Traffic Design Benchmarks Standard Templates

by Dr Gina Barney

The problem faced by most people when comparing traffic designs offered by lift companies, consultants, developers and others is that each design is based on different, often undeclared, criteria.

I propose a set of BENCHMARKS in the form of a set of STANDARD templates

I wrote in the Elevator Traffic Handbook (ETH) at page 353:

"… (traffic) analysis … is mainly based on the classical traffic pattern, depicted in Figure 4.2. It has been used to describe how people use lifts in a building and to size lift systems successfully for over half a century. But it is largely a figment of the imagination, as it probably has never existed. Siikonen, Peters and Sung, Powell and many others all report considerable differences to Figure 4.2. Just because Figure 4.2 has been "discredited" it does not mean it should be abandoned as a valuable tool. As a "benchmark" it is generally accepted world wide. Countless buildings have been designed to its "illusion" and the designs work !

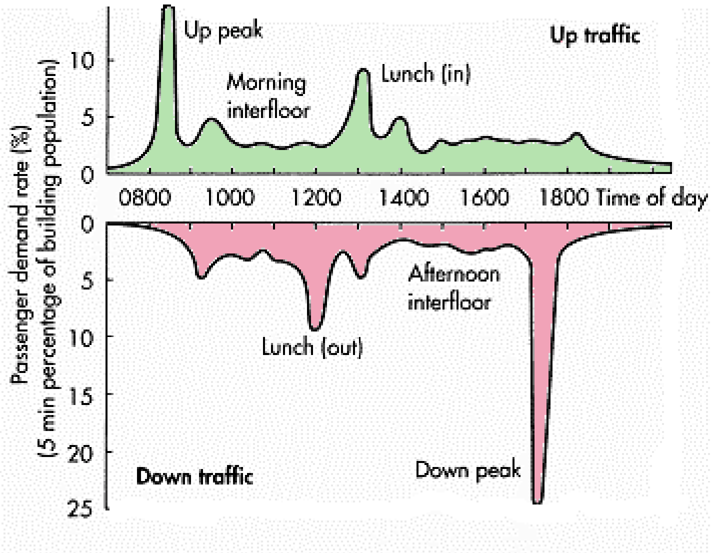
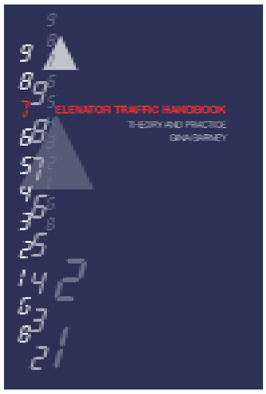


Figure 4.2 Passenger demand for an office building
(from the Elevator Traffic Handbook)

Classical representation of the passenger demand rate for an office building



Why does it work ?

The answer …

… is that the uppeak design provides an underlying capacity, which sets the performance of the three other major traffic conditions of down peak, interfloor and mid-day traffic … the ratio of inherent handling capacity for these three traffic patterns (can be) compared to uppeak handling capacity. With uppeak considered to be unity, the ratios are:

uppeak	1.0
down peak	1.6
mid-day	1.3.
interfloor	1.4.

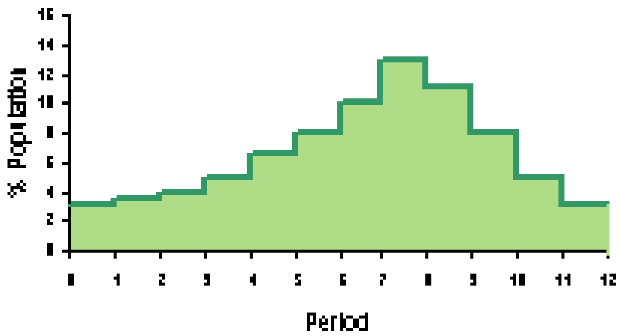
These ratios assume that all the handling capacity can be utilised … (in fact) the interfloor handling capacity is never utilised, as the demand is about one fifth of the uppeak demand."

Purchasers of lifts and their advisors are often faced by the problem of comparing traffic designs offered by lift companies, consultants, developers and others, especially those from simulations. Each design is based on different, often undeclared, criteria. To solve this problem …

I propose a set of BENCHMARKS in the form of a set of STANDARD templates

… which can be used to carry out the comparison.

STANDARD UPPEAK TRAFFIC TEMPLATE



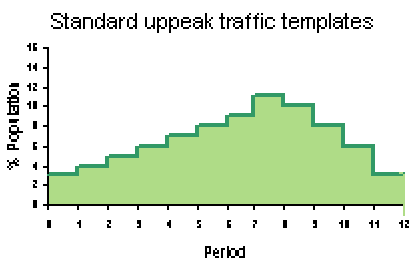
Question: There is only uppeak traffic.
Answer: A pure uppeak for simplicity and comparison with calculations.

Q: Eighty percent (80%) of the building population arrive in one hour.
A: Generally a building is never fully occupied at any time. Even when a building operates a fixed starting time regime there will always be absentees.

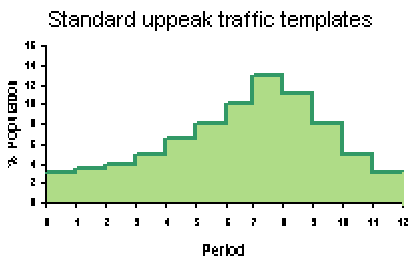
Q: In the first 7½ periods, 2/3rds (53%) of the population arrive and in last 4½ periods, 1/3rd of the population (27%) arrive, ie: 80% total. The peak arrival rate occurs in Period 8.
A: This emulates Figure 4.2 (ETH, 86) the figments of our imagination.

Q: The lowest arrival rate at the beginning and at the end of the one hour simulation is set at a background level of 3%.
A: This is a reasonable starting level. It causes the lifts to move about the building before the start of the uppeak profile and gives them some history. It is also about half the constant arrival rate needed to bring 80% of the population into the building in the 12, 5-minute periods (80/12 = 6⅔%). It is also the mid level used for the interfloor traffic template.

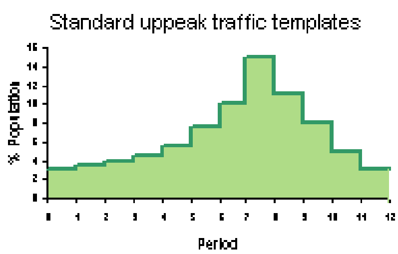
Q: What would the demand profiles look like ?
A: The 11% uppeak demand profile is squatter than the 15% uppeak demand profile, in order to ensure the area under the profile represents a total number of arrivals equal to 80%



Uppeak demand = 11%



Uppeak demand = 13%

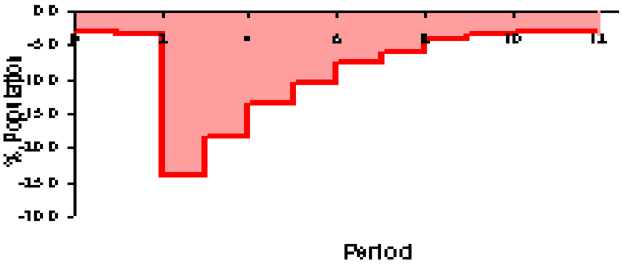


Uppeak demand = 15%

Q: How is the performance determined ?
A: Use performance indices, for example, the interval, car load, passenger average waiting time and passenger ninety percentile. The Period 8 data indicates the performance in the peak period at the main terminal floor. Calculated values use formulae from Table 15.3 (ETH, 353).

Parameter	**Period 8**	**Calculated**
Interval (s)		
Car load (%)		
AWT (s)		
90% tile (s)		

STANDARD DOWN PEAK TRAFFIC TEMPLATE



Q: There is only down peak traffic.
A: A pure down peak for simplicity and comparison with calculations.

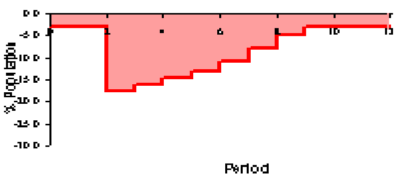
Q: The peak is high for ten minutes.
A: Observations, at the end of the working day, show that the down peak traffic is severe for about ten minutes and then tails off. It appears, even in flexitime regimes, that people leave as soon as core time ends.

Q: Period 3 is set at 1.6 times the assumed uppeak percentage population (%POP).
A: The assumption that a lift system has an underlying down peak capacity 1.6 times that provided in uppeak is generally accepted (ETH, 331).

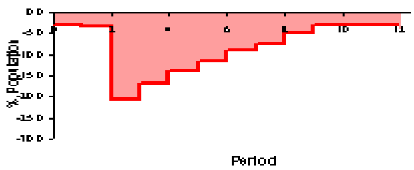
Q: In one hour 80% of the building population leave.
A: It would seem reasonable to assume that 80% leave in 60 minutes, mirroring the uppeak.

Q: The lowest departure rate at the start and at the end of the profile is the interfloor background level (3% per period)
A: As discussed in the uppeak section this gives the lifts some history before the peak sets in.

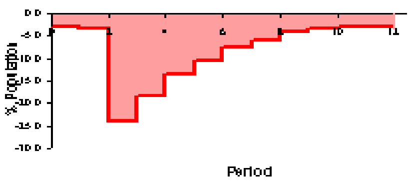
Q: What would the demand profiles look like ?
A: The 17.6 % down peak equivalent profile of the 11% uppeak profile is squatter than the 24% down peak equivalent profile of the 15% uppeak profile, in order to ensure the area under the profile represents a total number of departures equal to 80%.



Down peak demand = 11 × 1.6 = 17.6%



Down peak demand = 13 × 1.6 = 19.8%

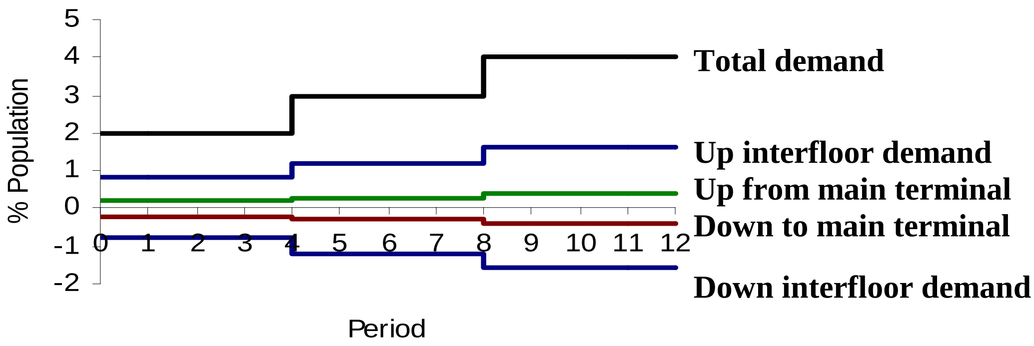


Down peak demand = 15 × 1.6 = 24.0%

Q: How is the performance determined ?
A: Use performance indices, for example, the interval, car load, passenger average waiting time and passenger ninety percentile. The Period 3 data indicates the performance in the peak period at all floors above the main terminal floor.

Parameter	**Period 3**
Interval (s)	
Car load (%)	
AWT (s)	
90% tile (s)	

STANDARD INTERFLOOR TRAFFIC TEMPLATE



Q: This a stepped profile.
A: There is no accepted profile of passenger demand for interfloor traffic. Bedford (ETH, 343) determined a busy system as one where between 30% and 36% of the building population used the lifts in one hour.

Q: The first 4 periods are at a 2% demand, ie: 24% movements in one hour. The second 4 periods are at a 3% demand, ie: 36% movements in one hour. The third 4 periods are at a 4% demand, ie: 48% movements in one hour.
A: The interfloor demand in a building is much lower than during the other peak periods. If one third of a zone population (33⅓%) use the lifts in one hour this is considered to be "busy". This is the interfloor background demand. The template therefore offers three levels with the middle one set at 36%.

Q: There is no relationship with the uppeak design demand or the down peak underlying handling capacity
A: Once people have arrived at their workplace their movements are work related.

Q: A demand of 80% is between all floors (except the main terminal) split 40% up and 40% down. A demand of 20% is between the main terminal floor and the other floors split 10% from all floors to the main terminal and 10% from the main terminal to all floors.
A: The main terminal will always be busy with arrivals and departures – it has been given a 10% preference for arrivals and a 10% attraction for departures.

Q: How is the performance determined ?
A: Use performance indices, for example, passenger average waiting time and passenger ninety percentile. The data for Periods 1-12 will indicate the overall performance for the one hour of interfloor demand for all floors.

Parameter	**Periods** 1-12
AWT (s)	
90% tile (s)	

STANDARD MID-DAY TRAFFIC TEMPLATE

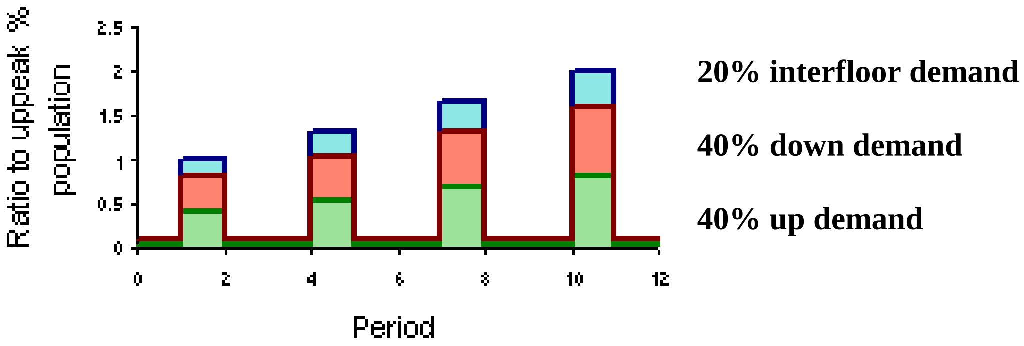
Q: Mid-day activity is related to uppeak handling capacity.
A: Mid-day activity is most probably related to the uppeak performance criteria. It is likely in a high prestige-high percentage population building that there will be a similarly intense demand at mid-day and vice-versa.

Q: Mid-day activity is complicated.
A: There are no specific profiles or recognised level of demand for mid-day activity. It has been determined that the underlying handling capacity is probably 1.3 times the uppeak handling capacity (ETH,354). In some buildings it is considered the most severe condition to be met. Simultaneous up and down activity can be expected with some interfloor demand. Generally the mid-day period is two hours (outside flexitime core time).

Q: There are four levels of demand, where %POP = the uppeak handling capacity.

$1^{st}=1\times\%POP$, $2^{nd}=1\frac{1}{3}\times\%POP$, $3^{rd}=1\frac{2}{3}\times\%POP$, $4^{th}=2\times\%POP$

A: The system's tolerance to these demands will be an indicator of performance.



Q: The demand is split 40% up from the main terminal 40% down to the main terminal and 20% interfloor.
A: This relates the demand to uppeak performance as indicated by Siikonen (ETH,348) and seems very plausible.

Q: There is a small activity between the four peak periods of 10% of the uppeak handling capacity (%POP).
A: It provides a history to the simulation model.

Q: How is the performance determined ?
A: Data for Periods 2, 5, 8, 11 will indicate the performance in the peak periods for all floors.

Parameter	**Period**			
	2	**5**	**8**	**11**
AWT (s)				
90% tile (s)				

A SIMULATION CASE STUDY

Given data:
Number of lifts = 6, Number of floors = 12, Rated capacity = 20 persons,
Speed = 2.5 m/s, Interfloor distance = 4 m, Performance time = 10.5 s.

Derived data:
Highest reversal floor = 11.7, Number of stops = 9.0.

Calculated data using formulae from Table 15.3 (ETH, 353)
Uppeak interval = 26.4 s, Uppeak car load = 80%, AWT = 22 s (estimated).
Period 8 results from simulation program.

Uppeak

Parameter	**Period 8**	**Calculated**
Interval (s)	38	26
Car load (%)	100	80
AWT (s)	15	22
90% tile (s)	33	n/a

The results show (as might be expected) that the calculation based on averages is quite different to the simulation. Simulation shows car load is too high.

Down peak

Parameter	**Period 3**
Interval (s)	16
Car load (%)	62
AWT (s)	24
90% tile (s)	60

AWT worse than uppeak, but the interval is shorter. Reasonable performance.

Interfloor

Parameter	**Periods** 1-12
AWT (s)	8
90% tile (s)	18

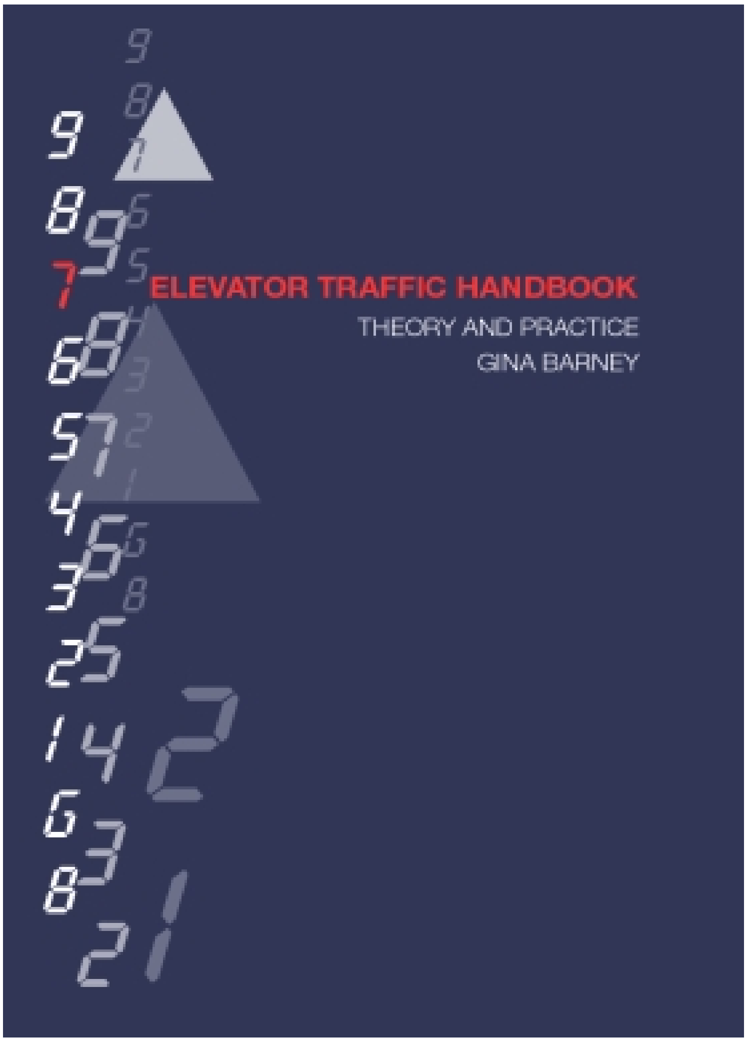
Good performance.

Mid-day

Parameter	**Pd 2**	**Pd 5**	**Pd 8**	**Pd 11**
AWT (s)	20	36	50	61
90% tile (s)	49	100	145	144

Period 5 is just about acceptable anything higher than 1⅓ times uppeak demand indicates there will be very long waits (as seen in real life).

(All simulated results from ELEVATE simulation program)



Elevator Traffic Handbook

Dr Gina Barney

Hardback ISBN 0415274761 Price £80 Spon Press

Vertical transportation engineers will find this book an authoritative resource. Other members of the design teams will find it a useful reference, and lecturers and students will be satisfied by this simple presentation of the underlying theory.

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