2nd Symposium on Lift and Escalator Technologies

Toward a more Efficient Elevator System
An Extended Summary

Ir Dr Albert So
Director, The Asian Institute of Built Environment, Hong Kong.
Scientific Advisor and Member of Board of Executives,
International Association of Elevator Engineers

It is appropriate to describe an efficient elevator system in two aspects, namely energy performance and traffic performance. The presenter developed two benchmarking parameters (So et al 2005) to measure the performance or efficiency of an elevator system, the first one on energy performance, i.e. J/kg/m, and the second on traffic performance.

Energy concern has been drawing great attention around the whole world due to the recent climate changes while issues like sustainability and carbon footprint call upon energy savings by all building systems. There are regulations in Europe such as VDI 4707 and in Hong Kong such as Cap 610 Building Energy Efficiency Ordinance that impose conditions on energy consumption of lift systems. However, they all focus on energy efficiency of individual motor drives without any referral to the overall lift system whose performance much more relies on the supervisory traffic control system rather than individual drives. With a view to it, a benchmarking parameter was developed, J/kg/m, (Lam et al 2006) that can evaluate energy performance from a holistic and systematic point of view. A system can then be appreciated by having an intelligent traffic control. Besides energy, traffic performance is the second, but equally important, factor to evaluate a lift system. The quantitative parameter to evaluate it is “Average Journey Time” which is the sum of “Average Travel Time” and “Average Waiting Time”, which was further enhanced by the presenter (So et al 2002a, So et al 2002b).

Various technologies were developed by the presenter to improve traffic performance. It is believed that if the supervisory controller can clearly identify the number of passengers waiting for lift service at each landing lobby, dispatching of cars to serve calls could certainly be much more effective. A computer vision based system to count the number of passengers at lobbies and inside cars was developed (So et al 1992). Of course, if the destination of all these passengers are known, traffic control could become perfect. That has been successfully implemented with the use of “destination based control” for almost two decades by some manufacturers. Even without passenger counting, the supervisory control could be improved by at least knowing the type of traffic pattern at a particular instant, such as up-peak, down-peak, two-way or single VIP floor etc. A neural network based system was developed by the presenter to deal with that so that past traffic patterns could be intelligently recorded and compared with current patterns on a real time basis to enhance control (So et al 1995). Having known the traffic patterns, intelligent supervisory control is the obvious solution. Zoning, usually static, has been a traditional method to improve traffic by reducing the round trip time of journeys. The mathematics of dynamic zoning was developed by the presenter, which could be implemented on a high speed computer (Chan et al 1995, So et al 1997, So et al 2001). Dynamic zoning makes control more efficient and flexible. With all intelligent control algorithms, increasing the speed of elevators may be the final way to immediately improve handling capacity by shortening the round trip time. Computational fluid dynamics was employed by the presenter to study the mechanical performance of ultra high speed lifts up to a speed of 25 m/s which still does not exist in the world till now (Yang et al, 1998, Shen et al 2004, Bai et al 2005).

Various technologies were also developed by the presenter to improve the energy performance of lift systems. A series of graphs and the method to obtain the graphs to describe the overall performance of a lift car and its drive were developed, including the voltage, current, power quality, vibration, speed, energy consumption and displacement etc. The system is called "Elevgraphy" and the article published in *Building Services Research and Technology* of CIBSE (So et al 2000) made him awarded the Carter Bronze Medal in 2003. To facilitate the implementation of energy conservation measures on lift and escalator systems, the presenter has been a member of Task Force of the Hong Kong Government since 1997 to compile the Code of Practice for and Guidelines on Energy Efficiency of Lift and Escalator Installations (1998 version, 2003 version and 2007 version). He was also the Chairman of the sub-committee to compile the part on Lifts and Escalators inside the Code of Practice for Energy Efficiency of Building Services Installation which will become mandatory from September, 2012 onwards (EMSD 2012). To facilitate the monitoring of lift and escalator systems, in particular their energy performance, the presenter carried out a one-year long consultancy project for the Architectural Services Department of HKSAR Government in 2007 to develop three sets of common protocols for effective communication between the elevator systems and building management systems, which are LonWorks, BACnet and XML based. Later, based on the outcomes of the project, the presenter helped ASHRAE Standing Standard Project Committee 135 to develop a set of objects on BACnet specifically for lifts and escalators (So et al 2011a, So 2011b, 2011c). Last but not least, the presenter developed an intelligent counterweight adjustment system based on continuous lift traffic monitoring, analysis and simulation to arrive at the optimal counterweight setting of a particular lift car to achieve minimum energy consumption (So et al 2012) over a period of time with the help of his parameter, J/kg/m.

REFERENCES

Bai H.L., Shen G.X. and So A. (2005), "Experimental-based study of the aerodynamics of super high speed elevators", *Building Services Engineering Research & Technology*, Vol. 26, No. 2, 2005, pp. 129-143.

Chan W.L., So A.T.P. and Lam K.C. (1995), "Dynamic zoning in elevator traffic control", in Barney G.C. Eds. *Elevator Technology 6, Proceedings of 6th World Congress on Elevator Technologies*, March, pp. 132-140, reprinted in *Elevatori*, November/December, 1996, reprinted in *Elevator World*, March, 1997, pp. 136-139.

EMSD (2012), *Code of Practice for Energy Efficiency of Building Services Installation*.

Lam D.C.M., So A.T.P., Ng T.K. (2006), "Energy Conservation Solutions for Lifts and Escalators of Hong Kong Housing Authority", *Elevator Technology 16, Proceedings of 16th World Congress on Elevator Technologies*, IAEE, Helsinki, June, 2006, pp. 190-199.

Shen G.X., So A.T.P. and Bai H.L. (2004), “Research works on super-high-speed lifts”, *Elevator World*, Vol. LII, No. 4, April, pp. 70-78, reprinted in *Lift Report*, No. 4, 2004, in German (pp. 4-13), in English (pp. 13-23).

So A.T.P., Chan W.L., Kuok H.S. and Liu S.K. (1992), "A computer vision based group supervisory control system", *Elevator Technology 4, Proceedings of Elevcon'92*, I.A.E.E., Amsterdam, May, pp. 249-258.

So A.T.P., Beebe J.R., Chan W.L. and Liu S.K. (1995), "Elevator traffic pattern recognition by artificial neural network", in Barney G.C. Eds. *Elevator Technology 6, Proceedings of 6th World Congress on Elevator Technologies*, March, pp. 122-131.

So A.T.P. and Chan W.L. (1997), "Comprehensive dynamic zoning algorithms", in Barney G.C. eds. *Elevator Technology 8*, April, 1997, pp. 98-107, reprinted in *Elevator World*, September, pp. 99-103.

So A.T.P. and Li T.K.L. (2000), "Energy performance assessment of lifts and escalators", *Building Services Engineering Research and Technology*, Vol. 21, No. 2, pp. 107-115.

So A.T.P. and Yu J.K.L. (2001), “Intelligent supervisory control for lifts: dynamic zoning”, *Building Services Engineering, Research and Technology*, Vol. 22, No. 1, pp. 14-33.

So A.T.P. and Suen W.S.M. (2002a), “Assessment of real-time lift traffic performance”, *Building Services Engineering, Research & Technology*, Vol. 23, No. 3, pp. 143-150.

So A.T.P. and Suen W.S.M. (2002b), “New formula for estimating average travel time”, *Elevatori*, Vol. 31, No. 4, pp. 66-70.

So A., Cheng G., Suen W. and Leung A. (2005), “Elevator performance evaluation in two numbers”, *Elevator World*, Vol. LIII, No. 1, January, pp. 102-105.

So A. and Swan B. (2011a), “Bacnet for elevators”, *Elevatori*, Vol. 1, Jan/Feb.

So Albert (2011b), “The elevator initiative of ashrae sspc-135 – development of efficient buildings with bacnet”, *Proceedings of BACnet Forum 2011, BACnet International*, 10th, November, on CD.

So Albert (2011c), “Open control protocols for buildings – bacnet”, *Proceedings of The 2nd Greater*

Pearl River Delta Conf. on Building Operation and Maintenance, AEEMM, 11th November, pp. 69-85.

So, A. and Wong C.T.C. (2012), “Implementation of counterweight adjustment to achieve energy savings”, *Elevator Technology 19, Proc. Elevcon 2012*, IAEE, Miami, May, pp. 185-192.

Yang H.W. and So A.T.P. (1998), "A 2-dimensional aerodynamic model for super high speed elevators", *International Journal of Elevator Engineering*, Vol. 2, pp. 19-32.