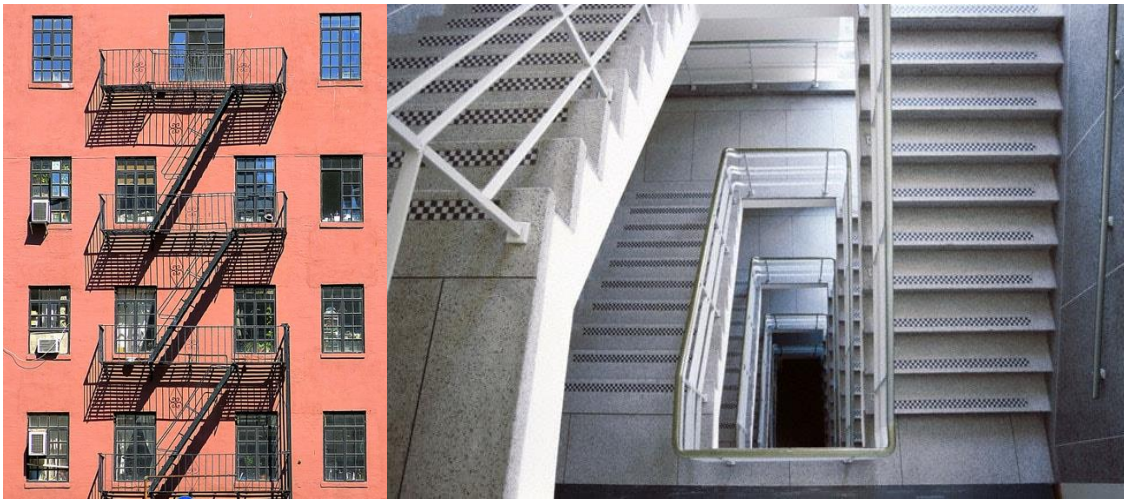
STATE DA VINCI DECATHLON 2018

CELEBRATING THE ACADEMIC GIFTS OF STUDENTS IN YEARS 5 & 6

ENGINEERING

TEAM NUMBER	
TOTAL	/43
RANK	

EASY ESCAPE



BACKGROUND

Our cities are growing vertically. As land is decreasing in availability, the only approach to packing more people into one space is by layering upwards. Average skyscrapers have 20-30 floors, with over 300 people per floor. In one 30 storey skyscraper, there may be over 9000 people working, compared to the 300 if only one floor was built.

While this is very convenient and efficient for productivity and business, it has the opposite effect for mobility. In a state of emergency, removing all the inhabitants of the building is a difficult task. Strict regulations are in place to ensure that buildings, at the minimum, are built with fire escape stairwells. These escape routes, however, do not assist people with **reduced mobility** and aren't particularly fast.

THE TASK

You have been briefed by the designers of a new 40 storey skyscraper that has been designed for a new business precinct in Parramatta. They are concerned with the effectiveness of traditional fire-escape stairwells to ensure people escape in an emergency. They have asked you to imagine the follow situation: a fire breaks out on the first floor of the building. It extends around the exits of the fire-escape stairwell so that even if all the inhabitants are to exit by the stairwell, they would not be able to leave the building.

They also expressed concerns about the permanence of the fire escape, which makes it inflexible during a disaster.

They have tasked you with designing an **innovative** and **more efficient** method of quickly removing people in the skyscraper in case of an emergency.

To assist you in your brainstorming, you have been given a recent **article** about emerging technologies in the field. This can be found at the **back** of this task.

DESIGN PARAMETERS

You will have **sixty minutes** to complete this task. The following are to be done:

1. **Design 3** potential escape systems and represent these with labelled sketches on page 4 (3 marks each)
2. Complete an **evaluation** on page 4 to conclude which design should be accepted (2 marks each)
3. **Construct** a **self-supporting working** model of your proposed escape system, built into a rudimentary (basic) 'shell' of a skyscraper. You will not be marked on the detail in your skyscraper model but will be assessed on its **structural quality** and **use of materials**. Marks **will** be awarded for your **detail** and **precision** of the escape system which you will model.

The system will be marked according to marking criteria below. Be sure to use these criteria when selecting and evaluating your designs!

You will be provided with a number of materials. It will be up to the team to decide what materials to use to construct the model. You are able to select from the following materials:

- 4 pieces of A4 paper
- 2 pieces of A4 cardboard
- 6 straws
- You may also use your own sticky tape, but sparingly.

MARKING CRITERIA

Criteria	Skilful	Effective	Sound	Limited
Three design sketches	6-9	4-6	3-1	0
Evaluations of designs	6	5-4	3-2	1-0
Use of materials in model	5	4	3	2-0
Scale of model	3	2	1	0
Structural quality of model	3	2	1	0
Working model component illustrating escape system	5	4	3	2-0
Novelty of escape system	4	3	2	1
Efficiency of escape system	4	3	2	1
Accommodation of escape system for less mobile occupants	4	3	2	1

TOTAL /43

DESIGN APPROACHES (15 MARKS)

			In the boxes below, present your three system designs. To evaluate each design, below each sketch, provide advantages/disadvantages of the system using the criteria described on page 2. Provide your final selection and evaluation in the bottom box.

The advent of super towers coupled with an ageing population have prompted engineers and fire officials to take a fresh look at fire safety and evacuation options for high rise fires.

In current international high-rise design, this may include the use of an increased number of exit stairways, the use of safe areas or refuge floors within the building and the use of elevators to facilitate emergency evacuation of building occupants.

“Most people can evacuate moderate distances with relative ease. As the difficulty of egress increases, the effective mobility of occupants decreases,” said Denny Verghese, senior fire performance engineer at Meinhardt. “Evacuation in tall buildings should therefore consider the limitations on the physical ability of its human occupants. It is well known these limitations are only increasing due to age and health related factors that affect the population of most large cities.”

Elevators

If the tendency for occupants is to go, and if stairs are not viable, what is the option?
In the United States, National Elevator Industry Inc (NEII) codes and standards analyst Brian Black says there are changing views on the role of the elevator in emergency occupant egress.

“The reasons behind prohibiting the use of elevators in a fire were based on historical concerns that have become modern anachronisms in new buildings,” he said.

“Due to today’s advances in building design and **elevator technology**, working elevators don’t become inoperable in fire situations, trapping passengers as the environment becomes untenable. There isn’t necessarily a serious loss of power to the building or a shutdown of the elevator system due to intrusion of water into the elevator shafts, capturing passengers engulfed by smoke or fire.”

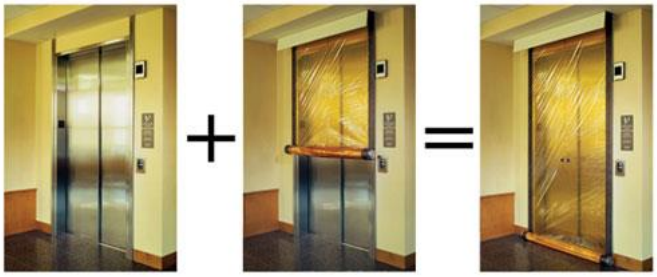
For persons using wheelchairs or those with a limited capacity to use exit stairs, elevators are really the only viable option in emergency circumstances, but Black admits that using elevators to evacuate non-disabled building occupants in building fires remained an idea outside of the norm.

He added, however, with extremely high-rise construction in particular, using elevators versus the exit stairs can shave hours off of the time it takes for building occupants to move from close proximity to a fire to the safety of the outdoors.

“Many have theorized that had the building elevators in the 9/11 World Trade Center attacks remained operational as a means to evacuate the upper stories of the buildings, more lives could have been saved,” he said. “In fact, in the 18 minutes after the North Tower was struck, hundreds of workers chose to evacuate the South Tower and reach safety on the ground floor by using the building’s elevators.”

Following the attacks, the American Society of Mechanical Engineers (ASME) A17 Elevators Standards Committee established a task group on the use of elevators for occupant evacuation. Within nine years the National Fire Protection Association (NFPA) and International Code Council and ASME Elevator Code all had new provisions.

These permitted extremely high-rise buildings to use elevator systems to safely remove building occupants from the upper stories of a building during fire. These occupant evacuation elevators are housed within specially designed elevator lobbies with hoistways and machine rooms protected from the intrusion of **fire**, smoke and water.



Combination of fire-rated elevator doors and rolling magnetic gasketing system

In fact, the International Building Code has incentives for installing these types of elevators where a building exceeds 420 feet in height.

In Australia, Society of Fire Safety national president Dr Weng Poh agrees that designing appropriate vertical transportation systems is a solution to evacuating tall buildings but that national codes are currently a barrier.

“The main issue is egress since the Building Code of Australia (BCA) does not allow a lift to be used in the event of a fire,” he said. “In fact, presently, there is no BCA solution to evacuate very tall buildings.”

“The Australian Building Codes Board has issued a guideline document regarding the design of lifts as an alternative solution for evacuation but it only contains various factors to be considered and no concrete solutions.”

Education
Wider stairwells, advanced sprinkler systems and alarms that give precise instructions during an emergency all make buildings safer.

“But to really make these systems work you really need to educate the occupants,” said Chris Jelenewicz, an engineering program manager at the Society of Fire Protection

Engineers, speaking to the *New York Times* after a high rise fire claimed a number of lives. “Many people don’t know whether they live in a fireproof building and don’t know whether they should stay or go during an emergency,” Johnson said.

Outside The Box
A number of alternative escape solutions have been proposed since 9/11 that do not require structural changes.

Helicopter: A rooftop heliport located a safe distance from antennas, mechanical installations and other hazards could provide a means of evacuation. However, not every building can have a heliport and evacuees, especially the disabled, cannot always get to the roof.

Parachutes: At least six companies are selling escape parachutes but this extreme method of egress is only suitable for the athletic and requires the jumper to be a suitable distance up.

Slides: Similar to the chutes used in airplane evacuation, slides have been listed as an alternate means of egress in the building codes of several US cities. Such slides, however, may not be feasible above the height that is reachable by fire department ladders.

Wires: These are stretched between buildings so that people can slide from one affected building to another, but again gives no consideration to those who are less mobile.

Tubes: A vertical tube of flexible material has been installed in some buildings in Asia and Europe. It can serve multiple floors, but unless it is located outside the building, it may be subject to the same hazards as stairways and elevators.

Collapsible elevators: This system has been developed in Israel and requires the installation of collapsible cubicles on the roof, which deploy along a rail on the outside of the building in an emergency. New York City has denied a permit for the system because of the potential bottlenecks as people try to enter the cubicles.
These are all interesting concepts, but they are not really practical or viable on a mass scale. “The fire engineering community is continuing to grapple with this challenge,” Poh said.

https://sourceable.net/high-rise-fires-rethinking-exit-strategies/