Chapter F: Exact group planning with traffic simulation

Introduction

This is the third edition of Chapter F because the macros of the workbooks Simxx of the previous edition did not work. The cause of this problem was the hidden personal macro workbook of excel, which assured the correct operation of all Simxx workbooks on the author's PC, however the workbooks were not self-contained systems, i.e. not suitable for downloading via a website. The author apologizes for the inconvenience this oversight may have caused. This shortcoming did not affect the functions of the mathematical model of the workbooks

The revised RSimxx workbooks are self-contained and more user-friendly because buttons execute macros. This is the main difference between workbooks Simxx and the revised workbooks RSimxx. The revised workbook RSim14 use the same examples as Sim14 plus a few new ones. Readers can now repeat and double-check all stress tests.

Stress tests enable the exact planning of group configurations for specific transport capacities and time-dependent service qualities. **Traffic simulation facilitates confirmation of calculated stress test data.** The stress test methods of this chapter facilitate building planners to gain insights how numbers of cars and contract loads determine group configurations and performance data. These insights and data enable building planners to design groups, which deliver specific service qualities for specific buildings.

Intelligent destination group controls (intelligent controls)

The quintessence of intelligent groups is the minimizing and equalizing of *permitted numbers of stops* during each up and down trip and all traffic conditions. This mode of control minimizes and equalizes round trip times, i.e. maximizes transport capacities and minimizes time-dependent service qualities. The logic is obvious: Each stop causes a great time "cost" for deceleration, door opening, passengers in/out, door closing and acceleration. Consequently, **intelligent groups control the numbers of permitted up and down stops relative to momentary up and down traffic densities** i.e. intelligent groups **control the dimension time**, which defines all group characteristics.

Equalized round-trip times facilitate regular departures of cars from floor zero and the top- or reversal floor. Sequential departing cars, which make roundtrips with the same round-trip-time, facilitate calculation of all group characteristics. *Equalizing of round times is also decisive for the quality, i.e. the consistency, of time-dependent service qualities.* The cars of an intelligent group operate like a "string" of cars, which rotates in a building zone. However, within this string cars can change their relative positions. For more information on this aspect of optimal performance, refer to Chapter 6: Average Waiting Time (AWT), the misleading parameter.
The solution for the optimal performance of groups began with the brilliant idea of Mr. Leo Weiser Port in Sydney Australia (1960's) to move the floor buttons in the cars to the landing boards. For more information, refer to Chapter 4: Group "brain power".

Group performance evaluations

The RSimxx workbooks enable architects and all building planners to make stress tests for any group i.e. to design groups for the specific demands of a new building or building zone. Stress test reveal the transport capacities and time-dependent service qualities of any group i.e. facilitate performance comparisons of groups with different configurations and and enable selection of the best possible configuration(s) for a specific task. Stress tests make the planning of groups of elevators an exact process i.e. enable contractual performance guarantees.

Appendix 1: "Guide for using simulation workbooks", explains the mathematical model, which facilitates calculation of stress test data. Stress tests are a calculation method, which reveals the performance data of **many simulations**.

Appendix 2: "Procedure for making stress tests" states the simple rules for executing stress tests. **Workbook RSim14** demonstrates stress tests for all types of traffic conditions. Readers, who study the logic and data of these examples and make a few stress tests, will soon be confident of their ability to plan groups.

The inherent relativity of group characteristics

Elevator companies have virtually standardized 1600 KG as the contract load for groups of elevators. This is a false and misleading standard because each additional car of a group improves group efficiency. An additional car facilitates lower contract loads for all cars. More cars imply that each car will make less stops and enhance group efficiency. Example: TWO cars with contracts loads of 50 % of the ONE large car they replace will have much higher transport capacities than 100 % of the large car, because under all traffic conditions the TWO cars make less stops. For time-dependent service qualities, the impact of an additional car is even greater. The elevator industry ignores this inherent relativity of group characteristics and suggests that more cars increase costs and space requirements. This is not true because intelligent groups usually allow service to one or two additional floors. Intelligent groups reduce costs per floor served and building space as well. Group planning with large cars obscures the optimal performance potential of groups. Intelligent groups optimize all characteristics of groups, including space and energy requirements. More and smaller cars increase service frequencies; reduce time-dependent service qualities, numbers of waiting passengers, lobby areas etc.

Cars may be as large, as customers may wish, however *excessive* contract loads are counter-productive because they permanently waste a huge amount of energy. Large cars are inefficient.

The silence of the elevator industry

Destination group controls became an industry standard more than 30 years ago. Each day millions of passengers automatically or manually register their destinations via mobile phones or lobby panels for car assignment. The memory of each group records the time of each demand, arrival of the assigned car and the arrival time of each passenger at destination. This implies the memories of existing groups with destination controls possess **complete information** in respect of traffic density patterns, time-dependent service qualities, transport capacities, coincidence of passengers having the same destinations, fluctuating floor- and zone populations, etc., etc. Elevator companies treat this information as if it is **strictly confidential**. If readers google for this type of information they will find an enormous number of documents, however, no data or relevant information. It is obvious that <u>elevator companies are not proud of the performance of their most prestigious product line.</u>

International conferences, like the 2017 and 2018 CTBUH meetings (Sydney, Dubai) or the two-yearly ELEVCON meetings of the IAEE (Berlin May 2018), strictly avoid topics like traffic density patterns of existing buildings, group service qualities, group efficiency, the relativity of group characteristics and the planning of groups. These topics are taboo.

Disturbing innovation

For the elevator industry, the optimal performance of groups is a disturbing innovation. Adoption of intelligent group control systems, which deliver optimal performance, implies the <u>standardization of group performance</u> i.e. elevator companies cannot suggest or claim that groups with their proprietary destination controls deliver better group performance.

The purpose of *proprietary* group controls seems to be the protection of the maintenance business of individual elevator companies. The *confidential software of proprietary group controls* are a big problem for third party maintenance providers. By ignoring the inherent relativity of group characteristics, promoting empirical planning and inefficient proprietary group controls, elevator companies obscure the performance potential of groups. It seems elevator companies deliberately degrade the efficiency and service qualities of groups to protect the lucrative maintenance business.

Communication with passengers / key functions of intelligent groups.

Mobile phones enable intelligent controls to communicate directly with each passenger. Consequently, intelligent groups have exact data of *momentary traffic densities.* At all times, they have complete data of all floor populations. Direct communication is of particular importance for building security. Visitors must go the reception (security) desk to borrow a communication device or to program their personal phone. If a visitor leaves the car on the wrong floor, security is informed and can contact that visitor. A building manager can sent a message to the entire building population, or a specific group or an individual. Intelligent building management systems will facilitate services for tenants. For control of air-conditioning and other functions momentary floor population data will be of interest.

Conclusions

The planning and performance of groups is a complex mathematical problem because performance data, the characteristics of groups and traffic conditions in buildings are interdependent. The author's discovery of the inherent relativity of group characteristics, almost 20 years ago, facilitates the solution of this problem. Unfortunately, elevator companies do not welcome this solution, however that long and almost unbelievable story does not fit fit the scope of this chapter.

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Elevator companies continue to use empirical group-planning methods with large cars i.e. they promote the same type of configurations as used for traditional groups with floor buttons in the cars. For traditional groups large cars were essential, because they cannot control car operations! Because of this practice, virtually all existing destination groups have contract loads, which are too high and numbers of cars, which are too small. This implies existing destination groups cause a great waste of energy, feature long waiting- and travel times, waste building space and reduce the number of rentable floors in new buildings.

Until now, the complex problem of the optimal planning and performance of groups enabled elevator companies to promote empirical planning and destination controls with proprietary software. Groups with confidential software are problematic for third parties who offer maintenance services for elevators. The use of secret proprietary group control systems has made the elevator industry very profitable. Apparently, the development of elevator group controls into intelligent building management systems was not of interest.

This chapter introduces simple methods, which solves both the planning and optimal performance of groups with intelligent destination controls. *This implies a century of insecurity in respect of group performance, caused by inexact and illogical planning and evaluation methods, has ended.*

The next chapter will evaluate the FIVE groups of tower WTC 4 in New York to demonstrate the consequences of empirical planning methods.

The author welcomes questions and suggestions.

Appendix 1: Guide for using traffic simulation workbooks.
Appendix 2: Procedure for making a “stress test”.

Appendix 1: Guide for using traffic simulation workbooks.

The mathematical model of the EXCEL workbooks RSim10 to RSim20 of this chapter facilitate performance evaluations of Low- and High Rise groups with any configuration and for any combination of up and/or down traffic densities. Identical mathematical models enable group planning for buildings or zones with up to 20 adjacent floors *above floor zero*. Line 11 represents hoist ways *as if they are horizontal trajectories*. Level zero is the main lobby floor.

For a mathematical model, the evaluation of a High-Rise group is just as easy as a Low-Rise group. By entering, for example, 15 in the green cell D8 and a higher contract speed in cell I4 instantaneously calculates the door-to-door flight times (DDFT's) for all possible travel distances to facilitate evaluations of High-Rise groups.

NB: *Green cells in line 11 define floors served; RED cells are non-existing floors.*
Green cells are **not write-protected**; all other cells of pages Simulation are write-protected.

In line 11, a “1” in a green cell defines a permitted up or down stop. Line 15 calculates the round-trip time (RTT) for any round-trip without passengers. Please note and check that placing permitted stops in random positions may affect calculated RTT’s with a few seconds. Stress tests place stops in fixed identical positions to assure the use of identical traffic conditions for group comparisons. Assumed carloads (cell G19 and G20) facilitates calculation of RTT’s with passengers. Cell J19 and J20 are the time allowances for car entry and exit of passengers.
The mathematical model reveals all time-dependent service qualities and transport capacities for round-trips with specific numbers of passengers i.e. traffic densities. Cell E6 counts the number of permitted UP stops and cell N6 the number of permitted DOWN stops. The reversal floor counts as an UP stop and as a DOWN stop.

Setting of assumed carloads is an indirect method for setting traffic densities, i.e. just like carloads define the traffic densities of existing groups. Cells M25 and M26 convert assumed carloads in traffic densities.

The calculated data of stress tests reflect how group configurations i.e. the number of cars, contract loads and speeds and number of floors served, affect performance data and other characteristics of groups, such as space- and energy requirements. In other words, they mimic traffic simulations. The ability to assess instantaneously a huge number of DDFT data via the Excel system facilitates high-speed stress test evaluations.

The calculated average round trip times facilitate calculation of average departure intervals, to assess average waiting- and travel times in the cars, etc. To appreciate the performance data and insights provide by stress tests requires to study this method, however the logic of the mathematical model is simple and undeniable. Or ask your elevator contractor to suggest a better system.

Appendix 2: Procedure for making stress tests.
Refer to workbook RSim14 for examples.

For the first round-trip of a stress test, delete the numbers of passengers in cells G19 and G20 and press button "Increase Pas" twice. Enter "1" for a permitted stop in the green cell of the lowest floor (D11) and the highest floor (Q11) served during the up trip. Enter a further "1" in the green cell of the lowest floor (AF11) served during the down trip. Press button "Record".
For the second round-trip, press button "Increase pas" to increase numbers for assumed passengers to three. Cells K19 and K20 change to "1". Press buttons "Increase UP stops" and "Increase Down stops" to correct numbers of permitted stops for three passengers. Press "Record".
For further round-trips, increase numbers for assumed passengers. If cells K19 and/or K20 change to "1" adjust numbers of permitted up and/or down stops. See Note 7 on page simulations. Press "Record". Continue roundtrip recordings until carloads reach their maxima in persons i.e. contract load/100. The buttons in the first line of each workbook facilitate to make stress tests quickly.

Remarks:
The examples of RSim14 demonstrate evaluations for combinations of up/down traffic densities. The NB of the High-Rise stress test on page Recorded Data line 190 deserves special attention because it demonstrates that a reduction of permitted stops is an efficient method to increase transport capacities.

Simultaneous traffic densities of 5 % are high. They imply that during a 50-minute period the entire building population can make an up or a down trip. The author is confident that intelligent groups, which can satisfy simultaneous traffic densities of at least 5 %, can satisfy all traffic densities that may occur in a specific building. Disclosure of the traffic density patterns and the time-dependent service qualities of existing groups will reveal the requirements of existing building populations.

Workbook RSim14 also state data for stress tests of **un-balanced simultaneous up down traffic** and **maximum transport capacities in ONE direction**, i.e. heaviest up or down traffic. These tests demonstrate that the mathematical model of the workbooks enable a complete range of group evaluation methods.

Please note that elevator companies engage in traffic simulation **after empirical planning**. This practice means elevator companies routinely provide correct traffic simulation data for groups with flawed configurations. This practice obscures the falsehood of empirical group planning. Stress tests assure correct group configurations **before engaging in traffic simulation**.

Stress tests and traffic simulation fully disclose the performance of any group. The methods of this chapter enables building planners to demand contractual guarantees for the performance of groups with intelligent destination controls.