Chapter 4: Group "brain power"

Summary: The term "brain power" or “brains” is used to designate all control components of a group. The origins and features of "collective selective" and "destination" group controls are briefly described.

Elevator “brain power”

Group “brain power” comprises the controls of individual elevators <u>and</u> their group control. The controls of individual elevators open and close the doors and control their drive- and other systems. In this book the focus is primarily on group control functions because "brain power" is decisive for best possible use of cars and their coordination.

Two different types of group controls are presently available:

- Traditional "collective selective" controls with UP/DOWN buttons on landings and floor buttons in the cars.
- “Destination” group controls.

In this chapter we will briefly review the origins of both types of group controls and their characteristics and features.

Origins of "collective selective" (traditional) group controls

Elevators in the first tall buildings, some 100 years ago, were equipped with **signal controls**, featuring UP and DOWN buttons on the landings and illuminated arrows on the car operating panels that informed **attendants** in the cars in which direction waiting passengers wanted to travel. The open, usually wrought iron, car construction permitted limited verbal communication between the attendants. A **dispatcher** at the main floor provided “supervisory control”.

Human intelligence and communication was the basis for efficient elevator operation. Over the years the human intelligence was replaced, first by relay logic, then solid-state electronics and today computers.

Elevators with traditional controls stop for landing calls when the desired direction of travel of waiting passengers and the direction of travel of the car are the same. Today we still use the term **“collective selective”** for this type of control. The majority of tall buildings all over the world probably still have elevators with UP and DOWN buttons on the landings, i.e. traditional group controls.

General features of "destination" group controls

To request service from a group of elevators with "destination" group controls, a passenger must enter his/her destination, or target floor, on a control panel(s) located in each and every lobby. (For other destination entry systems please refer to Chapter 11) A destination group control **responds to each destination entry with the identity of the assigned car**. The entrances of individual elevators are usually identified with capitals A, B, C, etc. Indicators in the cars confirm at which floors a specific car will stop. These indicators are usually integrated in the car entrance frames,. The **car operating panels**

do not have floor buttons, because "destination" controls “know” the target floors of all passengers assigned to a specific car. This implies that passengers cannot take control of the car by pressing floor buttons. With the destination as input the “brains” know the position, desired direction of travel and the destination of all waiting passengers. Consequently "intelligent destination" controls posses TWO essential assets:

- Full control over all cars
- Data of the service requirements of all waiting passengers.

This situation and the available data should theoretically enable groups of destination elevators to deliver best-possible performance at all times.

Brief history of "destination" controls

The inventor of "destination" controls is the late (1978) Mr. Leo Port who was responsible for the first such group in a government building in Sydney during the 1960’s. This system was not successful (unreliable) due to the immense number of relays that were used in this early system. Ultimately this destination control was replaced by a conventional "collective selective" group control.

The author had the pleasure of meeting Mr. Port in 1975, when he made a visit to the Schindler works in Switzerland. The concepts of destination controls as explained by Mr. Port have made a lasting impression on the author because full control of the cars and data of the requirements of waiting passengers should enable best-possible performance. He has been a promoter of destination group controls since this meeting. A few years after this meeting Schindler decided to develop a new generation of destination group controls. Several years later all leading elevator companies followed this example. Presently destination controls are probably the most popular system for new buildings.

Unfortunately till now these systems have not yet realized their full potential because the artificial intelligence systems required for best-possible performance did not receive the attention they deserve. Existing controls are re-active, i.e. not intelligent.

The "intelligent destination" group control systems described in this book will enable groups to deliver best-possible performance under all traffic conditions. Although these controls require complex data structures and may appear to be complicated they are in fact quite simple and can be realized soon with modern technology.

Objectives of group controls

The essential objective of elevator group controls is: best-possible control and coordination of the movements of the cars under all traffic conditions.
Best-possible group service qualities can be defined as follows:

- UP and DOWN transport capacities that satisfy all traffic conditions
- Shortest possible times to destinations under all traffic conditions. This implies that the sum of the Waiting Time and the Travel Time in the Cars shall be the shortest possible for all passengers under all traffic conditions
- Lowest possible average carloads.

As mentioned in Chapter 1 optimal building/elevator plans require best-possible group performance. Best possible planning and performance are the twin-objectives of this book.

"Collective selective" groups have limited control of cars

To have control of all cars of a group is a pre-condition for best-possible performance. This means the floor buttons in the cars of "collective selective" elevators create a problem. Whenever doors are open waiting passengers can enter any car and go to any floor. This “feature” of "collective selective" groups inhibits in particular the efficiency of **UP PEAK** traffic. Cars that are full with passengers having random destinations will make many stops causing long Round Trip Times (RTT’s). All service qualities are negatively affected by long RTT’s.

DOWN PEAK traffic is inherently more efficient because most passengers want to go to floor zero, however, during heavy DOWN PEAK traffic cars may reach full load after few stops and then travel non-stop to floor zero. This situation may cause very long waiting times for DOWN going passengers of "collective selective" groups, particularly during simultaneous UP and DOWN traffic. Chapter 16: “Module for heavy simultaneous UP and DOWN traffic” describes how "intelligent destination elevators" solve this problem.

During **NON PEAK** traffic "collective selective" elevators have slightly better control of the cars in view of the following:

- An UP or DOWN travelling car may decide not to stop for a landing call if the passengers in the car have not selected this floor as their destination.
- Prevention of car departures too soon after a previous departure from floor zero. This was one of the duties of the historical dispatcher.

It is obvious that the car movements of "collective selective" elevators are to a large extend controlled by the random destinations of passengers, i.e. by chance. This implies their **performance is essentially determined by "muscle power"**. During light and medium traffic conditions an artificial intelligence system can somewhat improve service qualities; however, **"brain power" cannot resolve the inherent problems of "collective selective" groups**.

The next chapter “Traditional elevator planning” will show that planning groups of "collective selective" elevators is rather simple. Their planning is not influenced by "brain power".

Terminology for "collective selective" group controls

For evaluation of group controls it is of interest to review the characteristics of traditional groups and the terms used to describe these characteristics.

Probable stops: This is the number of stops that a full or partially full car will probably make during an UP trip. The probable number of stops depends on the number of passengers in the car and the number of upper floors served. It derives from a standard mathematical formula. Chapter 13: "Transparent performance calculations" gives all details.

Bunching: When cars are in close proximity to each other and move in the same direction it is called bunching. High speed "collective selective" elevators have a **natural tendency to bunch**. The reason is simple: Making a stop takes at least 10 seconds for deceleration, acceleration, door operation and passenger movements. In these 10 seconds another car of the group can travel a long distance and make a stop at the same- or a nearby floor. It is obvious that **bunching entails long waiting times**, because when a "bunch of cars" has passed a floor it will take the "bunch" a long time to return.

Chapter 6: "Average Waiting Time (AWT), the misleading parameter" explains why the AWT parameter that results from traditional traffic calculations has caused much confusion about group service qualities.

Full cars: cannot respond to service calls. This implies that "collective selective" controls progressively **loose control** when traffic increases from medium to heavy and very heavy. **When "brains" are needed most "collective selective" elevators are least efficient**.

The historic dispatcher had better possibilities to optimize performance during busy periods. He knew his passengers and could "herd" passengers with the same destinations to a specific car. He could also instruct the attendants about selective servicing of landing calls (car assignment) and in this way reduce the number of stops and shorten Round Trip Times (RTT's). Delaying departure (dispatching) was another option to optimize the use of individual cars.

It is of interest to consider the operation of "collective selective" elevators in a building that is **under-elevatored**, i.e. the cars are always full during periods of heavy traffic. Under these circumstances passengers leaving a car will be replaced immediately by waiting passengers, who will not consider the direction of departure, because they know they can only go somewhere if they are in a car! The landing buttons play no role under these extreme circumstances because the cars stop in response to car commands only.

The "collective selective" group control cannot influence this situation and under such circumstances automatic operation becomes impossible. The building management will probably revert the elevators to operator control, i.e. an attendant in each car and a dispatcher at the main floor. Fortunately this extreme situation is rare, but it does happen when the **limitations of "collective selective" elevators** are not realized during the building planning phase.

Special features of "intelligent destination" group controls

Intelligent destination group controls will have two data structures. This combination of data structures enables the following functions:

- The artificial experience system with the ability to predict / anticipate changing traffic conditions.
- The artificial intelligence that disclose the performance potential of individual groups for all traffic conditions.

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The artificial experience system was introduced in chapter 2 and is described in detail in chapter 9.

The data structures that can disclose the performance potential of any group are developed and described step by step in the following chapters. The data structures enable intelligent destination groups to determine the modes of car operations that will satisfy anticipated traffic conditions. Most of the time two or more modes of car operations will be able to satisfy anticipated traffic densities. This implies that a preferred mode of car operation (option) may be selected in accordance with customer preferences.

Modes of car operations of car operations are characterized by the permitted number of stops for each UP trip and / or the permitted number of stops for each DOWN trip. This method of control and supporting features, such as avoiding very short waiting times (see chapter 6), make intelligent destination controls extremely flexible. This book will prove that intelligent destination controls can simultaneously deliver best-possible transport capacities and time-dependent service qualities relative to momentary traffic densities.

In other words: Typical for the performance of "intelligent elevators" is the **best-possible balance between transport capacities and time-dependent service qualities** for all traffic conditions.