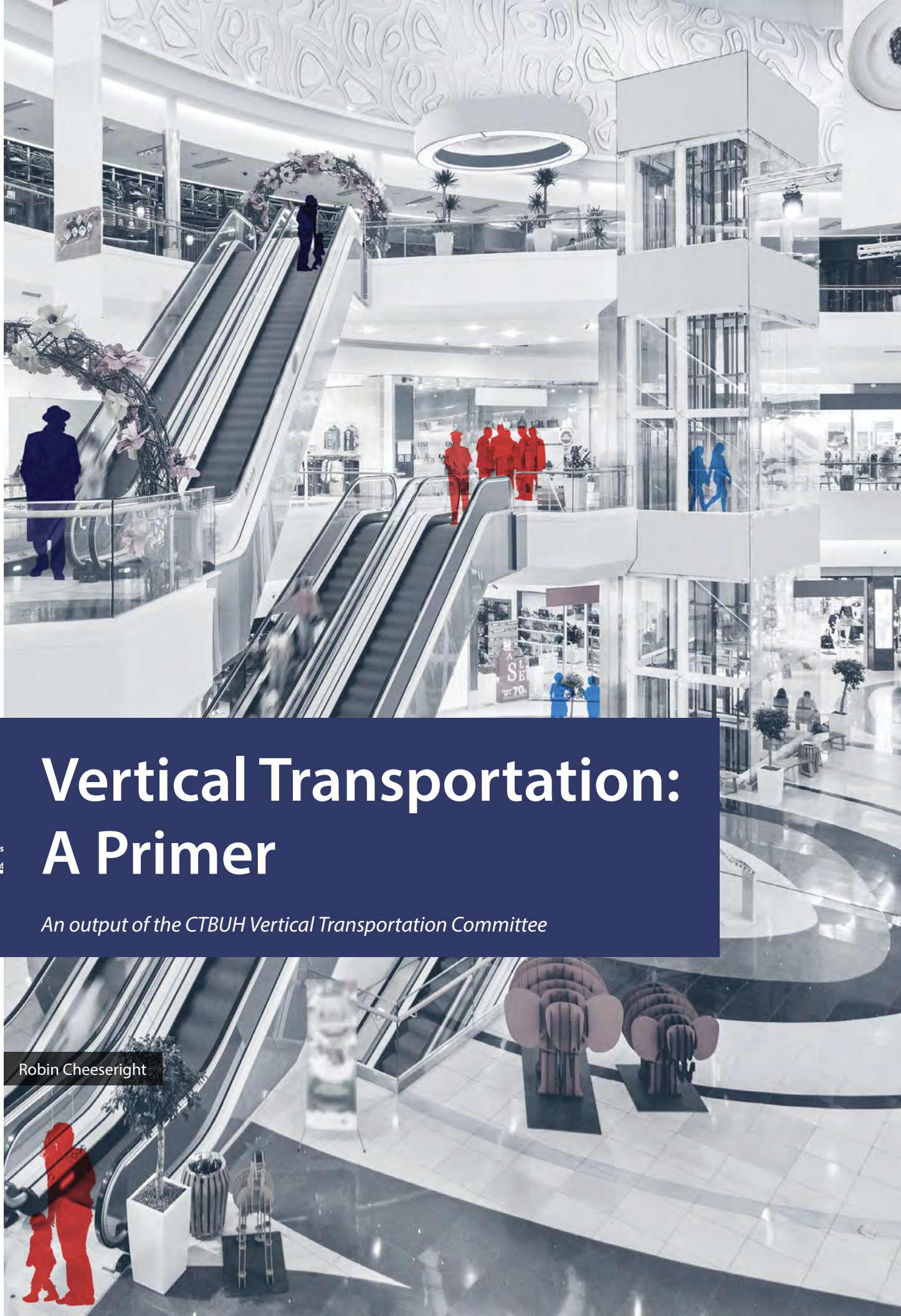

Council on Tall Buildings and Urban Habitat

Vertical Transportation: A Primer

An output of the CTBUH Vertical Transportation Committee

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About This Primer

As you approach an elevator in a building lobby, press a button or touch a key pad to allow you to continue your journey, glancing momentarily at the doors as you enter the elevator and are effortlessly transported to your destination. Have you ever wondered what has gone into making your life so easy? Are you aware of the technology behind those doors, how this type of elevator came to be in that building, how the building was designed, and the role of the elevators in that design? And more importantly, how will these elevators evolve to continue providing you with that effortless journey, especially as buildings get taller and technology adapts to accommodate the increasing demands placed upon vertical transportation?

Looking forward into the world of elevators and escalators in supertall buildings, The Council on Tall Buildings and Habitat (CTBUH) is pleased to provide this primer as an insight into vertical transportation. The objective of this primer is to provide knowledge to those involved in the design of tall buildings. Typically, for owners, developers and architects, this primer will assist to facilitate the design process by affording stakeholders greater knowledge, so as to ask informed questions and efficiently gain insights from vertical transportation (VT) experts. This primer is not a step-by-step "how-to" instruction manual, but rather, an information-sharing publication, which will arm the imaginative minds behind the design of tall buildings with a framework for understanding vertical transportation; one that will allow them to be more creative as buildings become taller.

This primer also gives an update on the latest technology currently being designed and installed. The key suppliers spend millions researching and developing technology to meet the future demands of an increasingly elevated world. As buildings become taller, it is a fascinating insight into how the key elevator manufacturers are responding to these inherent challenges.

This primer is unique, in that it addresses design issues and future technology for vertical transportation in supertall buildings (buildings that are 300 meters or taller). This version concentrates on technology and on providing insight into factors that need to be embraced for vertical transportation. Future versions will look at topics such as maintenance and user experiences. As tall buildings are rarely demolished, they will outlast the design life of elevators and escalators. Future editions of this primer will inevitably address the complexities of replacement or modernization of elevators in supertall buildings, noting the importance of their role in maintaining the asset value of the building, while also encompassing the recognition that buildings are largely to be kept operational and occupied during any refurbishment work.

It is worth mentioning that the global vertical transportation market is perhaps larger than many perceive. The global vertical transportation market consists of some 10 million operating elevators worldwide, and will exceed US$125 billion in value by 2021.

Without effective vertical transportation, supertall buildings would cease to function, and the prospect of living and working in them would become untenable. In a world where space to accommodate an exploding population inevitably drives living, working and recreational space in an upward direction, the effective design and reliability of vertical transportation takes on a new dimension. And the design must try and predict factors that will influence building usage far in the future, as moving from concept to construction of a supertall building can take many years.

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As a way of providing insight as to what is involved in this process, and what sort of technology supports the increasing demands placed on elevators and escalators, this primer will cover:

- Planning for the population within a building, the factors that will influence the number of people who use the building, and how they use the building;
- Density of building population, and how this will affect the vertical transportation strategy;
- How elevator design can accommodate building sway;
- How elevators can create a piston effect, and considerations around the dissipation of the subsequent air movement;
- Dealing with changing air temperatures and pressurization that inevitably occurs in tall buildings and elevator shafts;
- The benefits of digitizing elevator control, and how this can support building design;
- The growing demand for running multiple cars within one elevator shaft;
- How elevators support the fire and evacuation strategies for tall buildings;
- An overview of factors affecting installation of elevators;
- The relationship between escalators and elevators.

As a final note, although we will make the occasional reference to codes and standards, encompassing the detail and variances of codes and standards for elevators and escalators throughout the world is a complex subject beyond the brief of this primer. However, it is worth noting that codes and standards are a fundamental part of ensuring that the design, installation and maintenance of elevators and escalators are to a level that local engineers deem to be safe for all users and stakeholders. Compliance with codes and standards is the measure by which the insurance industry will deem suitable for insuring elevators and escalators, thereby reducing the liability of the owner and occupiers. Codes and standards do have regional variances, so it is important to note which are applicable to the area in which the development is taking place.

The first consideration when embarking on a vertical transportation plan is determining which general elevator configurations will suit the design for a particular building. By developing elevator configurations, design teams can then forge an early determination of the ideal core design and capacity. The primary emphasis of core design lies in managing the dynamic of designing an effective core, in order to balance vertical transportation requirements effectively against the imperative to create sufficient space to maximize floor area and thus revenue.

1.1 Typical High-Rise Elevator Configurations

Conventional high-rise buildings are usually quite straightforward in terms of vertical transportation design, since they are generally single-use towers accommodating either offices, hotels, or apartments, and most of the elevator systems serve every floor and consist of cars with single decks. Depending on the building height and size, an elevator system may have either two, three or four zones of direct/local elevators. Double-deck elevators may be used for some office buildings with a higher population density or a smaller central core.

1.2 Supertall Buildings – Unique Considerations

When it comes to supertall buildings of 300 meters or greater height, building developers and designers want their buildings to stand out, with attractive, eye-catching building shapes that will differentiate them from their neighbors. These buildings can take any form, from conventional squares and rectangles to circles, ellipses, triangles, rhomboids, fans, and many other asymmetrical and eccentric shapes (see figures 1.1 and 1.2).

The shape of the building impacts both structural and vertical transportation design. For example, in a round office building with a circular central core, all elevators may have to be designed in a "fan" arrangement, to increase handling capacity, floor efficiency and to match the building form. Vertical transportation designers must work closely with architects and structural engineers from earliest design stages to develop the optimum elevator system for moving people efficiently up and down the building.

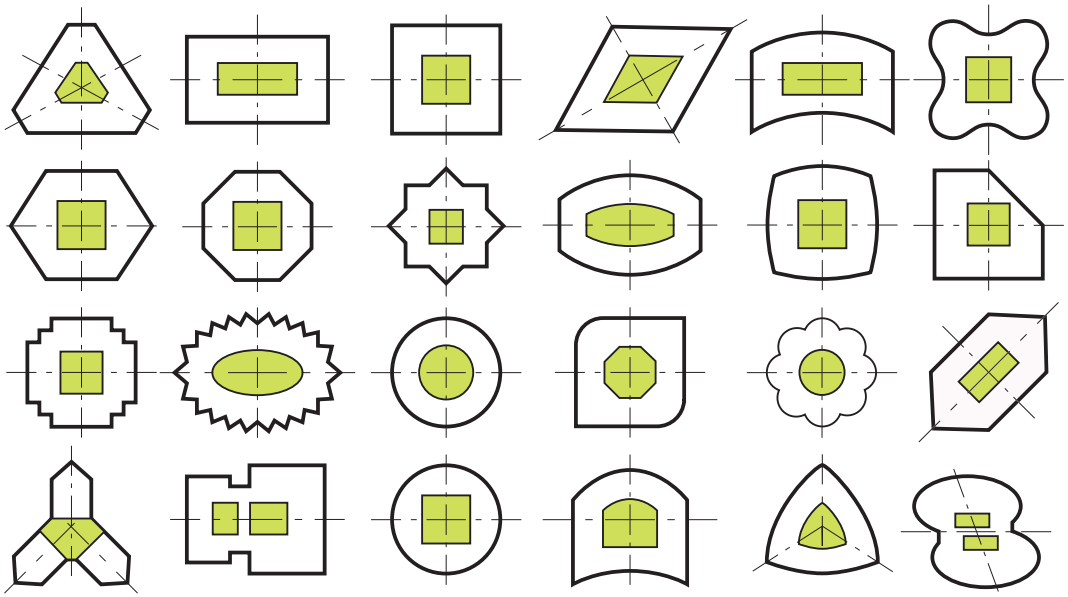

Figure 1.1. Various building shapes used in supertall buildings, with the core location identified in green. © WSP, redrawn by CTBUH