Chapter 1: Planning groups of elevators for tall buildings

Summary: Elevator planning must satisfy two conflicting demands:

1. Groups shall occupy the least possible building space to maximize rentable areas.
2. Groups must provide best possible service qualities under all traffic conditions.

These two demands define a single problem: the efficiency of elevator operations. This efficiency is primarily defined by building/elevator planning and secondly by elevator group controls. This book explains why and how "intelligent destination" group controls will enable best-possible planning and best-possible service qualities under all traffic conditions.

Building planning

The prime objective of this book is to make elevator planning for tall buildings an exact and logical exercise with predictable results that can be guaranteed. This is an ambitious objective because it must resolve a number of conflicting demands. The main conflicts from a building planning point of view are:

- A group shall take up as little building space as possible, i.e. a group shall have an optimal "footprint" or in other words the smallest possible "footprint" in relation to the number of floors served.
- A group must be able to satisfy all traffic conditions with best-possible service qualities as contractually agreed between the customer and elevator contractor.

The above demands define a single problem: **The efficiency of elevator operations**. This efficiency is defined primarily by elevator planning and secondly by the group control system. Groups of elevators that are capable of operation with best-possible efficiency under all traffic conditions will enable groups with best-possible characteristics including an optimal “footprint”. Group controls that cannot deliver best-possible efficiency may deliver acceptable performance; however, best-possible performance is essential for building plans that reduce the “footprint” of groups to the optimal minimum. This book proves that the difference is significant.

Tall buildings are usually served by groups of <u>local elevators</u> serving about 10 to 20 adjacent floors with single deck cars. <u>Flight times</u> of cars between floors have been optimized by modern drive- and door systems. It is probably correct to say that the **"muscle power"** characteristics of modern elevators have reached their optimum.

The best-possible use of "muscle power" should be assured by the group’s **"brain power".** Consequently this book must demonstrate for TWO elements why and how each element affects group performance:

1. Elevator planning, i.e. the number of cars in a group, their contract load and speed and the number of floors served. These data define the configuration and "muscle power" of groups.
2. Group control systems; define group "brain power", i.e. their ability to make best possible use of "muscle power".

Element 1 is best explained with a simple example. A large single-car can serve a low building or a short building zone. Obviously its time-dependent service qualities will be very poor. If instead of a single-car we plan a 2-car group the contract load of the 2-car configuration can be reduced by at least 50 % because the average number of stops per car is substantially reduced. The time dependent service qualities of this configuration will be much better.

The contract loads of a group can be further reduced by 3- or 4-car configurations. Time-dependent service qualities improve accordingly. With 5- or 6-car configurations groups may have very small contract loads and outstanding time dependent service qualities. Each increase of the number of cars allows a reduction of the contract load and a modest increase of the number of floors served. The use of more and smaller cars implies that each car will transport fewer passengers under all traffic conditions. Consequently the cars make fewer stops and are more efficient.

This simple logic is valid for any group and any group control system. It is an inherent feature of all groups. Please refer to Chapter 5 for the mathematical proof of these facts.

Element 2, group controls or "brain power" is a complex problem. This book presents the mathematical and practical solutions for best-possible control of car operations under all traffic conditions. The performance data and space requirements of groups with best possible configurations disclose and define the interdependence between elements 1 and 2.

Existing group controls

The majority of existing buildings have groups of elevators with "collective selective" controls, i.e. controls with UP / DOWN buttons in the lobbies and floor buttons in the cars. These traditional groups cannot be efficient because the movements of the cars are largely decided by the random destinations of passengers, i.e. by chance. During periods of heavy traffic these groups are in fact out of control.

Another type of existing group controls requires passengers to enter their destinations on panels in the lobbies and assigns passengers to specific cars. The cars stop at assigned destinations, i.e. floor buttons in the cars are not required. Unfortunately existing destination controls are not yet intelligent.

This book introduces **intelligent destination group controls.** Intelligent destination controls continuously monitor traffic conditions and learn to recognize and predict traffic densities and other traffic characteristics with a high degree of accuracy. Destination controls have at all times control over all cars. They can control the number of stops during each and every UP and/or DOWN trip. This book will prove that intelligent destination controls can simultaneously optimize the efficiency and the service qualities of groups under all traffic conditions.

"Intelligent destination" group controls

This book discloses why and how "brain power", i.e. intelligent destination group controls, can deliver best-possible service qualities under all traffic conditions.

Service quality, i.e. transport capacities and time-dependent service qualities, consists of several components that are interdependent with each other and:

- the characteristics of a specific building or building zone

- the characteristics of the group(s) serving a specific building
- the population of a specific building
- traffic conditions generated by the population.

We can say that best-possible group performance is **very well obscured** by a **large number of interdependencies.**

The solution of this puzzle is easily defined in words: **best-possible use and coordination of the cars of a group.** This book shows how mathematical- and operational data structures and an artificial experience (learning) system can be combined to form an **artificial intelligence system**. These systems provide "intelligent elevators" with the "brain power" and sensory abilities required for making the logical control decisions that assure best-possible service qualities under all traffic conditions.

To understand why and how intelligent destination controls enable best-possible car operations does not require know-how of sophisticated technology. Logic and fairly simple mathematics make the interdependencies of all service qualities transparent. When all interdependencies are known and their relationship can be evaluated, intelligent control decisions are reduced to selection of the specific **option for momentary car operations** that delivers the agreed service qualities and reflects customer preferences.

In the following chapters the topics that are relevant for best-possible efficiency are analyzed one by one and readers will soon begin to see the relationship between the group performance parameters, i.e. the service qualities **that together define the quality of elevator services**.

Benefits of "intelligent elevators"

The benefits of "Intelligent destination" group controls are substantial for passengers <u>and</u> for building owners, planners and managers.

<u>For passengers</u> (in new or existing buildings):

- Passengers reach their destinations earlier under all traffic conditions.
- Average numbers of passengers in the cars <u>and</u> average travel times in the cars are minimized improving travel comfort.
- Groups can maximize transport capacities in conjunction with best possible time-dependent service qualities for required transport capacities. In other words: "Intelligent elevators" are capable to operate with the **best-possible balance between transport capacities and time-dependent service qualities under all traffic conditions**.

<u>For building owners and planners</u> (<u>for **new** buildings</u>):

- Building volumes required for groups of elevators will be substantially reduced and rentable areas maximized.
- Energy consumption will be substantially reduced.
- **New group configurations** that are attractive in respect of the **relationship** between group service qualities and the costs of elevators, building volume, maintenance and energy are introduced.

For building managers (in new or existing buildings):

- Building management information systems that deliver statistics of building and floor populations, traffic flows to and from all floors, service quality statistics etc.
- Service qualities can be influenced by management preferences.
- Building security, climate control etc. can benefit from real time data.
- Monitoring of all aspects of elevator performance and automatic reporting of any malfunctions.

Other benefits

- Improved performance of groups in existing buildings
- Direct communication of passengers with group controls with wireless devices, for example mobile phones, will enable abolishing destination entry panels in lobbies.
- These systems will provide group controls with exact data in respect of the number and arrival times of all passengers in the elevator lobbies.
- **Building security** will be greatly enhanced if visitors must obtain special mobile devices from the building reception or security desk to use the elevators. Access can be limited to a specific floor(s) and/or during a specific time period. If a visitor disembarks on the wrong floor it can be automatically reported to security and/or the visitor.