Lifts Group

Notes of the CIBSE Lifts Group: Lift (US: Elevator) Traffic Analysis & Simulation Open Forum, 1st & 2nd March 2011, 76 Portland Place, London.

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1.0 INTRODUCTION

The purpose of the forum was to bring together those experienced in lift traffic analysis and simulation from different sectors of the industry for discussion and debate on topics of mutual interest.

The meeting was chaired by Mr Adam Scott, Chairman of the CIBSE Guide D 2010 Steering Committee. As always with CIBSE meetings the opinions and views expressed by the speakers did not necessarily agree with their organisations or CIBSE.

The meeting was opened by Mr Scott who welcomed everyone and thanked them for their attendance. He explained that the forum would be an informal open discussion session and that it was hoped that consensus could be reached which would influence future editions of Guide D.

2.0 DESIGNING LIFT INSTALLATIONS USING MODERN ESTIMATES OF PASSENGER DEMAND

Speaker Mr Rory Smith
Mr Smith described how lift passenger demand has changed over the past 90 years and how this change could affect the traditional methods of designing lift installations.

Mr Smith began by comparing the traditional office passenger demand profiles developed by Strakosch and Barney which illustrate very sharp morning up peaks and evening down peaks with the template developed by Siikonen in 2000 using real traffic data where the greatest demand is over the lunchtime period.
Nowadays there is greater access to data monitoring lift demand which has either been captured manually or electronically. Mr Smith gave examples of profiles collated from manual surveys by Peters Research Ltd and electronically from an installation in North America with destination control. All of these highlight that the Strakosch/Barney traffic demand pattern is generally no longer seen in modern office buildings.

There have been several changes in working practices that have affected all three traditional traffic peaks. Clerical workers have been replaced by more flexible knowledge workers who are no longer bound by the 9-5 culture. New legislation banning smoking in public buildings has increased lift demand as has the current trend for arriving at work and then returning to the main lobby or staff restaurant to purchase food and drink - the “Starbucks” effect - both of which add to the demand during the morning up peak. Historically workers brought lunch to work and ate at their desks but now the trend is to eat out or in dedicated staff restaurants.
The sharp evening down peak highlighted by Strakosch/Barney has been replaced by a mixed profile. Contributory factors include extended working hours, staff returning to the office late afternoon and increase of delivery/collection services.
Typically traffic patterns are now:

Up peak: 85% Up, 10% Down, 5% Interfloor.

Lunch Time: 45% Up, 45% Down, 10% Interfloor.
Down peak is no longer a factor because it is so spread out.

Mr Smith continued by saying that in addition there have been technological improvements such as dispatching algorithms, load weighing, closed loop door operations, intelligent door systems and variable speed drives.
In a short discussion it was commented that the Handling Capacity (HC) requirement for offices has changed over the years to reflect technological improvements and workforce changes. Traditionally a 12% up peak was assumed, but this may now be distributed 8% up, 3% down & 1% Interfloor. In the past up to 25% HC has been specified.

An example of a typical 18 floor building with 61 passengers per floor, initially with 6 of 1350kg cars at 2.5m/s, was used to propose that modern traffic templates/passenger demand profiles for the morning up peak and lunch time peak should be considered when designing lift installations. Mr Smith demonstrated, using simulation, that it may be possible to reduce the number of cars when using a fully optimised system. It was generally agreed that the lunch time peak destination control does not offer the same opportunities for performance improvement compared with the morning up peak. Some partial destination/hybrid input systems may work better than full destination control although some felt that these were confusing in buildings were there was a transient population. Other disadvantages of destination control include the registering of false calls, one person registering 1 call on behalf of a group all travelling to the same destination.

Mr Smith concluded by saying that it is now a reality with destination control to consider reducing the number of cars and/or size of cars, However great care needs to be taken as in reality lifts do not always perform as well as in simulation.

3.0 HANDLING CAPACITY AND WHERE DOES IT FIT IN TODAY'S ELEVATORING

Speaker Mrs Theresa Christy

Mrs Christy began by saying that in her experience Handling Capacity is a “real” issue in the field in today’s markets because the term is not fully understood by all especially when used relevant to simulation studies. Historically only the up peak situation was a consideration, but now the process is a lot more involved than just RTT calculations and Interval.

In static (traditional) analysis there are a number of measures and assumptions (RTT, Handling Capacity – Quantity, Interval – Quality, probable number of stops, high call reversal, cars leave fully loaded) and as a result the % handling capacity gives a theoretical maximum under stated conditions. Dynamic (simulation) analysis uses different metrics as a measure of quality (waiting times, times to destination, queue lengths). What then is the simulation measure of quantity – is it still handling capacity?

Mrs Christy posed the question to the forum, “Do we need handling capacity and interval any longer?” It was agreed by almost everyone that these measures are still valid as fundamental concepts. Dr Finschi advised that interval was no longer used at Schindler for traffic analyse but has been replaced by waiting time some years ago. Various opinions were expressed as to the actual relevance of handling capacity and interval in lift planning.

“They are still needed for validation purposes.”
“What value remains today? Some companies no longer use them.”
“In 5-10 years no longer used.”
“They give a starting point before simulation.”
“They are an easy starting point/rule of thumb but are not a deciding factor.”
“Customers have a very simplistic measure of performance and recognise interval and handling capacity.”
“One company tried to move away from equations to simulation but there has been resistance from the field.”
“Simulation gives a variety of measures but the ‘lay-person’ is not interested in all the details.”

Some people felt that the equations are a good point for comparison as each manufacturer have their own simulation package however the information they contain is not transparent. After further discussion it was felt that it was unlikely/impractical that the manufacturers would agree to use the same types of simulation since each manufacturer has developed its own platform and keeps its dispatching algorithms proprietary.

Specific to the UK, building, owners want to comply with BCO, which now includes waiting time. This metric should be easy to understand, however, it is often confused with interval. BCO is likely to align with Guide D in due course.

“How is theoretical Handling Capacity determined? In reality is Handling Capacity passenger demand?”

Discussion ensued regarding what is the correct type of simulation profile to use: step or constant? If we use constant is there a risk of over-designing? For owners the key elements are handling capacity and interval, but very few have any concept of average waiting time and time to destination. Many felt that the terminology should be reduced and simplified. Waiting time and number of stops were considered important.

In conclusion, Mrs Christy said that the challenge we have is which is the correct definition of Handling Capacity that should be used in simulation? Mrs Christy reminded the group that historically Handling Capacity referred to the theoretical maximum throughput under given conditions. When the Handling Capacity is used in simulation studies to mean “passenger demand” the concept of maximum throughput is easily lost. Mrs Christy proposed that the concept of passenger demand be referred to as “passenger demand” or some other descriptive term and not be called Handling Capacity because of the historical connotation that term has of maximum throughput. In addition what is the quantity measure in simulation?

4.0 SELECTION OF ELEVATORS USING SIMULATION

Speaker Dr Marja-Liisa Siikonen

Dr Siikonen described how simulation results for the same building may vary using different templates.

For conventional elevator systems it is possible to plan with up peak analysis. However with destination control simulation is required and realistic traffic templates should be used.

Dr Siikonen commented on the new star rating table in Guide D and that there appeared to be some inconsistency between chapters 3 and 4. She used the example of an installation in Germany which using the CIBSE modern office up peak template would require an 8 car group. However another procedure using a stepwise simulation method indicated a 6 car group was sufficient to meet demand She also showed measurements from the building's real time monitoring system which indicate the service level is currently excellent with six lifts. It was suggested that this "excellent service" may be related to the passenger demand being significantly less than was planned for.

Dr Siikonen suggested the CIBSE modern office templates should be modified and that a 2-hour constant traffic template for up peak and lunch time peak should be used to give a star rating system that was simple, reliable and sufficient for planning purposes. She proposed a further series of templates for different types of building (single & multi-tenant office, hotel & residential) using constant demand with mixed traffic profiles. She also suggested the current HC criteria should be used as arrival rate. Step or ramp simulations should be used jointly with templates to show the saturation points and Handling Capacity of the group.

A discussion followed regarding rated and actual capacity and which was the most appropriate to use. Consideration needs to be given to rated or actual capacity and the subsequent effect on the number of cars selected. Does using actual capacity lead to over lifted buildings? There was also discussion on passenger transfer times and whether less than one second should be used when more than six passengers enter a car but no conclusion was reached. This parameter has a direct effect on round trip times and service levels.

During the open discussion alternatives to Waiting Time as a measure of performance were debated, including percentage of calls answered with *x* seconds, but this was thought to be confusing for customers and system response times do not reflect queue build-up.

Not all eventualities can be designed for. Several factors need to be taken into account.

The CIBSE star rating criteria could be broadened to include Average Waiting Time and % of calls answered but it need to correspond to actual passenger experience and not a manufacturer's theoretical value.

Ideally for future editions of Guide D it would be good to have a pool of data from all companies.

5.0 THE ENERGY EFFICIENCY OF LIFTS: THEIR PLACE IN THE ENERGY CLASSIFICATION OF BUILDINGS AND THEIR MODELLING

Speaker Dr Eur-Ing Gina Barney

Dr Barney outlined the latest EU directive on the energy performance of buildings in which lifts and escalators may be classified as internal loads. The purpose of the EPBD is to improve the efficiency of all buildings. It does neglect lifts, escalators and moving walks. This is also the case with UK regulations.

She also highlighted other building energy rating schemes (UK-BREEAM, US-LEED, Australian-Green Star). All the schemes used different criteria and were not easily compared. For BREEAM only two credits were available for lifts out of a total of some 120 credits possible. Sometimes design decisions are made that increase energy efficiency but these are not necessarily the best choice for lifts.

Dr Barney reviewed the current ISO standard DIS25745-1 “Energy efficiency of lifts, escalators and moving walks” that sets out a standard procedure for taking energy measurements and for verifying subsequent energy usage. Currently it has three operational conditions (standby, idle and running). However it does not take into account any of the auxiliary services, eg: energy consumption of any air conditioning/heating in the machine room, internal car displays, etc.

She illustrated a method to compare different new systems or to assess the benefits of a modernisation by normalising the energy consumed during an ISO Reference Cycle and then from this to calculate the Specific Running Energy. The procedure to gather this information is not straightforward and needs to be done by an experienced engineer.

The ISO Reference Cycle model has four main elements:

Power consumption for an empty car travelling up
Door operation at the highest landing
Power consumption for an empty car travelling down
Door operations at the lowest landing

Measured data is needed for model to be input into simulation program. Currently limited information is available. Using figures gathered over several years for 50 installations she displayed graphs of running energy per year and standby power. The maximum (or minimum) values were often not coincident.

Using this data she had developed simplistic model based on the ISO reference cycle. Dr Barney is continuing to collate data that has been published in the public domain and asked for more to be sent to her.

She showed how such data could be used in an energy simulation model for a typical up peak traffic profile and similarly a down peak scenario.
Dr Barney concluded, by confirming the importance of energy ratings in today's markets and encouraged everyone to show both the ISO reference cycle energy value and the specific energy value.

She further concluded that lifts are already very efficient and any further improvements are only likely to be small.

6.0 STATE OF THE ART TRAFFIC ANALYSIS

Speaker Dr Lukas Finschi

Dr Finschi began by inviting people to suggest what was needed from a method for lift planning. Key words and phrases contributed included: standard, account for experience, universal for all types of building, based on real values from real sites, quick, well defined, easy, transparent - "no black box", reproducible, constantly applicable, standardised output, verifiable, reliable, useful, [account for modern] technology, not conflict with theory, definitions including inputs well defined.

Historically theoretical models of Handling Capacity and Interval have provided reliable and useful values. However, modern control systems, buildings and traffic are more complex than can be represented with round trip time calculations.

There was some debate whether or not formulae could be used to analyse destination control. Formulae for destination control exist, but it was stated that different systems perform differently. Now we have simulation there is less incentive to consider formulae and there was a common understanding that simulation should be used.

Dr Finschi suggested we need criteria to select a simulation method, criteria as have been contributed by the forum participants at the session's start. For his presentation Dr Finschi proposed that a simulation method should be clearly defined, simple and useful. He compared two exemplary methods in order to discuss how such criteria can be applied.

There was debate. Some suggested constant profiles lead to over design. Some suggested that peak templates tend to show optimistic values and are not fail safe.

Dr Finschi also referred to theory (Bernoulli and the "law of large numbers") to underline that simulations need to run long enough under stable conditions for results to stabilise – hardly achievable with peak templates, even when run multiple times. This was disputed. He also suggested that passengers should be generated assuming a Poisson assumption of passenger arrivals. Passengers arriving at equal time intervals would be too simplistic, but no one was proposing this.

Alternative methods were discussed. Dr Peters had found it least confusing for users if the passenger arrival rate corresponded exactly with the number of passengers generated (allowing for rounding to the nearest person). It was noted that it is helpful to report how many passengers the system will serve (i.e. handling capacity), and separately how many passenger the system needs to support (i.e. passenger demand/expected arrival rate).

Thus it is useful to have an analysis which shows performance for different levels of passenger demand/arrival rate.

Dr Finschi concluded his presentation by stating that the suggested method, based on constant traffic profiles had been used at Schindler for several years successfully and that the method has been validated repeatedly with measurements in buildings.

7.0 TRANSPORTATION SYSTEMS IN BUILDINGS CIBSE GUIDE D: 2010

Speaker Dr Richard Peters

Dr Peters opened his presentation by responding to some of the comments/issues raised by Dr Siikonen regarding the apparent inconsistencies between sections 3 and 4 of CIBSE Guide D.

The Example 3.1 in Guide D is the equivalent of Dr Barney's spreadsheet calculation which does not allow for any losses as it is an idealised formula and is not trying to reflect real life. However as simulation does have some "real world issues" and in order to align it with the theoretical RTT Peters (in Chapter 4) allows for 5% RTT losses. For reference Strakosch makes an allowance of 10% for inefficiencies, although not on all elements of his calculation.

Dr Peters continued by showing example 3.1 performed including 5% RTT losses. The result was then run in simulation with a generic group collective algorithm, using the CIBSE modern up peak and lunch time templates. Under the Quality of service criteria this building would be awarded a 5 star rating for both the morning and lunch time peaks. He then presented results showing consistency between RTT and simulation using example 4.1.

The CIBSE modern office templates are based on published data and Dr Peters said he would be happy to amend them if other companies were prepared to allow their data to be accounted for by making it available in the public domain. He would like to add templates for other building types in future editions of the Guide.

There was ongoing debate as to whether constant traffic templates or peak templates were most appropriate for lift selection using simulation. Researchers are invited to document and present alternatives planning methodologies for future discussion. These methodologies need to be sufficiently detailed, otherwise there is too much room for interpretation.

There is a temptation, Dr Peters noted, to be optimistic with simulation input parameters to reach the "required results". Furthermore he is aware that there are many choices in implementing a simulation which impact results. If simulations are presented around the saturation point, differences can be dramatic.

A discussion followed about how changing parameters in simulation can make a significant difference to the results.

Dr Peters suggested competition between suppliers in simulation is of little value unless suppliers can demonstrate their systems perform equally as well in reality as they do in simulation. To this end, the CIBSE Lift Group has offered to participate in peer review where enhanced performance is claimed. He presented results of work showing consistency between reality and simulation; and also showed measurements demonstrating a wide range of measurements of motor start delay for supposedly high quality, high speed lifts.

8.0 GENERAL DISCUSSIONS

Definitions of average waiting time and average time to destination.

The definitions provided in section 3.3 of CIBSE Guide D 2010 are generally accepted and being used by most manufacturers.

Future work on common simulation methods

Participants were invited to publish detailed simulation methodology before criteria to the level of detail in Guide D. CIBSE will arrange another forum in early 2014 to discuss proposals before the publication of the next CIBSE Guide D.

BCO 2009

This is a high level management document. The section on Lifts has been significantly enhanced in relation to previous editions, but there is insufficient space in the document for detailed design recommendations.

Residential buildings

Dr Powell provides guidance in his paper "An Alternate Approach to Traffic Analysis for Residential Buildings". This paper is available in the conference proceeding of ELEVCON Thessaloniki 2008, and in the Support/Archive section of www.peters-research.com

Other design documents

Aside from the recent work for CIBSE Guide D, most design recommendations internationally appear to be based on, or have evolved from The Vertical Transportation Handbook (Strakosch) and The Elevator Traffic Handbook (Barney).

BS 5655 Part 6 is being updated, and there is an opportunity to contribute to this revision.

ISO provides information on car sizes.

Evacuation service in office buildings

This topic attracts a lot of interest, particularly with building managers and owners. Some work has been done by Kone & Peters Research. There are other published papers including by Mr J. Fortune and Mr J Wit. In the US the current thinking is a phased approach. Back up power requirements need to be considered. Evacuation with destination control requires special attention.

Double Deck simulation

Double deck works particularly well with destination control because the system is less prone to non-coincident stops.

Ideally terminals should be in sight of lifts because of the variation in walking times from barriers/destination input stations to the lift lobbies.

9.0 CLOSING REMARKS

Thanks were expressed to Adam Scott for chairing the event, to Elizabeth Evans for taking notes, and to the speakers.