Vertical School Design:

Strategising the spatial configuration of a multi-storey typology to facilitate education in dense city environments.

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Adam Swinburn was awarded the Byera Hadley Travelling Scholarship in November 2015.
Cover image: Vertical School Graphic by Adam Swinburn

Vertical School Design: Strategising the spatial configuration of a multi-storey typology to facilitate education in dense city environments.

City centers have become increasingly desirable for couples and young families to live in, reversing a decades old trend of population flight to outlying suburbs.

As the population in cities grow, large tracts of land which would support a traditional horizontal model of school design are no longer obtainable and are not financially viable.

Therefore, for urban schools to accommodate the densification of cities, school design must transition from building outward to upward.

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Vertical School Design is a case study analysis of emerging multi-storey school models in our inner urban areas.

The spatial organisation patterns that emerge in vertical school design precedents are documented and considered as a resource to assist the thinking of architects, school administration and government officials when designing school architecture of a similar type.

1

Preface

In 2015 the International Grammar School hired students, alumni and staff from the UTS Master of Architecture program to be involved with an experiment to push school design as far as possible. The school felt that students would propose bold, innovative ideas and be more open-minded than seasoned professionals. The prime objective was to determine whether the International Grammar School should make a long-term commitment to its current location in Ultimo or consider moving the school to another Sydney suburb. The school had determined that remaining in rented quarters was not fiscally sustainable over the long term but purchasing the school buildings in Ultimo might not be possible.

What separated the International Grammar School from its conventional counterpart was its relatively small site which was governed by its location in inner Sydney. The problematic site constraints had resulted in a multi-level school. During a tour of the school, we quickly realised how different the school experience was to our childhood education in a typical low-rise suburban school. Back at university, early precedent studies revealed that the research and documentation for multi-level schools were non-existent or few and far between. A gap in the research made it difficult for both students and school administrators to make informed decisions in improving the school's design. Upon discovering this gap, which was further fuelled by media coverage for other controversial proposals of new necessary vertical schools in Australia, I felt that the success of a compact city model and densification of cities relied on providing meaningful school architecture to support families living there. Otherwise, why would anyone stay?

On the outset, vertical schools are perceived as hard – too different to the suburban school's Australians are familiar with, too tricky to fit all the strict programmatic requirements and too institutionalised. These perceptions precede a genuine investigation into a vertical

model. The vertical obstacle offers an opportunity to improve the school's condition and find innovative design solutions that did not exist before. Vertical school are not easy; they will require greater administration management and greater planning during design, but it can be a meaningful contribution to civic idealism, provide a more space efficient model of school design and offer an urban schooling perspective.

This report represents a snapshot of an ongoing passion project which is being completed outside of full-time work hours as a part-time research master's thesis at UTS. Over the past years, I've documented and investigated the spatial configurations of vertical schools so that architects and school administration have a resource to assist with the considerations for designing a multi-storey school. A resource that the International Grammar School at the time needed to help plan for future expansion.

The ideas and writing in the following report is a work in progress and far from perfect but, it's a reasonable basis for feedback so the writing can be refined into an informative set of strategies. I encourage readers to get in contact with comments and improvements as we owe it future school generations, to school architecture, to cities to design this school model well. Many of the spatial considerations here, which will become the final chapters of the thesis, are explored in this report on a case by case study and as a starting point for further analytical comparison.

Vertical Schools of note are in high-density cities across the world. The Byera Hadley Travelling Scholarship enabled me to visit nine cities spanning across Australia, Asia, Europe and North America to analyse 14 case studies. Each selected case study explores a different vertical spatial organisation strategy and represents a spectrum of issues and considerations that any new vertical school design project should consider. After receiving the grant in November 2015, it took six months to organise and coordinate school tours and 25 interviews with school principals and architects, such as renowned Pritzker prize winner and school design expert Herman Hertzberger. After the 2-month study trip in May, I spent 15 months transcribing 100,000 words worth of interviews and to 3D model precedent studies from collected architectural sets. All the drawings in this report are original and to help compare the different approaches to vertical schools. From now until the end of 2018 the chapters of the thesis will be written and adequately edited.

Schools are one of the most challenging buildings to visit and collect information on, primarily due to safety concerns and access restrictions. So that meaningful data could be obtained for a university-level publication, all interview questions were reviewed and approved by a Human Research Ethics Committee at UTS before the trips commencement. The methodology is filed under ETH16-0463. All interviews have been consented to in writing under UTS research standards. All school tours and child interactions were supervised by staff and under the rules of UTS child protection policy. Schools which required police checks were provided with requested material.

Design Charette at the International Grammar School, Ultimo.
Photograph: University of Technology Sydney

2

Introduction

Context

During the early years of the 20th century, new affluent middle-class families would move outward from crowded urban neighbourhoods and cities to spacious apartments and suburban homes to raise a family. The role and function of the city like Sydney as a residential and commercial hub changed as it went through a period of depopulation. Urban sprawl, shaped by the automobile age and rapid transit, made it possible to disperse population growth across undeveloped land surrounding the city centre. It was more likely that the people settling in the suburbs were families who express child-centred concerns, such as the desire for more space, large yards, good schools, and safe environments.

The low-density configuration of Australian cities characterised by suburban expansion traditionally supported greenfield school developments that have followed a nineteenth-century model. Its architecture encouraged liberal learning and school identity through the provisions of playing fields and ancillary facilities alongside classrooms. The conscious shaping of a 'community within a community' by providing all educational and recreational facilities on school campus reflected the desire to separate school-based learning from socialisation and physical environments that were seen as harmful to proper development. Improvements to school design and construction followed the middle class out to the suburbs where there was more money for investment and desire to provide schools to suit new values for the people living there.

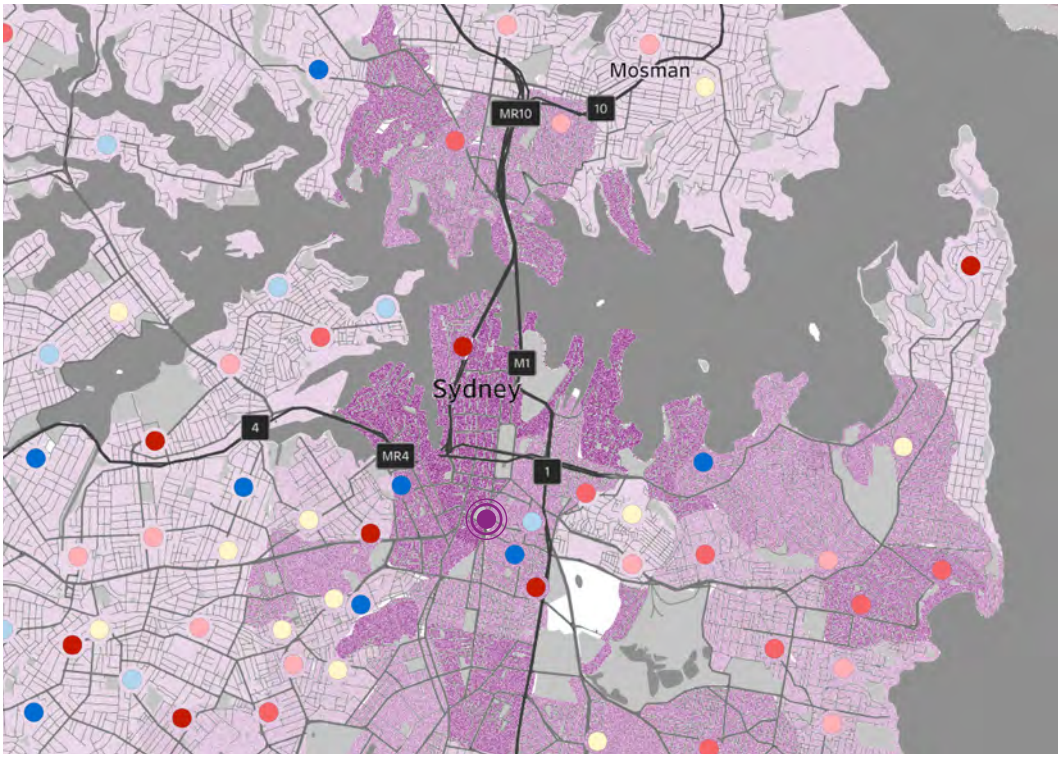
The departure of the middle class left the working class and the poor in the inner city. The Great Depression of the early 1930s hit the traditional working class inner areas severely with widespread unemployment. This period saw an increase in poverty and crime rates,

reduced building commissions and the degradation of existing building stock in inner-city areas of Sydney like Darlinghurst, Balmain and Surry Hills. The living conditions of the inner city were dirty, noisy, disordered, dangerous and unhealthy environments in which to raise children. Consequently, poor urban areas did not attract the investment and research to overcome the economic and site constraints of an inner-city school. As a result, urban schools often lacked large outdoor recreational spaces and could only provide small, overcrowded classrooms, which is impractical for learning.

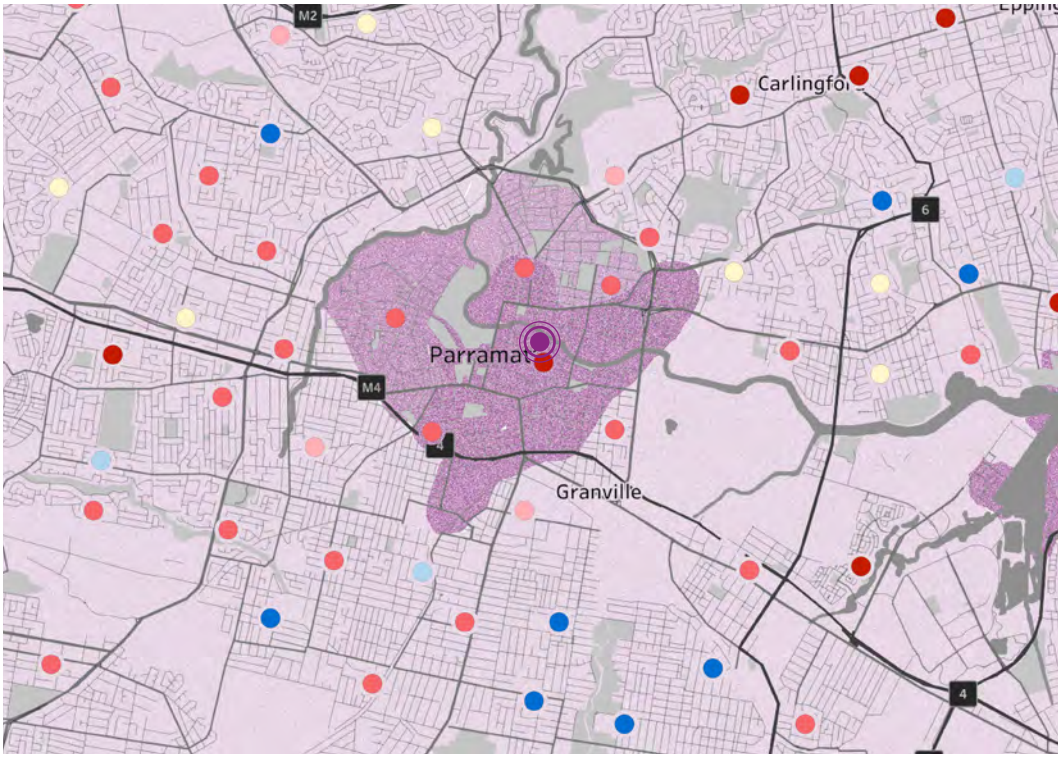
Today, demographic studies reveal that young adults are choosing to live in housing well located to sources of employment and culture, which means in the inner city. This dramatic and rapid shift for housing preferences in Australian metropolitan areas is due to the transition from a manufacturing economy to a service-based economy. The deindustrialisation and decline of manufacturing in capital cities have been brought about by expanding price competitive export-orientated economies in Asia which has allowed for urban renewal opportunities in city centres. For Sydney and Melbourne, urban consolidation planning policies since the 1980s and urban renewal, particularly the Building Better Cities program of the 1990s, have allowed for significant residential redevelopments and zoning of former employment-related uses, such as industrial land, warehouses, wharves and office space to accommodate rapid population growth and desirability. In 2016 over 60% of new residential development occurred within well-established areas of metropolitan Melbourne. This compares to 39% in 2011 and represents a significant shift in housing preferences away from greenfield estates, which have become fewer in inner-city areas.

Changing values amongst adult cohorts are encouraging densification closer to the city. Adults have not moved to the centre of cities merely to get to work faster. They have come to desire what citizens of Paris or Vienna experienced a century ago, around the clock street life, café sociability, a wider selection of urban activities, closer access to urban amenities and a sense of place. This is a stark contrast to the 20th-century spread of population through suburban sprawl, which failed to realise the traditional urbanism of density and valued centralised urban experiences.

To support an urban lifestyle, adults born between the 1980s-2000s have traded space for convenience. The market demand for home ownership and record high housing prices have made apartment living more affordable compared to a freestanding house. In 2001, one in seven (15.7%) of dwellings in Sydney were classified as high density, and by 2011 this proportion had increased to 20.7%. Unsurprisingly, the highest proportions were in the areas immediately surrounding Sydney CBD. Ultimo-Pyrmont has overtaken Kings Cross-Potts Point to become the most densely populated area in Australia. The 1986 census recorded 2,631 people living in Ultimo-Pyrmont compared to 2015 when there were 22,540 – an increase of 20,000 people. The advantage of these high-density developments is that they are primarily located along public transport linkages and within walking distance of local services. Greenfield estates can be as far as 40km away from the CBD and therefore require long commutes and a car dependency. People now object to the daily commute because the time it takes out the day and the pressure it puts on social and family life. Sydney is also the multicultural hub of Australia, with huge populations from Lebanon, China, India and Vietnam to name a few of the well-established groups. People from



Student Boom and Vertical School Demand in Sydney
Diagram: Adam Swinburn
Source: NSW Department of Education



Legend

Change in School Enrolments 2012-16

- More than 40%
- 20% to 40%
- 10% to 20%
- 5% to 10%
- 0% to 5%
- Neagtive

Proposed Sites for Vertical Schools

% of Units / Apartments in Area

80% 0%

Student Boom and Vertical School Demand in Parramatta
Diagram: Adam Swinburn
Source: NSW Department of Education

many of these cultures are accustomed to high-density living, which may be driving the growth in apartment living.

Across Australian capital cities, the increased demand for inner city living and changing age profile of young children has been a key driver of inner-city population growth and resulting pressures on schools. Couples and families increasingly choose to remain in the inner city and middle ring suburbs after they have had children, reversing a decades-old trend of population flight to outlying suburbs. Since 2012, enrolments for inner city schools in Sydney 'have skyrocketed by more than 13 percent, nearly 3.5 times the state average.' An example of this trend can be seen with Bourke Street Public School, a primary school located in the inner city suburb of Surry Hills. A 2015 report by the NSW Auditor-General noted that this school had seen enrolment growth of 255.2 percent between 2009 and 2014. According to the City of Sydney, the pressure on primary school enrolments is set to continue, with the number of primary schools aged children forecast to increase by over 50 percent between 2015 and 2025. The 'five to nine' age group is set to increase from 4,850 in 2016 to 7,450 in 2026. Cities like Perth is predicted to grow at an average annual rate of 4% between 2016 to 2026. However, Perth City's primary school-aged population is forecast to almost double between 2016 and 2026 to reach 1,715. This represents a growth rate of over 6% per annum. Furthermore, there is also a loss of young families residing in suburban Perth suggesting that young adults choose urban areas once they form families. Given the growth in the primary school age population in inner Perth, city schools may experience enrolment pressures in the coming years. As a result, a new secondary school, St George's Anglican Grammar School College, opened in Perth's CBD in 2015. This is the first new school in the city for over 100 years and evidence that families living in the city do not want to travel to the suburbs for their child's education, they want everything to be located at their doorstep, including the desire for inner city schools.

The changing makeup of urban areas requires a response from the education system to support parents with small children living in densely populated areas. There are strollers and prams all over city sidewalks, and it is clear that enrolment pressures on inner city schools are set to continue and increase in coming years. It is anticipated that by 2026 there will be 705,000 more children in Australian schools than there is today. To meet the mini baby boom which has been driven by the 20% more children than long-term averages being born each year since 2006, we need somewhere between 400 to 750 new schools to assist the 9,400 schools already in operation. The Greater Sydney Commission's Draft Central District Plan predicts that by 2039 there will be 41% growth in school-aged children with the largest expected increase in demand for the Bayside, Sydney, Randwick and Inner West local government areas. Unless capacity is rapidly expanded in the metropolitan region, the Department of Education projects that 45,000 children will not have classrooms in overburdened areas.

As the population in cities grows and densifies, the availability of large tracts of land that would support a traditional horizontal model of school design with a large physical footprint and suite of single-use facilities, are no longer obtainable and are financially unviable. For urban schools to meet accommodation schedules and engage with its high-density context, school design is to transition from building outward to upward. Coined

South Melbourne Ferrars School. Hayball, 2016

Inner Sydney High School. FJMT, 2017

Arthur Phillip High School (APHS) and the neighbouring Parramatta Public School (PPS). BVN & Grimshaw, 2016

'Vertical Schools' a wave of multi-storey schools has been proposed to provide educational facilities across capital cities. Recent decisions include a 15-storey school in Parramatta, the single biggest investment for schools within the state's history, a 14-storey school in Surry Hills, a 6-storey school in Adelaide and a 5-storey school in South Melbourne. These are the first of many significant high-rise schools to be built in Australia since the construction of St Andrews Cathedral School in 1976, the country's first vertical school.

The motivation for these schools to build tall is driven by both contextual and economic factors. Planning for schools is a long-term game. A child born today will join the school system in 5 years, so School Administration and Government officials observe growth patterns, like those mentioned above, to see where families live. When the demand for schools in inner-city areas is forecasted to be higher than the maximum enrolment supply, client's either expand upon an existing school or acquire a new site to start a school to suit the catchment area. Emerging growth areas such as Green Square comes at a higher land cost due to property prices. The development of 4,000 new dwellings at the heart of the town centre will grow the residential population to 61,000 when completed in 2031. The city's research identified that Green Square needs one new primary school and one high school in 2016, with an additional four new primary schools by 2031.

Site selection plays an important role when reconciling a large-scale institution with the surrounding urban tissue. The role of the vertical school as a piece of civic infrastructure can be instrumental to city making. Therefore, a good site would be located in the heart of the community so it can further promote community values. Creating a sense of community through a school is important because it is a place where people gather, is where parents do things, where sport happens and where you meet your neighbours. Most people meet and make their lifelong friends through the parent groups in their local communities. If the school lease or share its space after contact hours it can facilitate activities for the community and fill in blanks in the city. For example, spaces could be provided for kid's parties, maker spaces, meeting spaces, cooking classes, satellite library, and greenery.

Sites located in densely populated parts of the city can be within walking distances from where students live encouraging walking to school. This would provide health benefits while alleviating traffic around school zones and keep cars off roads. Like-wise schools located near sources of employment could mean that parents could travel to work with their children who are on their way to school. Cities tend to have better pre-established connections via public transport which could provide larger catchment areas and choice of school selection for parents.

The designing of vertical school environments can benefit with a symbiotic relationship with the city by being nearby a diverse range of activities outside of the school. Key buildings neighbouring the school such as sports centres, galleries and museums not only provide state-of-the-art facilities to assist education but help alleviate the allocation of precious space resources on the design of the school. The site constraints for some schools make it entirely impossible to allocate space for large functions, such as outdoor spaces like football fields and basketball courts for structured play. Selecting sites adjacent to

parks or fields is always desirable.

In comparison to suburban schools, urban schools have less site area to accommodate a design. The Murdoch College, a horizontal school, which moved to Perth city and rebranded as St Georges Anglican College, a vertical school is a recent example of how the two types compare. The old college was located on 12,000sqm of land with the campus buildings covering 6,000sqm. The new city building has a site area of 600sqm and 100% footprint coverage. The new urban campus has 4% of the site area and effectively 10% of the footprint to relocate its school. Thus, the area had to be stacked to accommodate area schedule for operation. In this case and many other case studies investigated, it is primarily the limited site area which governs the decision for a multi-storey school out of necessity.

St Georges Anglican School
(Previously Murdoch College)

Site: **Urban**
Habitable Floors: **7**

Site Area: **615 sqm**
Footprint Area: **615 sqm**
Coverage: **100%**

Murdoch College

Site: **Suburban**
Habitable Floors: **2**

Site Area: **12,000 sqm**
Footprint Area: **6,000 sqm**
Coverage: **50%**

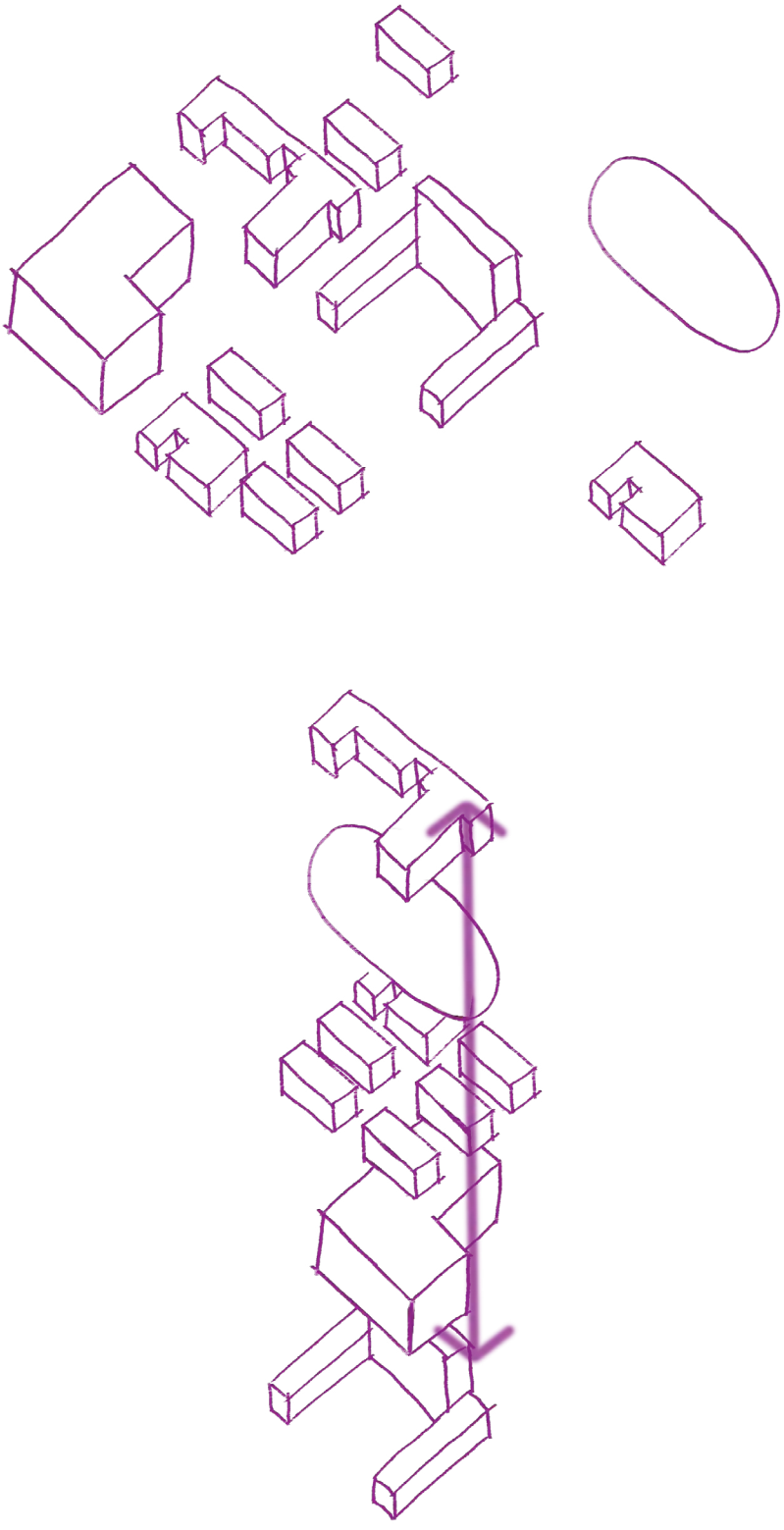
Site and Building Footprint of Murdoch College vs St Georges Anglican before the School moved to Perth CBD and rebranded.
Diagram: Adam Swinburn

Research Objectives and Questions

Considering the architectural response to tight site conditions govern the decision for a multi-storey school, there is a necessity to better understand how to organise a school within a vertical arrangement to overcome site constraints. Where research to date provides a comprehensive look at how students use a specific space or at best spaces across one floor (especially education reform), there is a disconnect with how the school is master planned and connected across floors and in section. This is critical to the planning and operation of a vertical school because tight site boundaries limit the ability to allocate multiple desirable spaces together or allow the inclusion of a size-specific facility.

To date, the organisation principles for vertical school design remain undocumented and untested. To fill the gap, this research investigates a series of analytical case studies by determining the spatial organisation of a series of vertical school types of 5 or more storeys in urban centres across the world. It reveals the spatial opportunities and challenges designing a vertical school must consider so that architects, school administration, and government officials can provide strategic school architecture that facilitates desirable learning and social experiences.

School design has a checkered history of innovation with constant changes to pedagogical thought. Building to a curriculum seems folly when a buildings lifetime will outlast ten or more different mandated curriculum documents. This research looks at the planning of schools around enduring principles of architectural design that can provide a framework for changing pedagogies. Enduring principles of vertical school design refers to the base building (and not fit-out) in which determines the broader spatial relationships that do not usually change during the life of the building and remain relevant within a contemporary context. The first principles include primary structure and its determination and rationale for locating spaces especially theatres, halls and gyms where they are. Secondly, circulation and connections between floors using stairs, lifts and atriums and how it creates a sense of space and connectedness within a vertical arrangement. Thirdly, the provision of outdoor spaces for student recreation and wellbeing within the city context. Fourth, building more on less land and maximising the possibilities from the surrounding urban context. Finally, adapting for growth and decline in student populations.



Horizontal Configuration to a Vertical Configuration
Diagram: Adam Swinburn

Methodology

During the design process, it is common for architects to review precedents. A precedent study is an assessment of knowledge gained by others. Precedents can demonstrate solutions to similar emerging problems encountered during the design process. By providing credible and synthesised data, it is possible to provide the tools for an evidence-based design approach in the development of new vertical schools. The proposed methodology to collect data was through a comparative case study analysis. Case studies are an appropriate research tool because it gathers in-depth information on a specific school that could not be obtained through any other form of experimentation. The primary technique used in conducting the case study research was a series of semi-structured interviews with both architect and school admin separately consisting of a set of open-ended questions. So the performance of the school design could be validated architect specific interview questions were focused on architectural intentions and compared against the post-occupancy evaluation of the design by the school administration. Interviews were supplemented with a school audit and analysis of architectural documentation to ensure rigour in the data gathering.

The pre-requisite for the selection of all case studies was that it had to be a multi-storey because of site restrictions that force the building to build up. Four storeys seem to be the maximum amount of flight of stairs students and staff would be prepared to walk psychologically. Therefore, each case study must have a minimum of 5 habitable levels and a gross plot ratio of 2 or more. The four key schools selected for this report have the largest total building areas from the overall case studies investigated and an average gross plot ratio of 6.5 and 10.5 vertical storeys. This selection reflects a holistic overview of the challenges and opportunities in designing a vertical school and the most current thinking of addressing economic and pedagogical models in completed projects.

Research is based on objectivity; case studies can be biased. To limit biases and generalisations, an investigation of 14 case studies overall increased the probability of reoccurring spatial considerations to emerge. These patterns become the basis for further interrogation and study as it is more probable that they are likely to reoccur in future projects. The 14 selected case studies are of architectural merit and had been published online or submitted for awards. These schools were easier to discover, collect information and set up as a case study, therefore, making up the bulk of the investigations.

Selected case studies are evenly split across Australasia, Europe and America. Of the cases visited 70% are secondary, 15% are primary and the remaining 15% offered K-12 years. At 65% most schools were private while the remaining 35% are public. All but one case study were co-education schools. Concerning pedagogical models, 70% used teacher-centred learning as opposed to the 30% which were a student-centred focus approach. Private Secondary schools were the most common type visited making up half of the total cases. Of these schools, 70% had teacher-centred learning models. The student population ranged between 400-1900 across the case studies, with 1200 students as the average size for a secondary school.

St Andrews Cathedral School, Sydney.

St Georges Anglican School, Perth

Singapore International School, Hong Kong

School of the Arts, Singapore

Montessori College East, Amsterdam

Chelsea Academy, London

Bridge Academy, London

William Jones College Preparatory, Chicago

GEMS Academy, Chicago

Ørestad College, Copenhagen

Xavier College, New York

Avenues: The World School, New York

Visited Case Studies
Photos: Adam Swinburn

Significance

The demand for a vertical school model has evolved out of migration patterns. City centres have become increasingly desirable for young couples to live in, reversing a decades-old trend of population flight to outlying suburbs to raise a family. There is a need for developing high-density schools in city centres, to accommodate the population explosion and lack of adequate schools, as well as to stimulate and accommodate jobs, housing growth, and urbanisation trends.

These urban schools will be subject to the cost of high land values and will likely require a density solution to be viable. A school designed around density will need to address height, scale, topography, setbacks, streetscape and public open spaces differently to a traditional or horizontal school model. High density must also be met with high amenity including greater consideration for solar access, acoustic impacts and visual privacy. Key to the movement of students around a vertical school campus will require student connectivity and strong interrelationships between levels.

Parents are attracted to areas with good schools. Schools are places that foster the intellectual, physical and emotional development of children as they prepare to join society as productive and engaged adults. There is an understanding that the location of learning cannot be confined to a single place – the classroom – but occurs across multiple spaces and places. Schools are thus designed to foster learning and engagement from students, teachers and the community. To continue making cities a desirable place once young adults move into a child-rearing stage of their life, we need to ensure that cities can provide good urban schools which may probably be vertical. To be a successful vertical school, it must consider its spatial organisation so it can optimise its ability to facilitate education and create student wellbeing even in a dense arrangement.

The population of Sydney is forecast to grow by over one million people in the next ten years. A significant number of these people will reside in or close to the Sydney CBD in new residential developments in areas such as Green Square, Central to Eveleigh precinct, Barangaroo, Central Square, the Bays Precinct and Ultimo. The population growth of inner Sydney suburbs though urban renewal and consolidation of land is occurring rapidly, putting significant pressure on public infrastructure, including transport, health services and education. A good school model can transform and revitalise these areas and its development. Having local schools in high-density areas may be beneficial for the dense populations that live by, encouraging health benefits like walking to school and promote a sense of community.

Parents, Kids and Prams Along New York City Sidewalks
Photograph: Adam Swinburn

3

Singapore International School, Hong Kong (HKSIS)

Architect: **MKPL**
Year Completed: **2011**

Site Area: **4,500 sqm**
Building Area: **23,000 sqm (Secondary)**
Gross Plot Ratio: **5**
Number of Habitable Levels: **14**

School Type: **Private Secondary (Primary School ajoined but not shown here)**
Student Population: **800 (Secondary)**
Pedagogical Model: **Teacher-Centred Learning**

In 1991 Singapore International School, Hong Kong (HKSIS) opened as a 3-storey primary school against a steep mountainside near Aberdeen. Nine years later in 2000, an additional four storeys were constructed on top of the primary school to expand its intake. A decision was made in 2007 to acquire an adjacent site which had become available. The acquisition allowed for the expansion of the campus to include a new secondary school as students, and parents wanted to stay in a school which supported a Singaporean curriculum and bilingual teaching all the way from Kindergarten to Year 12. Presently, the school is trying to expand both campuses with additional classrooms to further increase intake.

Singapore International Exterior from Nam Long Shang Road
Photograph: Tim Griffith

Organising the School Vertically

The new secondary campus saw a refurbishment and considerably large addition to an existing building. On top of the adaptive re-use challenge, the site presented tough site conditions. A steep slope along the mountainside reduced an already small 4,000 metres square by one-third. In comparison, Singapore's planning norm allowed for a typical site area of 24,000 square metres.

Due to the small buildable footprint and 23,000 square metres accommodation brief, the final design was distributed over 14 habitable levels adding 41m of vertical height to the existing building. In comparison, a local Hong Kong school is seven storeys. Local schools typically opt for a very efficient building form in which the same floor plan is mass repeated across the city.

The existing design would encounter a layer of moisture build up on the floors which would become slippery and dangerous for students during humid summer months. The buildings enclosures caused this. The key organisation strategy going forward with the secondary school design was the incorporation of a central atrium between the existing and new block. The atrium provides a passive climate responsive solution by cross-ventilating and removing trapped humid air. The natural ventilation alleviated the moisture build up and increased amenity; a crucial requirement considering the climatic environment of Hong Kong can be uncomfortable.

The buildings organisation puts all common accessible spaces to all students such as pre-u lounge situated in the middle of the building. Called the "meet level" strategy, it seeks to minimise circulation so that students would only need to travel either one flight up or one flight down to the common space. Although the building is 13 storeys, students do not need to walk between levels 1 through to 13. As a result, the primary learning space volume is a 7-storey structure made up of both new and existing building. In the middle of the stack are typical classrooms with speciality rooms such as science labs or music rooms at either end. Occasionally used spaces such as the top floor sports hall and bottom floor administration allows the building to function more like a medium rise - breaking down the verticality.

The largest big-box space, the sports hall, hovers above the central atrium and main plaza. Constrained by the site boundary and location of the existing building, the shear interruptible volume of the space forces itself to sit above the school. Fortunately, the area underneath the gym doubles as a canopy protecting the large plaza and gathering space on level 4 from the weather and the wind. The protection optimises the utilisation of a single space throughout the whole year.

The Auditorium caters for assemblies, seminars, and performances. Seating 200 out of the 900 students in the school, assemblies are run in 2-year group intervals at a time as the school has no indoor area where they can fit all the students and staff at the same time. In a multi-story, it's harder to gather all the students. HKSIS desire a space where the full school can congregate, for example, the administration could organise a performance for

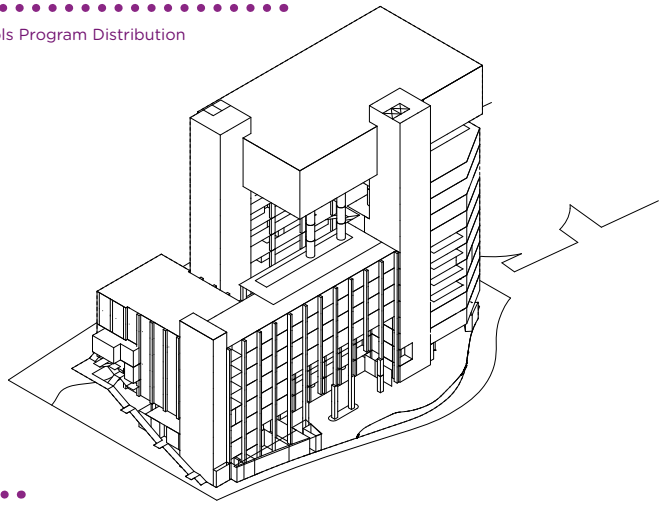
Singapore International Schools Program Distribution
Diagram: Adam Swinburn

Legend

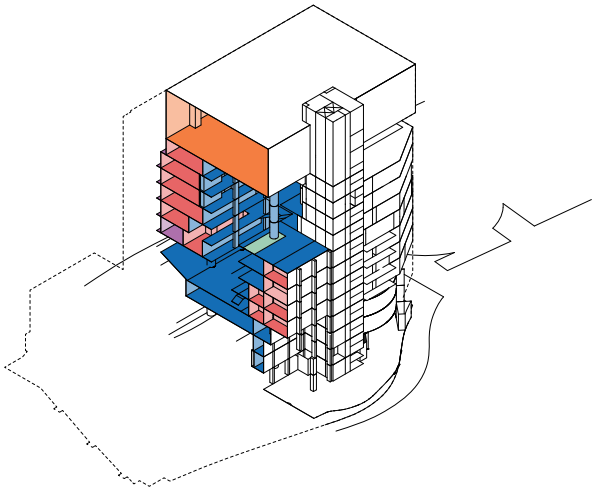
- Learning Spaces
- Hall
- Ancillary
- Circulation
- Outdoor

Scale

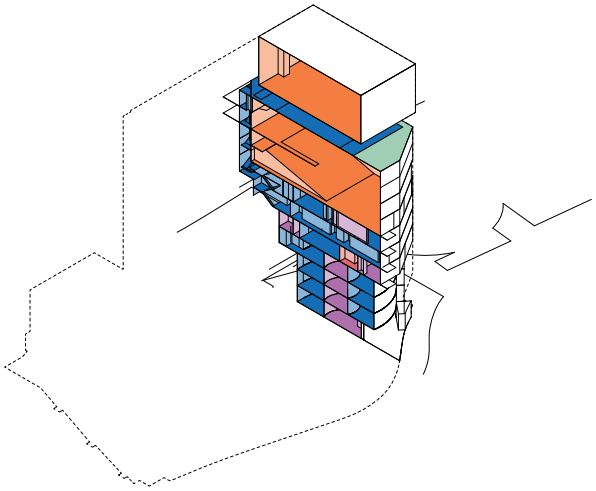
0 10 20 50m



Building Isometric



Section 1



Section 2

the school or a graduation. Currently, when students graduate, they cannot accommodate all the parents who want to come. A retractable step for seating in the auditorium increases the flexibility of the space to be converted into an exam hall.

Designing the addition of the secondary school was a challenge with the integration of the existing structure of the old building. The incorporation of both new and old structure can create height limitations in the building height or prevent preferable programmatic arrangements. For example, the car park cannot fit the bus or lorry in the main entrance because of lack of headroom. This effect deliveries and student drop-off.

The constraints of the existing structural columns made it difficult to design for more responsive classroom clusters. The inclusion of small meeting pods for discussion at the end of a classroom, called think-tanks, is an interesting pedagogical idea and utilisation of an awkward in-between space. Due to the think-tanks position within the middle of the floorplate and surrounded by other rooms, it cannot be naturally ventilated which inhibits its function as a classroom because it would go against building regulations.

The think-tank is successful at providing informal learning spaces as classrooms can be negatively perceived by students. However, the think-tank is unpopular compared to tables in the science garden. If possible, the school would pursue more informal outdoor spaces like these.

Year groups are stacked on top of each other with older kids located on higher floors and younger years on the bottom. Older years cohorts have more strength to walk up the stairs, so it sensible to locate them towards the top of the school. Year groups are further paired up in 7&8, 9&10, 11&12 configurations and can, therefore, share facilities on a common level in between. Paired years essentially allows a stacking of smaller communities which helps break down the scale and monumentality of the vertical building into a personable and human scale.

During the school's construction, the student population resided in a pancake style building which is typical of an office block. In comparison to then and now, students are more likely to stay after hours to study in the think-tank, play or just wander around. During weekends before exams students even came back to study because they like the school. A significant design difference between the schools is that the pancake model lacked a gathering space.

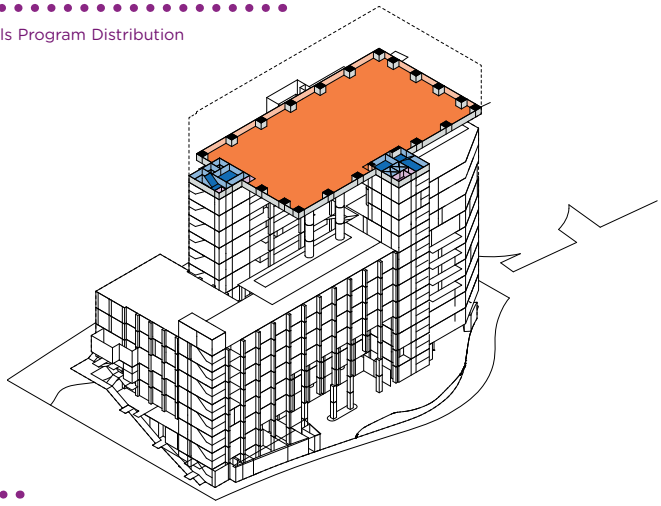
Singapore International Schools Program Distribution
Diagram: Adam Swinburn

Legend

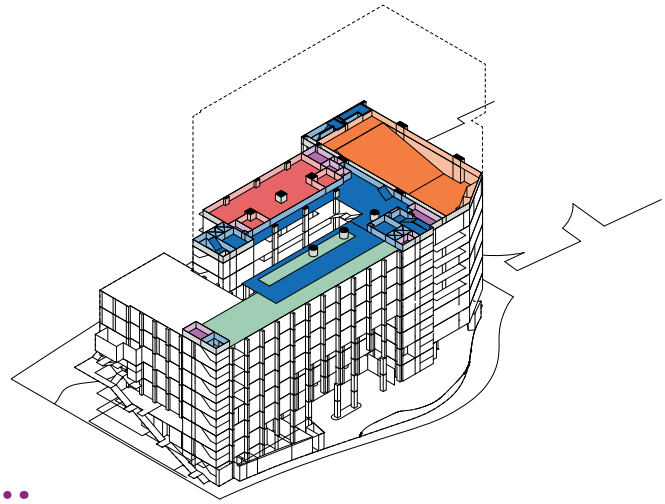
- Learning Spaces
- Hall
- Ancillary
- Circulation
- Outdoor

Scale

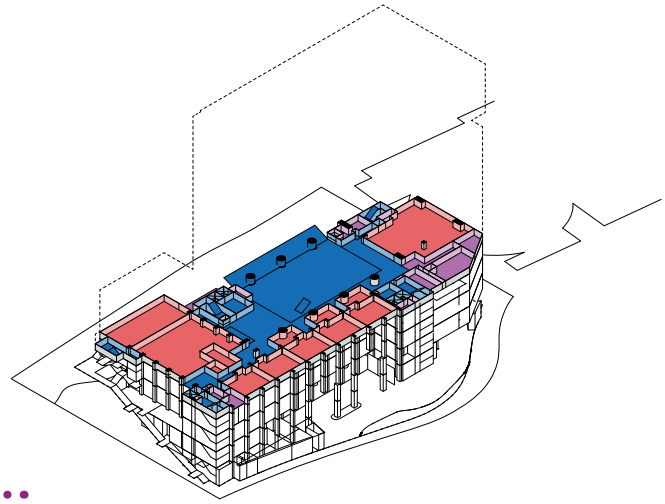
0 10 20 50m



Level 12 Sports Hall



Level 8 Science Garden, Science Lab and Auditorium



Level 4 Plaza, Amplitheatre, Library and Cafeteria

Circulation

The biggest issue encountered by HKSIS is vertical circulation management. The movement of students in the primary school is prolonged and becomes quite congested quickly. Students can be asked to walk between 7 storeys which can take a long time for students to reach their class, especially kindergarten students. Two reserved lifts serve the school for teachers and students with a disability. When designing the secondary school lessons from the shortcomings of the primary school could be considered. MKPL allowed for additional lifts and stairs to alleviate vertical circulation pressures. The central stair within the void is a feature and often a meeting point for students, so they encounter friends while travelling between floors. Because of the regular stair climbing, the stair detail has comfortable risers and treads.

The additional allowance for vertical circulation in the secondary building has resulted in fewer administration procedures implemented during arrival or dismissal. The primary school does not have a mass gathering space for an adequate pickup and drop-off area. A pick-up space is an important feature to allow parents of the primary students (more so than secondary) to pick-up their children. The lobby is tiny, so the parents must wait outside on the street which is a security flaw. It can be difficult for the administration to differentiate between parents, strangers or people trying to kidnap the children. As a result, there needs to be a lot of human resources to secure these events and control the students.

The school sometimes feel that the wide corridors for movement are too luxurious and could be made better use of functional spaces, however, they understand that the wide corridors are integral for student interaction between friends.

Wide corridors providing circulation and gathering spaces for students to hang out and study.
Photograph: Tim Griffith

Level 4 Covered Outdoor Gathering Space. Central stair connecting floors within the void seen in the distance. Photograph: Tim Griffith

Connecting Floors

The design consciously avoids a stratification of learning environments, in which floors are stacked together, by connecting spaces both along the vertical and horizontal axis. The key design intervention for a central atrium gravitates people towards the middle of the school because it enables visual connections and transparency across the different school levels. Stairs are strategically scattered along the atrium to encourage vertical circulation because the atrium creates more interest and interaction amongst the students. When students and staff are in the atrium connected spaces, they feel like they are a part of the larger school space and community.

Considering atriums create visual connections across floors and its surroundings the school do not need much signage because people can orientate themselves with ease. Framed views to the outside are important aspects to achieve this. Plus, views outwards feel less claustrophobic. Visual connections help students find each other. If activities are occurring in the plaza, such as students playing there, their friends will see them and go down to join in the game.

The condensed arrangement enhances the relationships of the students and also for the staff. Although the new school is more compact compared to the primary school, kids believe that areas feel larger and more spacious. If something happens, everyone knows about it very quickly because of the schools' compactness and the ability of the atrium to spread the word quickly.

From an operational point of view, the connection between floors in the secondary campus requires less human resources to manage because students can be supervised and communicated with from strategic locations. However, atriums need to be managed to operate safely. Students are naughty and deliberately damage or throw things over the balcony. Primary school students tend to be involved in more accidents on the stair than secondary students.

Atrium provides visual connection for students and staff across the entire building.
Photograph: Tim Griffith

Providing Outdoor Spaces

For vertical schools, the provisions for open space and play space is the most prominent challenge. HKSIS is in lack of a sports ground and sports facilities to adequately supply the current student population. The existing primary school facilities consist of a basketball court, a few smaller courts, and a mini rooftop soccer field. There are not enough spaces for students to have separate areas, so multiple games happen at the same time. Numerous games are a safety risk as there are more chances for collisions. Physical education classes in the sports hall and swimming pool usually have two classes occurring at the same time. Having different instructions for different groups of students means that students can easily be distracted. Some classes will have a fun swim, and the other formal training and the students are not happy seeing the other one playing while they are completing formal training.

The new secondary school architecture utilises rooftop spaces wherever possible to provide outdoor spaces. Spaces include the rooftop of the gymnasium for a multi-purpose court and a Science Garden breakout space on the 8th level for both teaching and leisure.

A large sports ground is the most desirable addition to the school campus. Options for land use include soccer, outdoor performance, graduation and student assemblies.

The key difference between primary school and secondary students is that the younger years require recreational spaces for unstructured play and imaginative games. Before the school's renovation, for example, younger students would go up to the rooftop and roll around on the artificial turf.

Level 12 Gym.
Photograph: Tim Griffith

Level 8 Science Garden is a popular gathering and Learning Space for Students.
Photograph: Adam Swinburn

Optimising Limited Space / Land Use

A school with a limited footprint requires its architect and school staff to be creative with the design, curriculum and administration to support multi-use spaces. Vertical schools tend to be more multifunctional because space is limited and designed with maximum flexibility in mind. To maintain flexibility administration changes such as staggered lunch times are more challenging for HKSIS to manage. The staggering of breaks means that kids cannot play in the classroom at lunch and are discouraged to play in the corridors. Playspaces outside of a conducted classroom disrupt the students. In a traditional horizontal school where space is typically more abundant, students would all be out at the same time.

HKSIS primary and secondary school share facilities to overcome the lack of space. A bridge which connects to the primary school on the 11th floor allows for cross-campus integration. The primary school does not have a gymnasium of its own but can now utilise the nearby facility. Likewise, the primary school contains an indoor swimming pool which the secondary students often use. Space optimisation extends beyond learning and well-being spaces. Although the school has two separate administrations, both schools share the same Human Resources department.

The plaza is the most attractive spaces for students to congregate or be. It has access to natural lighting, plenty of seating, accessible location to gather, close by the library and canteen, everything the students want and desire is within one floorplate. Students interpret the plaza as a leisure hotspot while the classrooms are formal, breaking up the conventionality of the spaces. The location of the plaza in between the canteen and library becomes a useful overflow space when areas become densely occupied.

Space is further optimised by the use of versatile furniture. For example, bookshelves in the library are on wheels so they can be pushed around to make places for small performances and storytelling. The administration has discovered that the library for secondary students is utilised less and not as widely successful as the library for the primary students. Primary students like to stay in the library while the secondary students like to borrow their book and sit outside in the plaza.

Across the road from the site, the government is building a podium containing an MTR (metro train station) with residential towers above. Next door to the school a university hostel is proposed. In the past HKSIS tried to acquire that land so they could build sports grounds and other facilities but the zoning would not allow the school to expand.

As part of a larger community use, HKSIS have received inquiries to rent out the building after hours. The school is unable to meet these requests because they don't have enough staff to manage the school outside of office hours. Managing how the public uses the building and whether their activities will disturb the neighbours, especially considering how close they are to the school, is too difficult. The neighbours can also see into the school building. The school does let the other schools use the car park sometimes, not for private use, but when they are hosting an event and require additional parking.

Level 4 Covered Outdoor Gathering Space.
Photograph: Tim Griffith

4

School of the Arts, Singapore

Architect: **WOHA**
Year Completed: **2009**

Site Area: **11,400 sqm**
Building Area: **52,945 sqm (Secondary)**
Gross Plot Ratio: **5**
Number of Habitable Levels: **11**

School Type: **Private Secondary**
Student Population: **1,200**
Pedagogical Model: **Teacher-Centred Learning**

School of the Arts is Singapore's first specialised secondary art school. The school first opened in a temporary location in 2008 and finally moved to its permanent purpose-built home in 2010. Positioned at a landmark location on a major intersection between the Colonial and Arts districts, the Orchard Road area and the CBD the new campus contributes to its context by providing a public ground plane below a secured school zone.

School of the Arts Exterior from the corner of Bras Basah Road and Prinsep Street.
Photograph: Patrick Bingham Hall

Organising the School Vertically

Given the school's prime location, limited site area and design brief/space programme, SOTA had to be a vertical school which was designed to a gross plot ratio of 5.0. As a result, SOTA is a 10-storey building with a habitable roof. The first three storeys are open to the public - comprising of two landscaped urban plazas, three performing arts venues (a concert hall, a drama theatre and a black box studio theatre), an exhibition gallery and a row of small retail shops and cafes. The top 7 storeys make up the secured academic zone, accessible only to staff and students. This academic zone is articulated into three interconnected structures.

Conceptually, the design of SOTA is ultimately an exploration into the incorporation of multiple elevated ground levels at strategic horizons, openness and porosity of form that facilitates cross ventilation of fresh air and natural daylighting, a creation of tropical community spaces, application of vertical greenery and designing for human scale.

High density must be matched with high amenity. The approach of introducing 'Multiple Ground Levels' – new horizontal datums for social interaction and landscape in the sky – allows adding of amenity at the same or greater ratio than the existing condition.

Passive design strategies in response to Singapore's tropical climate are essential in designing for human comfort and delight particularly in a dense inner-city school. The building section reveals how the major academic spaces slip and slide in section to create a connected series of vertical spaces that are open and airy, yet sheltered from the sun and rain. The volumes (Library, Lecture Theatre) that are suspended between the academic blocks are intentionally shaped to direct breezes to gathering areas. This wind-directing design has proved to be successful and extremely comfortable, with constant cooling breezes even in Singapore's low wind environment. Gardens on the top of decks also serve to cut out heat gain, absorb carbon, and provide shaded outdoor break-out spaces and play areas.

In SOTA's case, unlike a series of standalone buildings, the vertical school had greater structural challenges. Due to the need for large span structures/column free theatre interiors below, an entire 4th storey had to be dedicated as a structural transfer floor. The academic blocks were additionally designed to cantilever over significant existing trees within the western plaza to preserve them. This created an opportunity where the upper stratum serves as a 'tropical urban umbrella' over the public spaces below that are covered yet breezy.

Classrooms are designed in 9 x 9-metre modules with operable end walls to allow room sizes to be flexible for future needs.

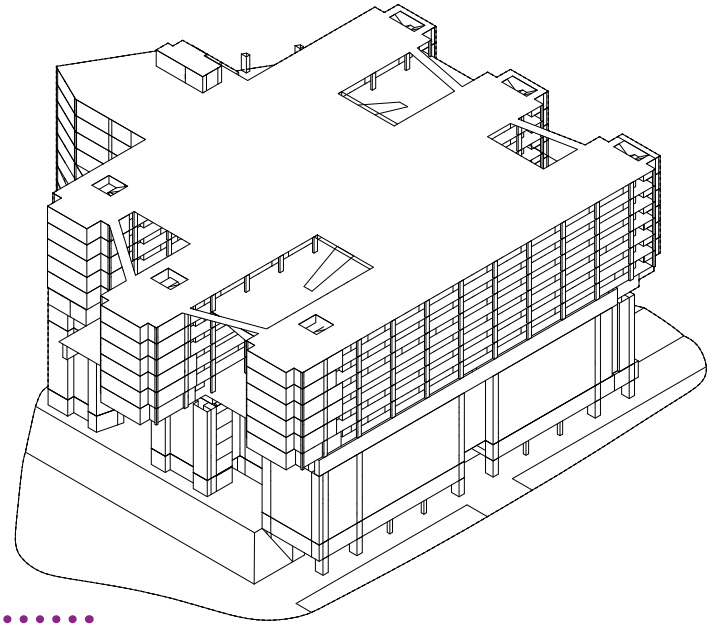
School of the Arts Program Distribution
Diagram: Adam Swinburn

Legend

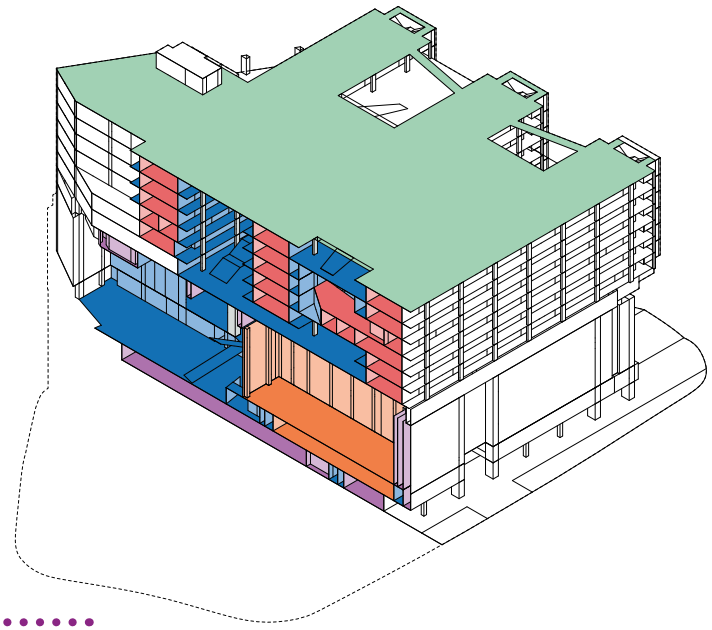
- Learning Spaces
- Hall
- Ancillary
- Circulation
- Outdoor

Scale

0 10 20 50m



Building Isometric

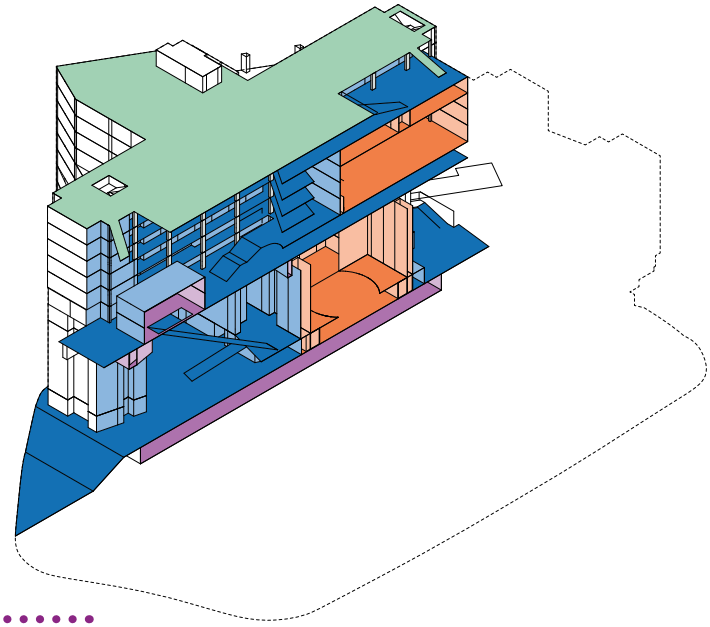


Section 1

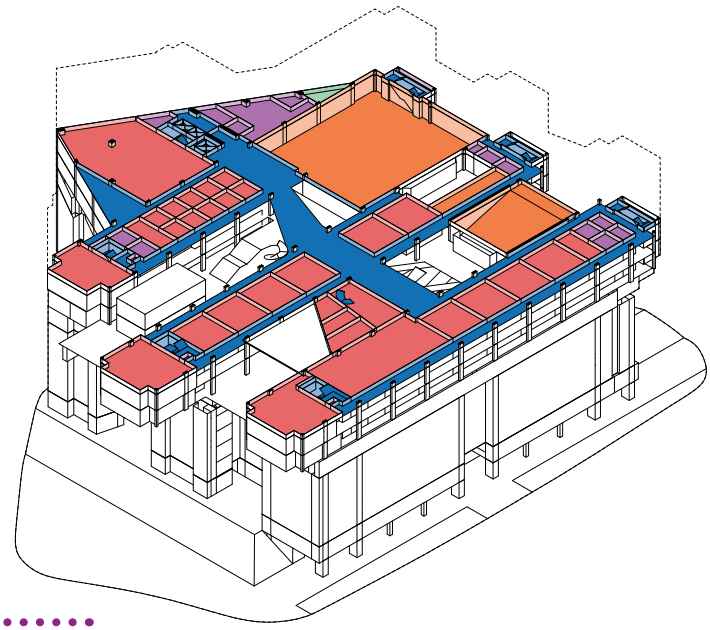
School of the Arts Program Distribution
Diagram: Adam Swinburn

Legend

- Learning Spaces
- Hall
- Ancillary
- Circulation
- Outdoor



Section 2



Level 8 Academic Zones, Library,
Hall and a Lecture Theatre

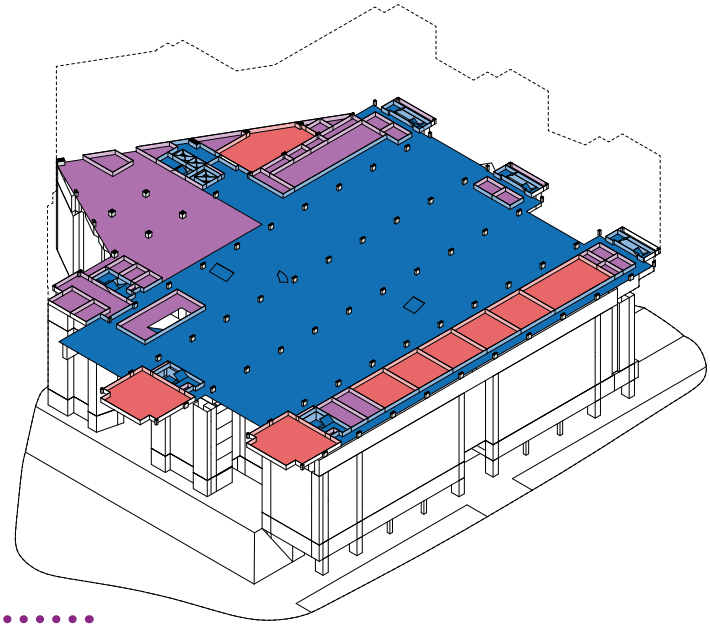
School of the Arts Program Distribution
Diagram: Adam Swinburn

Legend

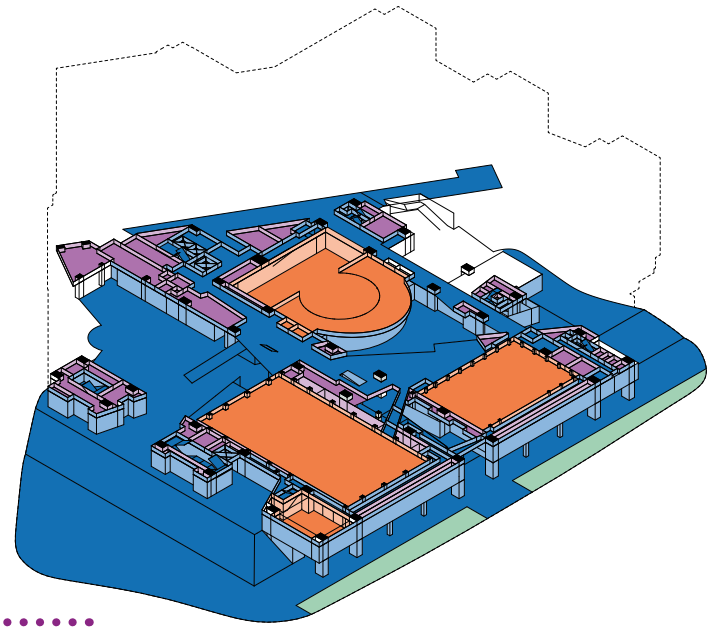
- Learning Spaces
- Hall
- Ancillary
- Circulation
- Outdoor

Scale

0 10 20 50m



Level 6 Sky Terrace and Assembly



Ground Floor

Circulation

The site is accessible by both students and the public from all boundaries surrounding the site. The formal entrance along Bras Basah Road faces onto a stepped public forecourt and amphitheatre with a further two entries along Prinsep Street which are activated by retail businesses along the edges of the building. While the podium containing the performing arts theatres and exhibition spaces are publicly accessible, the school is a secured zone and can be accessed by students and administration by a series of escalators which arrive at a security access point on the 5th storey. Within the academic blocks, open balconies provide access to classrooms; crisscrossed sky bridges provide access between the blocks and wide outdoor staircases handle vertical circulation.

Connecting Floors

The primary design strategy for SOTA was to create two visually connected horizontal strata, a space for public communications below, and space for safe, controlled interaction above. By stacking six storeys of academic blocks above a pedestal of performance venues, the physical separations achieve a secured school.

Level 7 Gathering Space within the Library
Photograph: Patrick Bingham Hall

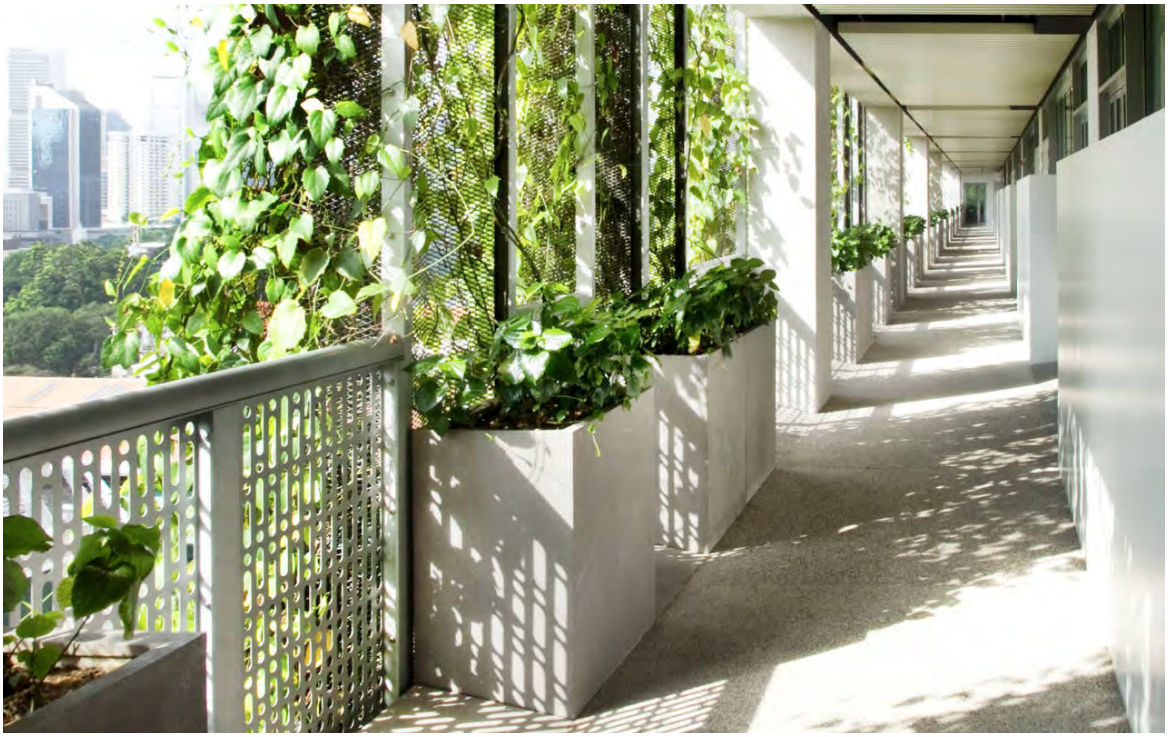
Level 5 Semi-Enclosed Gathering Space and Atrium.
Photograph: Patrick Bingham Hall

Providing Outdoor Spaces

There was also no available land on the ground floor to accommodate a school field and a parade square/assembly area – as you would have in a typical suburban school. This challenge was turned into an opportunity to create a "New Ground Level" on the 5th storey, which became the area for the assembly, canteen and administration offices. To ensure that the students have enough breakout spaces and play spaces, up to 50% of the academic floors are designed as informal interaction and recreational areas. This comes in the form of generous circulation spaces/staircases, link bridges, sky gardens, and an entire rooftop Sky Park that accommodates a sports field, fitness stations and a 400m running loop, with a view towards the Marina Bay.

SOTA is also currently subject to a height control limit, which, if lifted, would allow the roof to be fitted with some form of shading over the Sky Park, rendering it more usable during the mid-day.

Balcony Circulation between Classroom Spaces.
Photograph: Patrick Bingham Hall



Top Photo: Balcony Circulation between Classroom Spaces.
Photograph: Patrick Bingham Hall

Bottom Photo: Ground Floor Amplitheatre and Steps
Photograph: Patrick Bingham Hall

5

Avenues: The World School, New York

Architect: **Perkins Eastman**
Year Completed: **2011**

Site Area: **2,000 sqm**
Building Area: **20,000 sqm**
Gross Plot Ratio: **10**
Number of Habitable Levels: **10**

School Type: **Private K-12**
Student Population: **1,500**
Pedagogical Model: **Student-Centred Learning**

Avenues: The World School, New York, is the flagship campus of a school with plans to expand globally across 20 international campuses. The site sits within a prominent location in Chelsea along the Highline Park and within proximity to a new residential precinct, Hudson's Yard. This development will supply 3,000 to 4,000 new units to the area all within walking distance to the school. Avenues seek to fill the gap in the market for a high-quality private school in this area, especially considering the schools surrounding Chelsea are full. The catchment area includes the whole of Manhattan Island, some of Brooklyn and New Jersey with students transiting a maximum of 40 minutes each way.

Avenues: The World School Exterior from the High-Line
Photograph: Chris Cooper

Organising the School Vertically

Originally designed by architect Cass Gilbert in 1928, the school adaptively reused a ten-storey heritage-listed warehouse. Once gutted it provided a big open concrete box measuring a typical New York block width of 61m by an additional depth of 30.5m to fit out. An existing square structural grid of 7.3m defines the space within. Architectural firm Perkins Eastman and interior design consultant Bonnetti/Kozerski worked the 20,000sqm accommodation schedule into the existing building fabric. Completed in September 2012 for a total construction cost of USD 60 million. Although the economics do not allow a New York city school the space that is common for suburban schools, Avenues campus offers 10 to 20 percent more space than is typical in other metropolitan independent school facilities.

Avenues is designed as a series of year group specific smaller schools stacked on top of each other. The youngest students are on the lower levels because they are the most difficult to transport vertically but to also to reinforce the psychology feeling that the kids are graduating, moving and looking towards another part of the building vertically.

The ground floor contains the main entries, the parents' café, black box theatre and Avenues' major music support. The first floor is the Early Learning Centre (students up to 4 years of age) which have its own separate, secured and private lobby to better control interactions between students during peak moments of the day. After a year of operation, the Early Learning Centre relocated from its ground floor location to the first floor due to parent concerns such as a drive-by, car wrecking or an object being thrown from the street. The third level has a connection with the Highline, a repurposed elevated train line which has become a linear parkway. Before the building becoming a school and the Highline still operated trains, this was the floor which would accept deliveries for storage. Consequently, the existing building had higher ceilings on this level with a large garage and porch along the peripheries of the track. This level lends itself to be the common area of the school like the cafeteria to which every school child can experience daily. Visual links between the cafeteria and the greenery along the Highline create a relationship with nature. Learning spaces are further stacked above with level three, four and five providing space for the lower school (students between 5-12 years of age). Level six and seven serve the middle school (students between 12-14 years of age). Finally, level eight and nine serve the high school (students between 14-18 years of age), fitness centre and gymnasium. The roof has a small playground that wraps around the mechanical plant equipment. The use of classrooms between middle school and high school are very similar and have no significant differences. Therefore, STEAM (science, technology, engineering, art math) are located in-between the middle school and upper school floors which provide a common floor for fixed functions like lab spaces for both year groups to use. It also functions as a buffer and natural separation between the two different age groups. Avenues find this spatial organisation to be a very rational and won't stray too far from this concept in future campuses.

Demolition through thick concrete to achieve additional stairwells for circulation and mechanical systems on the roof was the greatest challenge in repurposing the design.

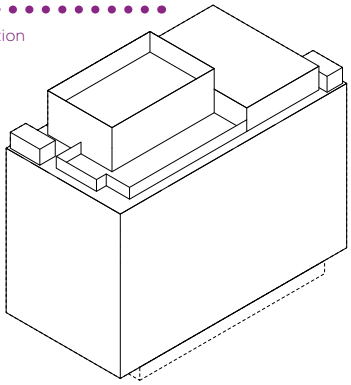
Avenues: The World School Program Distribution
Diagram: Adam Swinburn

Legend

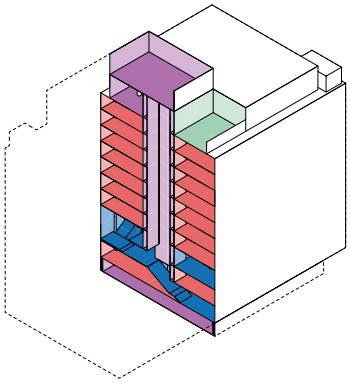
- Learning Spaces
- Hall
- Ancillary
- Circulation
- Outdoor

Scale

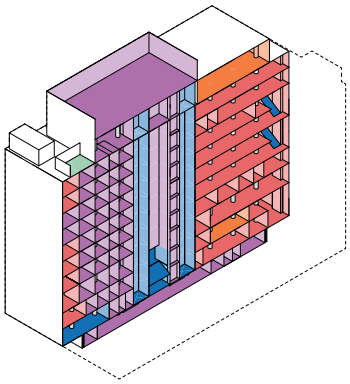
0 10 20 50m



Building Isometric



Section 1



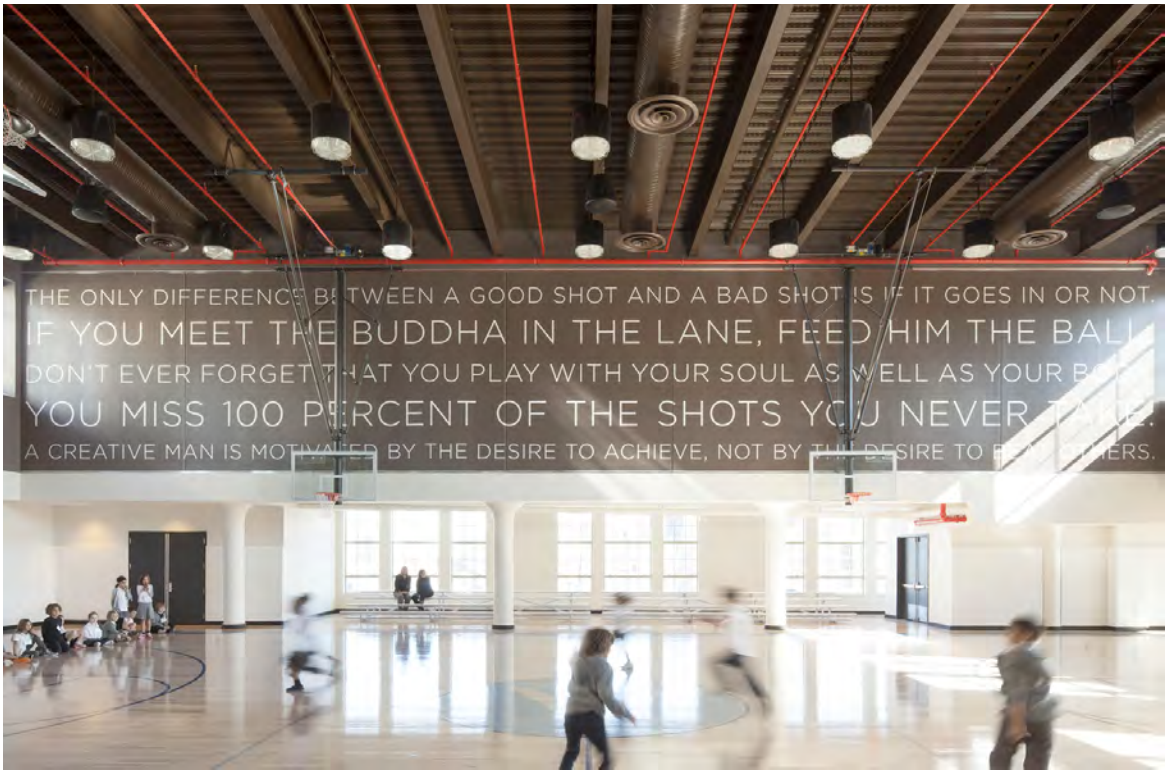
Section 2

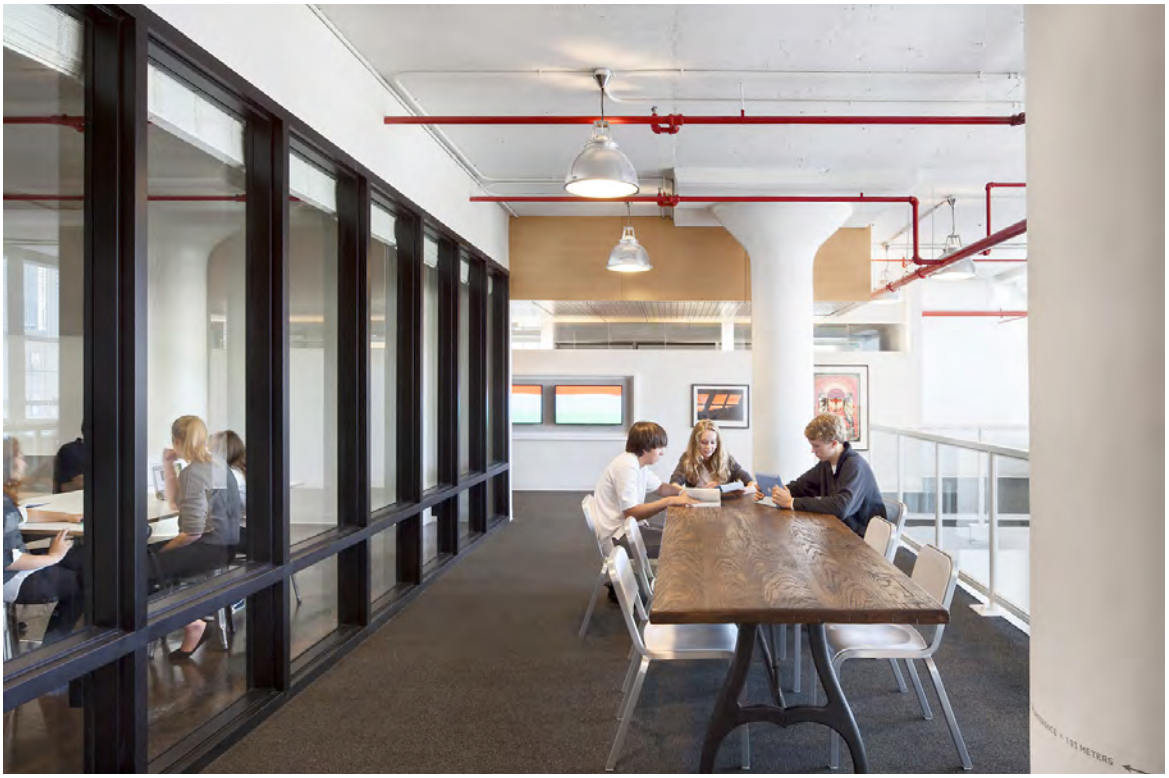
Because the new design was to be inserted into an existing building, the adoption of the predetermined structural grid became the basis for planning the layout of the school. Not all existing structural limitations could be overcome when overlaying the school design onto the existing structural plan. The structure gave way to undesirable situations such as a column in the dance studio and black box theatre which impedes on its function. The difficulty and financial expense of taking out columns and transferring load with beams and trusses made this option unviable with the budget. Consequently, the gym is strategically located on a new roof addition so that the existing structure would not encumber it. The additional height required for a serviceable gym is the only time the school builds beyond the heritage fabric.

In contrast to a purpose-built project where the architect can be specific with relationships between spaces, depths of rooms and the column set out, renovation work to an old ageing building is a good and moral lesson in sustainability, for school students as well as giving new life to an architectural classic. Purpose-built architecture allows for endless design possibilities and decisions while renovating an existing building tends to lead to 1 or 2 solutions. Designing with an existing building requires more creativity and thought to make use of the building conditions.

When redesigning a site with an existing building that needs to be retained, selecting a building with an offset core and shell model offers a high level of flexibility for the school design. Flexibility is integral because educational models change quickly and the school cannot be a time capsule with concrete block walls and immovable elements like the past. For Avenues, a typical floorplate consists of a few classrooms to one side and a large open studio space. The ratio of studio and classroom changes all the time (or even its use), so the building constantly adapts to the curriculum. Within short holiday timelines, the erection and removal of stud walls can quickly change the character and function of spaces or to align with a new pedagogical thought. Design flexibility is important to minimise potential future costs when inevitable changes and optimising of spaces occur.

When an existing vertical building is adapted as a vertical school, the ultimate goal is to try and find a building where big box expansion can occur. Determining where the gym and theatre are going to fit within the building is essential as many existing buildings may structurally be incapable of accepting large column-free spaces within a stack of floorplates. Spaces such as basketball courts have standard sizes, which can quickly limit site selections if the existing building or site area cannot accommodate them. Avenues are fortunate to just fit a regular size gym on its roof because of the offset core. However, to supply the greater requirements of recreational facilities which cannot fit within the vertical school, Avenues uses nearby facilities at Chelsea Piers. Utilising the city infrastructure provides Avenues with sporting facilities that they could never have afforded before. Students have the opportunity to go ice skating, mountain climbing and swimming. These are activities that are not typical in other schools.





Top Photo: Level 10 Gymnasium
Photograph: Chris Cooper

Bottom Photo: Typical Learning Space adjacent to an Atrium and Classroom.
Photograph: Chris Cooper

Circulation

The taller the school, the tougher it becomes to manage vertical circulation. For a school with student year groups ranging between Pre K –12, it is possible to build additional storeys into the design because the interactions between younger and older age groups are minimal. Controlling interactions by segregating big kids from little kids to different portions of the vertical school stop little students from being bullied or mowed down by larger students in the corridors. For this reason, Avenues provides a separate entry for younger students.

Avenues replaced two central stairs with new stairways in three corner locations to disperse the load on vertical circulation. Stairs tend to be a source of noise when students are travelling between levels. By relocating them to the corners of the building, the central studio space can less likely be interrupted by students moving through the building. This strategy is more likely to create studious academic environments for students to learn in.

Two large existing freight elevators were swapped out for four passenger-size destination-dispatch versions. One of the dedicated lifts serves the Early Learning Centre while the other 3 accommodate the greater school. The increased quantities of lifts reduce wait time in the building because there are more elevators in service. Students are authorised to use the lift whenever they please. However, students are encouraged to walk if they have to travel four storeys or less. The school believes that the more you lock kids down and limit them to a box, the more they begin to act out in frustration from being told what to do.

A good lift management strategy would be to lock down some floors, so the lift only goes to the ground and a limited number of levels, especially during heavy load periods. Dedicated floor destinations reduce the amount of starting and stopping of lifts and speed up the transportation. Destination dispatch systems employed by Avenues, commonly used in office buildings, did not work for the school. In an office building, people are going from the lobby up dropping people off and then down to collect people to take back to the ground. School students travel between floors with varying time delays for loading and unloading on each floor, so the system can become confused and difficult to program. Old-fashioned push-button lift with programmable elements to form security lockdown on certain levels would have been more preferable. When there is an event occurring outside of school hours, and you want visitors to only go to a particular floor having the control to isolate circulation so people cannot access the whole building is desirable.

Level 1 Early Learning Centre Circulation
Photograph: Chris Cooper

Connecting Floors

Perkins Eastman took advantage of the building's two-way slab construction to slice through intermediary floors to create open, dual level spaces within distinct lower-, middle-, and high-school hubs. Voids connecting floors are effective at creating a greater sense of space and connectedness. However, it's important to be careful of the function of spaces the void are connecting. The problem with Avenues void, which connects two floors on the side of the floorplate, is that each floor caters functions that are not acoustically compatible. The void creates moments where there are noisy activities on top and quiet activities down the bottom. Noise pollution between floors can affect the learning capabilities of the quiet students. Avenues in one instance have installed a glass wall to enclose the atrium so that it isolates the noise from the adjacent floor but maintain a visual connection. Connecting two floors with a grander stair and void has given more heart to the central space and despite the noise has fostered a stronger community.

The articulation of an atrium must respond to year groups which will inhabit the building. A primary school is different to a secondary school and is again different to a multi-year school. For Avenues, there's no real advantage to connect a 3-year-old with a 17-year-old visually as they would find each other's behaviours disgusting. The design strategy of the atrium should be articulated to the needs of each year group it will serve because there's different considerations of scale, ability to move and access to resources that they need. The atrium, for example, is fine for a high school, but primary school children like to climb on objects, which can become dangerous when there is a void. The visual connection of a 3-year-old looking up is also intimidating. The school must be friendly and domestic in scale for a kindergarten student who has never been away from their mother. The student needs to get comfortable; it's their first social experience and separation from the parents.

Typical Open Plan Studio banked by Classrooms along its periphery.
Photograph: Adam Swinburn

Typical Learning Space Vertical Connection
Photograph: Adam Swinburn

Providing Outdoor Spaces

The rooftop is home to outdoor playspace for pre-k and kindergarten students. Required mechanical systems dictate the footprint of the roof and the allowable play space, which is quite small, and is organised around the plant. Rooftop space is handy for providing outdoor spaces. Design options should consider locating mechanical systems in the basement to free up the roof for outdoor activities.

Avenues have a robust outdoor program with access to Chelsea Park one block away from the school. The park offers basketball courts, baseball diamonds, handball courts, multi-purpose asphalt surfaces, and plenty of space to sit down. The school also has a partnership with Chelsea Piers Sports & Entertainment Complex a 111,500-metre square health club and is accessible for all of the school's athletics and physical education programs. These facilities provide the school with access to a 23m pool, 400m track, boxing ring, rock wall, soccer fields, gymnastics, basketball courts, batting cages, ice skating and 180m fairway within an 8-minute walk from the school. The facilities and options provided in the partnership could not be spatially accommodated in the school as there is no availability of area for any fields.

Level 3 Cafeteria with views to the High-LIne
Photograph: Chris Cooper

Optimising Limited Space / Land Use

Vertical schools typically have little-underutilised spaces because space is at a premium and always in demand. However, there are opportunities to optimise spaces to achieve more efficient use. Avenues don't want more classrooms; they want fewer classrooms to increase the efficiency of use. Block schedules usually achieve 70% utilisation while open space learning with limited classrooms can achieve 90%. Scheduling and utilisation rates of spaces have strong correlations. Utilisation can be further improved by having kids spend longer periods of time doing common activities in one space. For example, Avenues divide the upper school into two groups where one does STEAM courses, and the other does humanities for a couple of days before rotating. Longer periods of time for one particular course allow the students to fill up the rooms and utilise it in a way that doesn't require them to pack it up hours later. Avenues could further utilise the cafeteria to be a common space during the day. However, the furniture needs to be rethought so it would not feel like a cafeteria.

The general arrangement of each floorplate places all the difficult utilities in the core with the academic spaces surrounding the glazing periphery. The advantage of a core and shell model is that developers can see the building as an adaptive reuse project if the school fails. A developer can gut it to become apartments or office. If the school design contains a lot of immovable walls all over the building, it limits the school's adaptability to be flexible space. An offset core allows for more open space to one side. However, the other end can get tight, especially in the case of Avenues. The niche wasn't big enough to be programmed for anything prescriptive but has lent itself as maker and tinker spaces. Sometimes these niche spaces are a library, teacher space or group space. Leftover space can be positive because it will be used differently to how the architect may envisage it. The greatest benefit to an offset core is that it allowed Avenues to fit a gym on the 10th floor.

Chelsea Park is One Block away from the School
Photograph: Victor Dud

6

William Jones College Preparatory, Chicago

Architect: **Perkins + Will**
Year Completed: **2013**

Site Area: **4,250 sqm**
Building Area: **25,800 sqm**
Gross Plot Ratio: **6**
Number of Habitable Levels: **7**

School Type: **Public Secondary**
Student Population: **1,900**
Pedagogical Model: **Teacher-Centred Learning**

The history of William Jones College Preparatory dates back to the 1960s when it was known as Jones Commercial. At the time it was a school dedicated to educating junior and senior girls who were preparing for administrative assistance roles in the workforce. As times changed, Jones College repositioned itself as an academic magnet. Similarly to what other schools were doing at the time, marketing the school as an academic magnet attracted a particular type of student the school wanted to enrol. As the demand for selective enrollment grew, a decision was made to acquire the site adjacent to the school and expand its plant to increase intake from 550 to 1,200 students. During the design phase of the expansion, the old school building was to be demolished to make way for outdoor spaces or to be repurposed as a charity school. Upon completion of the new school, a decision to operate across both the existing and new building meant that the school could further increase selective enrollment. The lateness in the decision to keep the current school suggested that the new and old designs could not be integrated as seamlessly had there been an earlier consideration. The new and existing buildings have different roles. Students like the existing building because there are more opportunities to be on your own. The school currently holds 1,900 students in grades 9-12.

William Jones College Preparatory from the corner of West Polk Street and South State Street
Photograph: James Steinkamp

Organising the School Vertically

The design and spatial configuration of the school were driven primarily by site conditions. The building footprint and associated floorplates of the school go right up to the building boundary. Perkins + Wills designed the school to operate over the largest floor plates possible, therefore, reducing the number of storeys and vertical circulation demand. Seven student inhabitable storeys measuring 30 x 120m each were required to meet the accommodation schedule with a further two storeys for plant and services.

Spatially, the three large big box spaces including the auditorium, gymnasium and the natatorium were the most significant challenge in organising. Side by side, only two big box spaces could fit on one floorplate. The auditorium was located on the ground due to code compliance, but also if people were to gather at the school for a function, it would be the most accessible space for a large audience. Stacked on the top level the gym and pool required a long-span structural solution to cater for it. There was a careful consideration on how to stack these spaces along the span. The gym is lighter than the pool, so it was placed above the auditorium to reduce the weight and structure which spans over it. The layout constructed is the one that lends itself to be the most financially economical organisation and stacking of the big box spaces. Although the full-size pool located on the 7th floor is unusual, it could not be programmed on the ground floor because of groundwater which inhibited deep excavation. Besides the additional load on the structure, the pool has functioned well in its location.

The theatre seats 490 people, ideal for performances, but it does not have the space to cater a full-scale assembly. For graduations, the school rents a theatre down the street as its cohort has expanded from 260 to 450 students. The gym, on the other hand, has a maximum capacity of 1000 students.

After the allocation of big-box spaces, the remaining program was slotted in around a classroom organisation strategy. Typical cells and bells classrooms are located on the middle floors (levels four and five) which run the length of the building so that most of a student's time is in the centre of the school. If you go to gym class, it's up two levels, drama down two levels. The typical student would go to the centre of the school for most of the day and then do little jogs out to specialised spaces. The conventional size of the classroom determined the column set-out for the building so that columns would not sit in the middle of learning spaces.

The ground floor lobby, with a triple height ceiling, creates a public presence to the school. By being able to see right through the lobby, it allows the school to be part of the city and not as a private closed institution. The lobby opens up to a lot of communal spaces and links shared spaces like the auditorium, the dining facility, the library, and all the spaces that could be used by the public. The lobby also doubles as a pre-function area for the auditorium. The ground floor south wing accommodates administration spaces for security purposes.

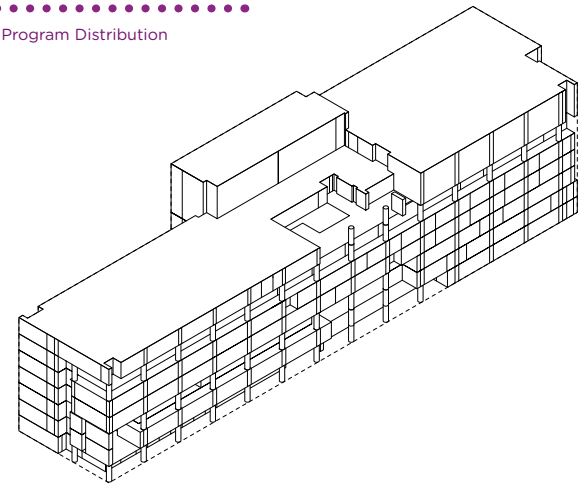
William Jones College Preparatory Program Distribution
Diagram: Adam Swinburn

Legend

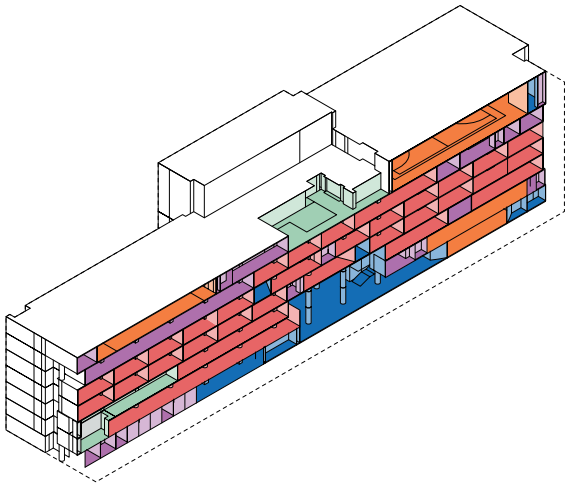
- Learning Spaces
- Hall
- Ancillary
- Circulation
- Outdoor

Scale

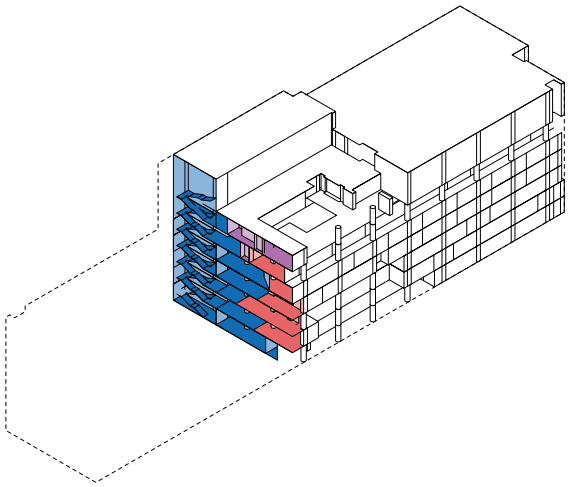
0 10 20 50m



Building Isometric



Section 1



Section 2

The design opted for larger over smaller floorplates because it would have been more expensive to build and higher as a result of allocating the accommodation brief. Larger floorplates are more efficient than smaller floorplates when comparing the availability of usable area for accommodation versus service requirements usually found in the core like lift shafts, fire stair and risers. The larger floorplate allows for the colocation of similar departments together so they can share space and resources.

If the school has an opportunity to redesign, the administration will redo the entrance, so it better integrates the security desk, and security features the school now deploys. Because there are a few entry points into the building, it could be easier for intruders to sneak in while large volumes of people move through.

The school's space priority at present is the need for additional classrooms. Also, the curriculum initially required a student to do two years of physical education classes, but a recent change has increased this to 4 years. The designed facilities cannot cater for this demand, so the school has incorporated a program called walking wellness where they walk around the block.

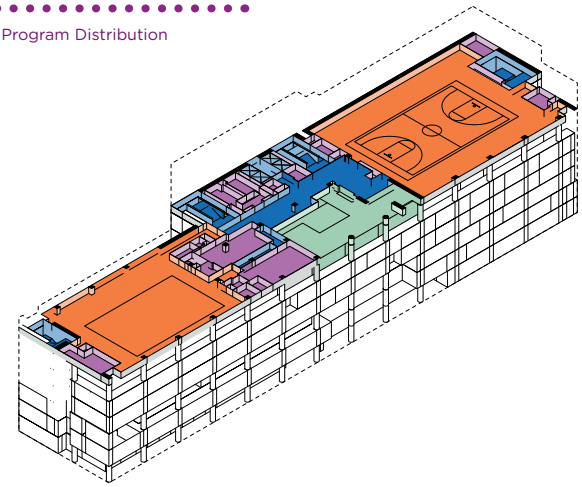
William Jones College Preparatory Program Distribution
Diagram: Adam Swinburn

Legend

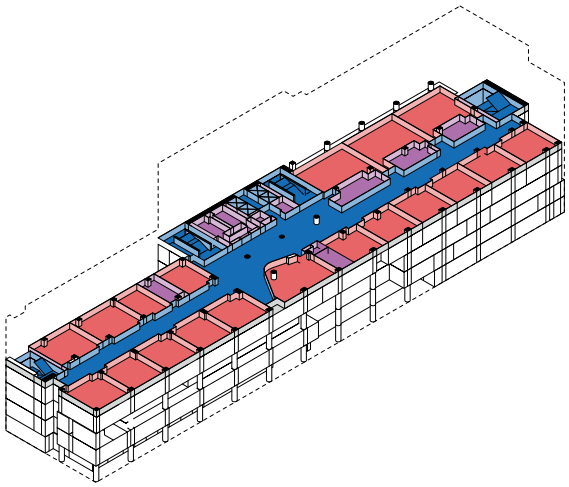
- Learning Spaces
- Hall
- Ancillary
- Circulation
- Outdoor

Scale

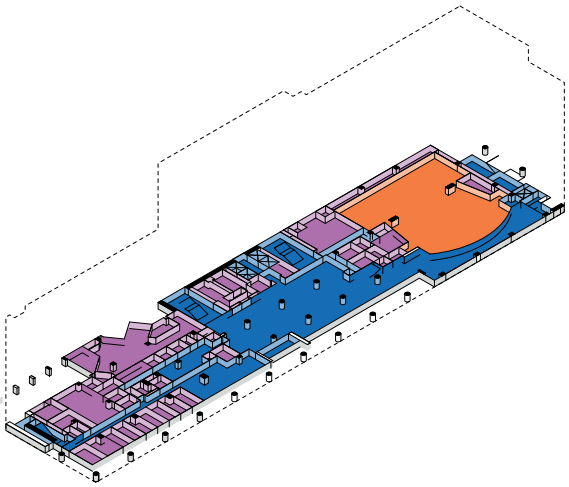
0 10 20 50m



Level 6 Gymnasium and Natatorium



Level 4 Classrooms



Ground Floor Lobby, Theatre and Administration

Circulation

The vertical circulation of the building is made up of four large staircases. Students utilise a fire stair at either end of the building as a shortcut and to reduce vertical circulation load on the two central stairs. A single wide central corridor connects the stairs with programmed spaces on either side of the corridor.

The stair and circulation are necessary, but a good celebrated design encourages people to use it but also to become a place for other functions such as a theatre like setting for sitting. The location of the stairs allows for the control of interactions between different groups of people. For example, when the Gym holds a student basketball match the main staircase could be closed off to the rest of the school for public spectator access while the athletes can take a side internal staircase so they don't have to interact with the public but can still get to the gym.

The long central corridor acts as the spine between program functions on each floorplate. Although the building and corridor are linear, the design provides sculpting to create different experiences along the floorplate. Sculpting is necessary because the gym is the gym, the classroom is the classroom, it's all the in-between spaces where social interaction takes place. For example, the students are not allowed to use the classrooms but do hang out in the corridors and stay late for cheerleading practice in the corridors or a routine for a talent show. Because space is so tight in a vertical school, it is critical to ensure that hallways and paths of circulation double to become practical social spaces.

The school administration feels that the corridor is a perfect width, although some teachers believe it can get too overcrowded. The visibility between the corridor and classroom was difficult to achieve with panes of glass because of the locker space required, which would obstruct it. Highlights were used to bring some natural light from the classrooms to the inside of the corridor. Without light, the corridor would have been dark due to its central situation on the floorplate.

The students traverse between the two buildings for classes mainly because the older building did not have the PE facilities.

Connecting Floors

Perkins + Wills tried to keep the number of floors in the design as minimal as possible because travel times can become more critical with each additional storey required. Emphasis was placed on connections within a floorplate rather than across multiple floors. However, the nature of cells and bells design means that the classrooms and hallways struggle to go beyond single-purpose spaces because it is flawed in opening up to a wider and larger space to accommodate a range of learning opportunities. A compartmentalisation of spaces hems the building making the corridor feel quite long.

Ground Floor Lobby
Photograph: James Steinkamp

Providing Outdoor Spaces

The site constraints did not allow for any outdoor open space to accommodate recreational activities. However, across most floors, there are pockets of exterior space for the students to use and even one where the teachers can use separately. The exterior spaces provide amenity which capitalises on its city view as a trade-off for the unavailable outdoor play space. These spaces are suitable for gathering and hanging out with friends which is appropriate for older year groups.

Located 10 minutes walk to Grant Park, the school has access to off-campus greenspace. The proximity of Grant Park made it more feasible to build a vertical school on the site because there were still opportunities for the students to access outdoor spaces suitable for physical education classes and structured play. Classes are extended to 90 minutes to allow time to get to the park. Students often play Frisbee or softball.

The school desire a private field. The advantage of having its private field would be easier on administration procedures for practices and scheduled games. Public parks, like Grant Park, get used for activities like Lollapalooza which destroys the grass making the field unusable for weeks until it grows back. In Chicago, getting permits for a scheduled game is harder because it is subject to availability and not always in the same location. Physical education classes are more flexible to operate because you don't need to run a full game. In the buildings current form, to provide a new field means that either a new neighbouring site would need to be acquired and demolished or re-engineer the roof to locate it above the school. Although the school has a green roof, the administration will not let children access it for liability reasons.

Rooftop Outdoor Space
Photograph: James Steinkamp

Outdoor Space Overlooking South State Street
Photograph: James Steinkamp

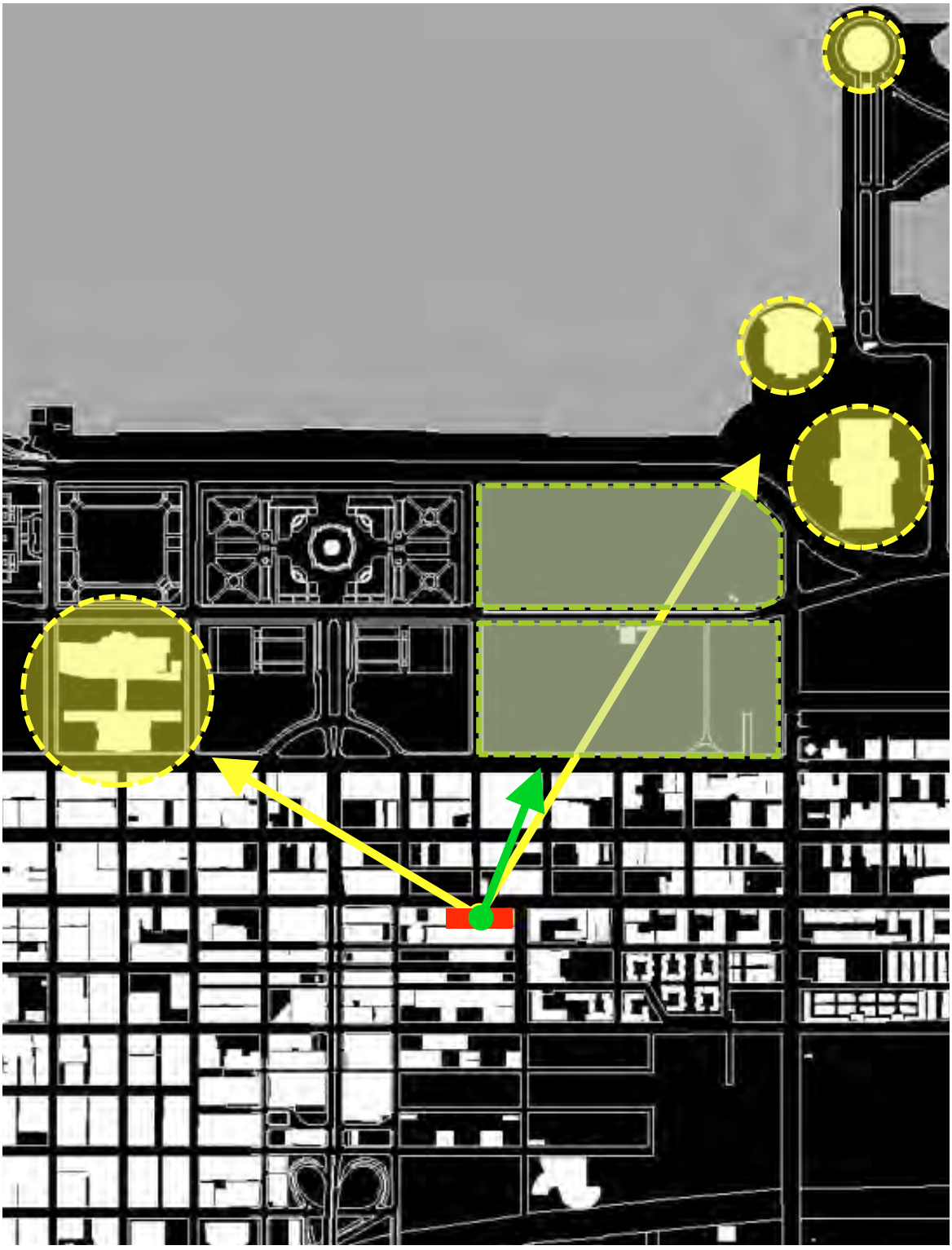
Optimising Limited Space / Land Use

Schools are great to have nearby residential because they operate at different hours to when the residents are inhabiting the buildings. Plus, the school can offer green space and facilities for community use outside of school hours. The advantage of a school in the city is its ability to give back to the city.

Letting the public come in is necessary for a vertical school because it's important that the school can give and take with the surrounding. Being conscious of ways to create income will help bolster schools with limited funding. In Chicago, they will get a budget, but the school can reinforce it with any amenity they can provide. Ideally, all the public areas which are used by the community are on lower floors so that if people want to use its spaces, they are accessible via one stair or short elevator ride.

William Jones College is forced to make relationships with other facilities in the city, and the kids can walk there, for example, no school can send their children to the Art Institute of Chicago. Vertical schools take advantage of what's out there and share with the rest of the city to make it happen. It essentially adds the curriculum of the city to the school itself, which a huge asset.

Students Learning from the nearby Art Institute of Chicago
Photograph: Nancy Harris Frohlich



Map illustrating utilised accessible parks in green and civic buildings for education in yellow.
Diagram: Perkins + Will

7

Interview with Kim Herforth Nielsen on Ørestad College and Vertical Schools

Kim Herforth Nielsen, 3XN founder and creative director, was questioned via email on the 27th of May 2016 regarding his considerations for vertical school design through the lessons learnt on Orestad College. Completed in 2007 the college is a vertically and horizontally interconnected school that encourages students to take responsibility for their learning.

AS: What factors govern the decision for a multi-story school?
KHN: The site conditions and what we want to achieve, i.e. in this case if we made a one-floor building the 12,000m2 would be spread out too far and create too great a distance between program elements.

AS: Can you explain the main layout considerations and strategies when arranging the design of a multi-story school?
KHN: We designed the Gymnasium specifically because we wanted to encourage visual and physical interaction and communication between students, faculty and staff. The central stair connecting the different levels satisfied a logistical and communication need. Everything then radiates out from the central spine.

AS: Compare building a school upwards to outwards, what are the spatial opportunities and challenges between the two? What makes for good school design when in a vertical arrangement?
Building up allows for shorter distances between functions and better visual contact and

Orestad College Vertical Connections
Photograph: Adam Swinburn

openness. If the school was spread out over only one floor, we would have to put the students on roller skates to get between classes! More seriously, it would have felt more like an airport than a school and it would have lost the ability to connect students with one another. Openness is crucial. Without it, different floors become an obstacle and isolate students and faculty from one another instead of fostering community and connection. It is also generally more efficient to stack floors, up to a point. If the floor plates are too small, it then is a more efficient option to keep everything on one level. I think that the ideal is to have each floor about 2,000m2 in a stacked solution.

AS: How does a multi-storey arrangement affect or support a school's pedagogy?
KHN: If the goal is to encourage interaction and collaboration, the building can and must support this, as we did at the Gynamsium. Yet this open building also accommodates events or activities that require quiet or privacy. We designed the space to cater to all of the various needs of students and teachers. A diversity of spaces to suit all needs is paramount. Acoustics are key in this type of open and flexible solution. We worked closely with acoustic consultants to ensure that all aspects of the school – open and more contained – were acoustically appropriate.

AS: How do the public, parents and students perceive vertical schools?
KHN: Neighborhood and community groups have embraced the school and use it as a social space for non-academic meetings and events. The principal has hired teachers especially for this building; teachers have had to develop new ways of working and teaching in such a different environment and it has not always been the right/best fit for each teacher. Students in Denmark can choose their high school and the Ørestad Gymnasium has become one of the most popular choices, which speaks to a successful design. But again, it is not the right environment for everyone, and I think that there certainly have been students who needed more structure or traditional setting and opted to attend another school. One sign that I see that the students clearly appreciate and respect the school is that there is almost no vandalism or graffiti compared to other schools. They take ownership of the school.

AS: If you could redesign the school – what would you do differently to improve the design of the school?
KHN: I like the wood as a material choice for the central stair; it adds a warmth to the space. But if I had to do it over again, I would probably choose a different material because the wood needs to be refinished regularly in response to its heavy wear. In general, if I redesigned the school I would explore using more and different materials, maybe a few practicalities like flow in the canteen to better serve a larger than anticipated student body, but generally keep the design intact. We designed a roof garden for students to use for science class as well as relaxation. It was not implemented due to lack of funding. If I could go back, I would like to have found a way to include this in the initial construction. I would also expand the existing terraces to connect the outside and inside on all floors.

Do you have any other comments in respect of the research project?
KHN: I think that it is very important for vertical schools to provide access to the outdoors at higher levels within the building itself, maintaining the connection to the outdoors and larger community no matter where students are in the building.

Orestad College Atrium where students can slide down the banister to travel between floors
Photograph: Adam Swinburn

8

Interview with Herman Hertzberger on Montessori College and Vertical Schools

Herman Hertzberger is one of the world's pre-eminent architects in the field of school design. With over 50 years of experience in school design completing 30 built projects and writing numerous publications he has demonstrated how the architecture of schools and the organisation of school buildings influence the social development of children. This interview took place on the 23rd of May 2016 in Hertzbergers studio in Amsterdam.

AS: What makes for good school design when in a vertical arrangement?

HH: When you are making independent storeys which has nothing to do with each other than already 2 storeys is too much for a school. The most important criteria is contact. This is true for every building. You must avoid the separation, but floors need separation in a normal regular building. You must have contact so people up and down the building can have a relationship. The school should be one space like a house. One space through the use of void. For a school it is hopeless when you have to go into corridors. The separation is in fact the wrong thing and quite important. We should design schools to be an open space and not just slices of buildings stacked upon each other.

Atrium should be something special, for example working islands and overlapping floors. In education terms it is really good when students have to travel through the whole building to see what everyone else is doing. It is important to have a view of everything, so they can be inspired by everything. People should be able to see each other so boys can look at pretty girls and vice versa. You see what the possibilities are. Articulate the

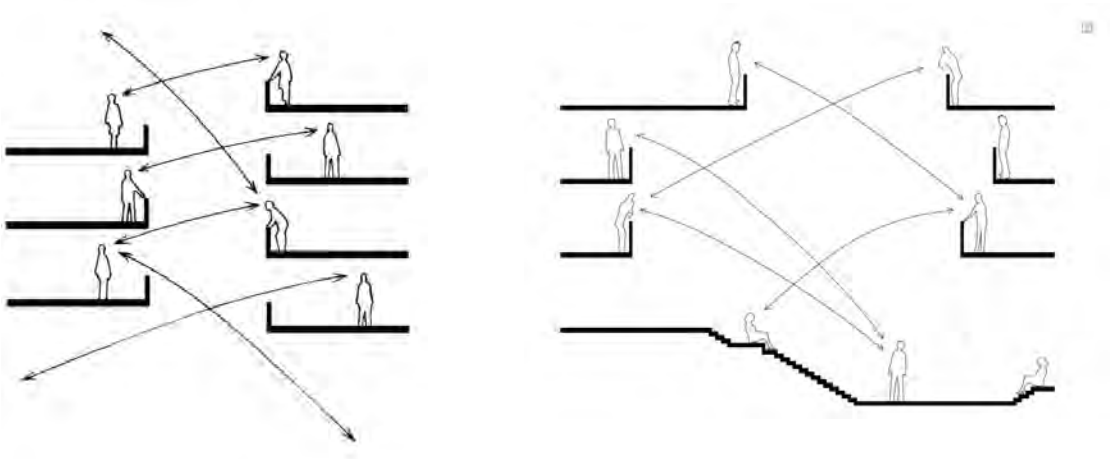
Montessori College Oost Vertical Connections
Photograph: Adam Swinburn

void in segments over the entire height of the building so it doesn't look too monumental. More like a landscape, rocks. You still have the feeling of an open school to ensure there's enough open space over the floors for the student to connect. If you don't articulate the void and it goes straight up it will look like a prison. All people student's teacher's students that have the feeling of being in one space with not so many floors. The stairs give you a feelings of centrality and being together.

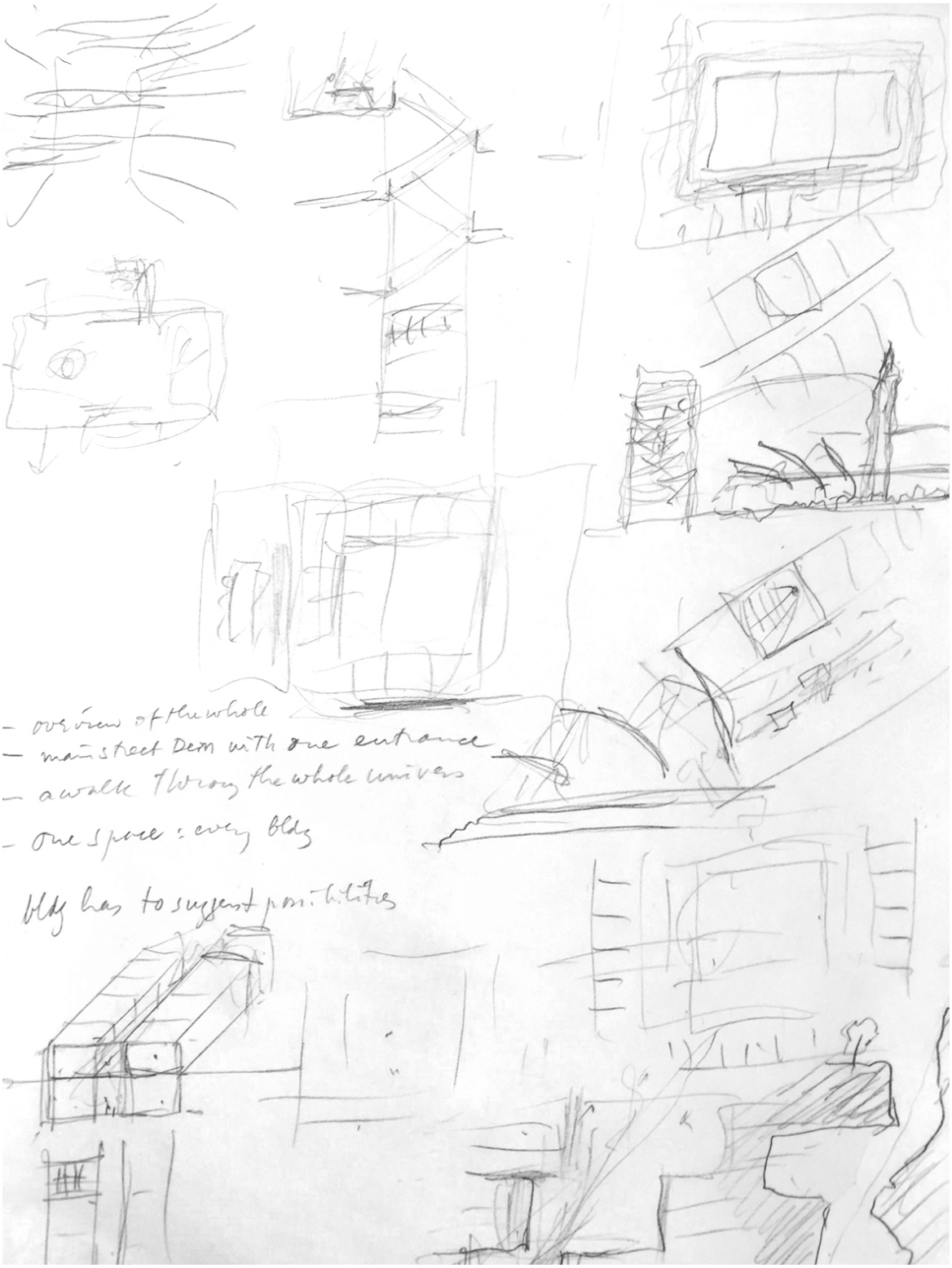
The circulation for one floor to another is the consideration. Stairs should be central. People not being able to walk upstairs is nonsense. The only negative comment or effect about vertical schools is for the teachers that they have to walk. Vertical schools and walking upstairs are no problems at all so long that you give them space and expression in the space. You can use stairs to make contact and exchange schemes. We made stairs so you could always see onto the next flight. As long as you perform the stairs in a way that you can give more possibilities of contact with each other – its very nice. Oost is good for the split levels. It makes it less stairs and more of a 3d dimensional stairway. In another school you can see big balconies where students work and study in the big central space. Including places for students to sit. Pompidou use the stairs as a circulation but there's not contact. You wouldn't make people walk too high. How high can you let kids walk up stairs? Its good for their physical being and doesn't take it too much time. The teachers though don't want to climb the stairs.

There is a psychology in building height that can create hierarchy in which a flat building cannot. In an elevated building you elevate people – why do churches have to be the highest point in historic cities. Functionally its for the bells but they don't want other people to compete with the church if they want to build higher. Psychologically the vertical school is elevating students.

At Montessori College Oost people come out of their classrooms where teachers have authority and transition into a communal public space. The idea of adapting public and private spaces in a building is important. One space is in fact should be a city. We always think of a city as being flat, what would you do with a vertical city?



Sketches of connections between levels.
Sketch: Herman Hertzberger



Sketches of Vertical School ideas and strategies during the interview
Sketch: Herman Hertzberger

9

Discussion

Organising the School Vertically

Pedagogical Look at School Organisation Models - Vertical schools to work well need to take a step back from the traditional layout. As seen in some schools visited like Montessori College Oost the academy typology where classrooms bank a central atrium and stair only work to a certain height as climbing too many flights of stairs becomes an unrealistic expectation for staff and students. As a school exceed four storeys, its organisation and circulation must be rethought.

Richer Communities - Building upwards can create a much richer community because there is more direct interaction due to the footprints compactness. It's more like the workplace. There is more bump space which brings various kinds of people together to connect and share ideas. Atriums create a lot of connectivity. People can see and communicate with each other although they are separated between or across floors. If the building was linear these connections are unable to happen.

Departmentalising vs Interdisciplinary Based Curriculum – School design is moving away from departmentalising the school based on subjects and faculties primarily because it is inefficient and not supportive of an interdisciplinary based curriculum. In a vertical school where space is particularly precious interdisciplinary subjects work well because it blurs the lines of designated spaces and creates more flexibility in the design. The consolidation of classrooms that support coursework and STEAM programs into one area can assist scheduling.

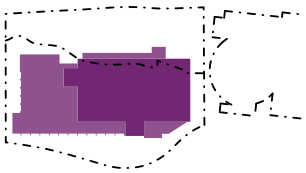
Secondary vs Primary - The operational challenges between primary and secondary

schools are different when in a vertical arrangement. Primary school students spend their time in one classroom except for sports, reducing the vertical circulation load on the building throughout the day. However, students do require more open space for recreational play including both structured and unstructured activities. Primary schools have further consideration for evacuation, bathroom facilities for kindergarteners, school pickup at arrival and dismissal times. The arrangement of the floorplate would have more classrooms around a central space for students to spill out on to. Primary school students have less day to day integration with the city, for example, it would not be safe to let students roam around the city during lunch breaks. In contrast, secondary school students are more difficult to organise and are required to circulate throughout the building for different classes more often. A secondary school has a greater variety of programs and facility-specific activities such as science laboratories, art rooms and workshops.

Stacking of Year Groups - Across all case studies younger year groups are located on the lowest floors and as they age they move up the building. Stacking via year levels is sensible because younger and smaller students are physically less capable of walking up the building and should spend most of their time in a part of the building which would be easier for them to evacuate during an emergency. Keeping year groups together is efficient because senior students require more specialised classroom spaces than younger years. Having younger kids on lower floors reduces their independence for lifts. Older students could be more responsible at using lifts. (Diagram Avenues with stacked configuration)
Pancake Model - A pancake school is where floorplates are stacked on top of each other with no consideration or connections between floors. This is the least desirable outcome for a vertical school especially if the school intends to foster community and sense of connection between students. The only time a pancake school could be appropriate is if the school student demographic have behaviour issues and interactions between students need to be controlled. For example, if a fight breaks out the cohort could escalate into a riot. Student cohorts behaviours change year to year. Designing a school to the behaviours of a single cohort in time may be detrimental to the future life of the building.

Common Meet Level Model - Within a three-storey block, the middle floor could be the collaborative zone with more prescribed or speciality classes above and below it. This middle floor would assist in gravitating people together for the utilisation of common spaces. By further providing all the spaces a student would need daily within this block, it could reduce circulation demands to other parts of the school as students would only be a single floor away from learning spaces.

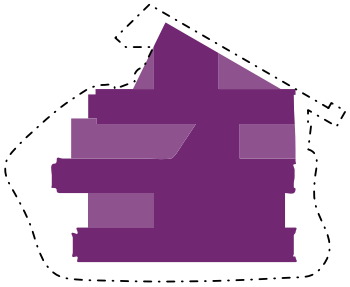
Multiple Hubs Model - To minimise movement a vertical model must think differently to previous typologies. A series of 2 storey home base hubs could accommodate most spaces students would need for most of their time with short distances to speciality classrooms. Students could stay in these spaces from half to the entire day. Double height pods with a mezzanine would make spaces feel more comfortable and create a sense of community for that hub between the two floors, which otherwise would be very hard to do with a pancake model. The advantage of smaller semi-isolated hubs is its ability to reduce the impact of noise on learning spaces between multiple floors.
Open Space - Open space is typically abundant in a suburban horizontal school but a



Singapore International School

Site Area: **4,500 sqm**
Footprint Area: **2,500 sqm**
Building Area: **23,000 sqm**

Habitable Floors: **14**
Gross Plot Ratio: **5**
Site Coverage: **55%**



School of the Arts

Site Area: **11,400 sqm**
Footprint Area: **7,850 sqm**
Building Area: **23,000 sqm**

Habitable Floors: **11**
Gross Plot Ratio: **5**
Site Coverage: **69%**

William Jones College

New Build
Site Area: **4,250 sqm**
Footprint Area: **3,900 sqm**
Building Area: **25,800 sqm**

Habitable Floors: **7**
Gross Plot Ratio: **6**
Site Coverage: **92%**

Avenues: The World School

Site Area: **2,000 sqm**
Footprint Area: **1,800 sqm**
Building Area: **25,800 sqm**

Habitable Floors: **10**
Gross Plot Ratio: **10**
Site Coverage: **90%**

Arthur Phillip High School

Site Area: **12,400 sqm**
Footprint Area: **5,050 sqm**
Building Area: **32,700 sqm**

Habitable Floors: **17**
Gross Plot Ratio: **2.6**
Site Coverage: **40.5%**

Vertical School Footprint vs Site Boundary
Diagram: Adam Swinburn

pancake model. The advantage of smaller semi-isolated hubs is its ability to reduce the impact of noise on learning spaces between multiple floors.

Open Space - Open space is typically abundant in a suburban horizontal school but a luxury and sort out commodity within the vertical. Large open space is essential for large gatherings like assemblies, play space during lunch breaks and as a flexible multi-purpose space which could be used as an overflow for a theatre lobby if positioned near compatible facilities. Locating an elevated open space midway in the building could act as a second ground floor minimising the circulation from below and beneath the plane. A similar principle could be applied to collaboration spaces such as an open plan studio.

Floorplate - In most cases visited the floorplate of the vertical school was an extrusion of the site. Case study typical floor plate sizes ranged dramatically between 500 sqm to 6,000 sqm depending on the site. Larger floorplates typically meant that there would be fewer levels required to house the accommodation schedule of the school. Smaller floorplates are less area efficient because of core requirements, services and circulation typical of a high-rise building. Additional floors are costlier to build as well. Larger floorplates lend themselves to the collocation of similar learning spaces along a horizontal axis. In some situations, like St Georges Anglican the small floorplate meant there was too much splitting up of functions. Depending on the school population 2,000 sqm floorplates seems to be an ideal size for a school in a stacked solution. For Ørestad College the success of creating its school heart is the live intensity and connectedness along the central circulation spine and different scaled gathering spaces. If the entire school area were organised on a single level, it would not achieve the same atmosphere and connections it creates now.

Ground Floor – Think differently about the administration. Clear out the reception from the ground to put more meaningful programs like cafes and community facilities. The parents café on the ground floor of Avenues is widely popular and successful. St Georges Anglican ground floor is partly leased out as a bank branch. St Andrews Cathedral School leases its lobby out for events such as voting booths for elections overseas. Schools are typically secured with fences around them. The ground floor of cities should be as public as possible and can be leased out for higher rent. Organising halls, auditoriums and other rentable spaces on the ground level with a secured school above could reinforce a school as the heart of a community, create profitable opportunities for underutilised spaces and maintain security via minimised access points.

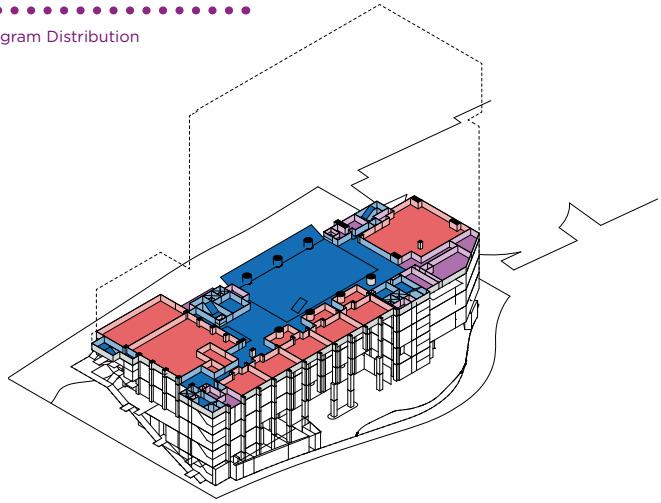
Singapore International School Program Distribution
Diagram: Adam Swinburn

Legend

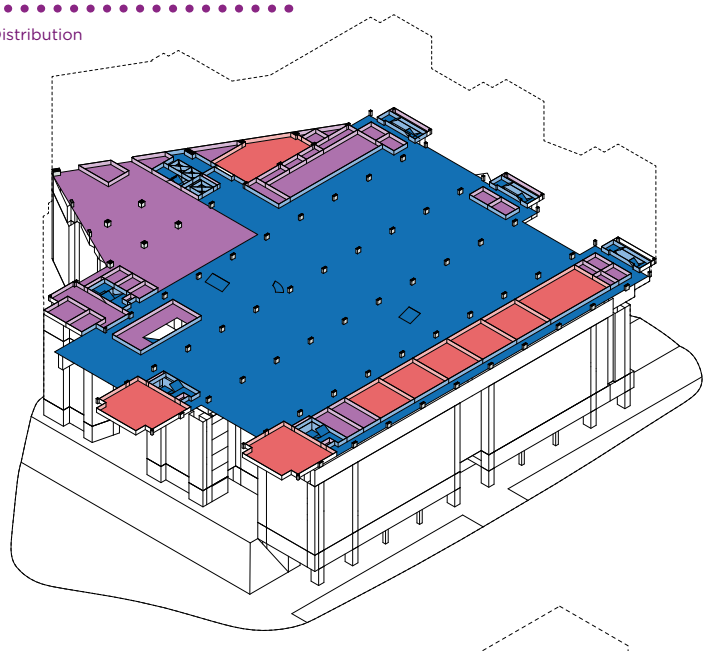
- Learning Spaces
- Hall
- Ancillary
- Circulation
- Outdoor

Scale

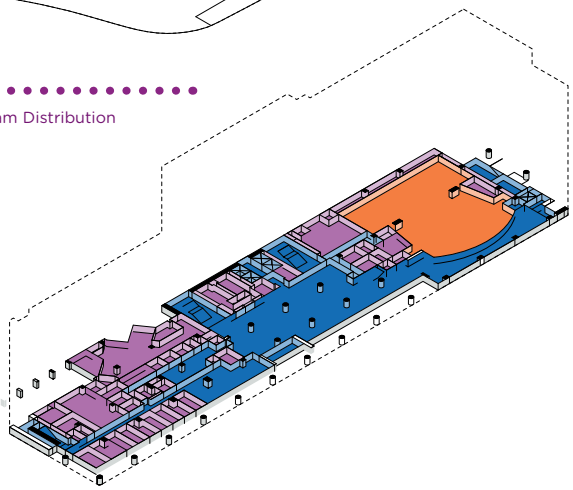
0 10 20 50m



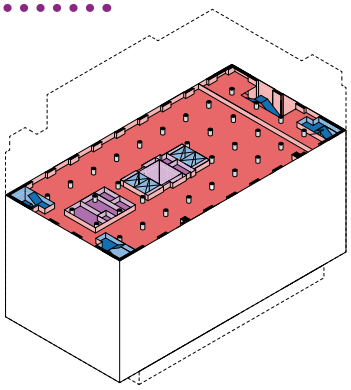
School of the Arts Program Distribution
Diagram: Adam Swinburn



William Jones College Preparatory Program Distribution
Diagram: Adam Swinburn



Avenues: The World School Program Distribution
Diagram: Adam Swinburn



Circulation

Primary vs Secondary - One of the most significant issues in vertical school design is the vertical circulation management. There are more vertical circulation considerations in secondary schools than primary schools. Secondary students move between specialised spaces while most of a primary student's education experience can be facilitated in one classroom except for sport. Vertical circulation amongst primary students is prolonged. Lift car sizes should be designed to fit a whole primary class so that the teacher can keep students together and supervise them while moving between floors.

Provide Desirable Path Options - Multiple circulation paths should be allowed for to reduce congestion coming to one spot. Ensure that these circulation paths are a central feature which is conducive to gathering spaces. Avoid lifts as a primary circulation method where possible. However, it may be necessary for students to use lifts to travel between a certain level and ground floor when they arrive at the school. Staggering start and dismissal times will assist in reducing load otherwise a substantial amount of additional lifts would be required

Fire Stair Utilisation - Make better use of fire stairs for inter-floor use when the building is solely occupied by the school. There are child protection considerations with co-occupancy and fire stairs are accessible to all tenants. Outsiders can get access to the school through unsupervised fire escapes, which is a potential hazard. Mixed-use design should investigate additional security considerations.
Lift Transportation Studies - Deploy vertical lift transportation studies to understand load times and wait times. Having students queue for lifts may create overcrowded spaces and create restlessness. Ensure lift lobby spaces are large enough to comfortably hold people who are waiting and look at doubling this space up as a larger open space or studio to get better utilisation.

Existing Guides - CIBSE (Chartered Institute for Building Services Engineers) Guide D outlines the general principles of vertical transport design in various types of buildings. The most applicable to a vertical school development outlined in this guide is that of university education facilities.

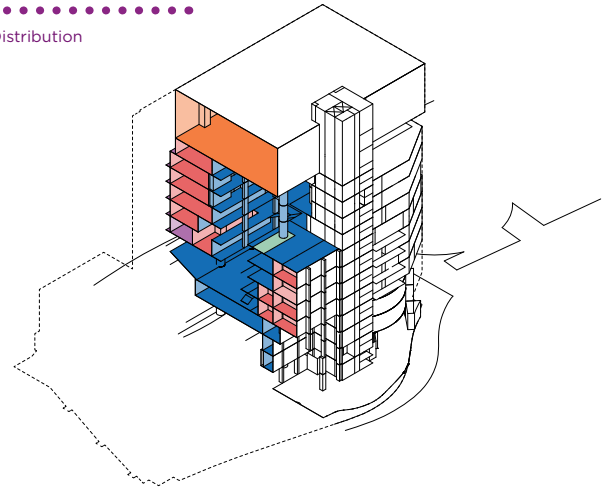
Singapore International School Program Distribution
Diagram: Adam Swinburn

Legend

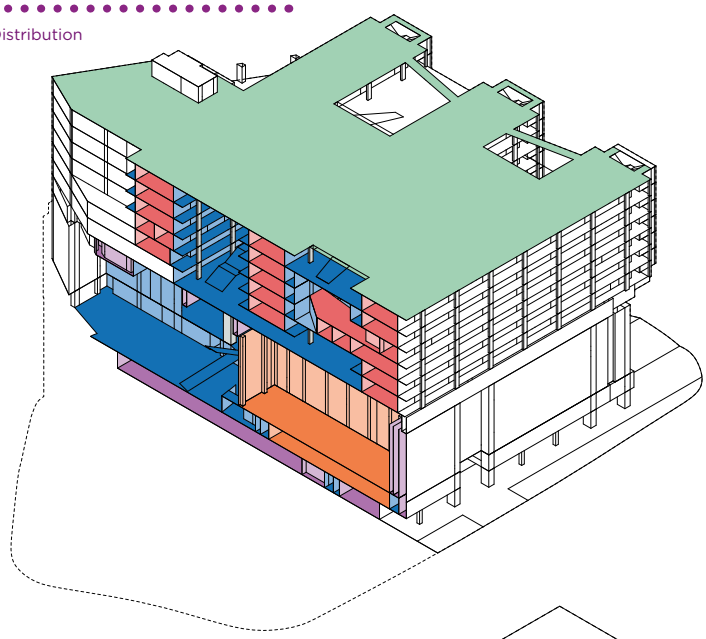
- Learning Spaces
- Hall
- Ancillary
- Circulation
- Outdoor

Scale

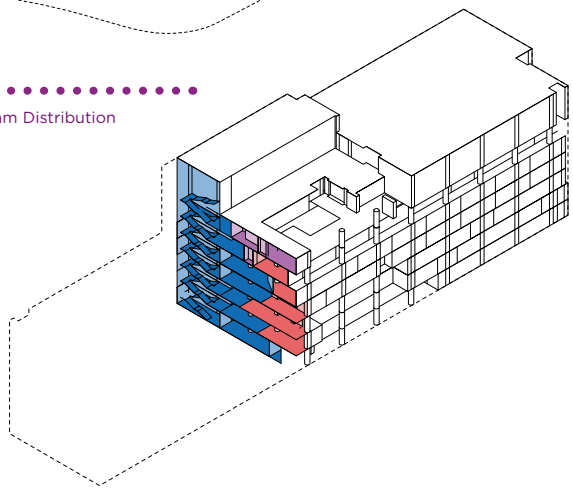
0 10 20 50m



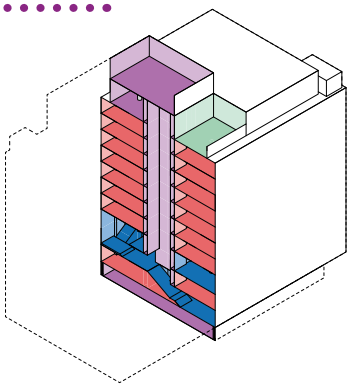
School of the Arts Program Distribution
Diagram: Adam Swinburn



William Jones College Preparatory Program Distribution
Diagram: Adam Swinburn



Avenues: The World School Program Distribution
Diagram: Adam Swinburn



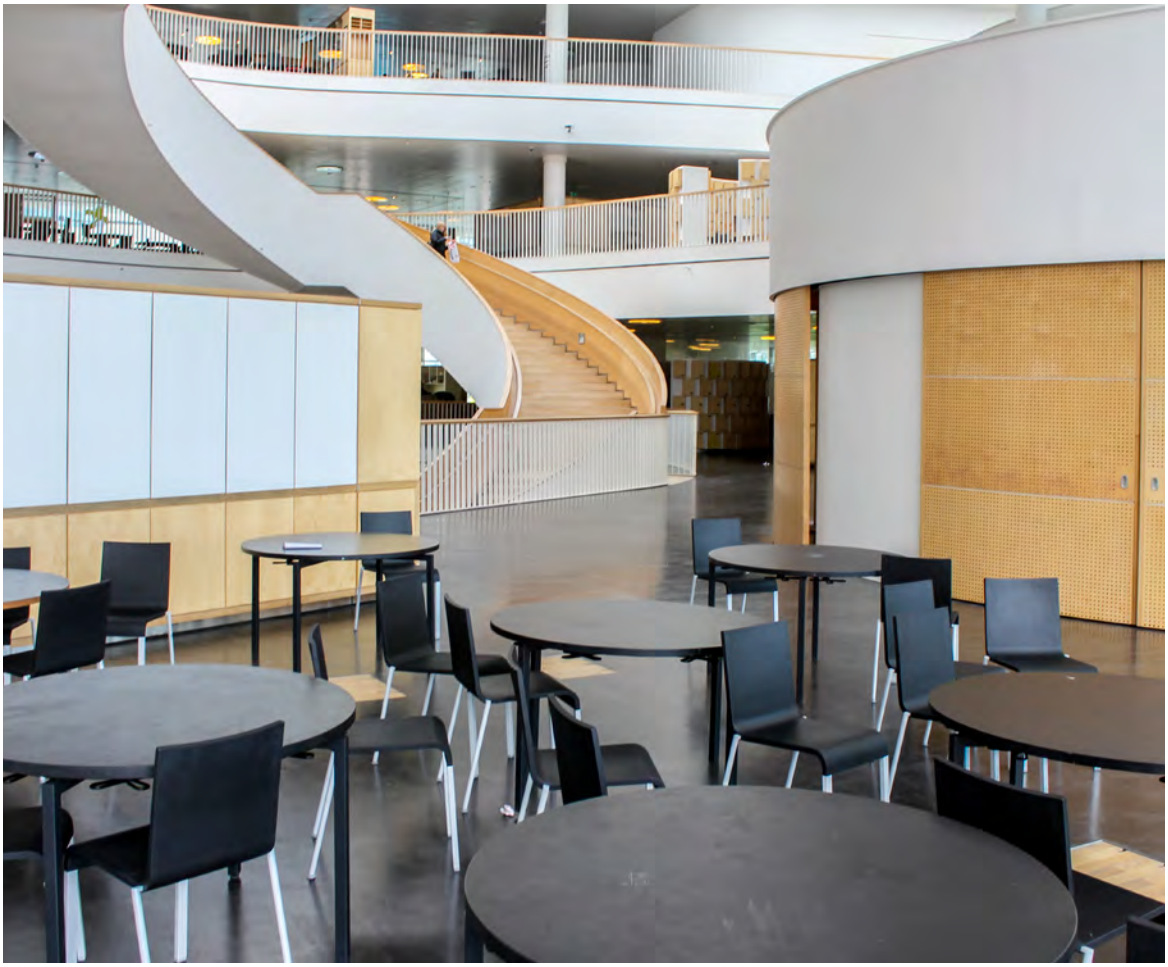
Connecting Floors

Atrium - The architectural move for a central atrium gravitates people towards the middle of the school because it enables visual connections and transparency across the different school levels. Stairs can be strategically scattered along the atrium to encourage vertical circulation. Connections across the atrium create more interest and interaction amongst the students. When students and staff are in an atrium connected space, they feel like they are a part of the larger school space and community and have an overview of the whole intellectual program.

Scale - When connecting floors, a sense of scale should always be considered. Large atriums may be intimidating for the youngest students who are going to school for the first time. As the student ages, the design should transition from a domestic scale which is comforting and be nurturing for younger students to the larger collaborative and connected city scale environments which prepare students for the real world and work environments they will move into after their formal education finish. The design should always be mindful of the needs of students at different learning ages.

Views - Considering atriums create visual connections across floors and its surroundings the school do not need much signage because people can orientate themselves with ease. Framed views to the outside are important aspects to achieve this. Plus, views outwards feel less claustrophobic. Visual connections help students find each other so they can meet, socialise and play games.

Managing Atriums - From an operational point of view, the connection between floors in the secondary campus requires less human resources to manage because students can be supervised and communicated with from strategic locations. However, atriums need to be managed to operate safely. Students are naughty and deliberately damage or throw things over the balcony. Primary school students tend to be involved in more accidents on the stair than secondary students.



Orestad College Learning Space with Visual Connections to Other Floors of the School
Photograph: Adam Swinburn

Providing Outdoor Spaces

Designing for Recreational Spaces – Maximising outdoor learning opportunities and access to daylight is essential for kids. All vertical schools investigated desired a large sports field as part of their facilities. The advantage of a having a field would make it easier for sports practice and scheduled games because getting permits have become harder, more competitive, subject to availability and possibly resorts to a location far away from the school. Public parks can be used for festivals where the grass can get destroyed and be inaccessible for weeks until it grows back. Sports fields can be multi-purposed including activities outside of games and play like graduations, outdoor performances, students announcements and as a marshalling point during an emergency.

Primary vs Secondary - The provision of play space for primary students are different to secondary because they require more unstructured play for made up games which may be easier to accommodate in a vertical school as they don't have predetermined sizes such as basketball court, or football field.

Balcony Spaces - Outdoor areas at higher levels within the building assists in maintaining a connection to the outdoors and the broader community, no matter where students are in the building. However, some case studies lock these spaces off from the school against the vision of the architect. For Bridge Academy, the driving factor for this was that there were too many separate spaces and they couldn't all be supervised. In other cases like the International Grammar School in Sydney, balustrades felt too low and posed a security risk. It is more practical for future vertical schools to have less but larger outdoor gathering spaces which can be supervised with minimal staff than smaller separate outdoor spaces requiring greater supervision. Larger spaces are more conducive for students to run around on so they can burn off energy and get fresh air, this was extremely important consideration for an all-boys school.

Staggered Lunch Breaks - Changes to administration procedures can allow for maximum utilisation of external spaces. Lunch-time can be staggered between schools and year groups to share facilities but also to prevent older year groups colliding with younger children. Learning spaces should be acoustically separated from these external spaces as children playing may disrupt learning in the classroom.

Massing Strategies - There are three key strategies to provide recreational facilities on tight sites. Firstly, the utilisation of rooftops which sit above structural systems and are unobstructed by plant spaces. Plants spaces should be located in basement levels where possible. Secondly, finding a site footprint large enough to cater for a football field size rooftop. The field could be suspended over the school as a deck or be the massing of the school. Finally, mass the program of the school to one side of the site allowing for maximum flexibility on the ground for recreational spaces. This strategy is deployed by Arthur Phillip High School in Parramatta.

Australian Context - The Australian climate allows for better multi-use outdoor spaces. Thus, it is important to have external areas of the high-rise school because it's what makes it uniquely Australian. Providing external areas with access to quality light is essential

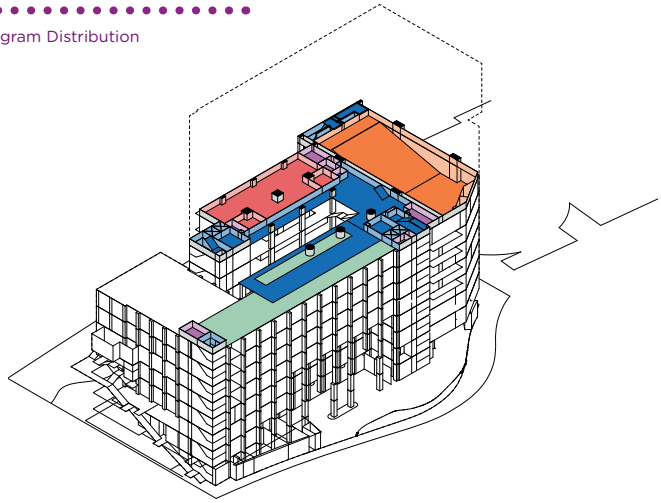
Singapore International School Program Distribution
Diagram: Adam Swinburn

Legend

- Learning Spaces
- Hall
- Ancillary
- Circulation
- Outdoor

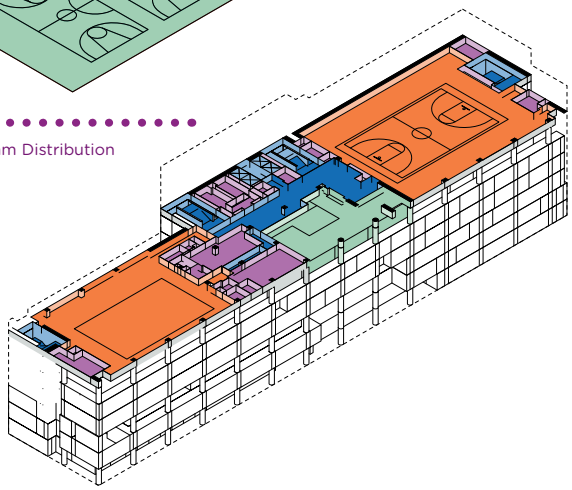
Scale

0 10 20 50m

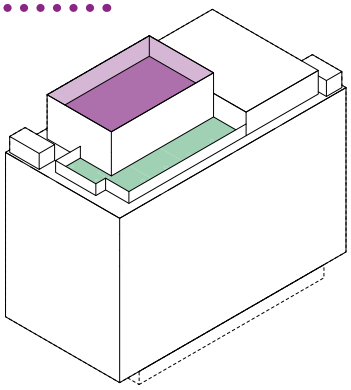


Arthur Phillip High School Program Distribution
Diagram: Adam Swinburn

William Jones College Preparatory Program Distribution
Diagram: Adam Swinburn



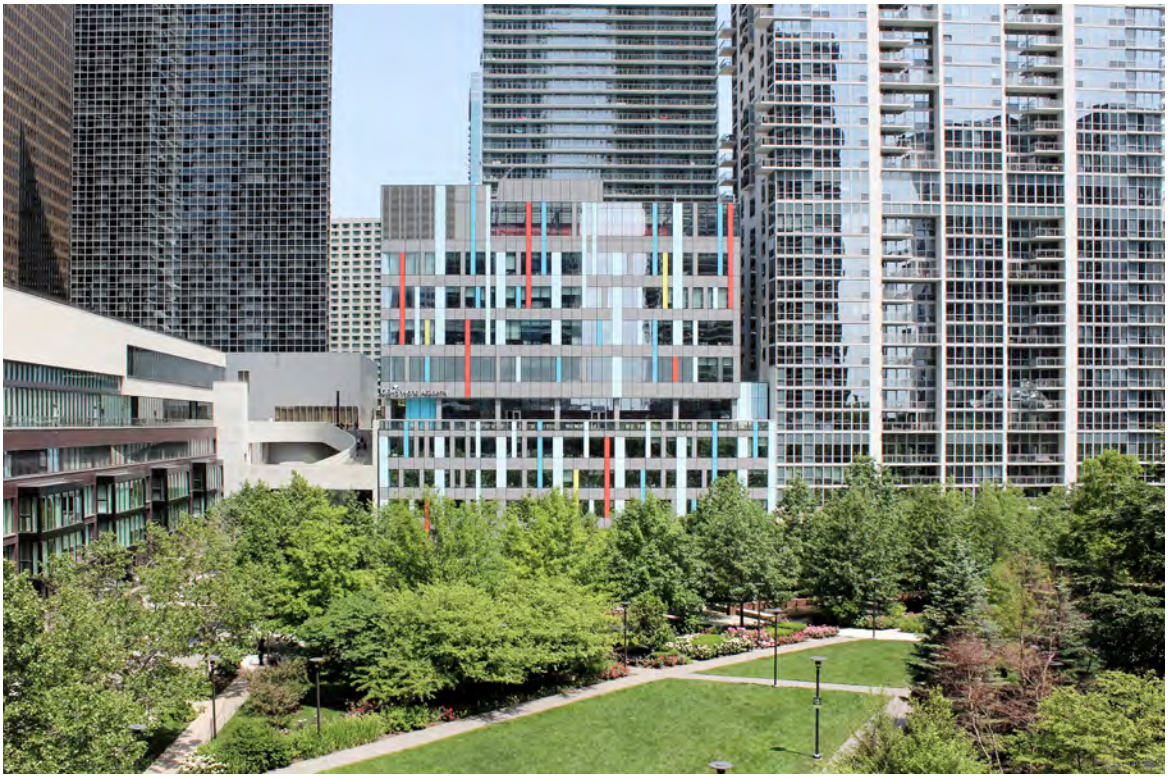
Avenues: The World School Program Distribution
Diagram: Adam Swinburn



to activating an outdoor gathering space. Australian schools see a connection between play and eating spaces because the climate allows it, this is different to the organisation of American schools where cafeterias are not linked to play spaces.

Master planning near Parks and Recreational Facilities – Master planning schools around parks and recreational facilities nearby would be an effective way to provide external spaces for wellbeing and sports for students. The primary considerations would be ensuring that relationships and agreements can be established with councils and institutes to make this possible. GEMS academy is an example of a school that is positioned across from a park. However, they are only allowed to use it for a maximum of 5 hours on rare occasions. The park district management felt that if the students were to use the park all the time, it would overwhelm the rest of the community and residents living nearby. This condition was put in place prior the construction of the school and drove the decision for an accessible rooftop. If the parks and recreational facilities are not located near the school, it can impact scheduling and curriculum. For Xavier College in New York, the football team need to travel 45 minutes away from the school to get access to a field for scheduled games and practice. This travel time can impact student's ability to attend other scheduled classes limiting the athletics program.

Primary School of Science and Biodiversity, Paris
Photograph: P. Guignard



Top Photo: Park Outside of GEMS Academy, Chicago
Photograph: Adam Swinburn

Bottom Photo: Rooftop of St Georges Anglican School, Perth
Photograph: Jeroth Diggeden

Optimising Limited Space / Land Use

Vertical School as Public Infrastructure - As a piece of civic infrastructure, there is a greater role and opportunity for the vertical school in city making. Schools tend to be either one of two city models. A civic/co-sharing model, meaning it acts as an urban element and simultaneously as a school space, or a fortress model whereby it is gated, children cannot leave and the public cannot enter. The physical stratification of the vertical school could be a benefit here as a secured school zone could sit above facilities which could be publicly accessible. This includes theatres, gyms, swimming pools, gathering spaces and libraries. If these spaces cannot be provided on the ground floor and are higher up in the building, the design could utilise a circulation system which controls the public from accessing secured parts of the school. An example of this would be a lift which can only travel between the entrance and the desired floor. As a shared building the vertical school can fill in blanks in the city such as facilitate activities for the community (who are living in high-density environments) that do not have space to host events. E.g. hosting kid parties, maker spaces, meeting spaces, cooking classes, satellite library, and greenery.

City Infrastructure as Vertical School Facilities - Key buildings neighbouring the school such as sports centres, galleries and museums are potentially better tools to assist education because the school can leverage from the state of the art facilities. This allows a vertical school to forego various programs allowing precious space resources and funding to be invested in other parts of the school. For example, a school located in the art and theatre district of Chelsea, New York would be able to organise access to an auditorium for the occasional school assembly and theatre production.

Collocating - By master planning schools together and pooling common resources between facilities, collocating would enable the school to provide a service that it might not usually have. For example, if two schools could only spatially offer half a basketball court each, together they could make a full one.

Mixed Use development and Shared Tenancy - Mixed development and shared tenancy are not always conducive. It's about the compatibilities of uses. For example, restaurants are noisy and have fumes. However, Community facilities are much better. The most prominent issue with shared infrastructure is maintenance, staffing, and security. If a private company managed shared infrastructure, it would take the edge of school administration. E.g. A gym which is utilised by the school but accessible out of hours for the community. Consideration must be given to situations such as if the public breaks equipment is the school is liable to fix it. The ground floor is a high-rent space which is underutilised by school's due to security. Having the school start on the first floor is more economically viable.

Legend

Existing School Campus

School Expansion

Mixed-Use Development Above

Eighteen-Storey Apartment Tower Anchored to a Six-Storey School Base, New York
Photograph: David Sundberg

Adapting for Growth and Decline

Acquiring Additional Sites - The city is always in flux. The physical expansion of a vertical school via site acquisitions can be expensive and preferable site locations are dependent on timing and availability. An urban campus mentality of acquiring a nearby site to grow the school could allow for expansion with minimal disturbance to the operation of the school. However, there is a risk that existing buildings nearby are not suitable for repurposing or challenging to obtain altogether. St Andrews Cathedral school in an example of an urban campus which is made up of 2 vertical buildings to meet its capacity.

Staging - The nature of a vertical school makes it harder to plan for long-term growth as high-rise buildings do not readily lend themselves for physical expansion without foresight. Strategising how the original vertical school is organised and can be expanded with minimal disruption is critical to the model's success as a school. Vertical schools investigated typically staged works within limited holiday periods. Minor work is more achievable than major developments as it can impact everyday school operation. Demolition works occurring at Singapore International School were delayed into the school year. This meant that students struggled to concentrate while builders jackhammered concrete below creating loud noises and vibrations through the building.

Core and Shell - The vertical school can be responsive to significant shifts in student populations. Structural systems could be over engineered allowing for the provision of additional floors later to allow for the school to expand. Other strategies include core and shell models which enable the school to invest some money and build for anticipated expansion but complete and pay for a fit-out later when the school is ready to occupy the space.

Re-purposing - School design has become a reflection of the work environments and cities that students will move into and become a part of once their formal education is completed. One significant advantage to the core and shell model is the school's flexibility to be more converted into an office should the school close.

Top Photo: New Vertical School Extension at Xavier College, New York
Photograph: Adam Swinburn

Bottom Photo: New Campus Construction at the Australian Internatioanl School, Singapore
Photograph: Adam Swinburn

10

Conclusion

The continuing population growth and desirability of Australian city centres rely on a model of school architecture which can be multi-storey as a result of tight urban sites which make large tracts of land not financially viable. As the low-rise sprawling campus model from the nineteenth century reflected the suburban condition surrounding the school, the densification of city centres in the twenty-first century is motivating the design for high-rise vertical campuses. Students of the next generation are very likely to attend a vertical school. High-density developments like office towers can be seen as a one type suits all approach, it is critical that the future of vertical schools is designed to be more than a pancake floorplate stacked building or an afterthought in the city master planning process post the construction of apartment buildings. From this study, we can conclude that vertical school architecture that has been strategically designed to provide quality outdoor spaces suitable for recreational activities, visual and physical connections between floors to foster school community, and a secured school zone above publicly accessible shared facilities have the greatest potential of providing a positive school experience and meaningful civic infrastructure for the greater city.

11

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This thesis represents a collection of school design wisdom and expertise from people who have whole heartily dedicated their lives to improving architecture for education. I would like to thank all those who contributed to the research listed below. Their knowledge captured in this thesis will inspire and educate many architects, school administrators and government officials who are perplexed by the issue of vertical school design.

John Cross
Executive Director at St Andrews Cathedral School, Sydney

Duncan McLagan
Director at DWA Architects, Perth

Rensche Diggeden
Principal at St Georges Anglican School, Perth

WOHA
Project Architect at WOHA, SIngapore

Ada Ng
Head of Department / Facilities Management at Singapore International School, Hong Kong

Pit Li Phan
Director at MKPL architects, Singapore

Ian Ward
Assistant Head of Upper Elementary at the Australian International School, Singapore

Allan Kajer Anderson
Principal at Ørestad College, Copenhagen

Kim Herforth Nielsen
Co-founder and Principal at 3XN, Copenhagen

Clyde Bossari
Central Bureau at Montessori College Oost, Amsterdam

Herman Hertzberger
Founder of AHH, Amsterdam

Matt Williams
Principal at Chelsea Academy, London

John Southall
Director at Feilden Clegg Bradley Studios, London

Chris Brown
Principal at Bridge Academy, London

Kieth Papa
Architect Director at BDP, London

M. Perdriat
Principal at the Primary School of Science and Biodiversity, Paris

Michael LiVignin
Principal at Xavier College, New York

Raymond Bordwell
Global Chief Facilities Officer at Avenues: The World School, New York

Therese Plunkett
Vice Principal at William Jones College Preparatory, Chicago

Bryan Shabel
Principal at Perkins + Will, Chicago

Lynne Sorkin
Director at bKL Architects, Chicago

Geoff Jones
Principal at GEMS Acadmey, Chicago

Ali Bounds
Practice Director at BVN Architects, Sydney

Phillip Rossington
Principal at BVN Architects, Sydney

Fiona Young
Studio Director at Hayball Architects, Sydney

Richard Leonard
Director at Hayball Architects, Melbourne

Shane Wood
Senior Associate at DWP Suters, Sydney

12

About the Author Adam Swinburn

Adam Swinburn is a NSW registered Sydney-based Architect. He graduated with a Masters and Bachelor of Architecture from the University of Technology, Sydney. Across his professional career, he has contributed towards the success of award-winning projects at Johnson Pilton Walker, Denton Corker Marshall, Candalepas Associates and Bijl Architecture.

During his studies, Adam was awarded the Designing Architecture in Response to Climate Change Scholarship where he attended a six-month workshop and seminar in Turin, Italy and Toulouse, France. The experience heightened his ability to be culturally and environmentally sympathetic when designing outside of shared customs, beliefs and languages.

Passionate about research and solving spatial problems in our cities, Adam has undertaken a part-time research masters strategising the spatial configuration of a new vertical school typology. The ongoing study is part of a significant campus redesign for the International Grammar School, Ultimo. In 2015 the international fieldwork component was supported by a Byera Hadley Travelling Scholarship.

From managing a semi-detached dwelling in Kirribilli, collaborating on a significant commercial tower as part of the transformation of Parramatta CBD, and progressing the Site Development Plan for the Australian War Memorial in Canberra - Adam continues to apply sound design principles to deliver highly resolved architecture.

13

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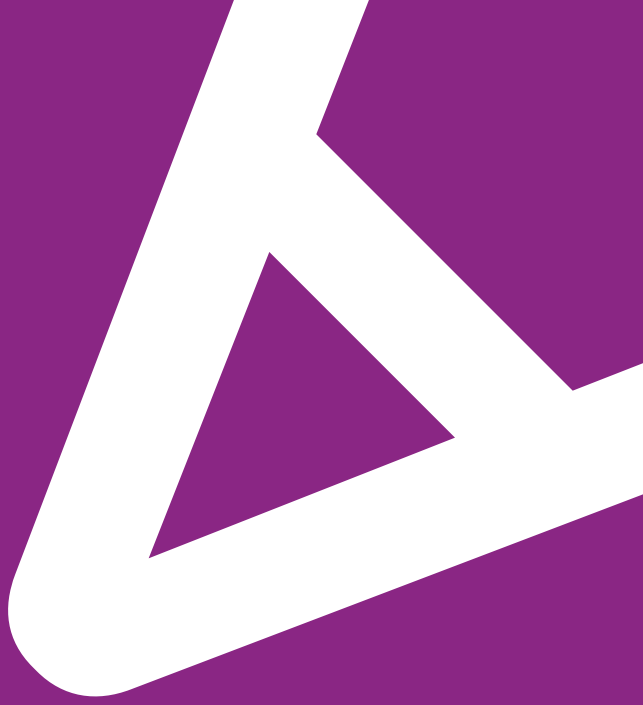

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