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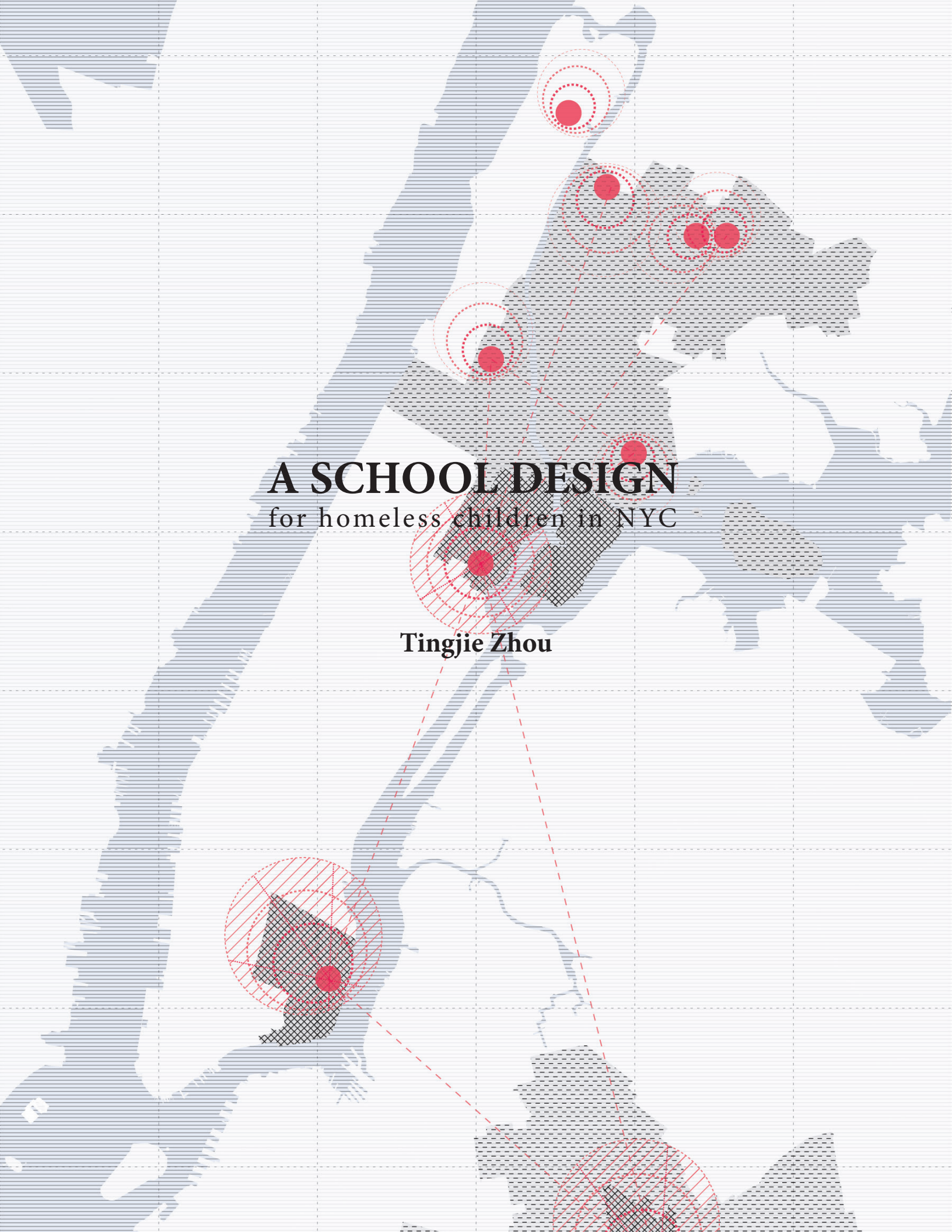
A School Design: for homeless children in NYC

Tingjie Zhou
Syracuse University



A SCHOOL DESIGN

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ABSTRACT

By the end of 2017, more than fifteen thousand homeless families with over twenty-three thousand children lived in shelters in New York City (Coalition for the homeless, *Facts About Homelessness*). Receiving education in a school, a daily activity for school age children, can easily become an unachievable thing for homeless children. Though many programs and acts are carried out to help these children, their educational situation is still severe.

Noticing the circumstance that homeless children are facing, I'm interested in the role that architecture can play in responding to homeless children's educational concerns. When looking at the schools with high percentage of homeless children, it's notable that most of these schools have family shelters nearby. Considering this as a point of departure, this thesis seeks to address the challenges of providing a quality education for homeless children broadening its architectural scope to the surrounding community.

In terms of the social and technical complexity of school design for homeless children, my inquiry is applying an evidence-based and data-driven design method to school design. The data relevant to this thesis will include social data on homeless children's education concerns and technical data on building environment. Led by the collected data and the hypotheses based on evidence, the school design proposal aims at discovering opportunities to improve the quality of education and retain homeless children in school. Meanwhile, the process of the school design proposal will be complied into a textual and graphic documentation, which can serve as a design methodology reference for designers, architects and students.

A SCHOOL DESIGN
for homeless children in NYC

Tingjie Zhou

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Date of Graduation: May 2019
Syracuse University School of Architecture

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Social Issue

By the end of 2017, more than fifteen thousand homeless families with over twenty-three thousand children lived in shelters in New York City (Figure 1). Report from SIRS shows the number of student defined as homelessness in NYC is more than one hundred thousand (Figure 2). Homeless students includes those who are doubled-up, living in hotel/ motel, living in shelters and those who are unsheltered.

In some schools, the percentage of children who are homeless reaches 30% (Institute for Children, Poverty and Homelessness, *"Interactive Map"*). When looking at the schools with high percentage of homeless children, it's notable that most of these schools have family shelters nearby (Figure 3).

Receiving education in a school, a daily activity for school age children, can easily become an unachievable thing for homeless children. Though many programs and acts are carried out to help these children, their educational situation is still severe.

According to a 2016 report from the Independent Budget Office of the City of New York, children who are housed in the city's homeless shelters have obstacles to get to school and have high rates of absence (*Pappas, "Not Reaching the Door"*). Children's education is affected by housing instability.

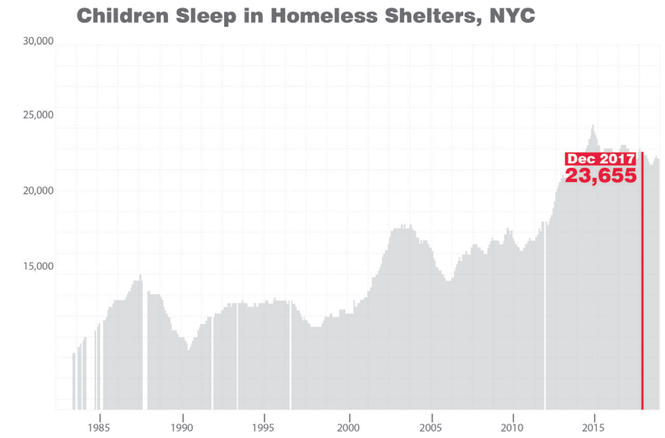


Figure 1 Children in Shelters
(Based on data from Coalition for the Homeless)

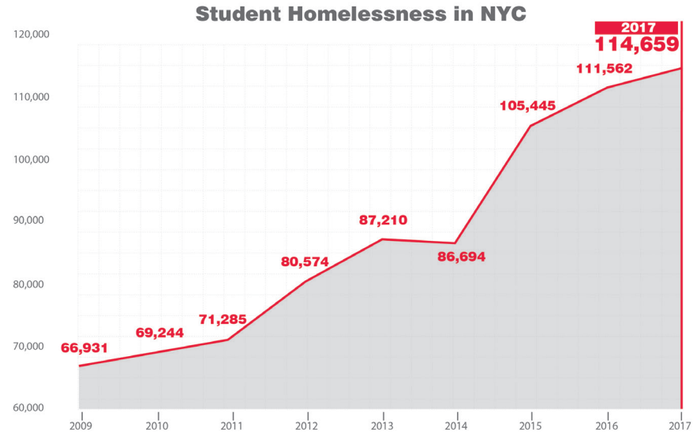


Figure 2 Student Homelessness
(Based on data from New York State Education Department in the Student Information Repository System)

SITUATION

Architecture's Role in Education

A study in New York City reveals that middle and high schools with unsatisfactory building components have higher suspension rates, lower test scores and lower attendance (Boese, "*A Data Analysis Report*"). A lot of experiments and research results show that people's working and learning performance are influenced by physical environment (Tanner, "*Student Outcome,*"). Architecture as a tangible environment can shape people's behavior. Thus, though thoughtful design, school architecture can benefit students.

The Potential of Data and Evidence in Design

Data is a potent tool that can help us understand situations we are facing. It can also be a powerful tool to guide architecture design decisions. The data relevant to this thesis will include sociological data on homeless children's education issue and technical data on building environment.
For each unique project, evidence as well as hypotheses from research can help make critical design decisions.

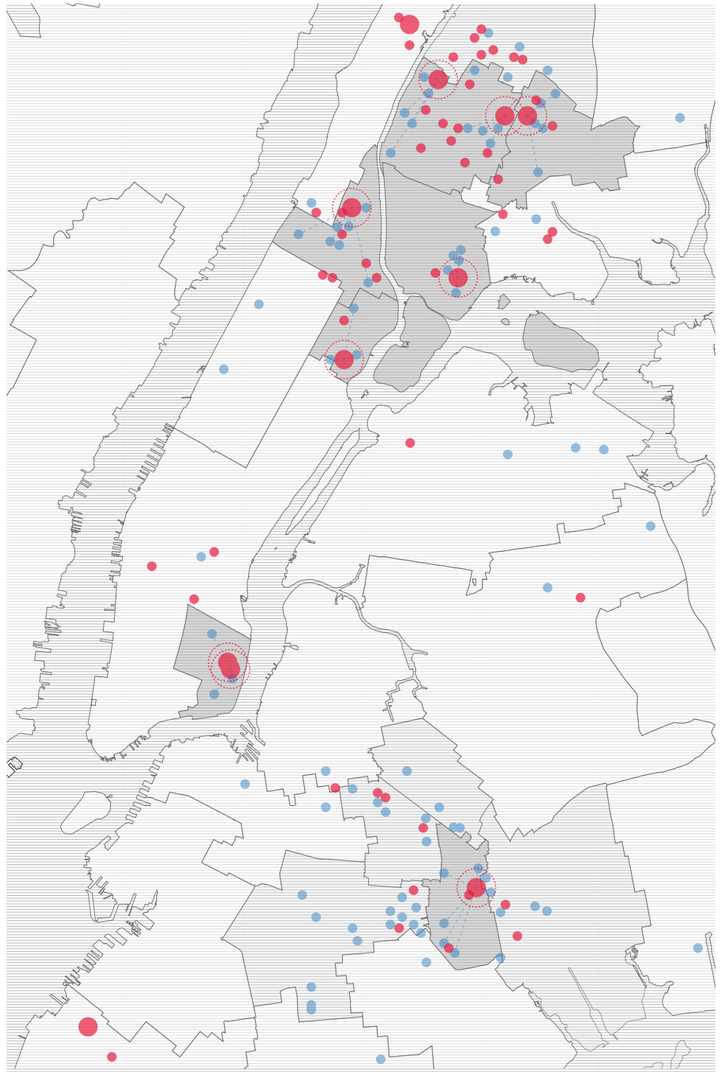


Figure 3 Schools and Shelters
(Based on data from Institute for Children, Poverty and Homelessness)

Architecture is never neutral. It either heals or hurts. Our mission is to research, build, and advocate for architecture that promotes justice and human dignity.

(MASS Design Group, *"About"*)

POSITION

The education dilemma that homeless children face, caused by deep-rooted homelessness in New York City, is a complicated issue. It cannot be eradicated without the efforts of political, social and economical contributions.

However, I also believe that architecture as a physical environment can influence people's behavior and cognition either positively or negatively. So I hope through rational and logical design process, school architecture could release the stress that homeless children are going through and promote justice and human dignity.

In this thesis, I'm focusing on some of the factors that prevent homeless children from receiving education in school. By collecting and analyzing data, especially sociological data, I am doing a data-driven conceptual school design for homeless children. Hopefully, the research, data-driven design process, and the school design would become a prototype and referential case for those who want dedicate themselves to helping homeless children.

QUESTION

Based on the severe education situation of homeless children and the role that architecture can play, here comes the questions.

Question 1:
Concerning the difficulty for homeless children to focus on their education, how can evidence and data be applied to school design for retaining homeless students in school, and helping them get fair opportunities to receive education?

Question 2:
Taking the elementary school design in Bronx, New York City as an example, how can the sociological and environmental data influence the design outcome and contribute to the school prototype especially for homeless children?

In order to answer these questions, the first step took was to figure out: ***what is data-driven design*** and ***what is evidence-based design***.

WHAT IS DATA-DRIVEN DESIGN?

"... connects the built environment to predictive analytics and operational design through computational design."

(HDR, *"Data-Driven Design"*, 3)

Use sensors and devices to monitor visibility, noise, humidity, light, temperature, and air quality.
Cameras track the location of workers over time.
Steelcase uses a sensor-based system to help organize and optimize office space.

(Denny, *"Big Data."*)

Get data about actual utilization of space at any given point of time in any office buildings through machine learning.

(*Rajagopal*, *"Microsoft Office."*)

The following images show some aspects, in which advanced design companies such as HDR and Zaha Hadid Architects apply data-driven method to architecture design.

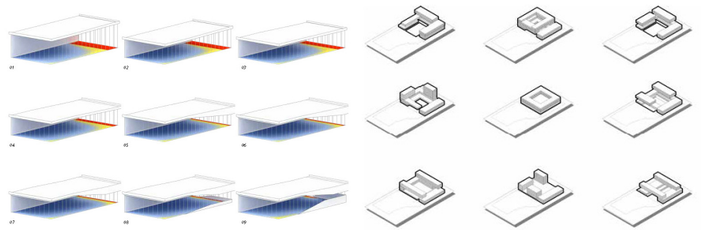


Figure 4 Daylight
(Source: HDR)

Figure 5 Building Geometry
(Source: HDR)

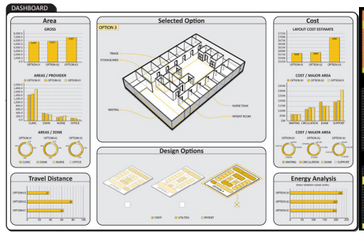


Figure 6 Cost
(Source: HDR)

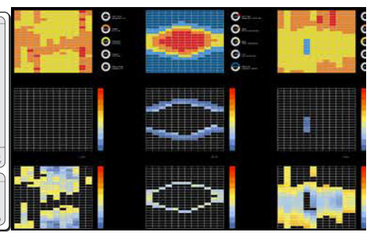


Figure 7 Energy Efficiency
(Source: HDR)

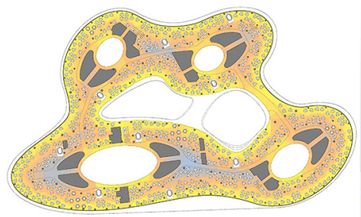


Figure 8 Beijing SOHO Daylight
(Source: Zaha Hadid Architects)

Figure 9 Office Occupancy
(Source: Steelcace)

WHAT IS DATA-DRIVEN DESIGN?

After learning about data-driven design in different design companies (HDR, Zaha Hadid Architects, Steelcace, and Microsoft), the follwing chart is a summary of tools used for data-driven design and relevant aspects.

Tools	*Aspect Determined*	
Sensors	Visibility	Air Quality
Monitor Devices	Noise	Construction Cost
Camera Tracking	Humidity	Energy Efficiency
Sensor-based System	Light	Daylight
Machine Learning	Temperature	Building Geometry

WHAT IS DATA-DRIVEN DESIGN?

Considering the time limitation as well as technical difficulty, I'm not taking the tools that advanced companies usually use for data-driven design. Instead, I come up with the tools that I plan to use in this thesis and its potential aspects.

Tools	Aspect Determined	
Quantitative Data	Program	Energy Efficiency
Qualitative Data	Program Layout	Light
Simulation Tools	Floor Area	Daylight
~~Sensors~~	Building Geometry	Air Quality
~~Monitor Devices~~	Space Capacity	Temperature
~~Camera Tracking~~	Visibility	...
~~Sensor-based System~~		
~~Machine Learning~~	~~Noise~~	~~Construction Cost~~

WHAT IS EVIDENCE-BASED DESIGN?

"Evidence-based design is a process for the conscientious, explicit, and judicious use of current best evidence from research and practice in making critical decisions, together with an informed client, about the design of each individual and unique project."

(Hamilton and Watkins, *"Evidence-Based Design for Multiple Building Types,"* 9)

"Presented with a problem, researchers draw on theory, training, accumulated knowledge, and experience to generate tentative ideas about how to solve it."

(Zeisel, *"Inquiry By Design,"* 18)

WHAT IS EVIDENCE-BASED DESIGN?

An explicit definition of evidence-based design is following:

The design elements are produced by fact, analogies and hypotheses, which are based on collected information and stories from books, news, reports, videos.

The fact, analogies and hypotheses together reflect homeless children's life and education condition as well as their specific needs.

METHODOLOGY

The method of this thesis includes four steps:
1. Data and Evidence Collecting
2. Imaging
3. Presenting
4. Testing

Here are some examples of what these steps contain.

Data and Evidence Collecting

Situation Evidence
•Excerpt evidence and stories from books, videos, reports, news.

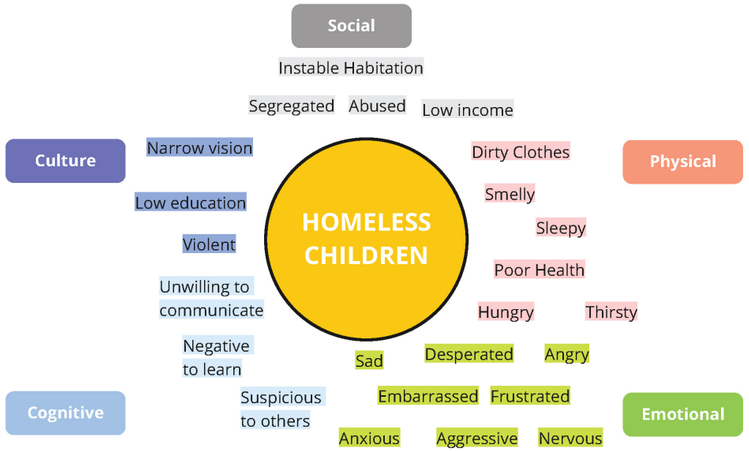
Site Data
•Collect geographic data of schools with homeless students in NYC.
•Collect geographic data of family shelters in NYC.
•Filter the schools with more than 40% homelsss students.
•Based on the collected data, map the schools and family shelters.
•Filter schools surrounded by dense family shelters as potential sites.
•The final selected project site is PS 65 Mother Hale Academy, which is located in the Bronx.
•Collect census data, academic performance data, enrollment and attendance data of the Mother Hale Academy.
•Analyze the data and extract relevant information of the school.

Technical Data and Evidence
•Physical environment and behavior study.
•School design pattern study.
•School design case study.
•Anthropometric data.

Imaging

Visualizing data and evidence.

Example: five factors of homeless children based on evidence



4. Testing

After coming up with the conceptual school design, building environment simulation tools will be used to test green and sustainable aspect of the school.

Example:
Use wind-rose to test building opening directions and natural ventilation.
Use sun-path and dry bulb temperature to test building geometry and indoor temperature.

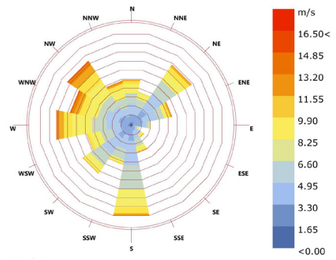


Figure 10. NYC Wind-Rose
1 Jan 1:00 - 31 Dec 24:00
Hourly Data: Wind Speed (m/s)

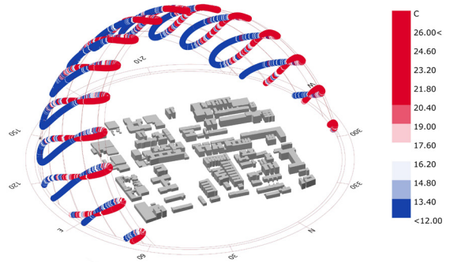


Figure 11. NYC Sun-path and Dry Bulb Temperature

SITE STUDY

A school with high percentage of homeless children in the Bronx, NYC is selected as the site.

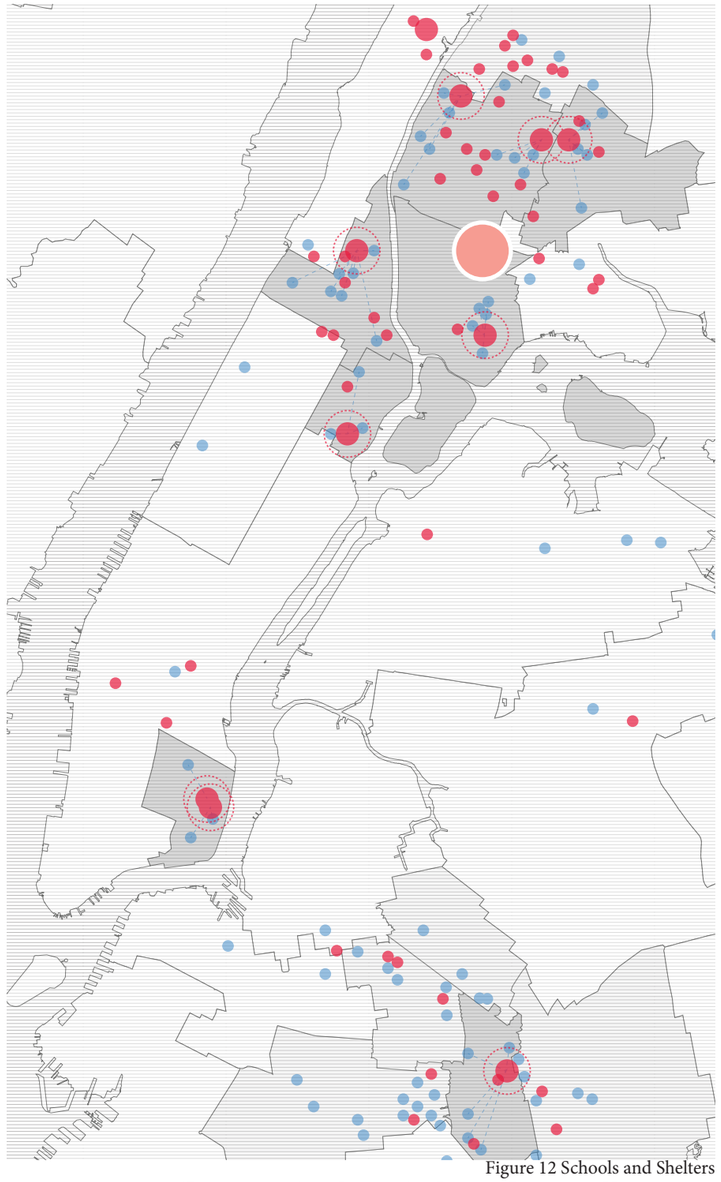


Figure 12 Schools and Shelters
(Based on data from Institute for Children, Poverty and Homelessness)

Mother Hale Academy

Borough:	Bronx
Total Students:	Around 400
Percentage of Homelessness:	40%
Student attendance:	89% (City: 93%)
Students chronically absent:	47% (City: 23%)
Grades:	K-5

Ingludes General and Special Education Students	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
All Students	**414**	**388**	**400**	**390**	**360**
Grade	**2013-2014**	**2014-2015**	**2015-2016**	**2016-2017**	**2017-2018**
Kindergarten	71	71	74	76	63
Grade 1	76	68	76	71	59
Grade 2	71	71	73	73	66
Grade 3	66	58	68	48	63
Grade 4	57	63	57	67	48
Grade 5	73	57	52	55	61

Figure 13 Students in Need of Additional Supports (2017-18)
(Source: Based on NYC Department of Education)

	%	n	Compared to District Average	Compared to City Average
Economic Need Index	98.2%		+5.5%	+26.2%
Students in Families Eligible for HRA Assistance	94.2%	339	+9.2%	+29.8%
Students in Families with Income Below Federal Poverty Level (Estimated)	54.0%		+6.1%	+28.4%
Students in Temporary Housing	46.4%	167	+22.4%	+32.6%

Figure 14 Enrollment Over Time
(Source: Based on NYC Department of Education)

Figure 15. Site Boundary
(Source: Google Map)

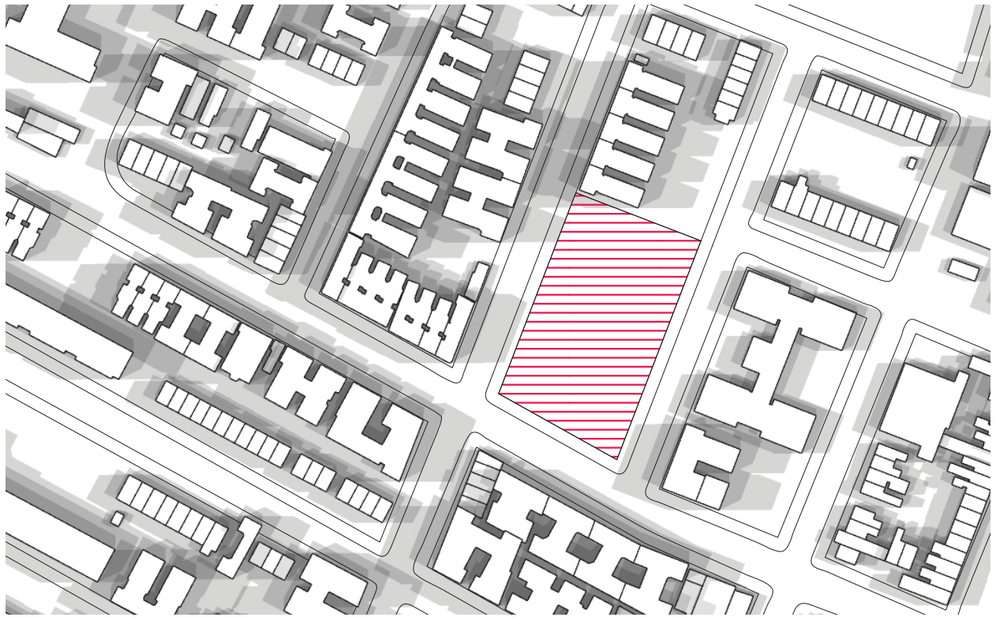


Figure 16. Summer Sun Shadow Jun 22, 8am/10am/12pm/2pm/4pm

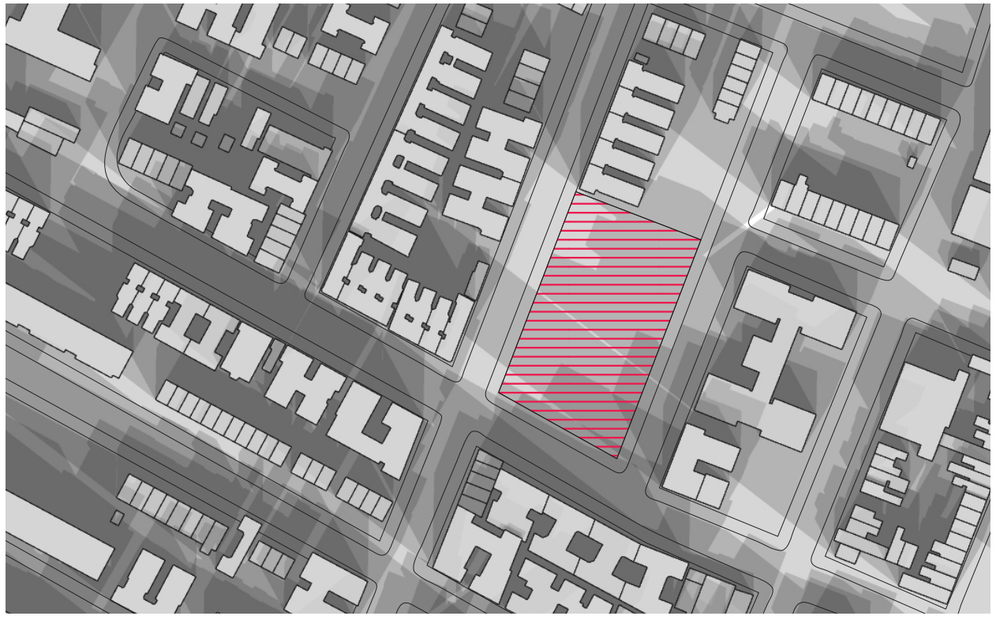


Figure 17. Winter Sun Shadow Dec 22, 8am/10am/12pm/2pm/4pm

DESIGN PROCESS

The chart below shows the process from original evidence and data to design aspects such as program, program layout, and building geometry. Evidence column in this page comes from the case study oklahoma city school, which is specially designed for homeless children (see Appendix I).

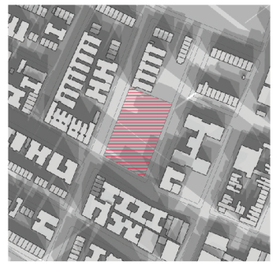
EVIDENCE	SPECIFIC NEEDS OF SPACE	PROGRAM
Homeless children don't have a place to host playdates. They want "a place to sit with friends."	More space for students to sit together	Social Activity Space
"If I want to do a Lego project, I can't leave it out because where I stay tonight may not be where I stay tomorrow."	A space that children can individually owned. They can relax surrounded by their things in this space.	Cubicle
Many of the children are behind developmentally and behaviorally when it relates to cooperation and group play.	An area for reinforcing social skills.	Group-learning Space
Homeless children need a sense of belonging and the feeling that they can own the space they're in.	Flexible, moveable, and durable furniture.	
A student drew a button in his classroom that read " Alarm for the police."	Security and Safety. Transparency / Glass. Faculty can have a full view of everyone.	
Homeless children often come into school feeling tired and restless.	A space to nap.	Resting space
Homeless children's families can't afford daily supplies.	A space/storage to provide coats, sneakers, stationery, whatever a child might need to get through the school day.	Free supply room

Bellan, *"In Oklahoma City, a School Designed for Homeless Children"*

CALCULATION FROM DATA

DATA

Sun Shadow in Summer

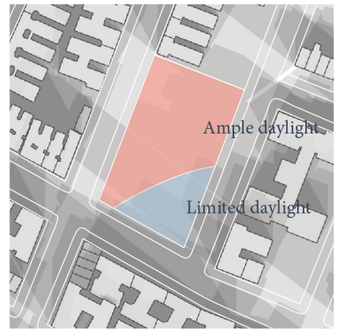


Sun Shadow in Winter

Anthropometric Data

Building Codes

BUILDING GEOMETRY AND PROGRAM LAYOUT



EVIDENCE	SPECIFIC NEEDS OF SPACE	PROGRAM	CALCULATION FROM DATA
It turned out that when students didn't have clean clothes, they often stayed home from school out of embarrassment. "I think people don't talk about not having clean clothes because it makes you want to cry or go home or run away or something. It doesn't feel good." 85% of high-risk elementary school students increased their attendance during the 2017 - 2018 program. (Whirlpool, *"Care Counts Result"*)	Laundry with washing machines and dryers.	Laundry	Unsheltered rate: 5% Sheltered & unsheltered rate: 40% Accommodation capacity: 5 to 64 students
Children who are housed in the city's homeless shelters have obstacles to get to school and have high rates of absence. Children's education is affected by housing instability. (New York City Independent Budget Office, *"2016 Report"*)	Accommodation should be provided to homeless children so as to retain them in school.	Accommodation	Number of classroom: 18 Classroom size: 1029 Sq.Ft to 1344 Sq.Ft
"As the percentage of students receiving school lunch at free and reduced cost increased, the achievement level decreased." (Tanner, *"Student Outcome"*)	A place where every student can get free lunch. A place where students can cook with parents.	Family Kitchen	
School districts that serve large populations of students of color and students from low-income families receive far less funding than those serving White and more affluent students. (Morgan and Amerikaner, *"Funding Gaps 2018"*)	Getting income or reducing expenditure.	Science Lab Art Studio Offices provided to external artists and craftman.	

DATA

Mother Hale Academy Total Student: 400
Mother Hale Academy Homelessness rate: 40%

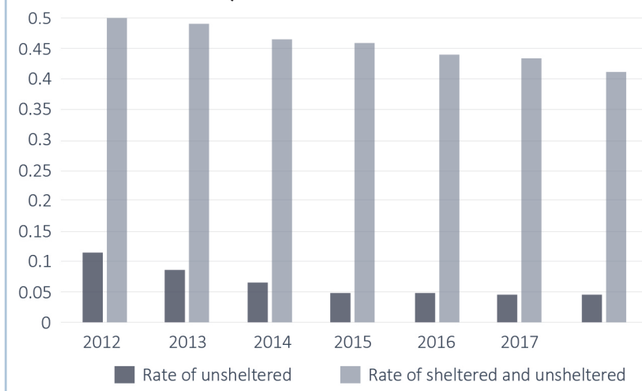


Figure 18. Accommodation rates of homeless students in Bronx
(Based on accommodation data from
New York State Education Department in the Student Information Repository System)

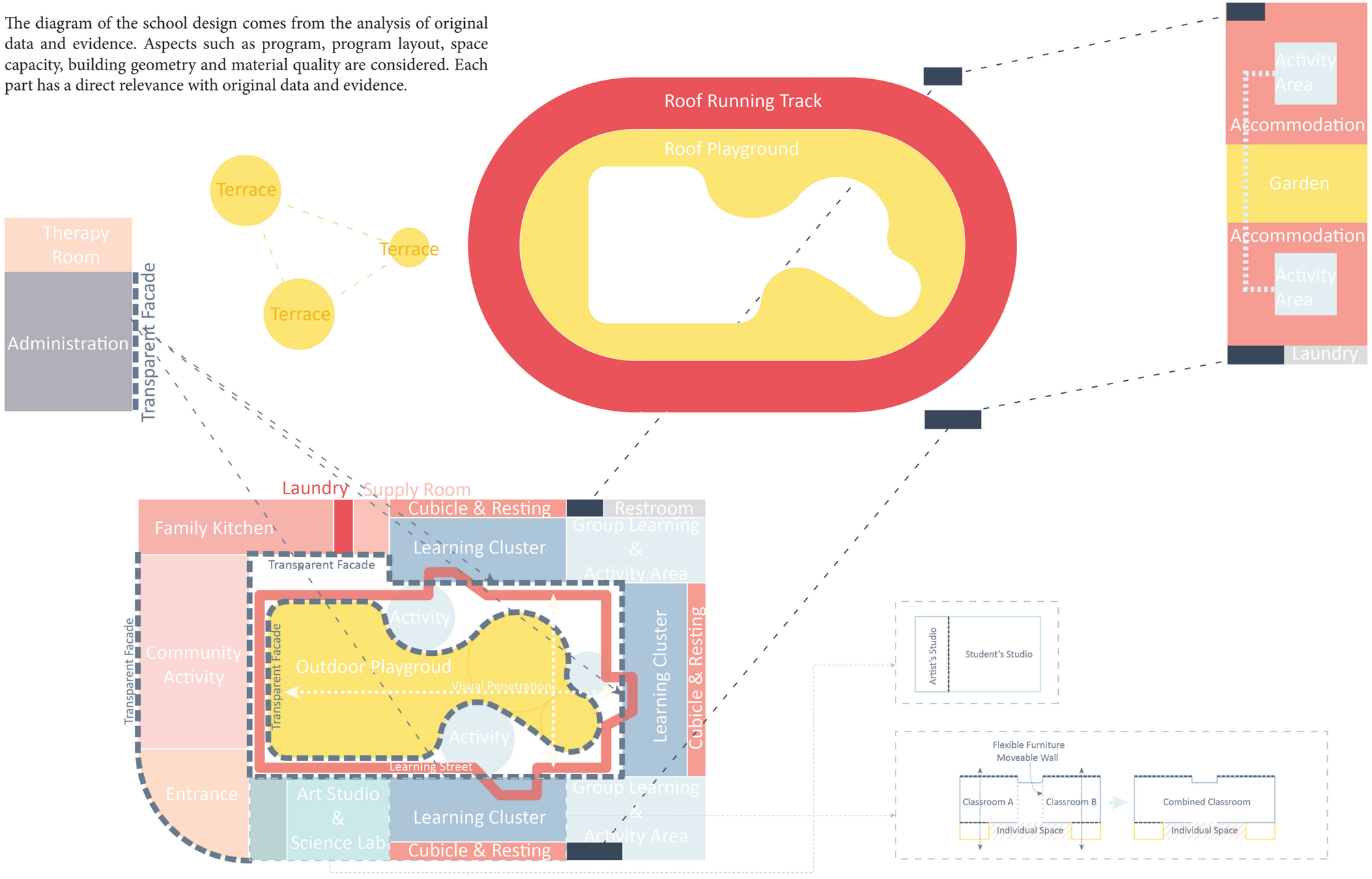
Number of Students plus 1 Teacher	Elementary School [Sq.Ft. (Meters)]	Secondary School [Sq.Ft. (Meters)]
10	539 (50.13)	704 (65.47)
11	564 (52.45)	768 (71.42)
12	637 (59.24)	832 (77.38)
13	686 (63.80)	896 (83.33)
14	735 (68.36)	960 (89.28)
15	784 (72.91)	1024 (95.23)
16	833 (77.47)	1088 (101.18)
17	882 (82.03)	1152(107.14)
18	931 (86.58)	1216 (113.09)
19	980 (91.14)	1280 (119.04)
20	***1029 (95.70)***	***1344 (124.99)***

Figure 19. Classroom Size (Source: C. Kenneth Tanner)

Total Student: 400
Grade: K-5
Around 20 students/classroom
Dimensions of social space of children at different ages

Figure 20. Diagram of the school

The diagram of the school design comes from the analysis of original data and evidence. Aspects such as program, program layout, space capacity, building geometry and material quality are considered. Each part has a direct relevance with original data and evidence.



A student drew a button in his classroom that read " Alarm for the police."
(Bellan, *"Oklahoma City School."*)

Security and Safety.
Transparency / Glass.
Faculty can have a full view of everyone.

Transparency

"As the percentage of students receiving school lunch at free and reduced cost increased, the achievement level decreased."
(Tanner, "Student Outcome.")

A place where every student can get free lunch.
A place where students can cook with parents/community members.

Family Kitchen

It turned out that when students didn't have clean clothes, they often stayed home fro school out of embarrassment.
"I think people don't talk about not having clean clothes because it makes you want to cry or go home or run away or something. It doesn't feel good."
85% of high-risk elementary school students* increased their attendance during the 2017 - 2018 program.

*High-risk elementary school students is defined as elementary students with more than 15 days absent across the 2017-2018 school year (average of 1.5 days or more absent per month).
(Whirlpool, *"Care Counts Result ."*)

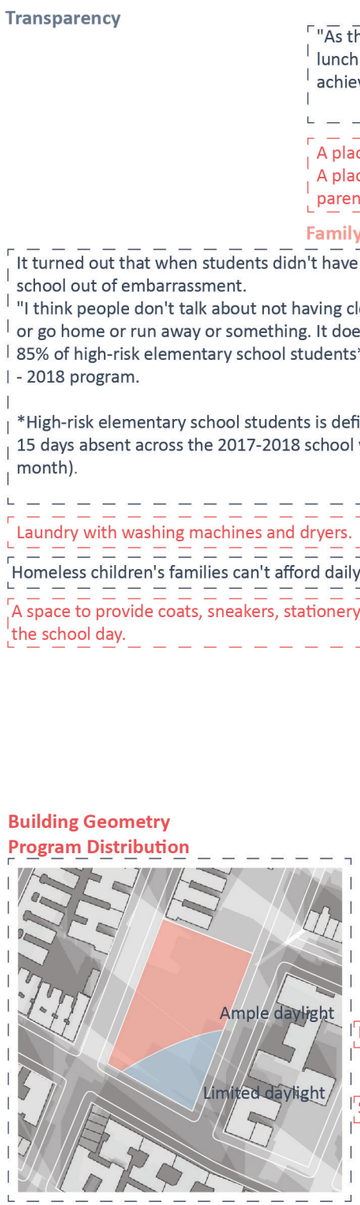
Laundry

Laundry with washing machines and dryers.

Homeless children's families can't afford daily supplies. (Bellan, *"Oklahoma City School."*)

Supply Room

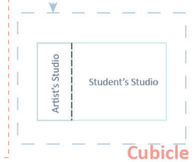
A space to provide coats, sneakers, stationery, whatever a child might need to get through the school day.



Building Geometry
Program Distribution

Long-time stay

Short-time stay



Cubicle

"If I want to do a Lego project, I can't leave it out because where I stay tonight may not be where I stay tomorrow."
(Bellan, *"Oklahoma City School."*)

A space that children can individually owned. They can relax surrounded by their things in this space.

Homeless children often come into school feeling tired and restless. (Bellan, *"Oklahoma City School."*)

A space to nap.

Resting

The need of broadening students' knowledge and abilities in different area. (Bellan, *"Oklahoma City School."*)

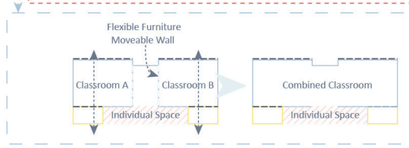
Space for different learning activities.

Art & Scienc

Limited education funding for public school.
(Morgan and Amerikaner, *"Funding Gaps 2018"*)

Providing pace for Artists, craftsmen, etc.
Reducing expenditure on hiring teachers.

Studio



Education Space

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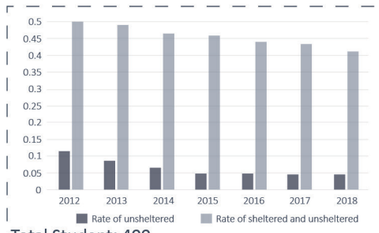
Total Student: 400
Grade: K-5
Around 20 students/classroom

Number of classroom: 18
Classroom size: 1029 Sq.Ft to 1344 Sq.Ft

Accommodation

Children who are housed in the city's homeless shelters have obstacles to get to school and have high rates of absence. Children's education is affected by housing instability.
(Pappas, "Not Reaching the Door")

Accommodation should be provided to homeless children so as to retain them in school.



Total Student: 400
Homelessness rate: 40%
NYC students' accommodation data from SIRS

Unsheltered rate: 5%
Sheltered & unsheltered rate: 40%
Accommodation capacity: 5 to 64 students

Social, Activity & Group Learning

Homeless children don't have a place to host playdates. They want "a place to sit with friends." (Bellan, *"Oklahoma City School."*)

More space for students to sit together.

Many of the children are behind developmentally and behaviorally when it relates to cooperation and group play. (Bellan, *"Oklahoma City School."*)

An area for reinforcing social skills.

Homeless children need a sense of belonging and the feeling that they can own the space they're in. (Bellan, *"Oklahoma City School."*)

Flexible, moveable, and durable furniture.

Vistas of 50 feet or more are recommended to change focal length for eye health.
(Nair and Fielding, "The Language of School Design.")

Broaden visual field.

DESIGN PRESENTATION

The elementary school is designed based on the analysis of original data and evidence as shown in design process, which contains aspects such as program, space capacity and material.

The program layout cannot be fully explained by single data or evidence. However, it has an explicit intention to have group-learning and social space the most prominent parts in school, as well as connect different space by them. As a school specially designed for meeting homeless children's special needs, spaces for community service and accommodation also play an important role. All the community service spaces are near the entrance and have transparent facade towards streets to welcome nearby communities. Accommodation is lifted and separated from main education space to avoiding disturbance.

Detailed program and spaces as well as their intentions are shown by scenarios.

For a further data-driven development, the school design can be optimized by analyzing building environmental data such as natural ventilation, daylight, energy efficiency, etc.

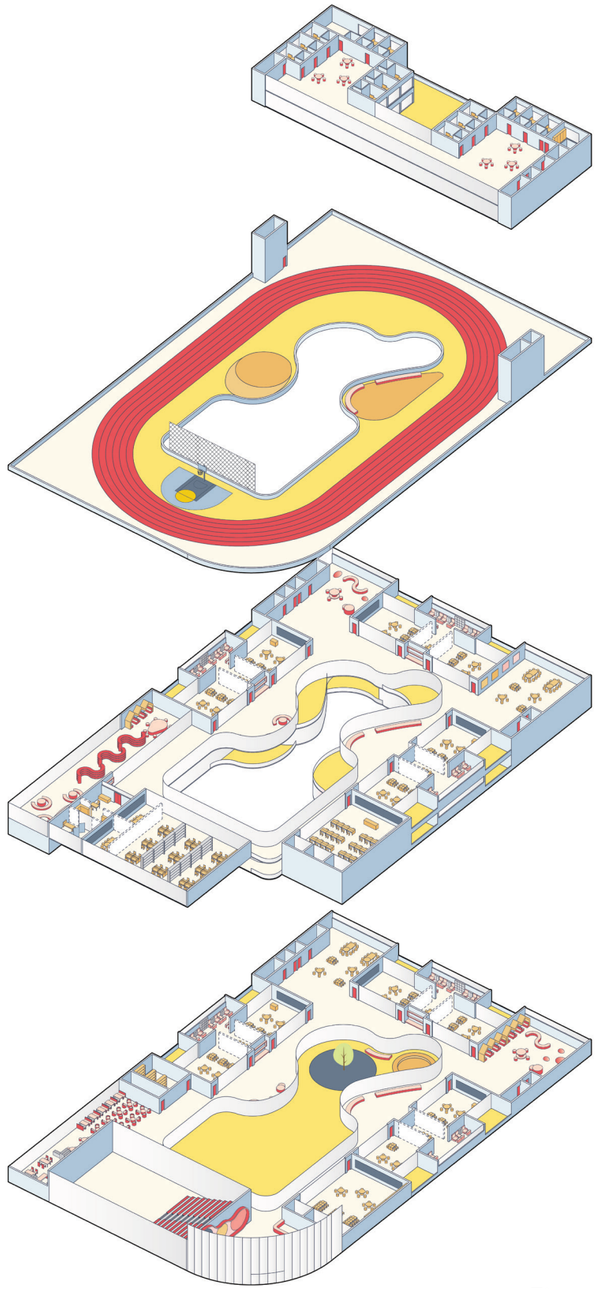
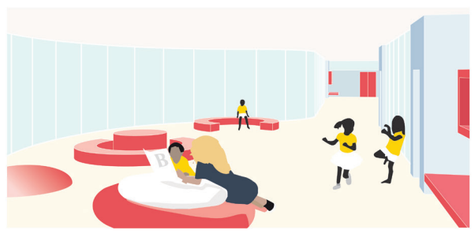


Figure 21. Exploded Axon

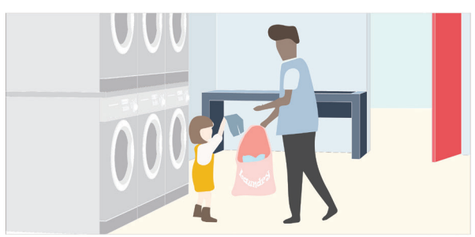
Outdoor Playground
Outdoor playgrounds are surrounded by transparent facades, which allows interaction between indoor space and outdoor space.
Large outdoor areas also provide space for homeless children to hang out with friends.

Roof Sport Space
Due to site area limitations, a running track and a basketball court are placed on the roof. Physical exercise helps children have a healthy body.

Activity Room
Flexible furniture makes dierent activities possible to happen in this space. Children can re-arrange the space as they like, which creates a sense of belonging.



Learning Street
Corridor is not a boring narrow space for quikly walking through. It's expanded to a "learning street", where children can play and learn from each other.

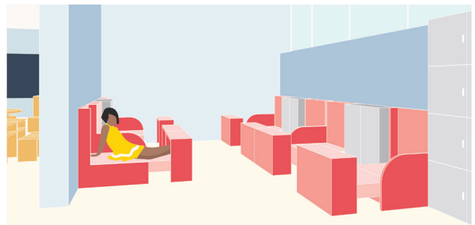


Laundry
The laundry is equipped with washing machines and dryers. Homeless children and their parents can bring dirty clothes to the laundry.
Clean clothes make homeless children more confident. Thus childre are willing to come to shool.

Figure 22-26. Scenarios

Accommodation
For those unsheltered homeless children and those who live in cars, garages, etc, accommodation is provided.
Parents are also welcome to live here in special situations.

Neighborhood
The accommodation area is like a community, where homeless children can experience the social life with neighbors just like what the other children have every day.



Cubicle and Resting Space
Individual cubicles are provided to students where they can store their own stuff. The fexible furniture can be transformed into a bed. Children can have a rest here if they feel sleepy and tired.

Social Activity Corner
Each learning cluster has a corner for children to sit and play with peers. This corner also exhibit children's work to improve their confidence and achievability.

Art Studio
Students' art studio is adjacent to teachers' studio. Due to limited education funding, the teachers can be homeless artists who need a place to live and work. It can be a win-win solution.

Figure 27-31. Scenarios

APPENDIX I
OKLAHOMA CITY SCHOOL

MA+ Architecture came up with a design that would address the challenges homeless students face every day while finding ways to replicate the experiences of children who don't suffer from homelessness.

The school was designed in part by kids. They submitted drawings and ideas of what they'd like to see in the new school.

Here are some of the factors that influence the design:

As homeless children generally don't have a place to host playdates, the school provides them with many spaces to meet their request for "a place to sit with friends."

As many of homeless children are behind developmentally and behaviorally in cooperation and group play, a range of group-learning areas are designed for them to meet with each other and reinforce social skills.

Nurse's office has a space to nap for those who come into school feeling tired and restless.

Homeless children show a strong desire for safety and security. Considering this need, the layout of the school reinforces safety with glass facades to allow administration offices have a full view of anyone approaching.

(Bellan, *"In Oklahoma City, a School Designed for Homeless Children."*)

Figure 32. Program
(Source: MA+ Architecture)

Figure 33. Family Kitchen
(Source: MA+ Architecture)

Figure 34. Corridor
(Source: MA+ Architecture)

APPENDIX II
WHIRLPOOL CARE COUNTS PROGRAM

"I think people don't talk about not having clean clothes because it makes you want to cry or go home or run away or something. It doesn't feel good."
(Logan, an eighth-grader)

It turned out that when students didn't have clean clothes, they often stayed home from school out of embarrassment
(Kirk, *"One Answer to School Attendance"*).

The program saw more than half of participating high-risk students were no longer at risk for chronic absenteeism. According to teachers surveyed in 2015-2016, for the school that participated in the Whirlpool Care Counts Program, 89% of students had increased classroom participation. 95% of students had more motivation in class. 95% of students participated in more extracurricular activities.
(Whirlpool, *"Results"*)

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