Layered Zoning enables extremely tall buildings

Figures 2 and 3, on the next page, show schematic concepts for extremely tall buildings with 12 and 18 L**ayered Zones,** served by triple-deck local groups. These concepts are based on local triple-deck groups, which serve zones above and below Sky Lobbies. This type of configuration is very efficient, because the local groups share the same set of eight hoist ways. Single deck local groups can also share a common set of hoist ways, as was mentioned In Chapter 12: “Express elevators to Sky lobbies”, however, triple-deck groups, which serve three zones, introduce a fundamentally different option for the planning of tall buildings.

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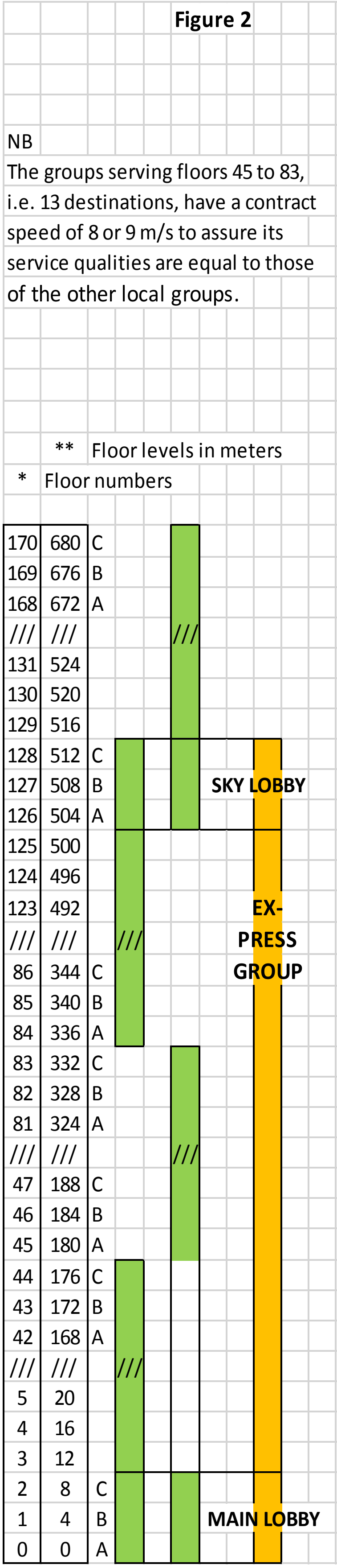

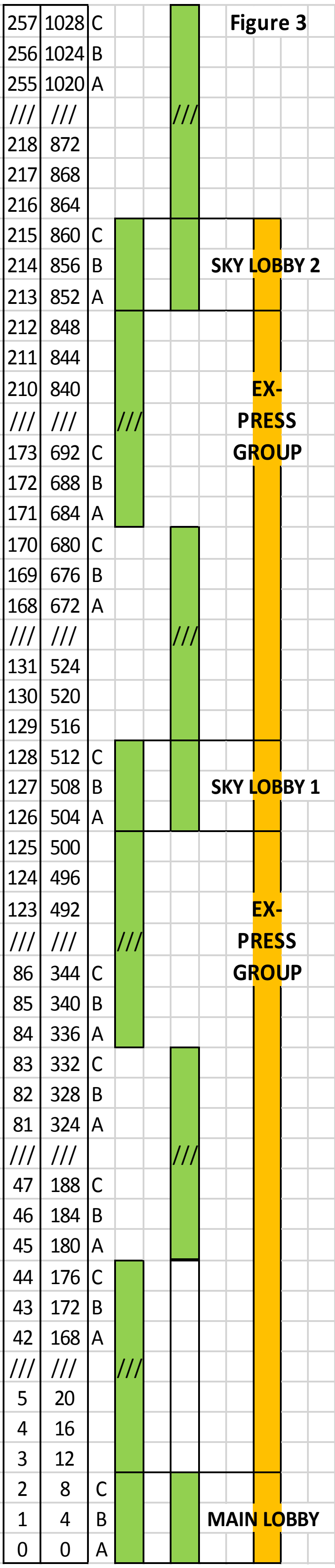

The green 8-car triple-deck "local" groups share two sets of eight hoist ways. The local group for floors 45 - 83 serves 13 destinations. (See NB Fig. 2)

From each Sky Lobby one local group serves floors below the Sky Lobby to create space for machine rooms and elevator pits in the building sections where zones meet. The long distances between local groups using the same hoist ways also form safety zones between the local groups.

The planning concepts of figures 2 and 3 have advantages other than sharing the same set of hoist ways: High level Sky Lobbies are more valuable. The extra travel time to a Sky Lobby on a higher level is short: the extra distance divided by a high contract speed. Low level Sky Lobbies makes the sharing of hoist ways impossible or at least much more difficult and less economical.

The local groups operating from a Sky Lobby can be identical with the group serving floors zero to 44 and deliver the same service qualities.

The configuration of Figure 2 is probably unproblematic; however, the configuration of Figure 3 is rather speculative because a Sky Lobby at level 852 meter introduces several problems, which go beyond the scope of this book.

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Planning and configuration of Express groups and Sky Lobbies

Express elevators do not require a central location. Integration of sub-groups of two or more elevators, in structural columns distributed over the perimeter of a very tall building, would be ideal. The direct communication system will guide incoming passengers to their nearest assigned express elevator. Express elevators should always have through door openings for simultaneous loading and unloading of cars.

If a building requires two Sky Lobbies, one intelligent group should serve both Lobbies. Only a single group can support the variable traffic densities of two lobbies.

The greatest problem for express groups are transport capacities. These should at least match the transport capacities of local groups operating from Sky Lobbies. Consequently, the huge evacuation capacity of triple-deck groups also affects express groups. The maximum speed of elevators affects transport capacities. This the topic of the next chapter.

Providing triple-deck cars of express groups with an additional deck dedicated to tourists and observation platforms deserves consideration. If traffic flows of building users and tourists can be separated it will be beneficial for both.

Concluding remarks

This chapter demonstrates the importance of the numbers of cars in a group in combination with control of the number of permitted stops. This combination delivers short departure intervals, i.e. the ability to use consecutively departing cars during heavy traffic densities. Short departure intervals reduce the number of incoming or outgoing passengers per interval. These interdependencies explain and prove the inherent relativity of group characteristics. This applies for groups with single-deck cars and even more for groups with multi-deck cars.

Apparently, the wrong assumption that elevator cars must be large continues to influence group planning. This assumption appeared to be true during approximately 100 years when floor buttons in the cars determined elevator performance. Four large cars was the industry standard for the great majority of groups, and six large cars the alternative for prestigious buildings, although the 6-car configuration is flawed. Groups, which have been installed in recent years with 6 or even more cars large cars and destination controls do confirm their group controls are flawed and inefficient.

Presently architects and group planners need to know that their first concern must be the number of cars of a group. Four cars imply larger cars and longer waiting times. Six cars imply shorter waiting times, smaller cars, and improved efficiency.

Please help to convey this news to the planners of tall buildings.

Appendix: Performance evaluation of triple-deck group.

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Flr n	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
Flr lv	0	12	24	36	48	60	72	84	96	108	120	132	144	156	168	156	144	132	120	108	96	84	72	60	48	36	24	12	0	
Stop	0		2	3		5		7		9		11			14		12		10		8	7			4		2			
at le	0	0	24	36	0	60	0	84	0	108	0	132	0	0	168	0	144	0	120	0	96	84	0	0	48	0	24	0	0	
CLPS	0	0	24	36	36	60	60	84	84	108	108	132	132	132	168	168	144	144	120	120	96	84	84	84	48	48	24	24	0	Totals
Tr D	0	0	24	12	0	24	0	24	0	24	0	24	0	0	36	0	24	0	24	0	24	12	0	0	36	0	24	0	24	336
DDF	0.0	0.0	15.4	12.5	0.0	15.4	0.0	15.4	0.0	15.4	0.0	15.4	0.0	0.0	17.5	0.0	15.4	0.0	15.4	0.0	15.4	12.5	0.0	0.0	17.5	0.0	15.4	0.0	15.4	214.0

Permitted stops		7 UP	6 DOWN
ROUND TRIP TIME without passengers		214.0	seconds
Time cost passenger entry/exit	up	16	seconds
Time cost passenger entry/exit	down	16	seconds
RTT with passengers		246	seconds
Departure Interval	RTT/8	30.8	seconds

NB: Each deck transports 8 passengers up and down during each round trip. Per car and per roundtrip a total of 48 passengers are, or can be, transported.

During a period of 5 minutes each car can make 300 / 246 =	1.22	round trips
The group makes 8 x 1.22 = 9.8 r-trips per 5 nin.	9.8	round trips
Total nr of up passengers on 3 decks 9.8 * 24 =	234	persons
Total nr of down passengers on 3 decks 9.8 * 24 =	234	persons
In percentage of population (3150 persons) 234 / 31.5 =	7.43	%
Number of incoming persons per 5 minutes 7.43 * 31.5 =	234	persons Total for zone A, B, and C
Number of incoming persons per 5 minutes per zone 234/3 =	78	persons
Number of incoming persons per second 78 /300 =	0.26	
Number of incoming persons per interval 30.8 * 0.26 =	8	persons per deck and per interval
Each triple-deck car has a total car load of 3 * 8 =	24	passengers
Their probable number of destinations is	<12	See chapter 13 Appendix 1
At least 50 % of incoming passengers can be assigned to the 1st dep car		
Their average waiting time interval / 2	15.4	seconds
A maximum of 4 passengers came in during the previous interval		
Their maximum waiting time will be approximately	38.4	(interval * 1.25)
Total of averages	53.8	seconds
Average waiting time all passengers	27	seconds

Door to Door Flight times for direct trips to all floors

Desti-nation numbers	Desti-nation levels (m)	DDFT in seconds
0	0	0.0
1	12	12.5
2	24	15.4
3	36	17.5
4	48	19.5
5	60	21.5
6	72	23.5
7	84	25.5
8	96	27.5
9	108	29.5
10	120	31.5
11	132	33.5
12	144	35.5
13	156	37.5
14	168	39.5

Stops	Destinations assigned to passengers by FCFS mode of car operations
at level	Floor levels of assigned destinations
CLPS	Car level previous stop
Tr D	Travel distance from previous stop
DDFT	Door to door flight time for trip distance, from DDFT Table