RE-THINKING THE PORTABLE SCHOOL:
A NEW SYSTEM FOR THE DURHAM DISTRICT SCHOOL BOARD

by

Jacqueline Green

Submitted in partial fulfilment of the requirements
for the degree of Master of Architecture

at

Dalhousie University
Halifax, Nova Scotia
March 2013

DALHOUSIE UNIVERSITY

SCHOOL OF ARCHITECTURE

The undersigned hereby certify that they have read and recommend to the Faculty of Graduate Studies for acceptance a thesis entitled "Re-Thinking the Portable School: A New System for the Durham District School Board" by Jacqueline Green in partial fulfilment of the requirements for the degree of Master of Architecture.

Dated: March 19, 2013

Supervisor: _____

Reader: _____

Reader: _____

Reader: _____

DALHOUSIE UNIVERSITY

Date: March 19, 2013

AUTHOR: Jacqueline Green

TITLE: Re-Thinking the Portable School: A New System for the Durham District School Board

DEPARTMENT OR SCHOOL: School of Architecture

DEGREE: MArch   CONVOCATION: May   YEAR: 2013

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CONTENTS

ABSTRACT

This thesis investigates strategies for the portable classroom as a way of envisioning a new model for elementary schools in the region of Durham, Ontario. The portable and the school configuration is informed by a set of rules determined by site and program, making each school building unique and suited for its particular context. Geometry and play are at the core of how children learn, and the architecture will implicitly and explicitly engage this sense of play and learning. The pieces making up the modules have an aesthetic similar to Lego and K'nex toys, which immediately engages the childrens' imagination and understanding, creating both a playful and engaging environment for learning. The strategy also brings together a variety of geometric pieces that form different classroom types and which can reconfigure for different rooms and uses. As such, the students may understand how the modules stack and stagger to create unique interstitial spaces for the public and for informal learning. These modules can be reconfigured using interior components that create a variety of smaller environments within the larger classrooms. As well as for expansion and contraction of school populations, these components could be recycled for use by other schools with growing populations. Thus, changing the role of the portable into a malleable, moveable aggregate, and making it easier

and therefore economical to add, transform and subtract classrooms and learning spaces, school buildings come to life and change along with their setting.

ACKNOWLEDGEMENTS

CHAPTER 1: INTRODUCTION

We have to go from something that is basically an industrial style of education – a manufacturing model – which is based on linearity, and conformity, and 'batching' people. We have to move to a model that is based on principles of agriculture. We have to recognize that human flourishing is not a mechanical process, it's an organic process. And you cannot predict the outcome of human development. All you can do is, like a farmer, create the conditions under which they will begin to flourish.

(Robinson 2010, speech)

Thesis Intent

This thesis investigates relationships between learning, play and environment. It holds that to create learning environments for elementary age children the architecture should emphasize individuality, identity, and support the fact that every child thrives with a different method of teaching in different types of environments. Children learn primarily through play, especially at a younger age. Toys too, are used as learning tools and are often basic shapes and volumes that come together to create different forms. With the intention to create a didactic architecture, this thesis uses toys as precedents to develop a strategy for building schools in Durham, Ontario for the Durham District School Board.

This project uses play to create malleable spaces with five classroom module 'kits'. The modules allow the school building to grow and shrink incrementally as needed with population changes, making the massing of every school building in the region unlike the others. A re-design of the portable classroom can aggregate in different ways to create unique unexpected spaces, both exterior and interior. The architectural tectonics of these modules are expressed such that children can understand the pieces needed to form different enclosures. A portable, modular strategy has the potential for expansion over time with the same architectural language as the existing condition, eliminating a hierarchy of spaces among classrooms and emphasizing every child's right to equal opportunity.

Versatile, transformable environments using reconfigurable modules and furniture provides active learning for children. These spaces can be transformed using moveable partitions, storage units and lightweight furniture so that they will accommodate different group sizes and encourage participatory learning.

Applying a strategy to the components of this thesis, they follow rules similar to a game to make unique school buildings in the region. Therefore, children can learn from the buildings themselves at a variety of scales; the classroom interior and its spatial potential, the coming together of pieces to create the classroom modules, the way in

which they attach to each-other and to the main core, the unique leftover public spaces created by these volumes, and the variety of volumes (schools) in the region that is made possible using the same components. Just like every child and their way of learning is unique, each school building will offer un-replicated environments for the children to uncover and understand.

Piaget's stages of cognitive development

INTUITIVE

"Child thinks in a classificatory way but may be unaware of classifications."

CONCRETE OPERATIONS

"Child is able to use logical operations such as reversability, clasification and serialization."

FORMAL OPERATIONS

"Trial steps towards abstract conceptualization occur."

ergonomics of learning

4-5

6-7

8-9

10-11

12-13

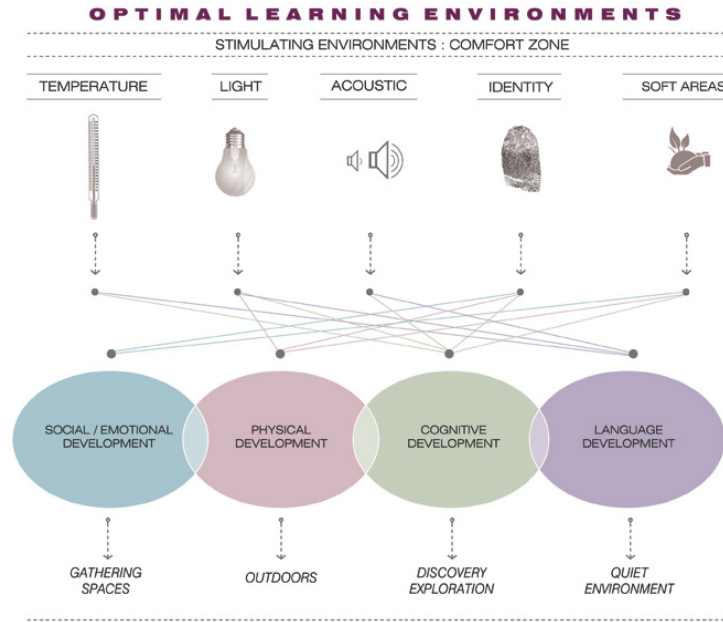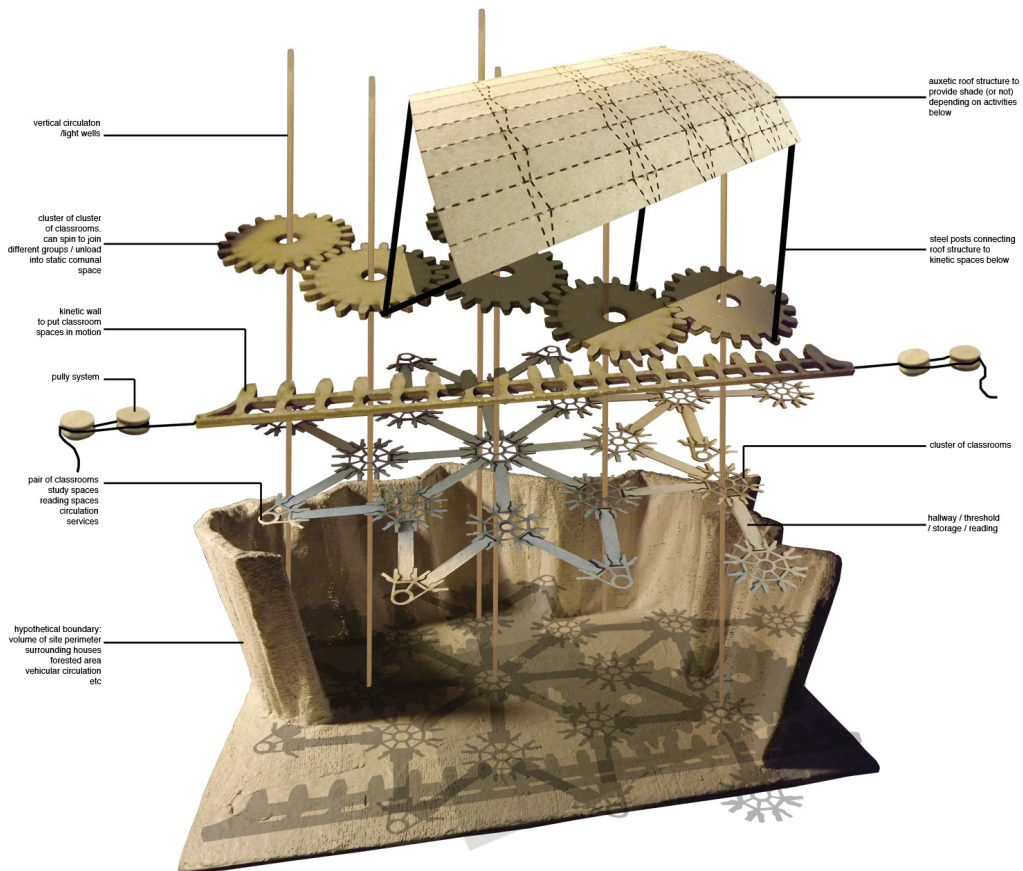Educational toys children play with between the ages of 1 and 13.

Illustration of the different types of environments for learning. (Orellama 2011)

Demonstrating how furniture and fixtures will be operated manually using recognizable systems similar to toys.

Thesis Question

How can toys inform a strategy for classroom modules and their aggregation, to create specificity and transformability for the elementary school model with unique public spaces that are flexible and connected to their population and context?
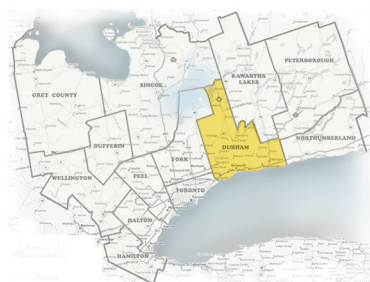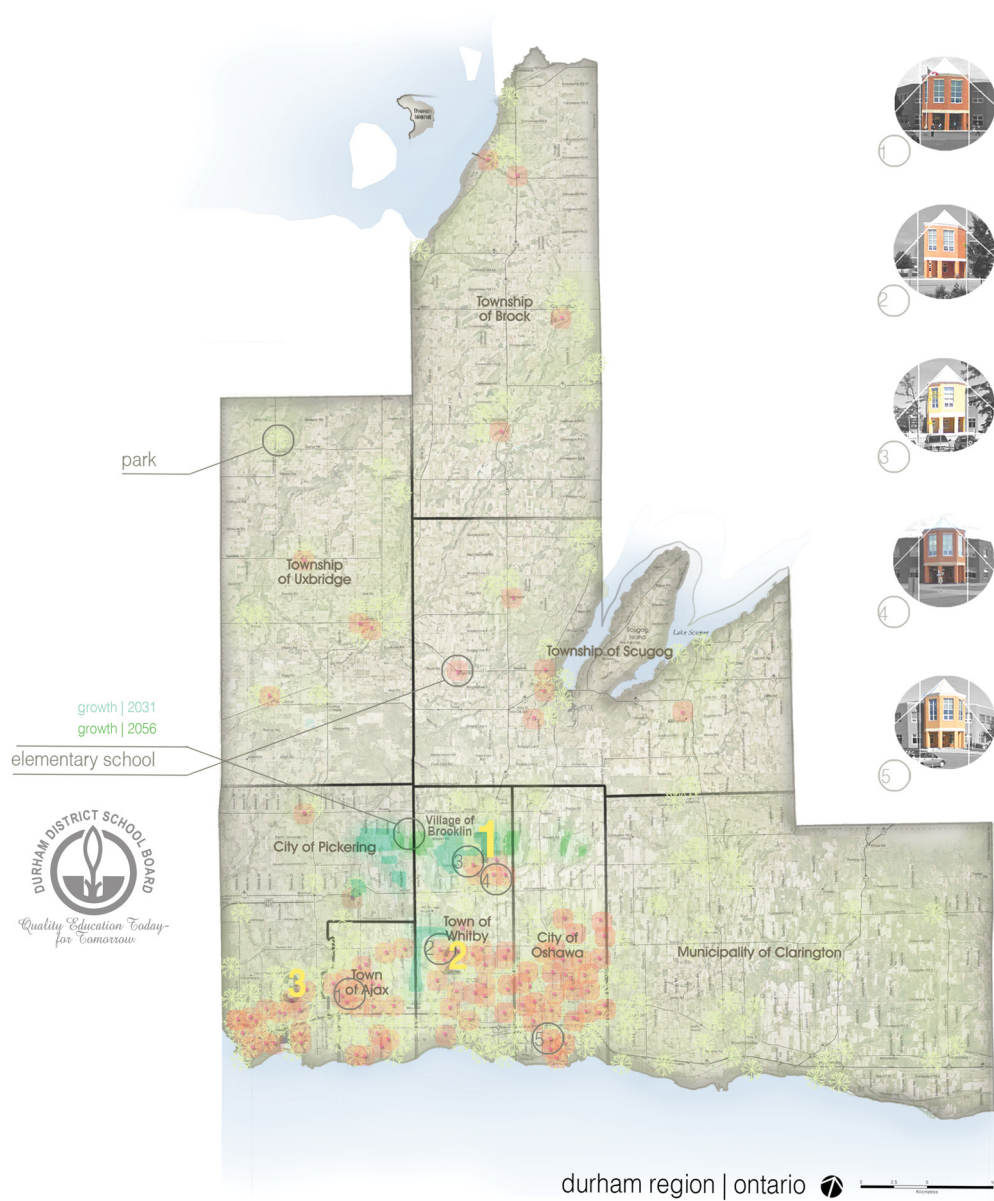
Site: Durham Region

The broader site of this thesis is the Durham Region, which is located in Southern Ontario and is part of the Greater Toronto Area, made up of eight towns. The Durham District School Board is responsible for the public schools in the region, with over 80 schools in seven of the towns. The school board has developed a method for building new schools, now choosing one of four building models every time a new school is needed. Four new schools are currently under construction in the region, with more to come in the future of these growing towns. The only variations to a building model when it is appropriated to a new site are the brick type and some minor interior adjustments, mostly to finishes, furniture, and fixtures, which are the result of surveys conducted with the user 6 months post-occupation of its previous iteration.

The existing schools in the region do not respond to their given context, as exact replicas of the same school can be found even in the same area. The existing models end up having

permanent portables that are not directly attached to the school, some school sites having up to 10 permanent portables. Once there are enough portables to make up a new wing of the school, much of the site is taken over and under construction for several months, further blocking the site and making it less permeable once the addition is complete. The portables in this thesis will feel more like classroom pods which aggregate around nodes and along arteries to create a playful massing, instead of a linear scheme with long, monotonous hallways.

In working with three sites, this thesis is looking for and testing what is unique and what is the same, in order to challenge the norm for school construction and to understand the significance of the formal variations, unexpected spaces, and module aggregate differences from site to site. How can [this] school change the existing peripheral conditions, compared to its state with the existing school? For these reasons I have chosen to work with existing Durham District School Board sites.

Durham Region; locating Durham District schools and thesis sites. (The Regional Municipality of Durham 2006).

if the expansion were
to continue this way ...

2012

new wing

2013
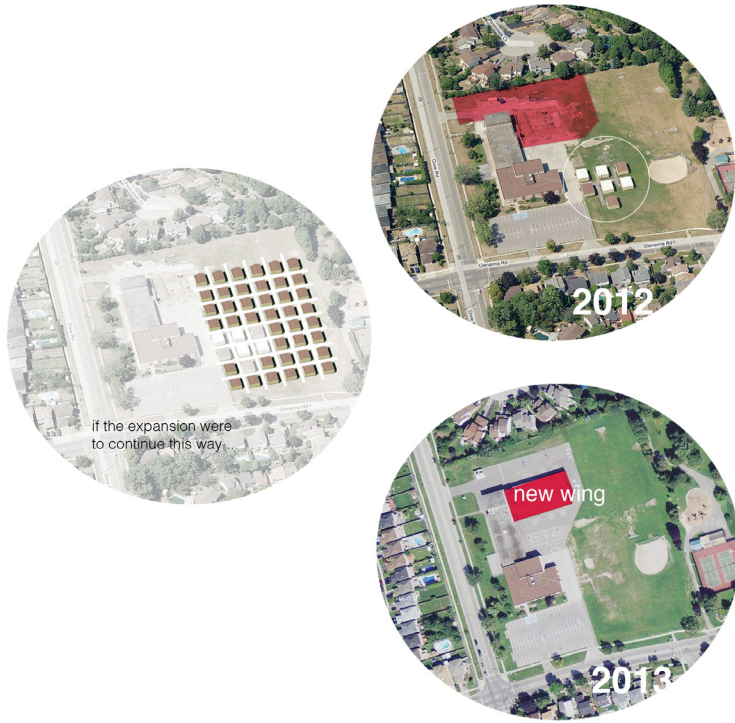
EXISTING METHOD OF EXPANSION

Demonstrating the current portable / new wing system of the existing public schools.

Program

This thesis demonstrates how an architectural intervention could lead to learning and the activation of not only the building itself, but that of the larger suburban setting. The design ideals move away from the existing "cells and bells" model of many schools which accomodates an industrial "factory" model of education, and instead creates changeable, child-sized environments for students to reconfigure themselves.

The existing Durham District School Board models have clear circulation schemes with main arteries within the school. The proposed buildings in this thesis have similarly legible plans, but instead a very different site strategy and a playful aggregation of classroom modules, connector elements and public spaces that accommodate shared spaces, breaking up the existing monotonous nature of these main arteries and circulation areas, bringing light into this environment. The current strategy used for the proposed school being focused on in this thesis, the Unnamed Vipond School, has a program list which can accommodate future growth through the development of a large site and the school's main spaces.

The massing for the three school sites in question accommodates the existing program of the schools. The main arteries of these school buildings are divided into two: one for use by the

students, and one for use by the public after-hours and during the summertime, leading to the hub of the school which is the library.

The three sites in question and their proposed massing to accommodate their existing program.

Site 1: Unnamed Vipond School

The primary site of this thesis is in the Village of Brooklin, located in the Town of Whitby. The new building is currently under construction, its opening scheduled for the Fall of 2014. I have chosen this site because it resides in one of the fastest-growing suburban towns in the region, and is one of the largest elementary school buildings with six kindergarten classrooms and 17 junior and intermediate classrooms. All of the elements in the site strategy are present at this site; expanding suburbs calling for an expandable school building, houses along the periphery and in close proximity to the school, a creek and forested area nearby, and an adjacent Catholic school building.

Brooklin school site under construction; Summer 2012.
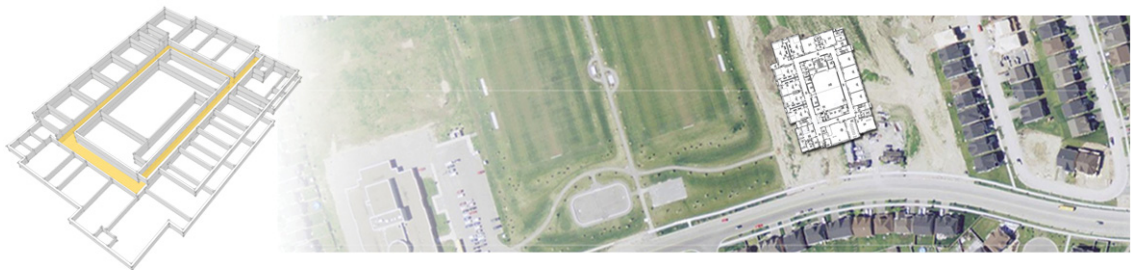
Unnamed Vipond School site and Durham District School Board building model.

Site 2: Ormiston Public School

Ormiston Public School has been in operation for over 20 years and is nestled in a dense suburban town. It is located in a zone with no room for residential growth. This school also has a Catholic school adjacent to the site, and a public playground next door. The Ormiston school building is smaller than the proposed Vipond building; it has only three kindergarten classrooms and 14 junior and intermediate classrooms. The one programmatic difference with this school is that it offers a daycare for the children in the surrounding area.

Ormiston Public School building and site.

Site 3: Dunbar Public School

William Dunbar Public School is located in the City of Pickering, bounded by suburbs and a heavily forested area. There are a few schools in the same area as this school: another public school as well as a Catholic elementary school. This school building is also nearly 20 years old, and a whole wing was added to the school in the 1990's to accommodate for the growth in the area. Prior to its renovation there were 6 portables on the site, whose imprints remained

for several years after permanent expansion. This site is small and does not allow for much growth; there are three kindergarten rooms, 14 grade levels 1-8 classrooms, and the parking lot takes up most of this small site.
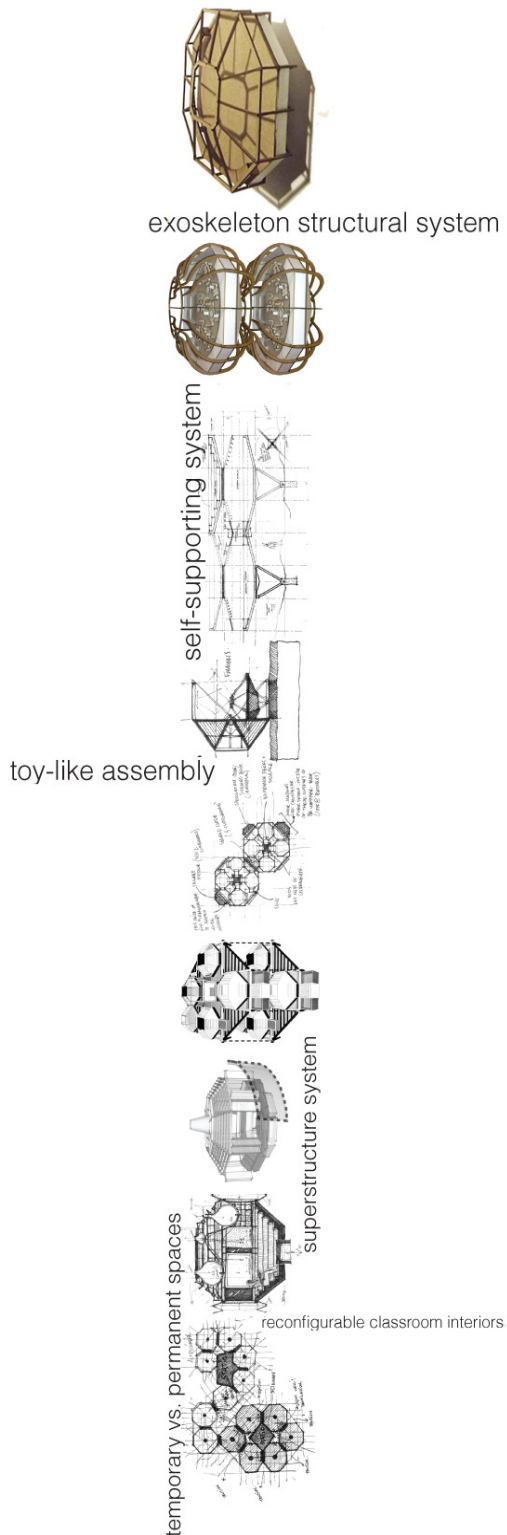

William Dunbar Public School building and site.

exoskeleton structural system

self-supporting system

toy-like assembly

superstructure system

temporary vs. permanent spaces

reconfigurable classroom interiors

Design process of octagonal classroom unit.

CHAPTER 2: DESIGN

The Portable Classroom

In this project, an octagonal classroom module accommodates several spatial and programmatic functions at the scale of the room and school. The idea for both the form and the exterior frame structure with in-fill panels gave the classroom portables both functional (acoustic, views, ventilation and day-light) as well as programmatic reason that enable more flexible and more comfortable environments. This multi-faceted volume is composed of a series of articulated joints and components that are lightweight, meaning they are easier to assemble and disassemble. Because this volume is made up of different geometries including the circle, triangle, rectangle, and square, it allows for a variety of interior layouts with different furniture as well as a wider variety of interstitial spaces.

The modules can also stack directly on top of each other or stagger on their slanted roof edge, creating a smaller overall school height and more playful relationship between rooms. This variation in stacking and the simple geometries and detailing make the possibility of removing and recycling the individual components. When a junior classroom is no longer needed, its frame can continue to support the modules above and below it and the pieces which form the enclosure can be removed and recycled elsewhere.

The (3-D printed) pieces making up the elementary schools.

Aggregate Components

Each portable classroom is made up of identifiable pieces or parts similar to toys such as Lego and K'nex, and these are used to enable the schools and the public space to adapt and adjust to their changing circumstances. Each school building here is made up of seven different types of pieces overall: the classroom (A), for kindergarten, junior, intermediate, and special rooms for music, science, and art; its connector piece and the main circulation core (B) which connect to the hub of the school (the library); shared spaces connecting the classrooms to form clusters (D); and the multi-purpose space for physical education and events (C).

A hypothetical aggregating of the pieces to create a school building.

CHILDREN LEARN THROUGH PLAY...
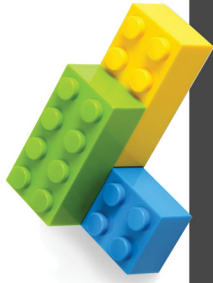
Piaget's stages of cognitive development

INTUITIVE

"Child thinks in a classificatory way but may be unaware of classifications."

CONCRETE OPERATIONS

"Child is able to use logical operations such as reversability, classification and serialization."

FORMAL OPERATIONS

"Trial steps towards abstract conceptualization occur."

MODULE PIECES DRAWING INFLUENCE FROM K'NEX AND LEGO TOYS

A diagram of the 33 total piece types needed to make up the classroom modules.

Building Strategy

1. Types of Classrooms

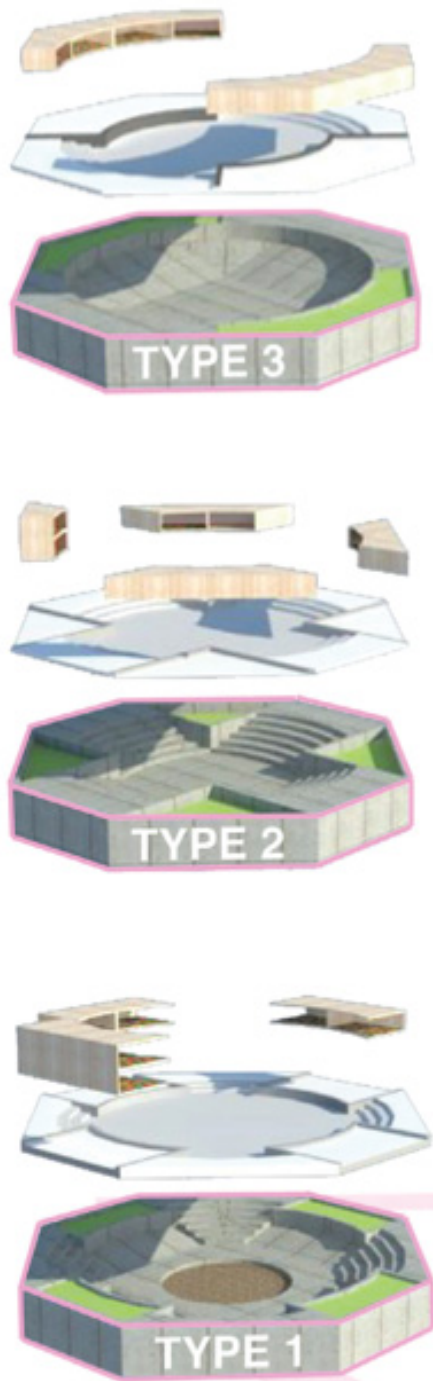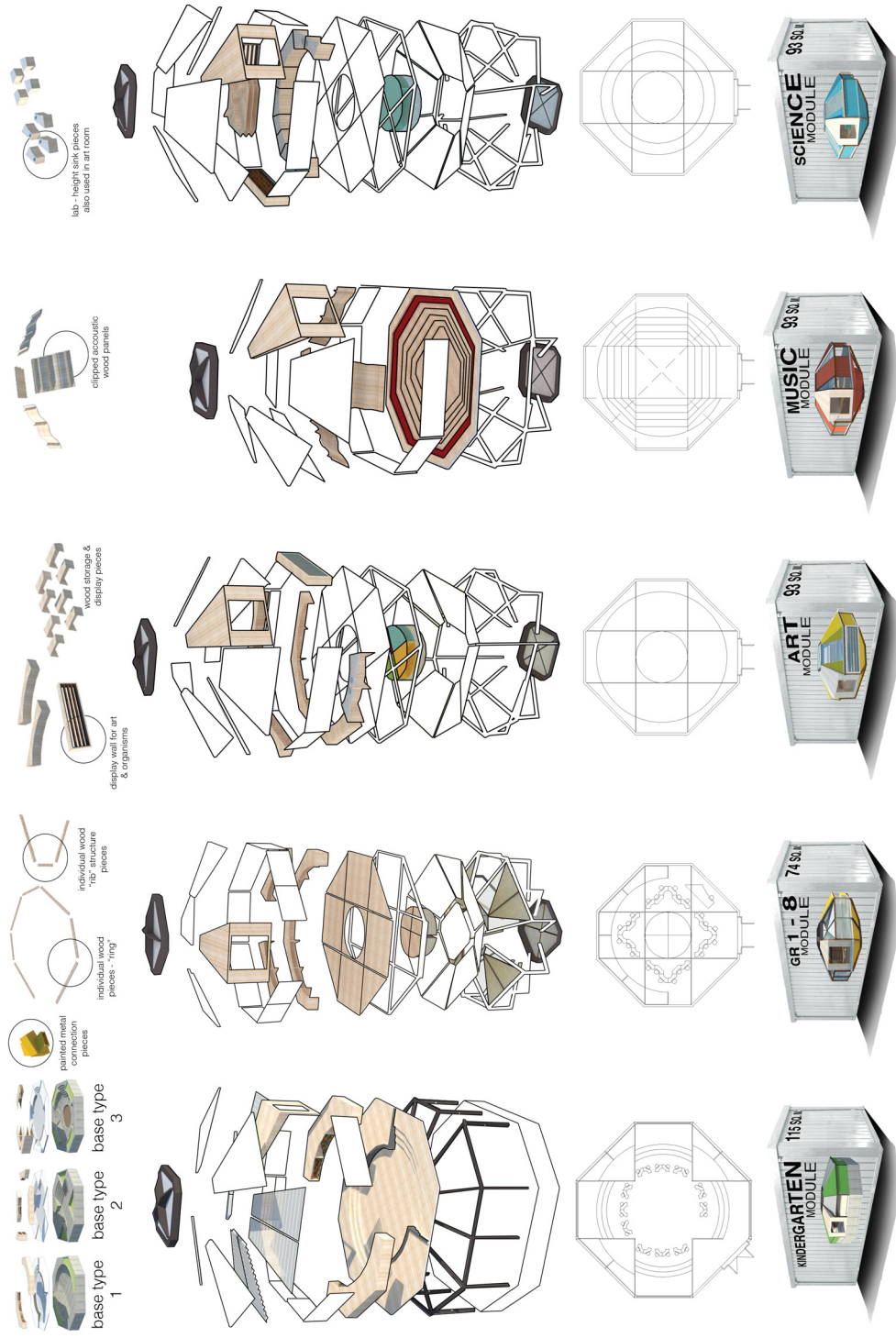Typically elementary schools have five classroom types: kindergarten, grades 1-8, science, art, and music rooms. The first to be placed on site in this strategy are the kindergarten modules, placed near residences and away from vehicular traffic for safe outdoor play areas; they are also the first to be placed because they support junior and intermediate-level classrooms above. These modules have three base piece types to serve as public spaces before they become enclosed classrooms, each piece illustrating the layout for the future classroom. The second types of modules to be placed are the science, art and music modules. These rooms should be located along the public route through the school, with organisms, artwork and performances on display to create active hallways for the public. The music room module is to be placed as far away from the other classrooms to create an acoustically sound school overall, and the science and art room are to have especially good natural daylighting; modules cannot stagger atop these rooms or be placed in the shadows of other modules. Grade levels 1-6 should be on the second level of the school, stacked directly overtop the kindergarten modules. Intermediate (grades 7 and 8) modules stagger between the former rooms and are the third level of the school.

"Seeds for growth"; the three kindergarten base piece types.

CLASSROOM TYPES

base type 1
base type 2
base type 3

painted metal connection pieces

individual wood pieces - "ring"

individual wood "rib" structure pieces

display wall for art & organisms

wood storage & display pieces

clipped accoustic wood panels

lab - height sink pieces also used in art room

KINDERGARTEN MODULE 115 sq.m.

GR 1 - 8 MODULE 74 sq.m.

ART MODULE 93 sq.m.

MUSIC MODULE 93 sq.m.

SCIENCE MODULE 93 sq.m.

1

There are 5 different classroom module types: kindergarten modules are nestled near homes & away from vehicular traffic on ground level. Junior modules are stacked directly on top, and intermediate modules are staggered on third level. Art, music & science modules on ground level near public path to activate public thru-ways with displays and performanes.

Building strategy step 1.

2. Stacking and Staggering

Standard elementary school practices cannot have an overall height above 3 storeys to enable easy access of the school building for its students. The classroom modules themselves have stacking and staggering rules that preserve natural daylight into the rooms and cross-ventilation into each classroom module. Classrooms can be placed two-wide for as long as the site permits, but when they are 3-wide they can only extend two rows, so one module is not left in the center without natural ventilation and daylight. Every kindergarten module can have a junior module stacked on top of it, and the top intermediate module staggers in between two second-level junior modules, with most of their load being carried by shared spaces for the junior classrooms below.

There are fewer kindergarten classrooms in every elementary school than there are intermediate classrooms, so only a handful of intermediate modules will be supported by these structures. Some of the other modules may either be supported by larger spaces, or other intermediate classrooms so long as they are not stacked / staggered more than three modules high (as not to tower above the suburban condition). The rest of the modules will be held within a secondary structure lifted off the ground level for minimal contact with the site for easy removal and maintenance of public and informal

spaces on the ground level of the schools. Entire clusters of classrooms will be supported by a larger structure whereas the individual "outlier" classrooms will be supported individually until enough are added to form an additional cluster.
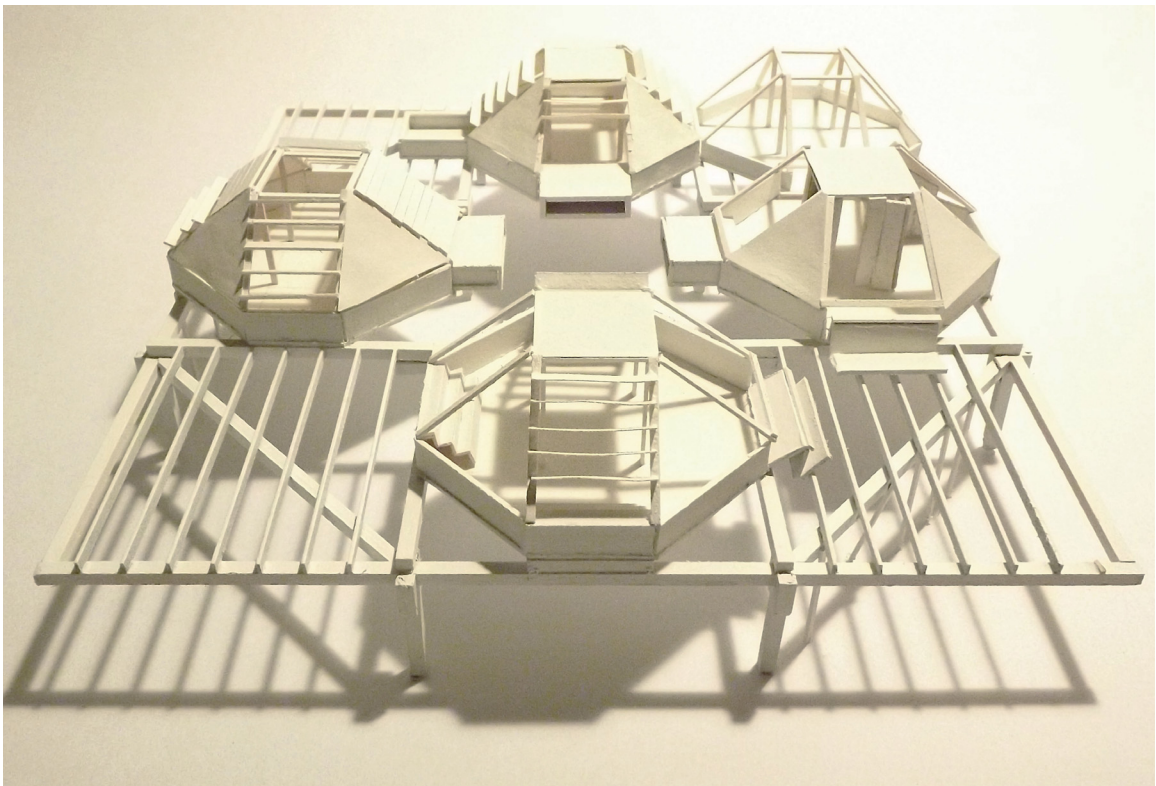
Model of structure to support additional classroom modules.

outside

core

**STACKING / STAGGERING & AGGGREGATING**

2
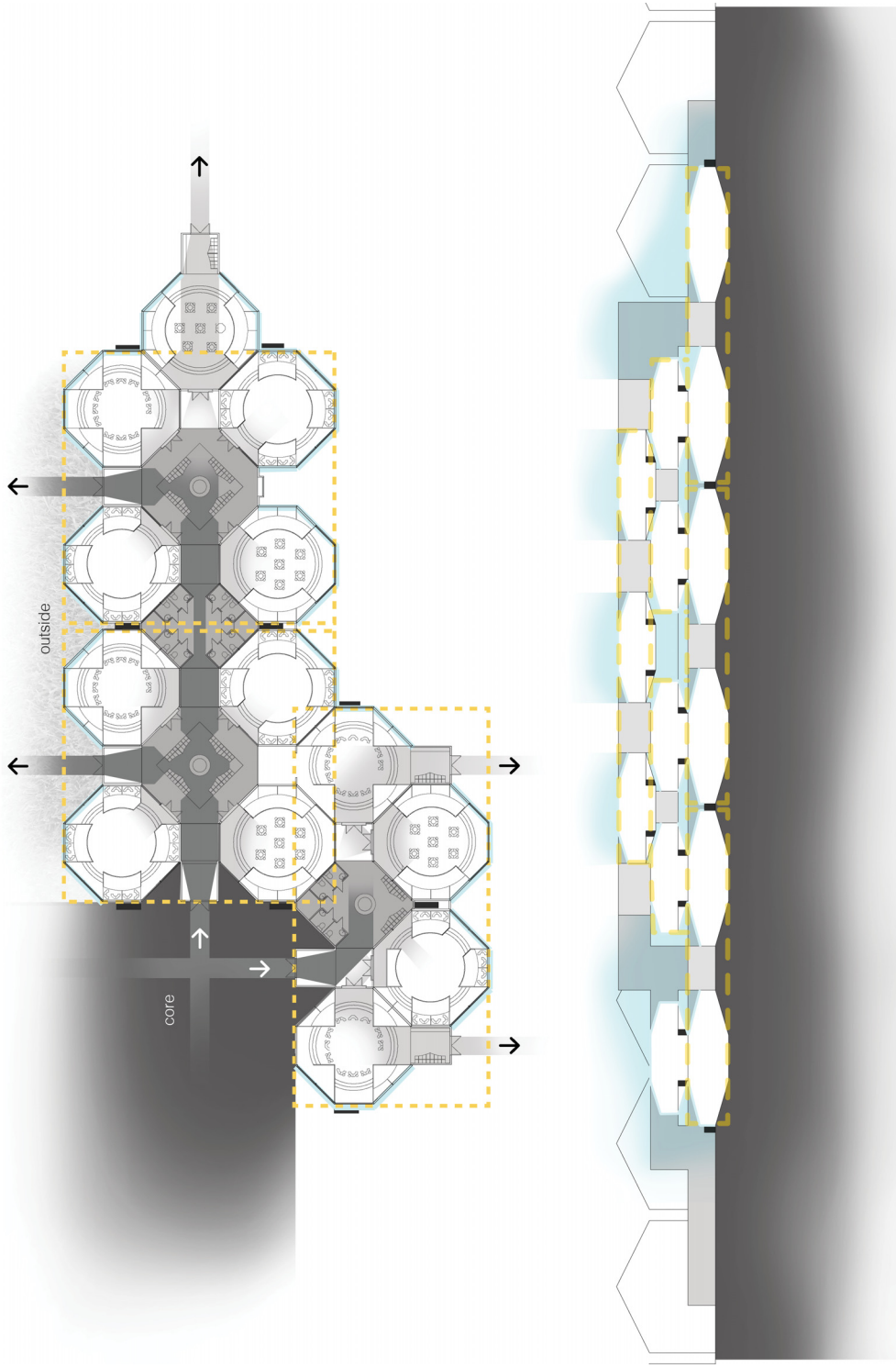
Schools cannot have an overall height above 3 storeys in order to preserve views and daylight into surrounding homes, as well as into the modules themselves. Every module must have at least one vertical face for daylight and ventilation, meaning there can never be a module bound by 8 other modules. Each kindergarten module must be accomodated with one bathroom and sufficient storage / changeroom space. Junior & intermediate modules must all have access to a shared space and a washroom nearby.
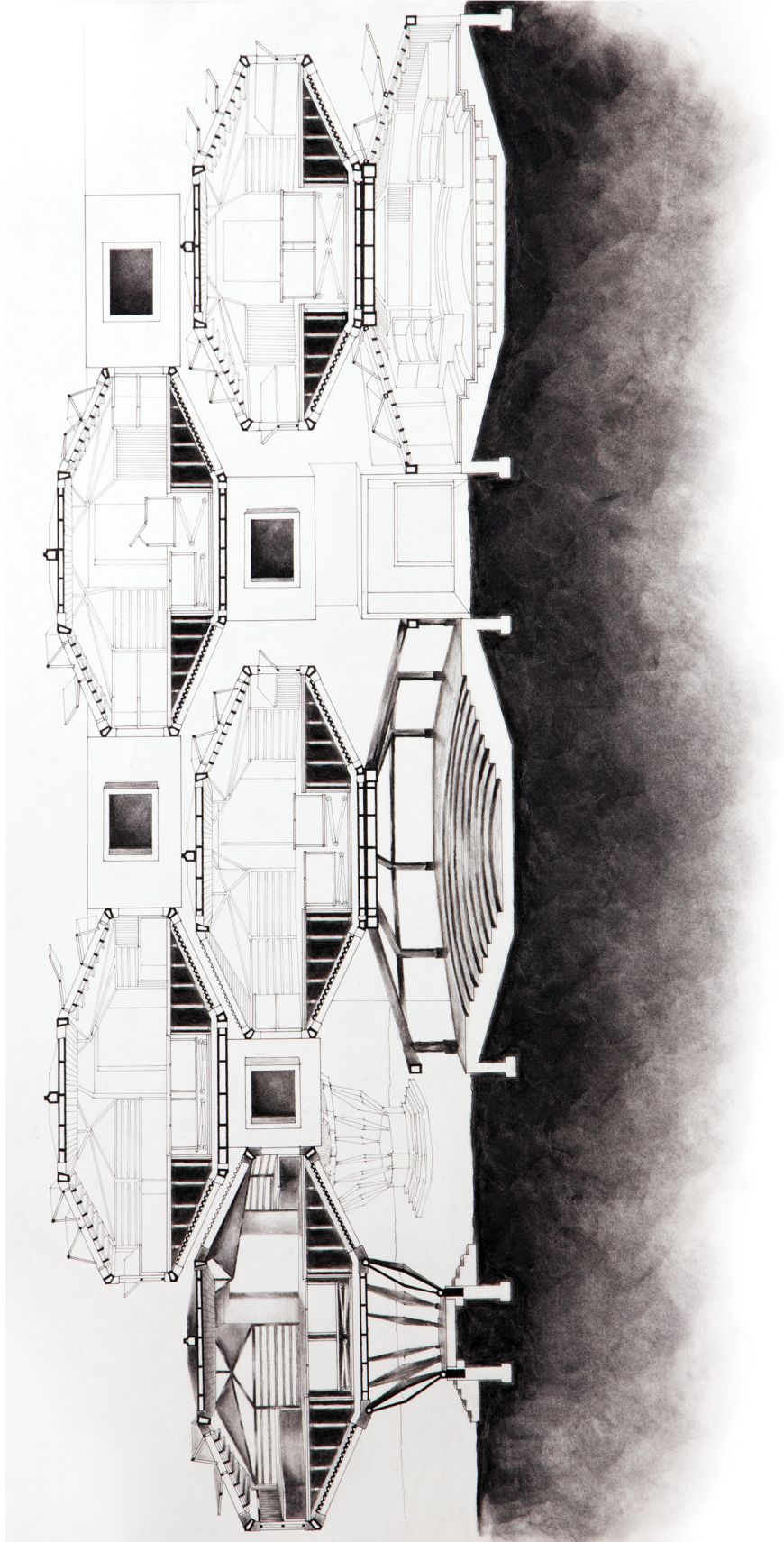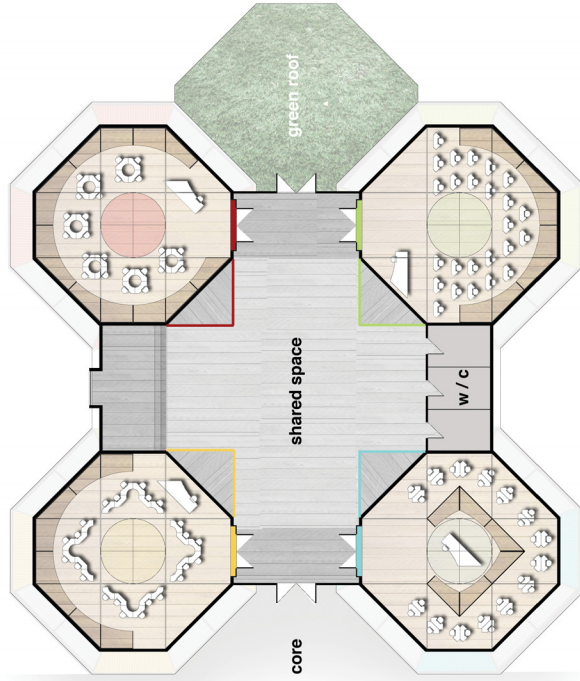
Building strategy step 2.
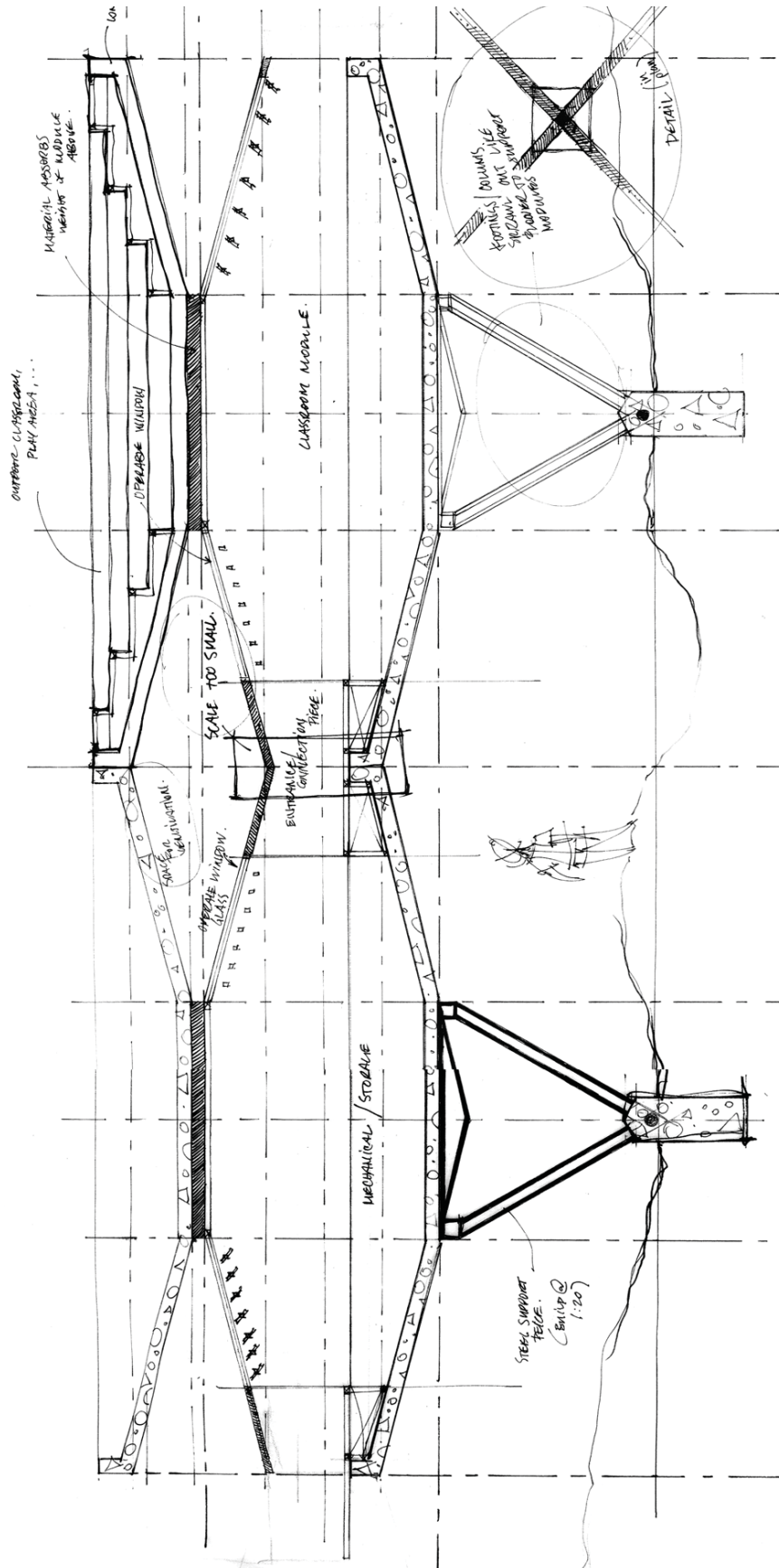
Section through independently-supported modules.

Section through classroom modules of Brooklin school.

3. Connections & Configurations

The modules are each "plugged" into connector pieces B and D (page 17) that accommodate lockers, services, bathrooms, shared spaces and changerooms. These are made up of pieces in the same way as the modules themselves. These pieces can also be added to in order to accommodate future growth, or can be removed for use by another growing school if the population for a given school is decreasing. The architectural expression of these connector pieces is similar to the module components in that they are clad in corrugated metal and have metal seams between them to illustrate that they can be added to and expanded.

CONNECTIONS & CONFIGURATIONS

3

LEV 1 kindergarten module cluster   1:50

green roof

shared space

w / c

core

type 3

type 1

changeroom

type 1

type 1

exit

exit

LEV 2 junior module cluster   1:50

shared

shared

core
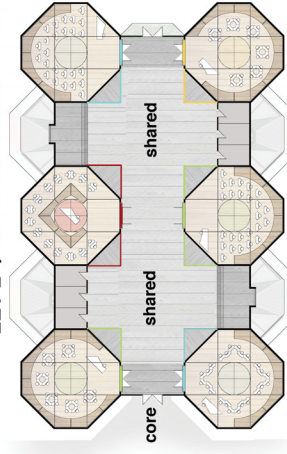
LEV 3 intermediate module cluster   1:100
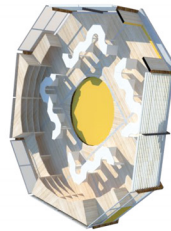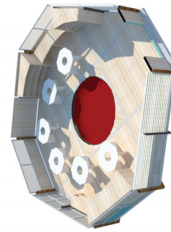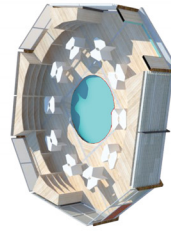
The classroom modules are primarily clustered into groups of four with one shared diamond-shaped space and washrooms at equal intervals between them. Shared spaces are for informal gathering or bringing together students from different rooms for a learning session. All furniture in the modules is easy to reconfigure for different group types / teaching styles, with operable fixtures to control daylighting and ventilation differently depending on activities.

Building strategy step 3.

4. Growth and Shrinking

Just as the frame of the intermediate classroom leaves a mark of what was there at one time after the classroom is removed, the kindergarten rooms leave an imprint in the ground when they are removed from the site as well. These imprints serve public spaces or outdoor classroom, or playground for the children. They can exist prior to future growth of classrooms as well, offering this useable space in the meantime. Unlike the intermediate rooms, which serve a variety of purposes and have different functions for science, music, art, and so on, the kindergarten rooms all have the same programme: craft, story-time, nap-time, play, and foundations for future learning. There are three different kindergarten base "types" with different layouts, extruded from the public space once they are added to the site. Once it is removed the leftover space will be a narrative of sorts, illustrating what once was.

GROWTH & SHRINKAGE OF SCHOOLS
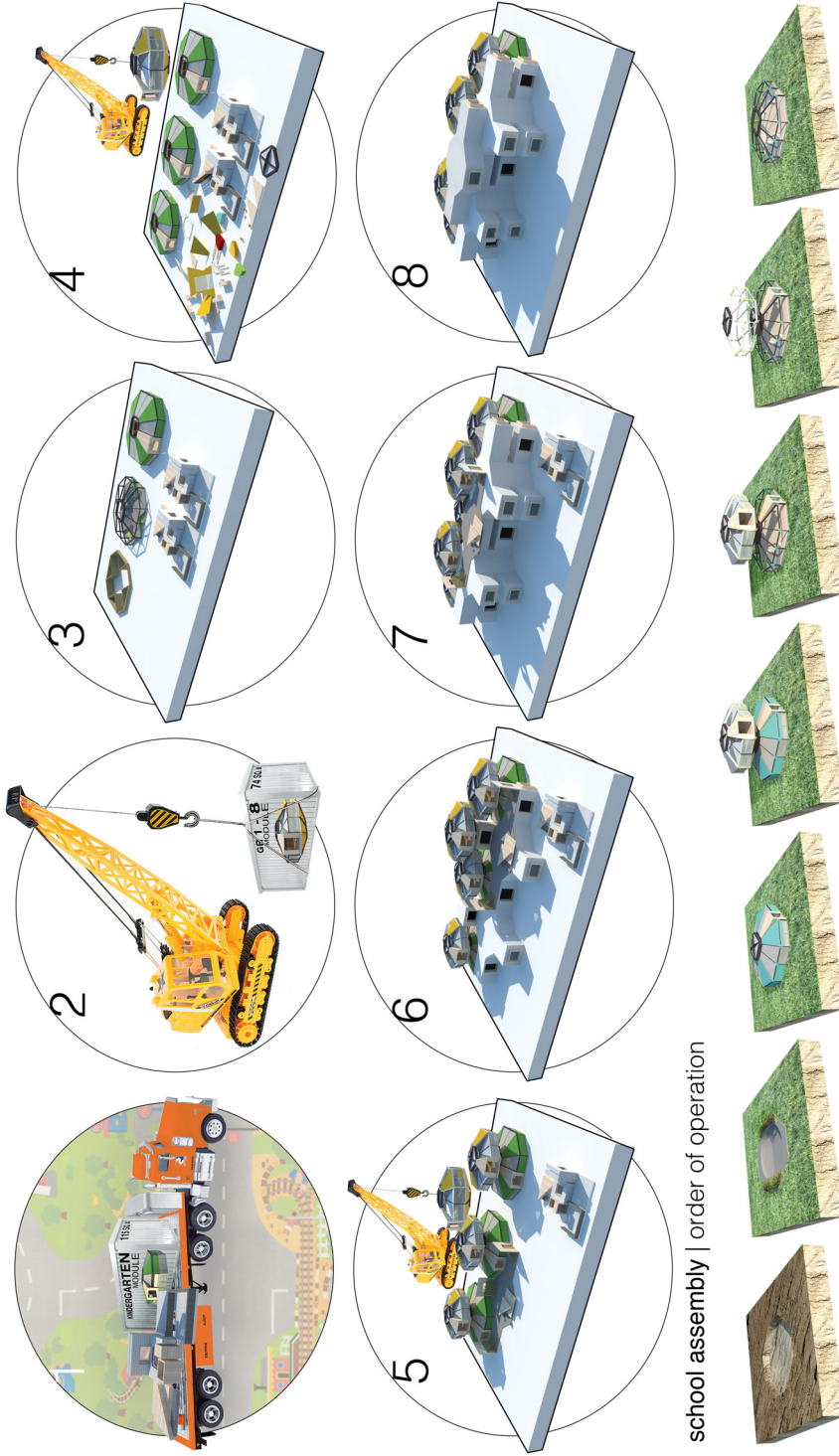
school assembly | order of operation

kindergarten & junior modules | before & after

4

1	2	3	4	5	6	7
excavate site for future kindergarten classroom	pour concrete to form one of three kindergarten base types for public use	install frame and module pieces to form kindergarten module/b when new classroom needed	stack new junior - level classroom module atop kindergarten module	remove & recycle kindergarten module pieces once classroom no longer needed	remove & recycle junior-level module pieces & frame once no longer needed	formal public space / outdoor classroom left behind with frame for future vertical growth.

The base pieces of the kindergarten modules will function as public spaces before a module is enclosed to form a classroom, and will leave behind a formal public space / outdoor classroom once the enclosure is recycled for another school. Modules 1 - 8 will leave behind a frame when the room is no longer needed, remaining on site for future growth. Every part of the school is modular and accomodates expansion and contraction with fluctuating populations in their suburban settings.

Building strategy step 4.

Site Strategy

Each classroom module will arrive on-site as a set of prefabricated parts with a guidebook for assembly. These new schools will also have a set of rules to help the School Board respond to particular site conditions and to accommodate its community. The schools follow two sets of rules: one relating to site, and one relating to the modules themselves. These two sets of relationships ensure that the context, site, public program and classroom configurations are all interconnected and beneficial to one another.

1. Context

First, connect public pedestrian paths through site to integrate it into the existing network and enable it to be easily accessed from various points along the site's edge. In this way the school and site does not pose an obstacle to the neighbourhoods nearby and instead allows traffic and use through the site after school hours and during the summertime.

2. Bike and Car Parking

As parking takes up much of the site area it is important to locate these zones on the site before appropriating modules. Parking should be as close to the main connector on the site as possible for easier accessibility and more leftover space for the school, field, and public space.

3. Entrance and Access / Exits

There should be a clear differentiation between public access and private (student/teacher) access. These two entrances should be placed along public paths and gesturing towards the parking area. Routes through the school should meander around or above the public passage in order to maintain safe environments for the student population.

program

general office
staff room
2 special ed
multi-purpose
resources
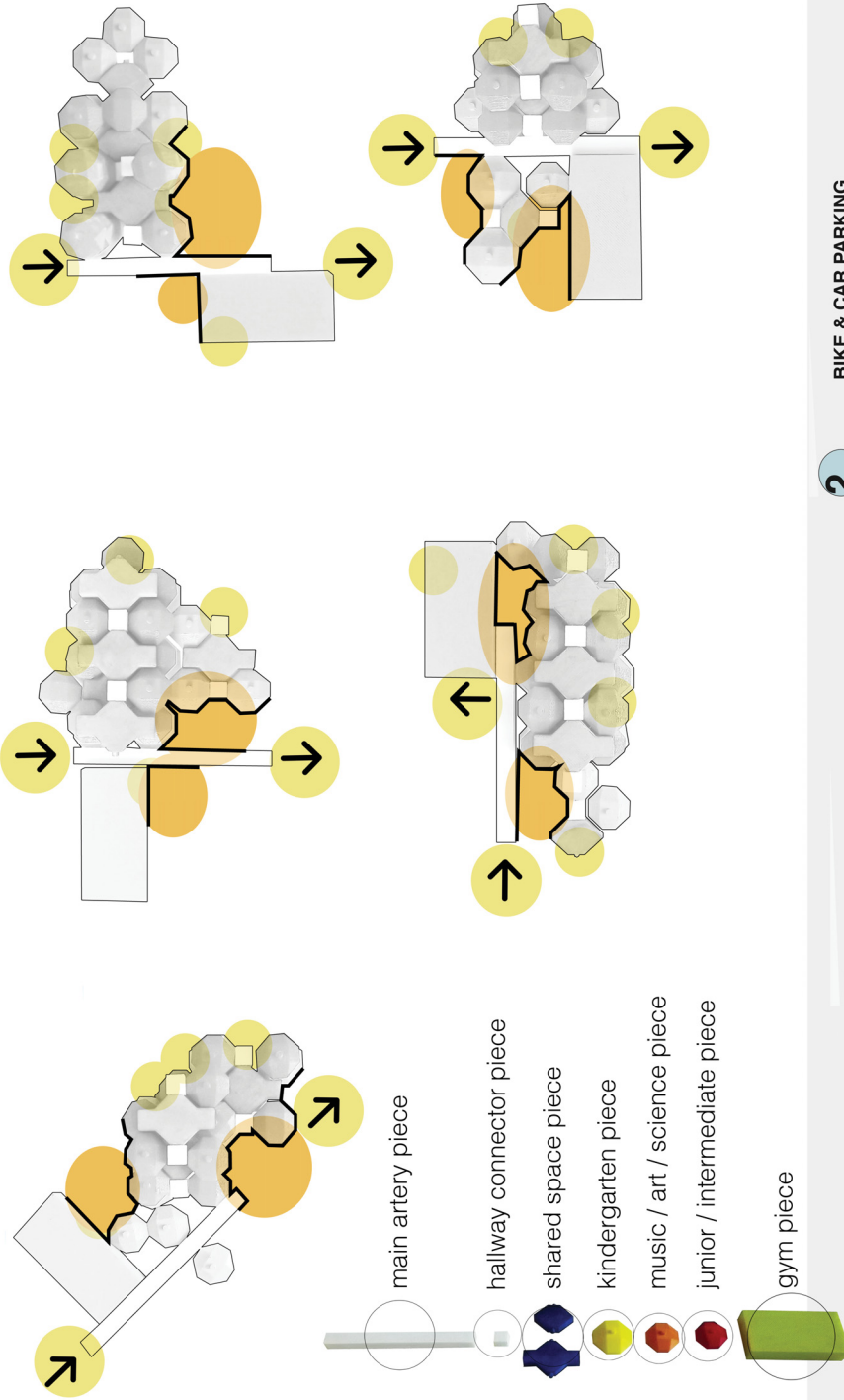computer room
library
general purpose

under
construction

x6

x17

KINDERGARTEN MODULE 115 sq.
GR 1 - 8 MODULE 74 sq.

SCIENCE MODULE x1
MUSIC MODULE x1
ART MODULE x1

site 1 | brooklin

general office
staff room
2 special ed
multi-purpose
resources
computer room
library
general purpose

+ daycare

x3

x14

KINDERGARTEN MODULE 115 sq.
GR 1 - 8 MODULE 74 sq.

SCIENCE MODULE x1
MUSIC MODULE x1
ART MODULE x1

site 2 | whitby

general office
staff room
2 special ed
multi-purpose
resources
computer room
library
general purpose

+ new wing

x3

x14

KINDERGARTEN MODULE 115 sq.
GR 1 - 8 MODULE 74 sq.

SCIENCE MODULE x1
MUSIC MODULE x1
ART MODULE x1

site 3 | pickering

PUBLIC PEDESTRIAN PATHS

1

Connect existing paths through site so that it can be accessed from various points along the periphery. This way the school site does not pose as an obstacle to bringing together the surrounding smaller neighbourhoods. Gates will secure the school site during weekdays, and will be open evenings, weekends and during the summertime for community use of kindergarten public base pieces, the library, field, and multi - purpose rooms.

Site strategy step 1.

4. Public Spaces

The public outdoor spaces should be placed along the routes through the site and in plain view for safety reasons. These spaces are along the library, the multi-purpose room, and are situated where future or removed kindergarten classrooms are located. The base pieces of these modules will be embedded in the land, with three different types to provide a formal variety of public spaces or for outdoor classroom use.
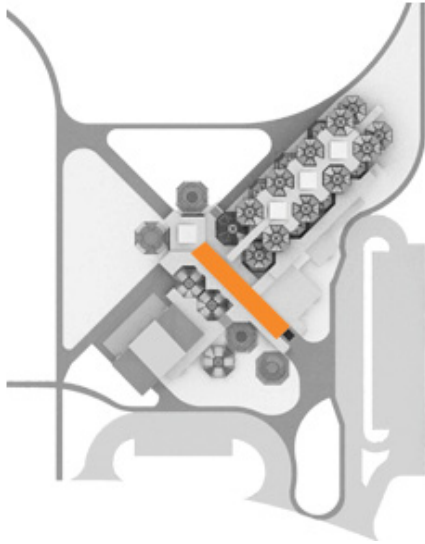
PUBLIC SPACES

BIKE & CAR PARKING

ENTRANCE & EXITS

2

3

4

main artery piece

hallway connector piece

shared space piece

kindergarten piece

music / art / science piece

junior / intermediate piece

gym piece

Bike and car parking close to main artery into site.

There should be a clear differentiation between public and private paths through the school the create safe environments for the students. The public passage leads to the library for shared use but is only accessible after school hours and during the weekends / summer time. Private (teacher / student) paths should meander around and above public passage. The paths should connect nodes on the site and gesture towards the park nd public spaces created by the kindergarten module base pieces.

Site strategy steps 2, 3 & 4.
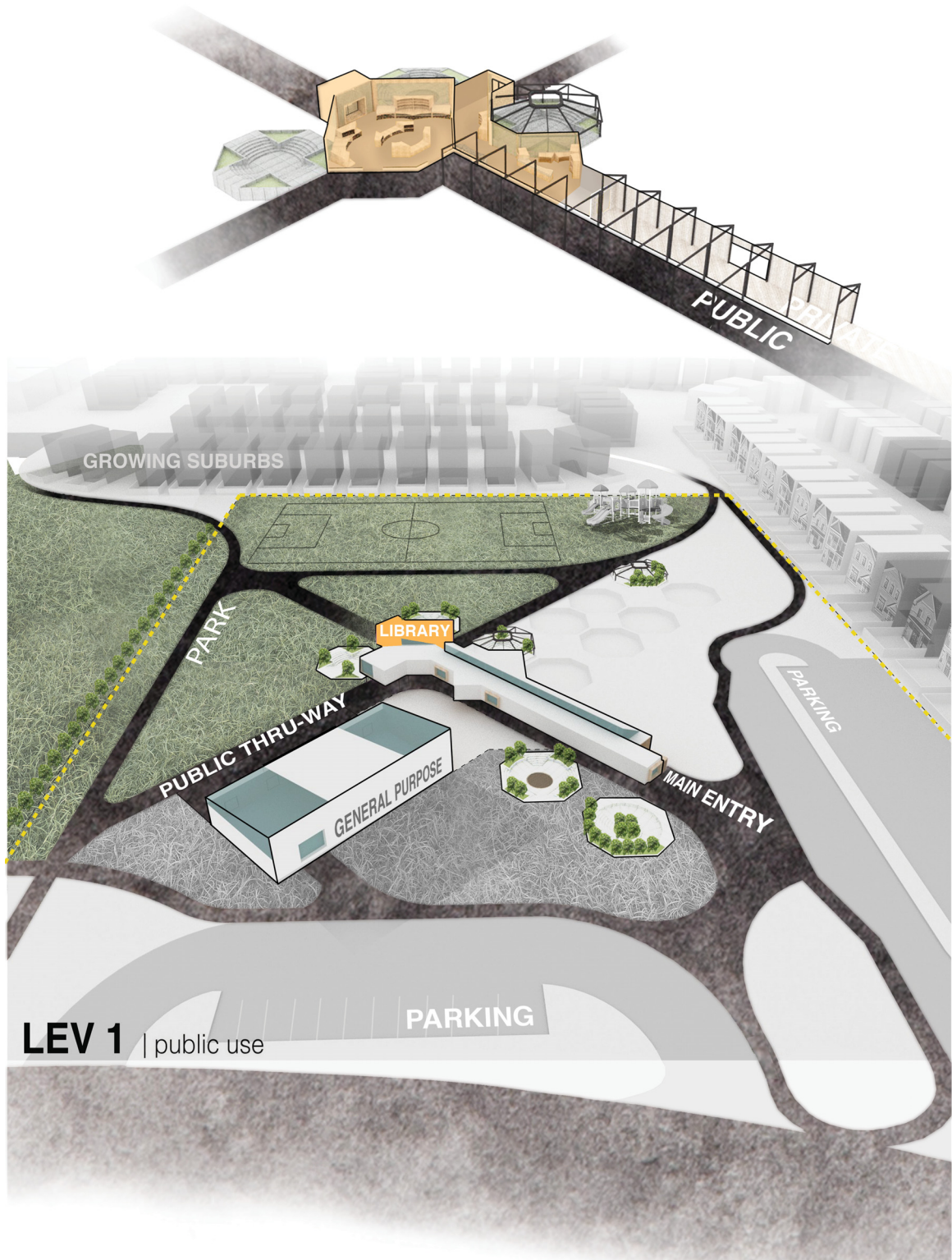
Brooklin Site School Design

The Brooklin School site was chosen to test the building and site strategies outlined above. The public paths were first connected across the site, and the library space is placed where the most paths intersect, facing the park adjacent to the site as well as the Catholic school next door. The main artery through the site for both public and school traffic leads to the library and connects the two most disconnected points at the site.

Plan of new Unnamed Vipond School, showing main circulation core for both the public and the student body.
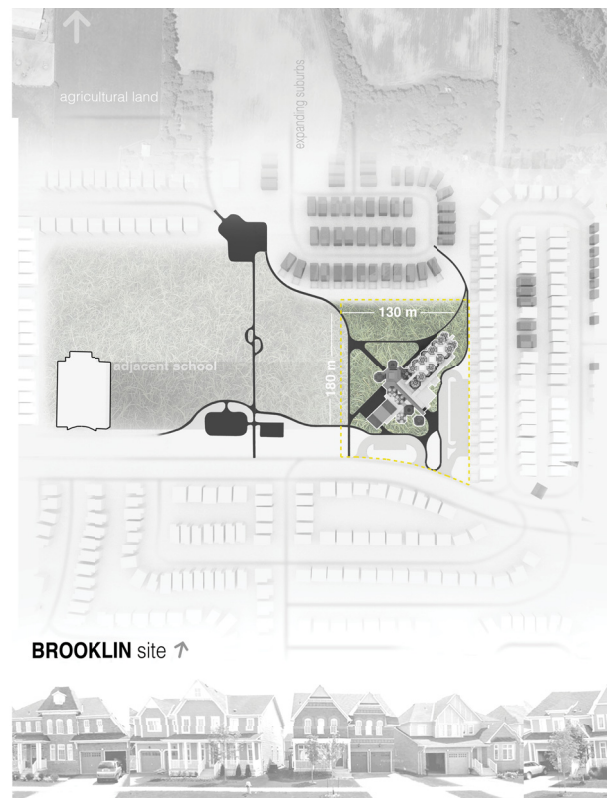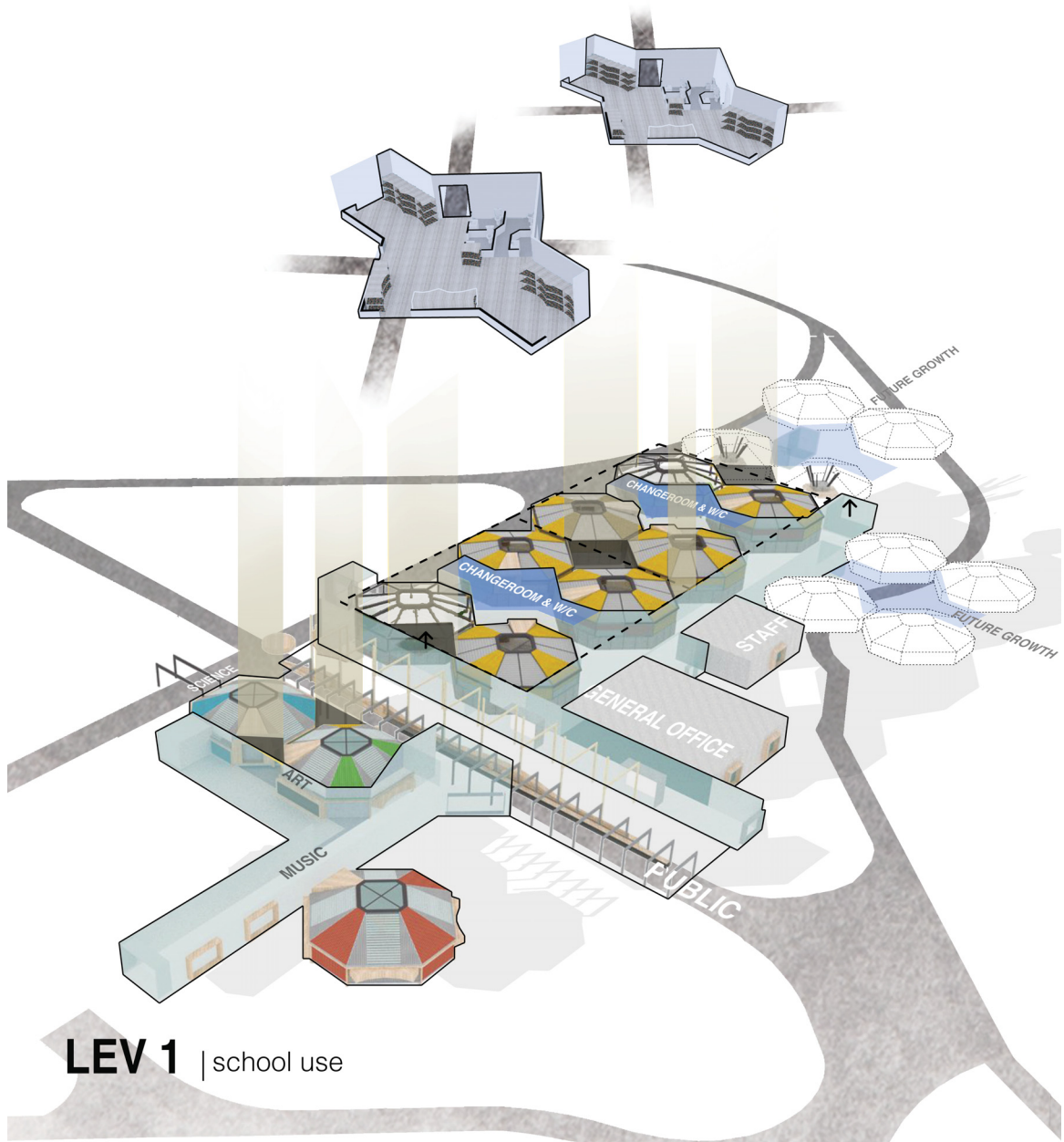

BROOKLIN site ↑

Site plan of Brooklin school illustrating public paths and immediate context.

The kindergarten modules were placed nearest the residences and farthest away from vehicular traffic for a safe playground. The junior and intermediate modules are stacked and staggered overtop the kindergarten modules, meanwhile preserving light and ventilation for each classroom. The extendable corridor and the rest of the school is then placed, serving in this thesis almost as an armature for the modules. The gym space is near the field and public park, and accommodates the public at its entry point from the park.

In this thesis, the spaces in the school are bright and playful. This new learning environment inspires children and teachers to learn creatively and to change their environment to suit their learning needs (see illustrations on pages 40-45).

PUBLIC

GROWING SUBURBS

PARK

PUBLIC THRU-WAY

LIBRARY

GENERAL PURPOSE

MAIN ENTRY

PARKING

LEV 1 | public use

PARKING

Level one of Brooklin school showing public spaces (gym, space outside gym, library and kindergarten base pieces) and pedestrian paths.

LEV 1 | school use

Level one of Brooklin school showing kindergarten modules as well as music, science and art rooms.
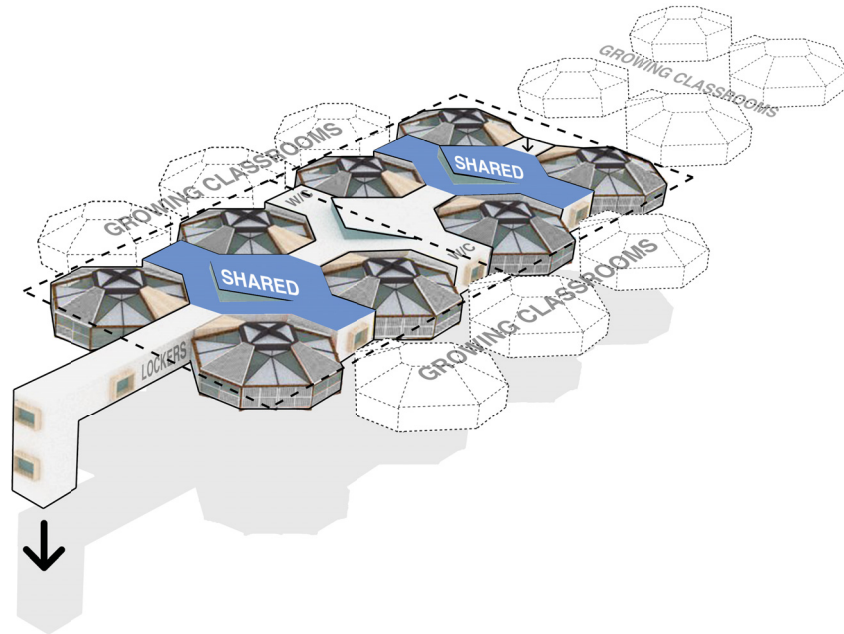
LEV 3 | intermediate
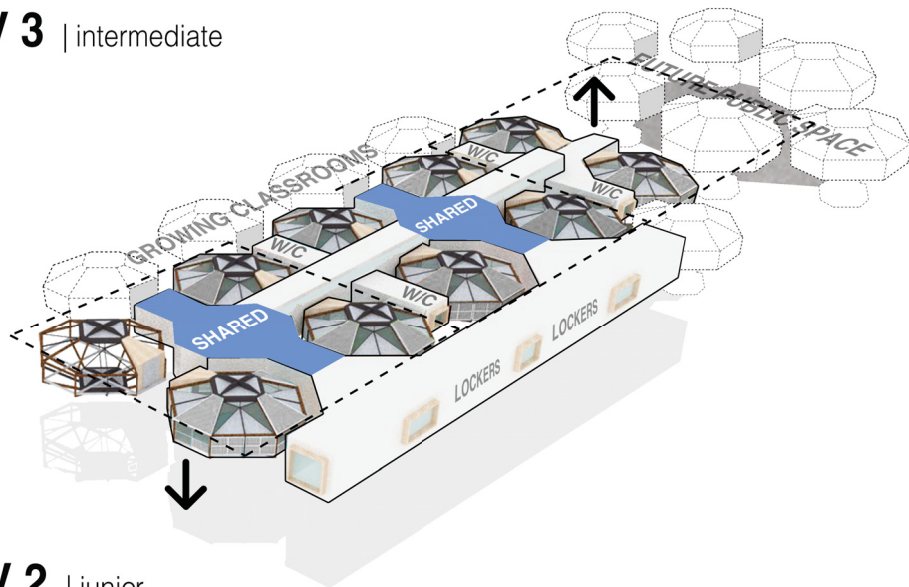
LEV 2 | junior

Levels two and three of Brooklin school.

View approaching school from pedestrian path through site.

View from inside public space; i.e. kindergarten base piece.

View approaching library.

View from inside the hallway, the public path to the right.

View from inside shared space in between junior-level classrooms.

View from inside classroom module.

CHAPTER 3: CONCLUSION

Schools are by necessity something that need to adapt and change due to change in demographics and usefulness. If these institutional buildings could take on a didactic architectural language, the children could come to understand how the building fulfills these needs. In re-designing the portable, this thesis takes on these issues, making it able to accommodate the character of its context as well as create unexpected spaces and playful environments. The students can reconfigure these spaces themselves, giving every child an opportunity for informal, self-guided learning. Stacking and staggering these classrooms is a familiar way of creating intimate, personal spaces for the children as they play with toys to learn spatial relations in a similar way.

The trial design at the Brooklin site demonstrates these values, with an interesting ground condition of public spaces (kindergarten base pieces) and welcoming threshold conditions into the library and gym. The school has a playful aesthetic with visible connectors, colour and wood interior finishes to make the students feel comfortable. The shared spaces offer an informal environment for meeting that can be reconfigured into smaller areas for playing, reading, talking, and writing.

If I were to expand on the idea of play and rules of the game, the mechanical components of the modules and of the school would follow a similar

set of rules and be aggregated similarily to the classrooms.

If this thesis would be realized in the Durham Region School District, the lightweight building components and modules could be fabricated and delivered by a company like Panasonic or General Motors, in the City of Oshawa. This would bring together know how and economic need, as both these companies create vehicles or gadgets very similar to the portable classrooms. These companies could devote an entire site to the fabrication of these components, delivering them to their respective sites whenever a new classroom or school is needed in the region.

The aggregation of portables in this thesis create interesting and ever-changing school buildings for the children where they can come to understand spatial relations, geometry, light, ventilation, volumetric rules, and structure. The students can learn in an informal environment and they can both observe and play a part in changing their school building and their learning environment. This is created through a playfulness in the architecture and in how the pieces are articulated, each with a set of rules, very much like a toy. The students of these schools are provided with a building as unique as their learning needs, filled with child-sized, reconfigurable geometric spaces that foster an intellectual growth.

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