Data Driven Design Decisions

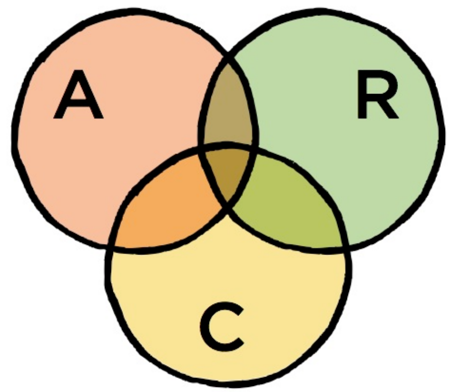
MKTHINK

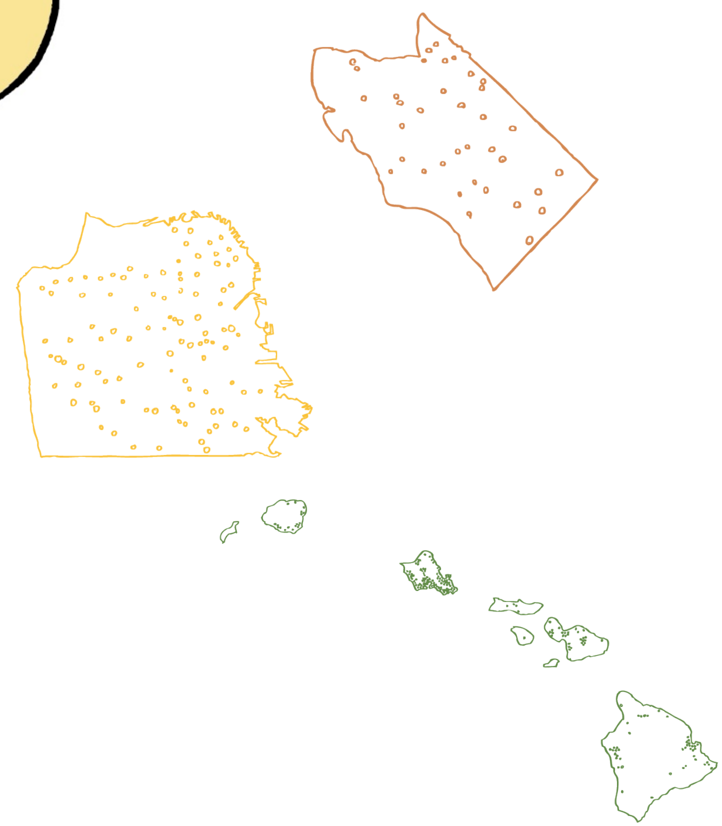
the IDEAS company for the built environment

May 2015

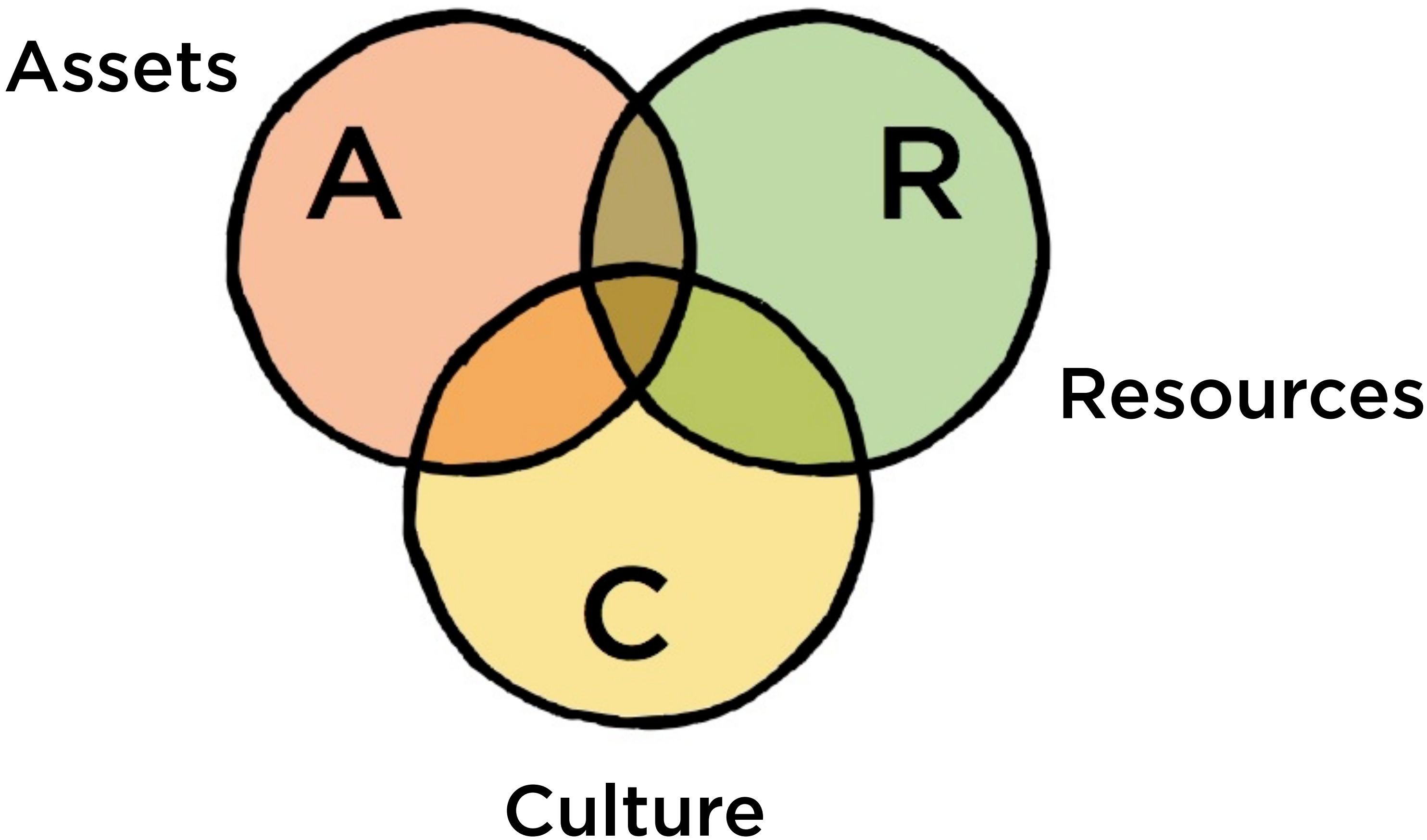
Overview

- About MKThink
- Why Use Data?
- Analysis Process
- Example 1:
  Arlington Public Schools
  Occupancy and Utilization
- Example 2:
  San Francisco Unified School District
  School Lunch Supply Chain
- Example 3
  Hawai'i Department of Education
  Energy Systems Study





MKThink



Why Use Data?

1. Data can be used to simplify and model complex systems.

2. Data can reveal patterns and can be used to do comparative analysis.

3. Data can help us make better decisions based on proof.

New Websites

570

New websites are created every minute.

820,800

New websites are created every day.

299,592,000

New websites are created every year.

Bernard Marr, CEO Advanced Performance Institute, 2014.

Data Centers

6,000

Number of football fields equivalent to the area of all the world's data centers.

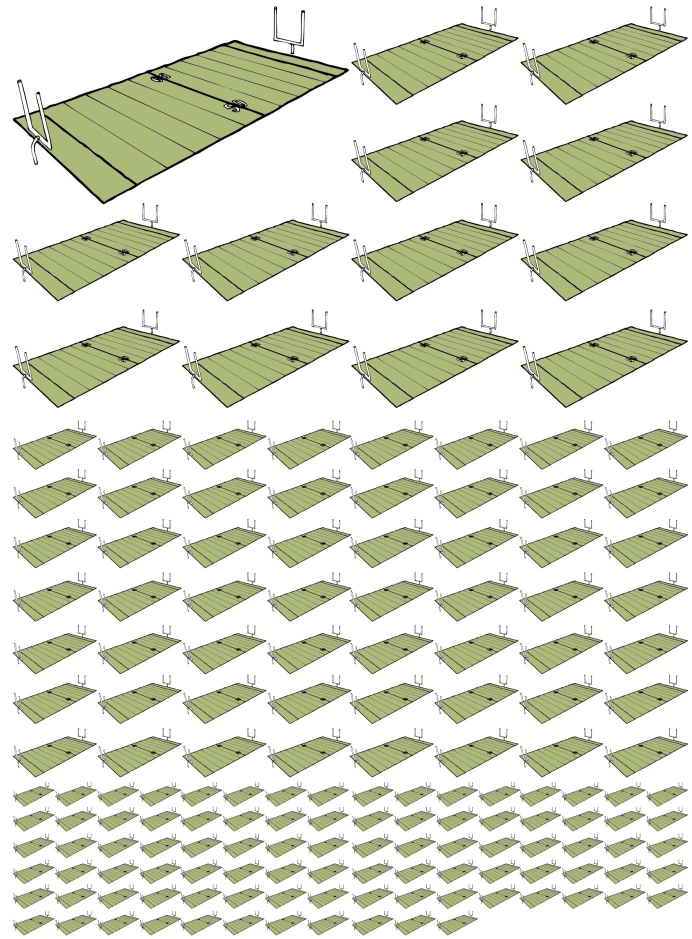
7,920

Number of acres of land used to house all the world's data centers.

345,600,000

Square feet of building space dedicated to all the world's data centers.

Bernard Marr, CEO Advanced Performance Institute, 2014.



MKTHINK
the IDEAS company for the built environment

Digital Universe

70,000,000,000,000,000,000,000

Rough estimate of the number of stars in the observable universe.

82,000,000,000,000,000,000,000

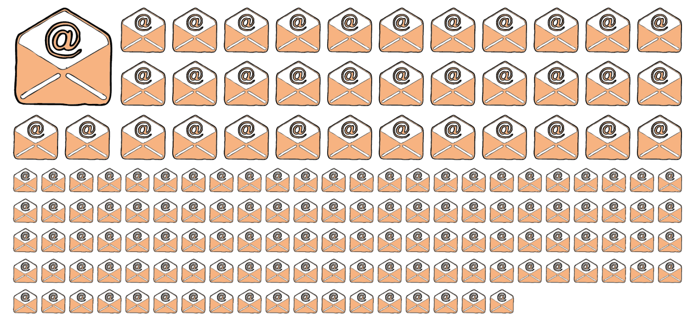
Number of Bits of information stored in the digital universe.

Bernard Marr, CEO Advanced Performance Institute, 2014.

Digital Breadcrumbs

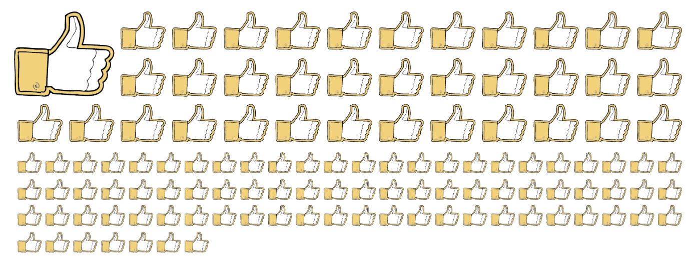
204,000,00

Emails sent every minute.



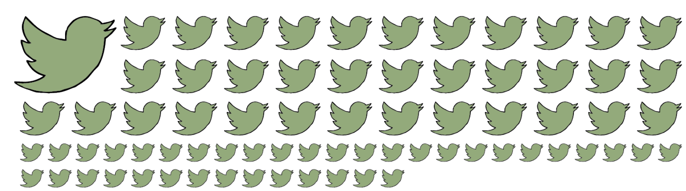
1,800,000

Facebook likes every minute.



278,000

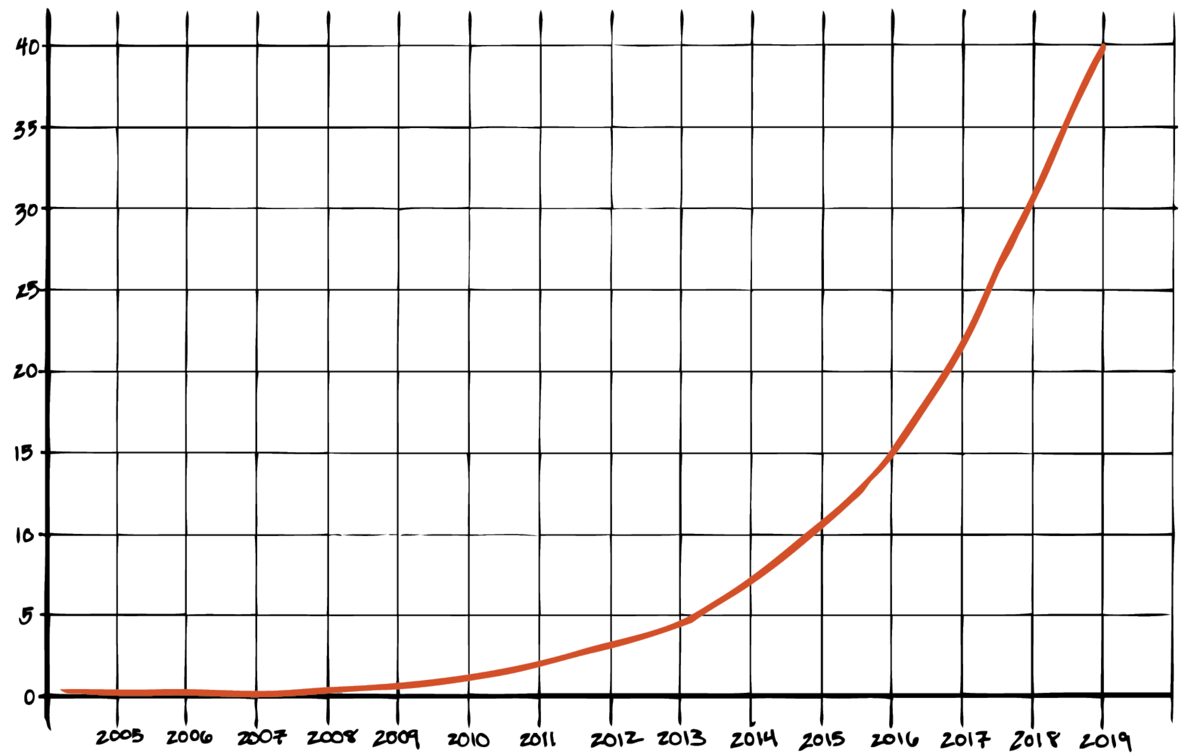
Tweets sent every minute.



Bernard Marr, CEO Advanced Performance Institute, 2014.

Projected Growth of Data

Global Data (in zettabytes)

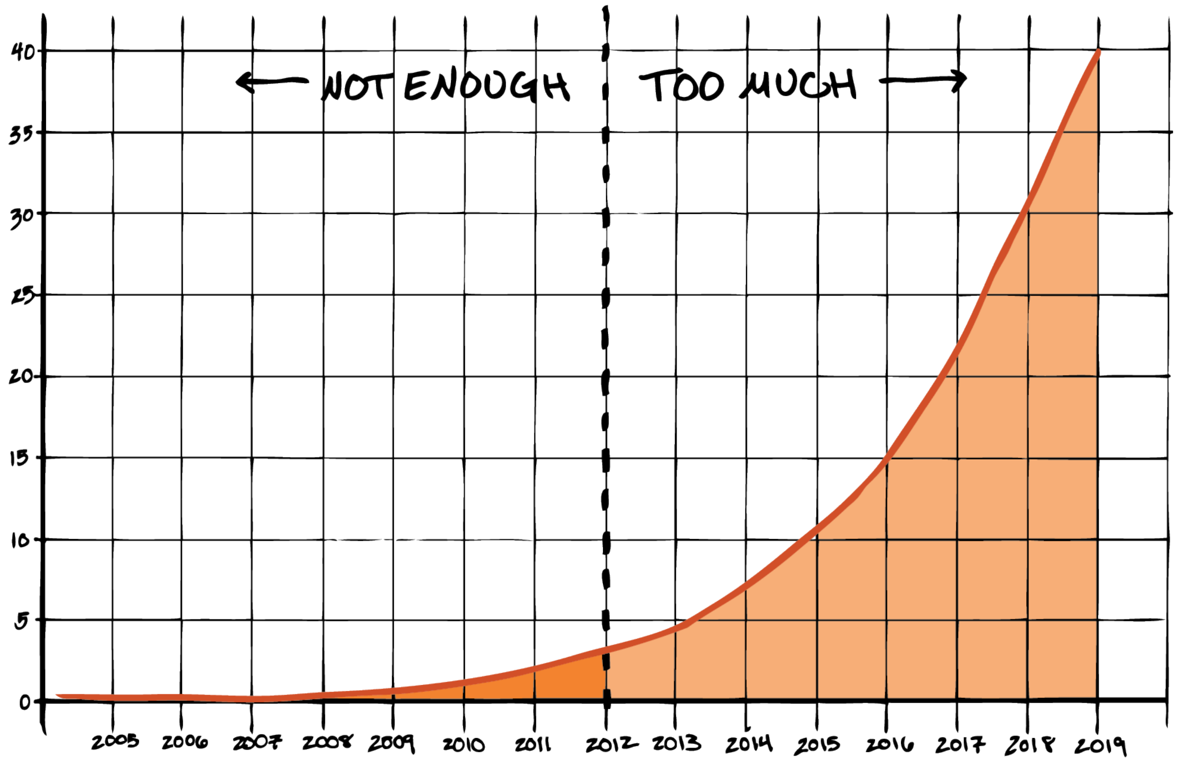


1 zettabyte = 1,000,000,000,000 gigabytes

The New Economy. "Big Data Is Not Without Its Problems." January 8, 2015.

Projected Growth of Data

Global Data (in zettabytes)



1 zettabyte = 1,000,000,000,000 gigabytes

The New Economy. "Big Data Is Not Without Its Problems." January 8, 2015.

Signal or Noise?

"There isn't any more truth in the world than there was before the Internet or the printing press. Most of the data is just noise, as most of the universe is filled with empty space."

Nate Silver

Silver, Nate. *The Signal and the Noise: Why Most Predictions Fail – but Some Don't. London: Penguin Books Ltd., 2012. Print.*

Central Challenge

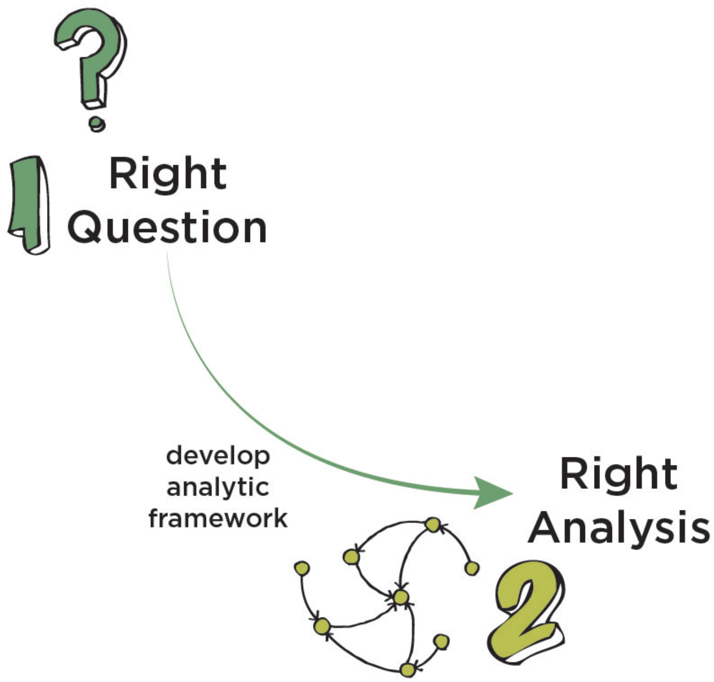
How can we ***harness data*** and ***cut through the noise***, to help us ***make better decisions*** about facilities planning and capital investments?

Ask the Right Question

- In order to get to the best solution, it is imperative to start by asking the right question

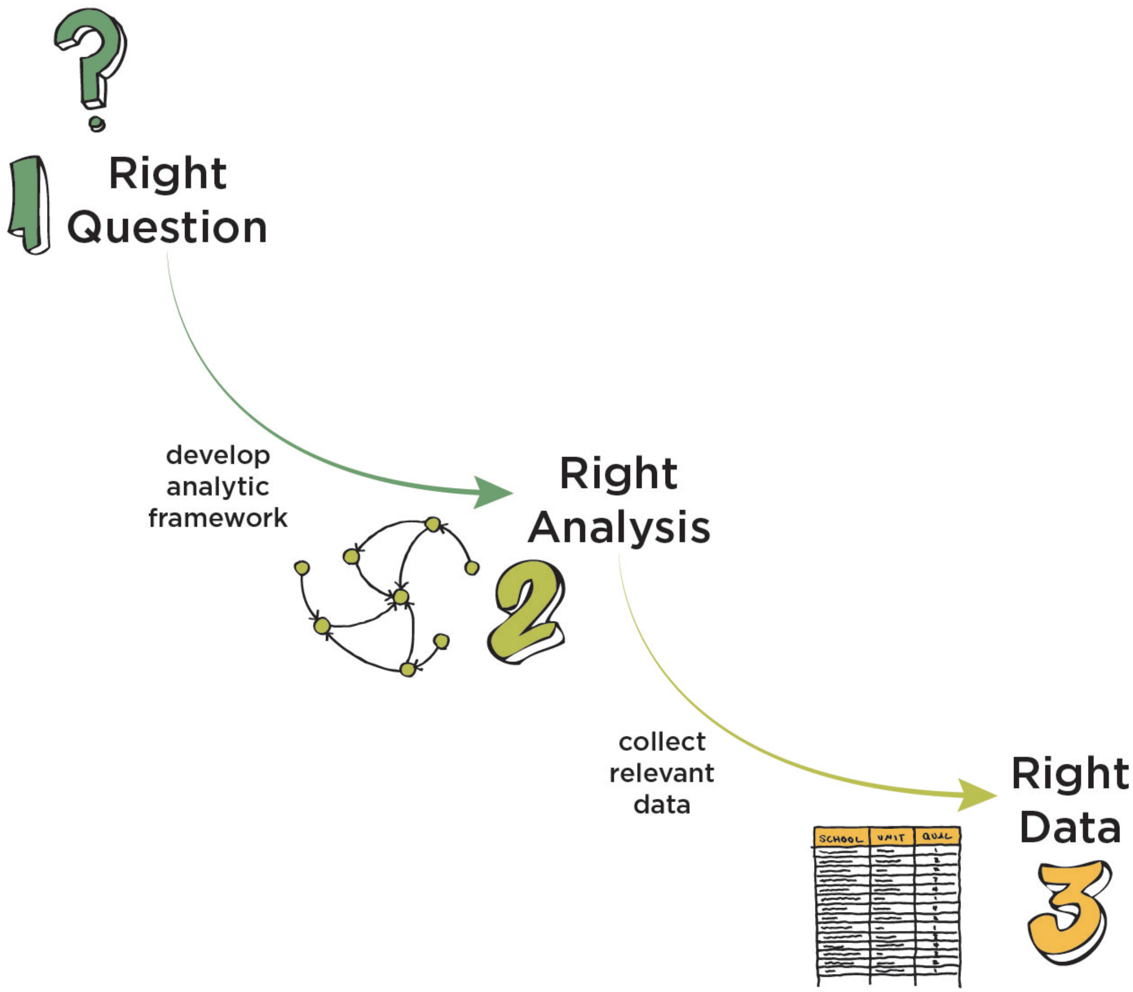
- Sometimes our clients already have a question in mind, but sometimes we need to work with them to adjust the focus and/or intent of the question

Create Analytical Framework



- Identify all the important components of the system in question and define the relationships between system components
- Analytic framework is based off of system model and is the structure for relational database
- Developing the analytic framework is a ***qualitative, design exercise***

Identify Necessary Data



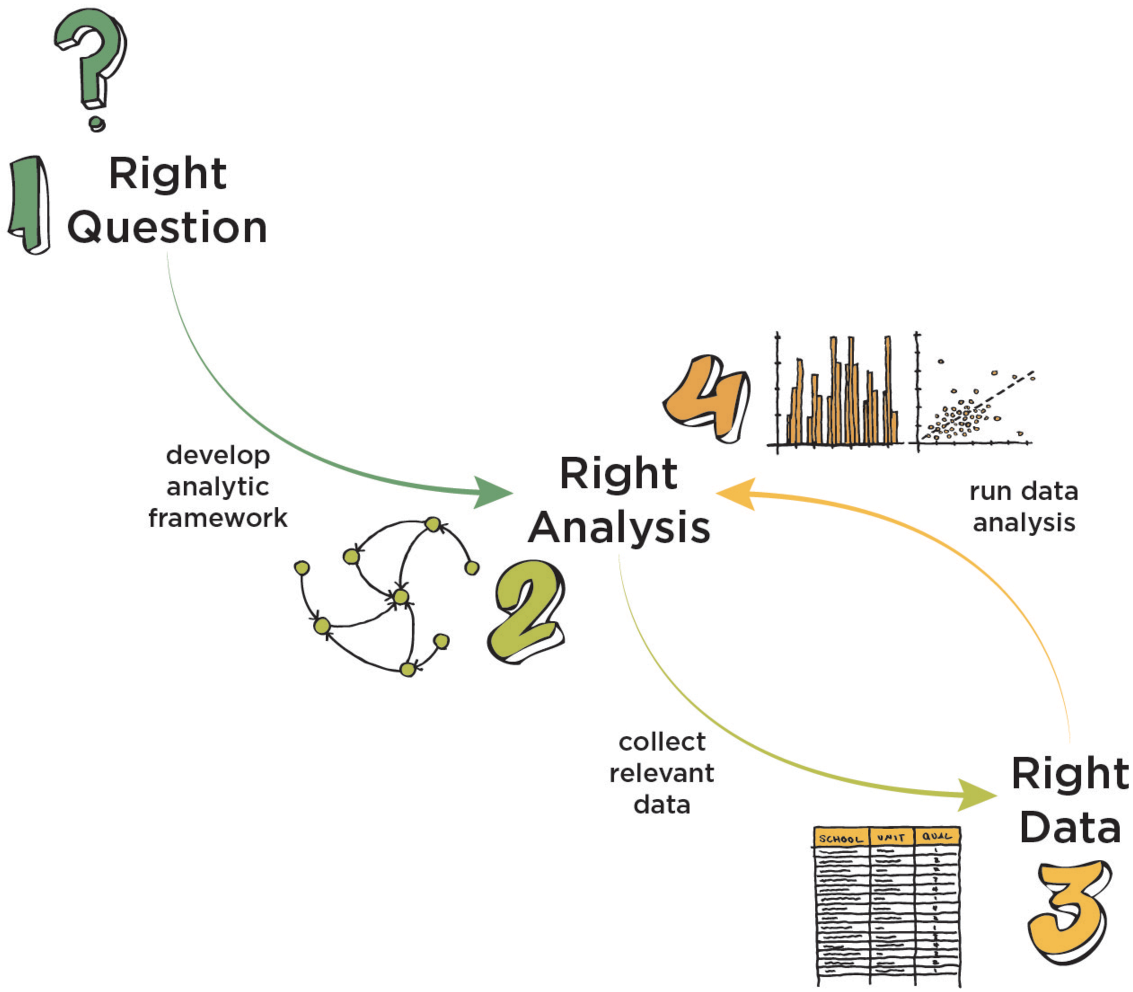
- Identify data points necessary to define the system components
- Identify authoritative data sources
- Determine appropriate collection methods

Self Reported

Focus Groups
Interviews
Surveys
Observation
Instrumentation

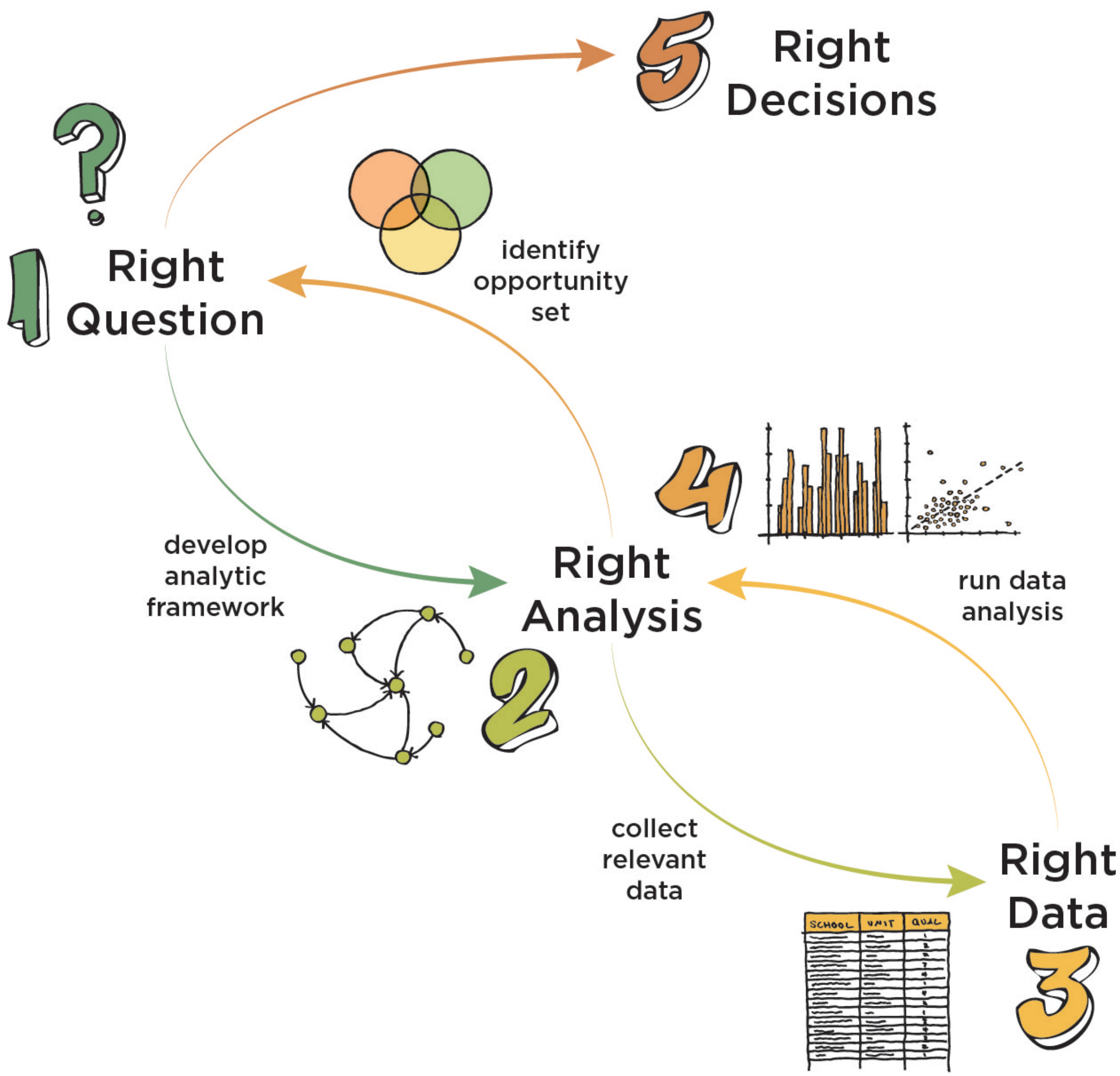
Objective Collection

Run Analysis



- Scrub and format datasets
- Enter datasets into relational database and flesh out data model
- Run analysis on collected data using analytical framework

Answer Question

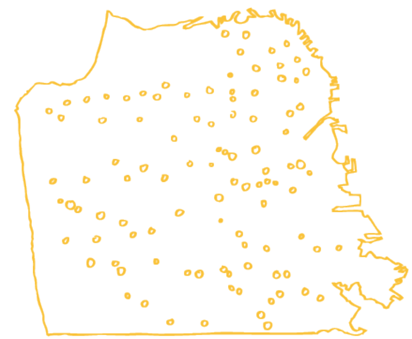


- Identify key findings from data analysis
- Reflect on original question based off of key findings and initial conclusions
- Develop a set of options or scenarios to respond to the question at hand
- Identify tradeoffs for each option by testing sensitivity of variables

Examples

Finding the Right Question:
Arlington Public Schools
Occupancy and Utilization

Building a System Model:
San Francisco Unified School District
Supply Chain Consolidation



Collecting the Right Data:
Hawai'i Department of Education
Thermal Comfort and Heat Abatement Research

Asking the Right Question

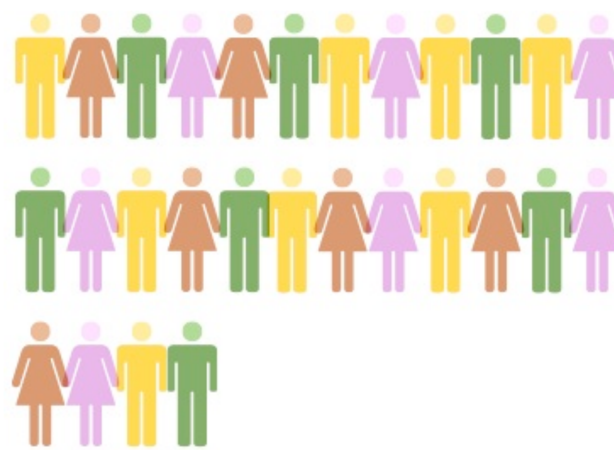
Arlington Public Schools

Occupancy and Utilization

Project Context

Arlington Public Schools

- 13th Largest school system in Virginia
- 2013-14 Enrollment was 23,316 students
- Enrollment has grown by 3,782 students since 2008, and average of 3.8% per year
- Enrollment is projected to grow by another 3,300 students by 2018-19 school year
- Increase in enrollment will affect all grade levels but will have the greatest impact on high schools



Asking the Right Question

Arlington Public Schools

Right Question

Data Seen By Client:
Census Projections
Enrollment Projections

Original Question:
"Where should we build a new building?"

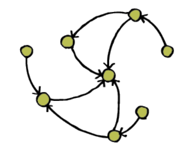
Data Seen By Client:
Real Estate Availability
Classroom Loading
Facility Capacity

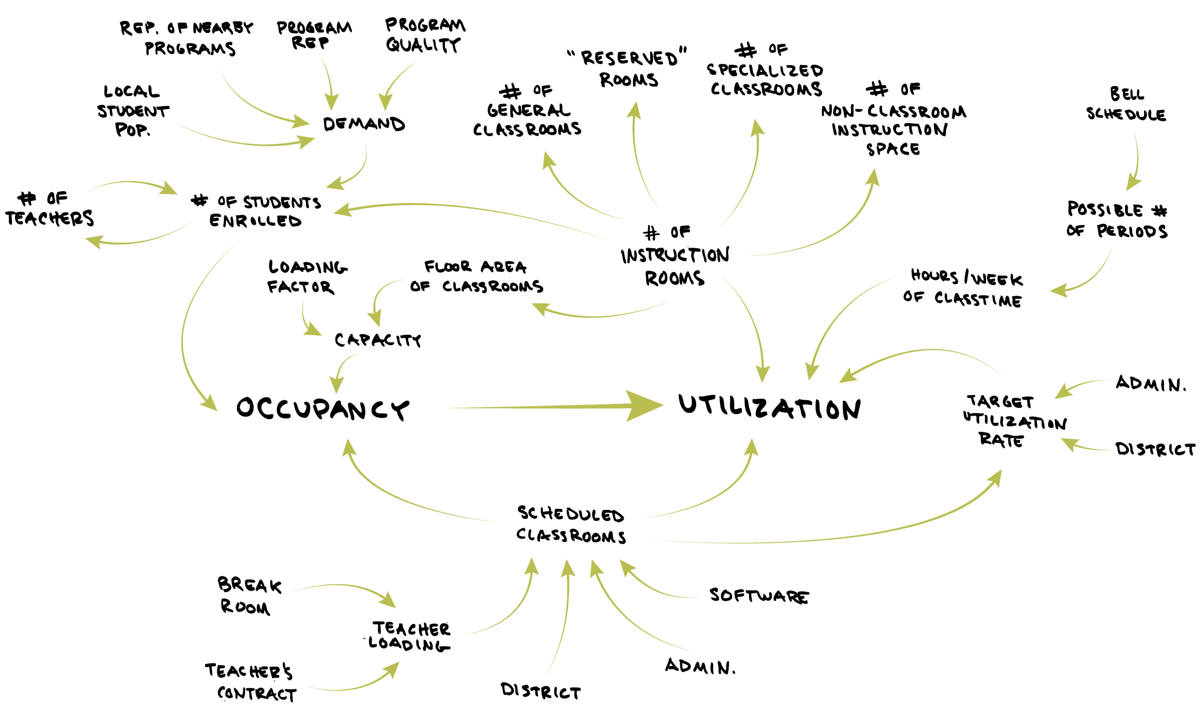
Modified Question:
"How might we better utilize our existing buildings?"

Developing Analysis

Arlington Public Schools

2 Right Analysis



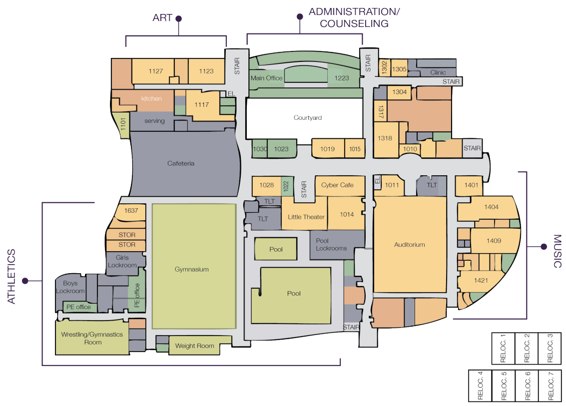


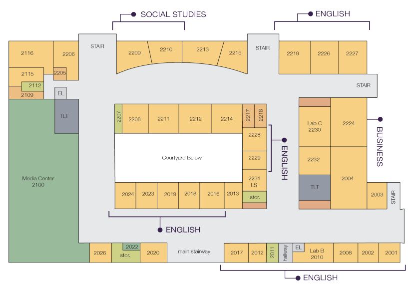
- Identified all the aspects affecting occupancy and utilization for APS middle and high schools
- Determined which components were important to model

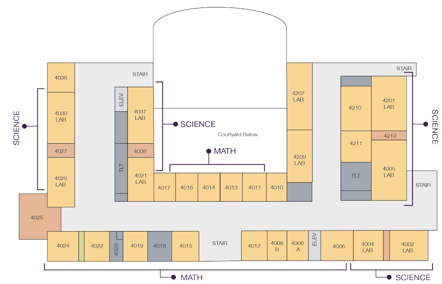
Data Collection

Arlington Public Schools

Right Data





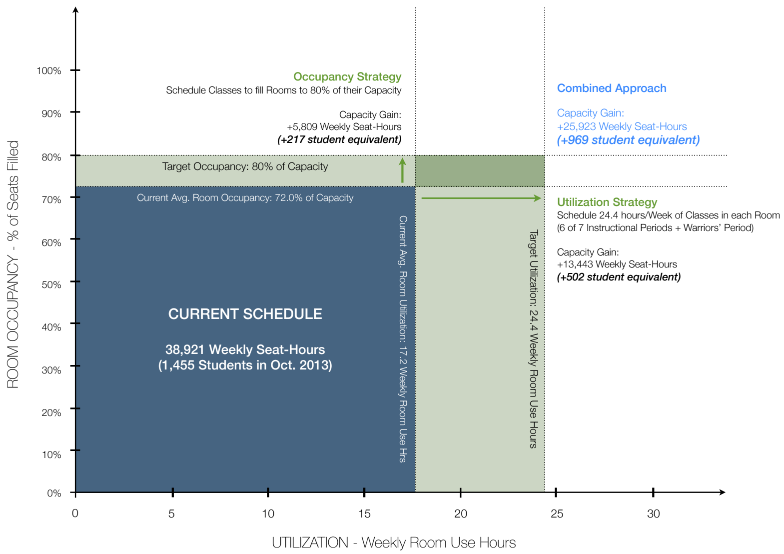


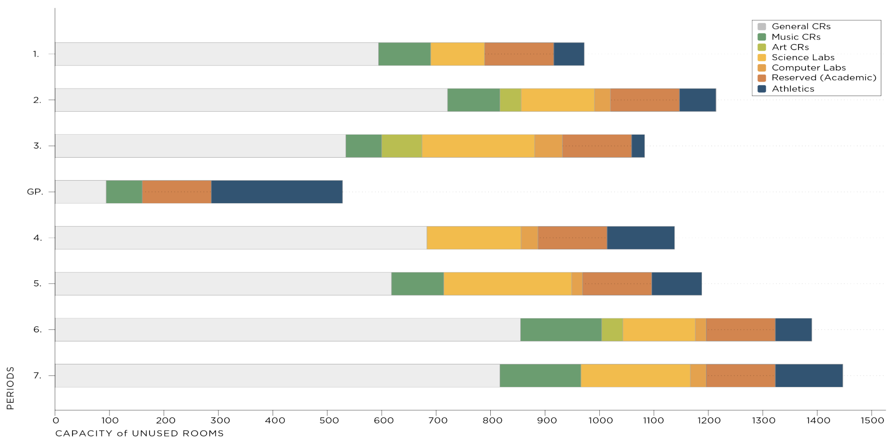
Parent (Room ID)	Item (Room Assignment ID)	Alias	Start Time	End Time	School Year	Use Profile	FICM Space Use Code (general)	FICM Space Use Description (general)	FICM Space Use Code (specific)	FICM Space Use Description (specific)	Capacity
APS001_001_RM423	APS001_001_423_RA	WL-3208 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM307	APS001_001_307_RA	WL-2214 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM315	APS001_001_315_RA	WL-2228 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM501	APS001_001_501_RA	WL-4008B RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	23
APS001_001_RM475	APS001_001_475_RA	WL-4012 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM486	APS001_001_486_RA	WL-4024 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM024	APS001_001_024_RA	WL-1637 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	23
APS001_001_RM302	APS001_001_302_RA	WL-2209 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	23
APS001_001_RM406	APS001_001_406_RA	WL-3021 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	23
APS001_001_RM472	APS001_001_472_RA	WL-4006 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	23
APS001_001_RM413	APS001_001_413_RA	WL-3036 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM474	APS001_001_474_RA	WL-4011 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM496	APS001_001_496_RA	WL-4209 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	50
APS001_008_RM545	APS001_008_545_RA	WL-RELOC7 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	23
APS001_001_RM005	APS001_001_005_RA	WL-1019 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	33
APS001_001_RM281	APS001_001_281_RA	WL-2012 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM287	APS001_001_287_RA	WL-2020 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	22
APS001_001_RM289	APS001_001_289_RA	WL-2023 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM297	APS001_001_297_RA	WL-2116 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	29
APS001_001_RM303	APS001_001_303_RA	WL-2210 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM308	APS001_001_308_RA	WL-2215 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM395	APS001_001_395_RA	WL-3010 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM397	APS001_001_397_RA	WL-3012 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM407	APS001_001_407_RA	WL-3023 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM417	APS001_001_417_RA	WL-3202 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM420	APS001_001_420_RA	WL-3205 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM427	APS001_001_427_RA	WL-3214 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM478	APS001_001_478_RA	WL-4015 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM479	APS001_001_479_RA	WL-4016 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM481	APS001_001_481_RA	WL-4018 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM274	APS001_001_274_RA	WL-2001 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM286	APS001_001_286_RA	WL-2019 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM304	APS001_001_304_RA	WL-2211 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM314	APS001_001_314_RA	WL-2227 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM392	APS001_001_392_RA	WL-3006 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	26
APS001_001_RM393	APS001_001_393_RA	WL-3007 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM394	APS001_001_394_RA	WL-3008 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM398	APS001_001_398_RA	WL-3013 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM399	APS001_001_399_RA	WL-3014 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM400	APS001_001_400_RA	WL-3015 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM402	APS001_001_402_RA	WL-3017 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM419	APS001_001_419_RA	WL-3204 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM422	APS001_001_422_RA	WL-3207 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM424	APS001_001_424_RA	WL-3209 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM426	APS001_001_426_RA	WL-3212 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM434	APS001_001_434_RA	WL-3224 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM500	APS001_001_500_RA	WL-4008A RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM485	APS001_001_485_RA	WL-4022 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	23
APS001_002_RM539	APS001_002_539_RA	WL-RELOC1 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	23
APS001_006_RM543	APS001_006_543_RA	WL-RELOC5 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	23
APS001_007_RM544	APS001_007_544_RA	WL-RELOC6 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	23
APS001_001_RM275	APS001_001_275_RA	WL-2002 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM306	APS001_001_306_RA	WL-2213 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24
APS001_001_RM421	APS001_001_421_RA	WL-3206 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM301	APS001_001_301_RA	WL-2208 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	25
APS001_001_RM313	APS001_001_313_RA	WL-2226 RA	9/3/13	6/13/14	2013-14	Scheduled	100	Classroom Facilities	110	Classroom	24

- Collected classroom scheduling data, classroom occupancy per period, and facilities level data to assess occupancy and utilization
- Overlaid all analysis on facilities floor plans to understand how occupancy changes spatially over time

Occupancy Analysis

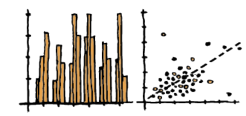
Arlington Public Schools





Weekly Room Use Hours By Room Type

Right Analysis



- Developed data model to describe the components defined in system/ supply chain model
- Evaluated various scenarios based on model inputs and assumptions

Recommendations

Arlington Public Schools

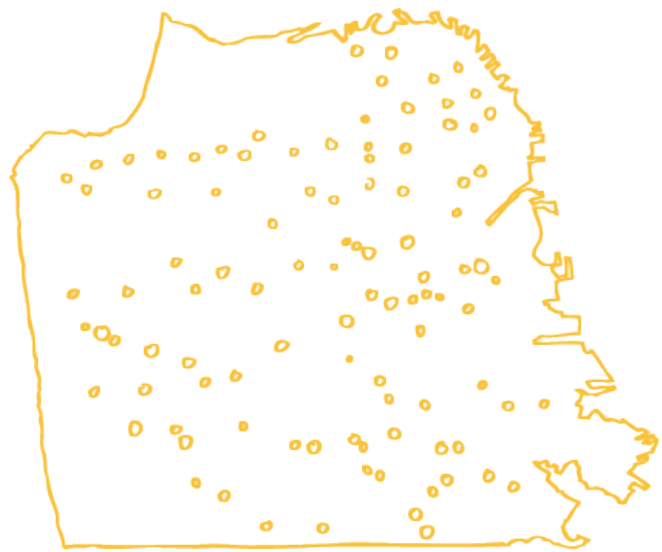
5 Right Decisions

- Utilize unscheduled spaces to increase capacity at peak periods of the day
- Further develop and utilize professional learning centers (PLCs) to have teachers share classrooms and increase capacity, occupancy, and utilization of classrooms across the district
- Do not build a new building prior to attempting to optimize classroom occupancy through operational changes

Building a System Model

San Francisco Unified School District

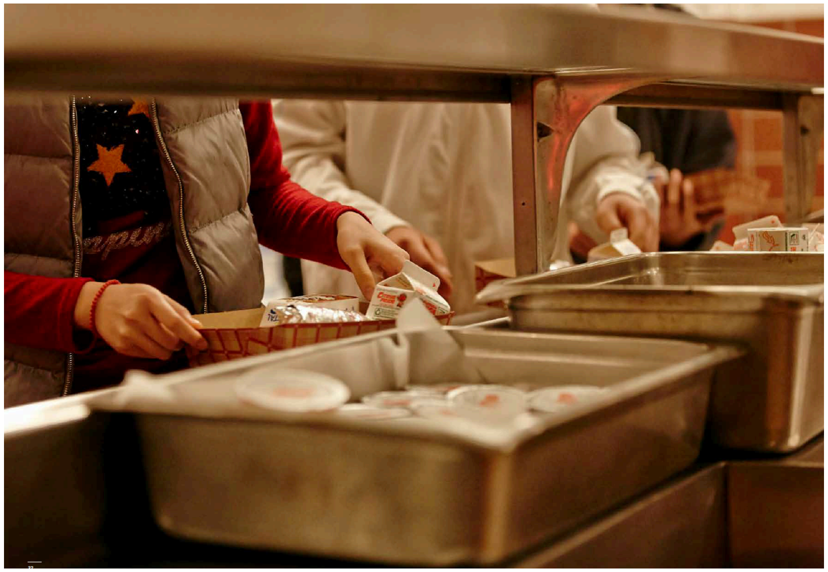
Supply Chain Consolidation



Project Context

San Francisco Unified School District

- Student Nutritional Services Division engaged with IDEO to develop design recommendations to improve the school food experience
- SFUSD currently serves 10,170 meals per day, capturing about 40% participation of enrolled students
- Visited 105 school sites to inventory kitchen and dining facilities and equipment
- Developed scenario model to test viability of regional and central kitchen strategies



Asking the Right Question

San Francisco Unified School District

Right Question

Data Seen By Client:
IDEO Design Recommendations
Design Solution Financial Model

Original Question:
“Where should we build three regional kitchens?”

Data Seen By Client:
Operations/Supply Chain
Facilities Data

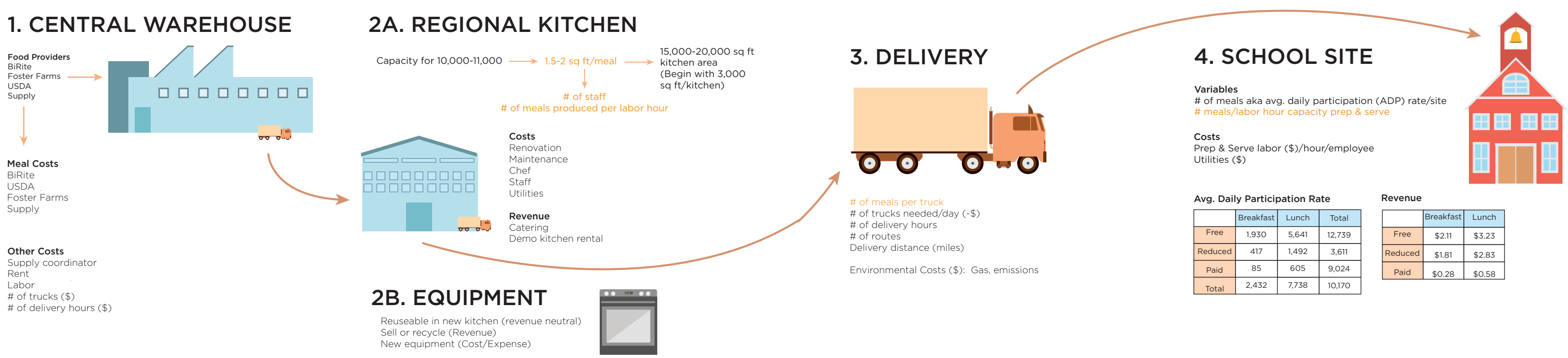
Modified Question:
“Where should we build three regional kitchens, or one central kitchen?”

Building a System Model

San Francisco Unified

2 Right Analysis

- Worked with district staff to develop a system model of the district's food supply chain and meal production system
- Identified datasets relevant to each component of the supply chain and started filling in the information with existing data
- Defined approach for collecting all remaining data points



Avg. Daily Participation Rate

	Breakfast	Lunch	Total
Free	1,930	5,641	12,739
Reduced	417	1,492	3,611
Paid	85	605	9,024
Total	2,432	7,738	10,170

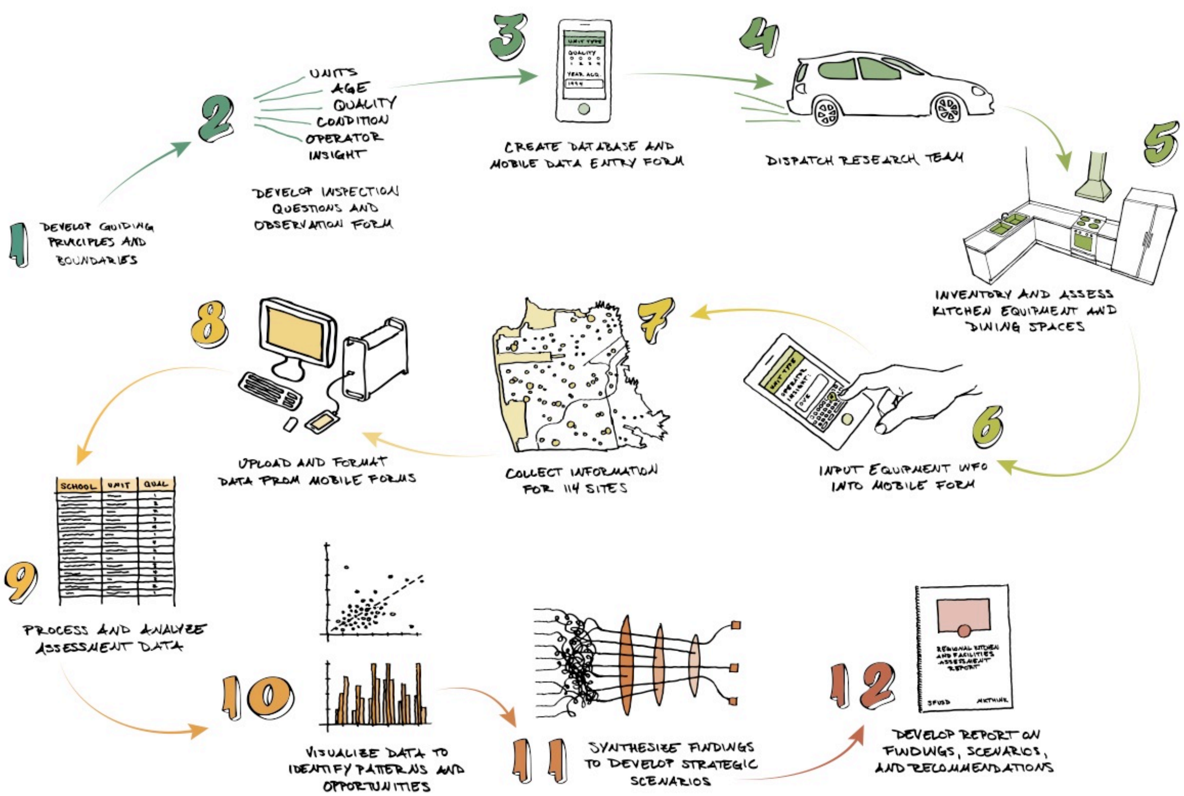
Revenue

	Breakfast	Lunch
Free	$2.11	$3.23
Reduced	$1.81	$2.83
Paid	$0.28	$0.58

Data Collection

San Francisco Unified School District

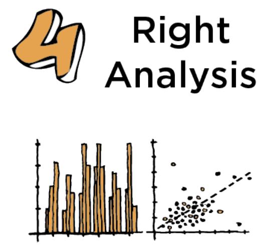
Right Data

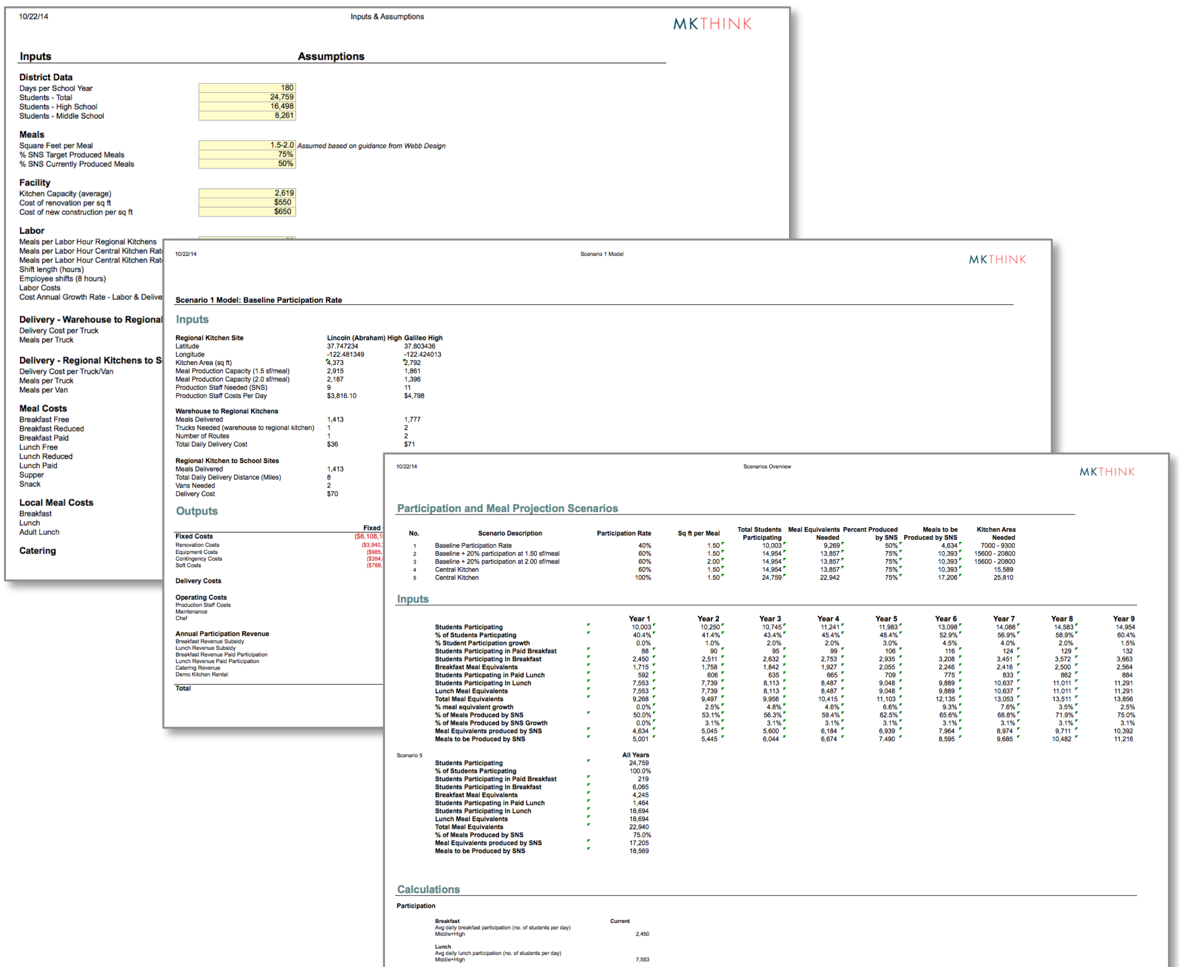


- Digitized data collection forms to streamline collection process
- Dispatched data collection teams to 105 school sites to assess and record equipment and facilities data

Modeling and Analysis

San Francisco Unified School District



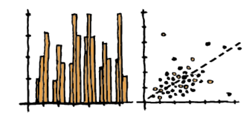


- Developed data model to describe the components defined in system/ supply chain model
- Set assumptions for unknown or projected variables
- Evaluated various scenarios using key metrics

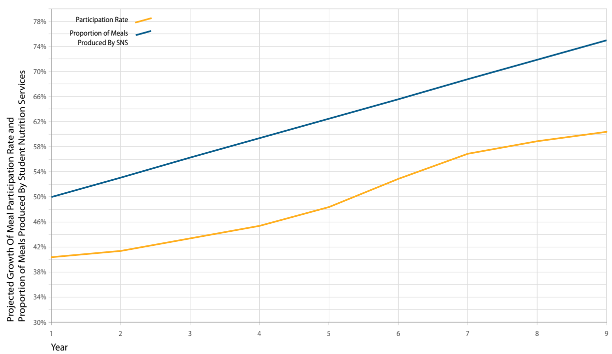
Modeling and Analysis

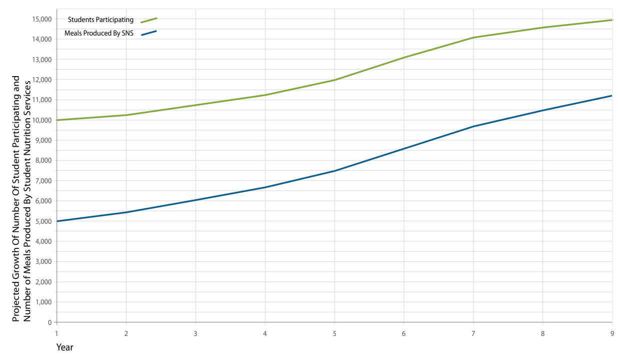
San Francisco Unified School District

Right Analysis

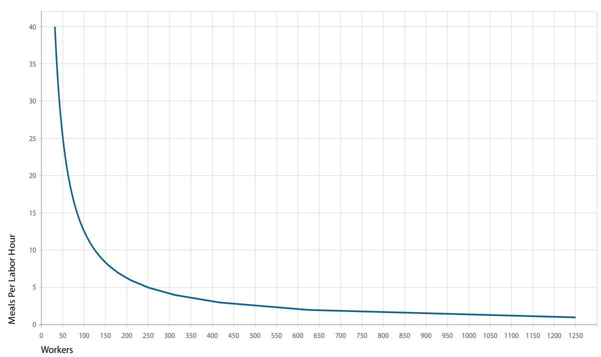


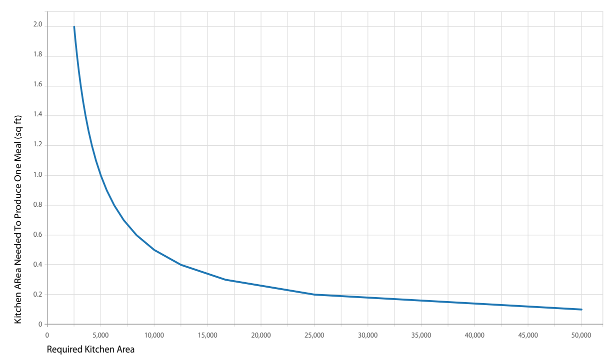
Model Inputs and Assumptions





Model Sensitivities

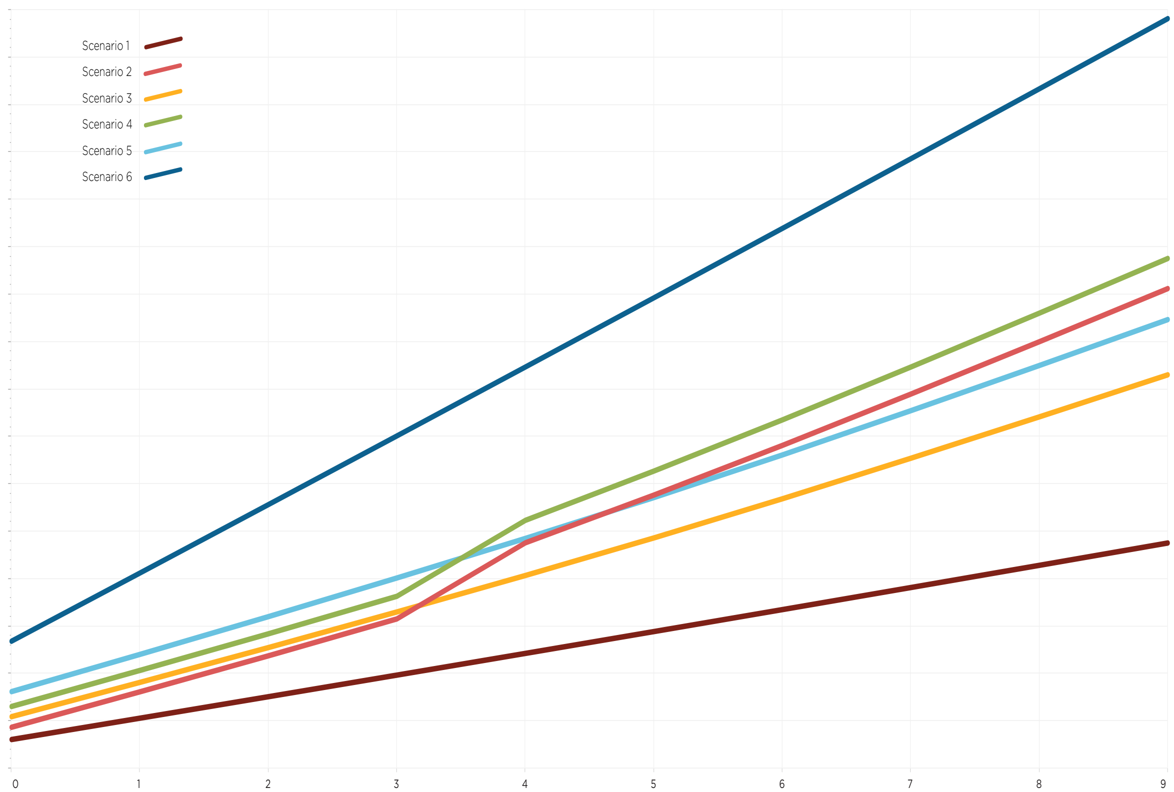




- Defined model assumptions with client to team assure alignment with SNS and district goals
- Determined sensitivities of various model parameters

Recommendations

San Francisco Unified School District



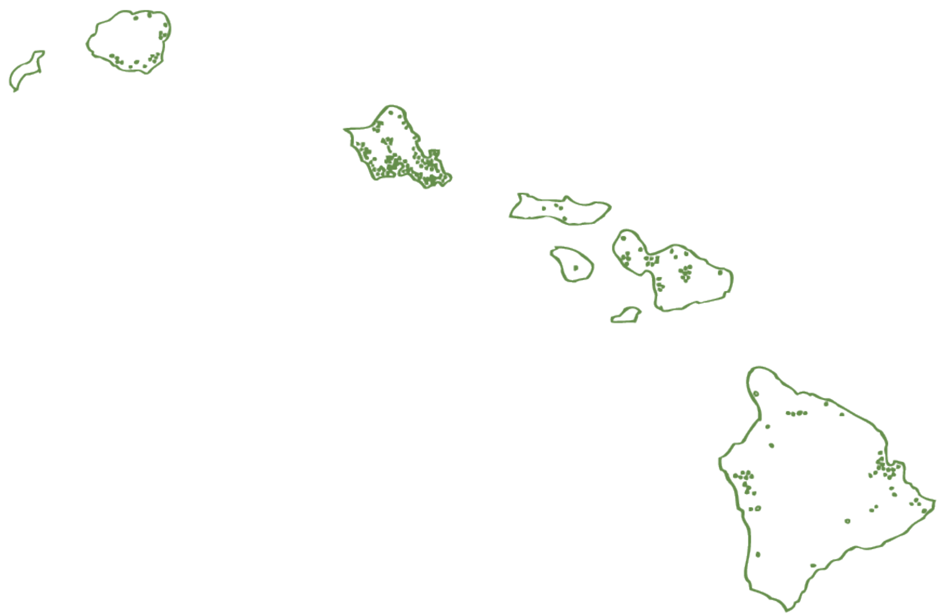
- Assessed value of various scenarios over a ten year time period

- Used model results to recommend the development of a phased regional kitchen strategy or a single central kitchen strategy

Collecting the Right Data

Hawai'i Department of Education

Thermal Comfort and Heat Abatement Research



Project Context

Hawai’i Department of Education

- Collect data pertaining to building assets, energy usage, comfort level, and financials from the Campbell, Ilima, Kaimiloa, and Pohakea campuses through field installed instrumentation and on-site observation

- Identify opportunities for improvements in energy consumption, comfort levels, and overall economics associated with comfortable learning environments

- Develop various scenarios and options through to create a draft strategic plan to guide future physical building modifications

Asking the Right Question

Hawai’i Department of Education

Right Question

Data Seen By Client:
Feedback from students, families, and teachers
Temperature Data

Original Question:
“Students are uncomfortable so we need to lower the temperature so we need air conditioning, how are we going to pay for it?”

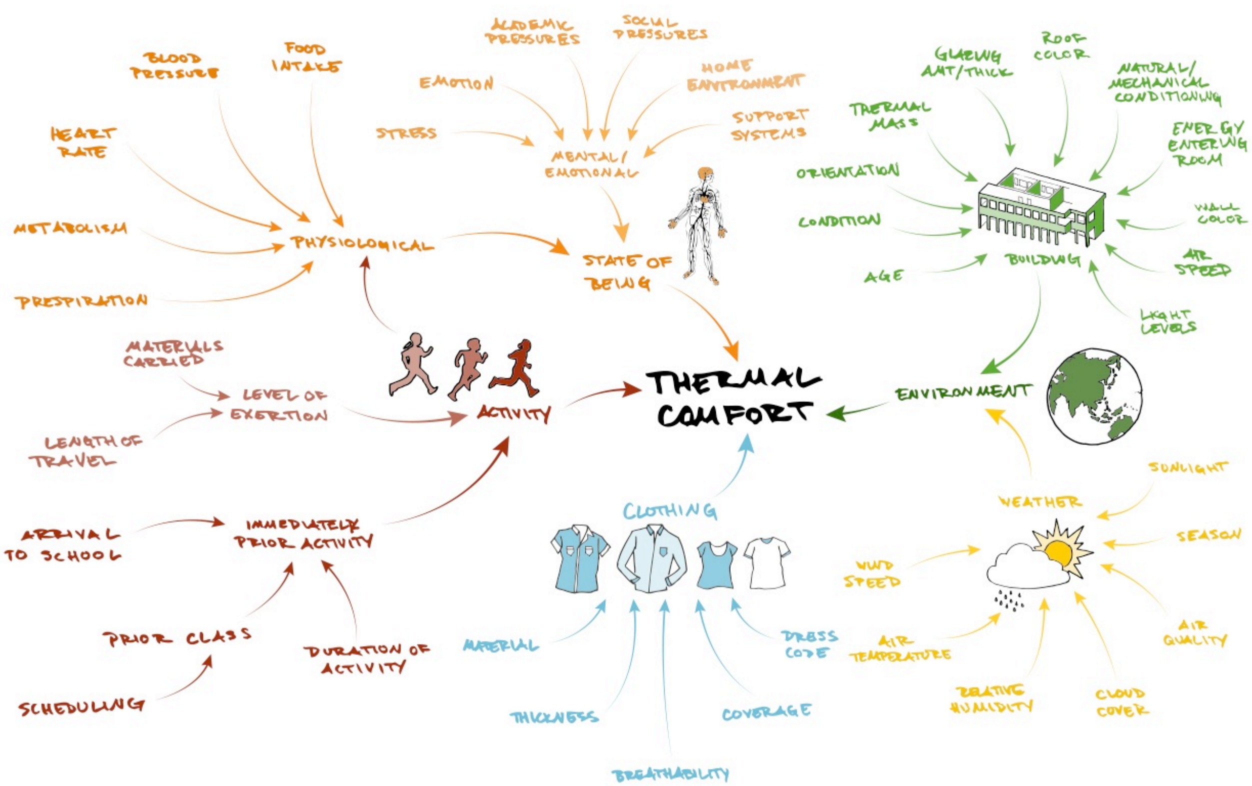
Data Seen By Client:
Fuel/Operating Costs
Installation Costs

Modified Question:
“Students are uncomfortable, how do we improve thermal comfort?”

Building System Model

Hawai'i Department of Education

Right Analysis



- Defined asset, resource, and cultural variables associated with Thermal Comfort
- Mapped the relationships between variables

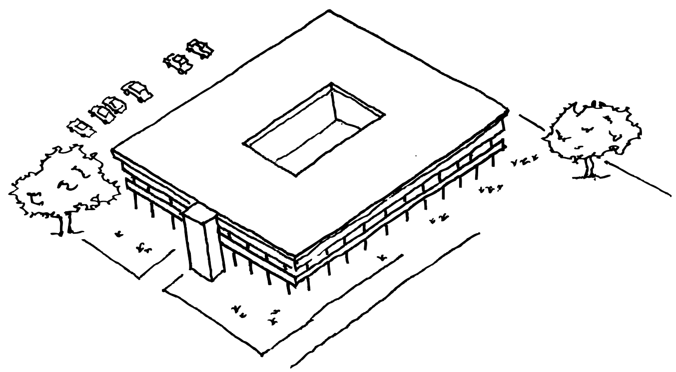
Collecting Relevant Data

Hawai’i Department of Education

3 Right Data

Site Attributes:

- Surrounding Ground Material
  - % Grass
  - % Dirt
  - % Paving: Concrete
  - % Paving: Asphalt
  - % Shaded by Trees
  - % Shaded By Other

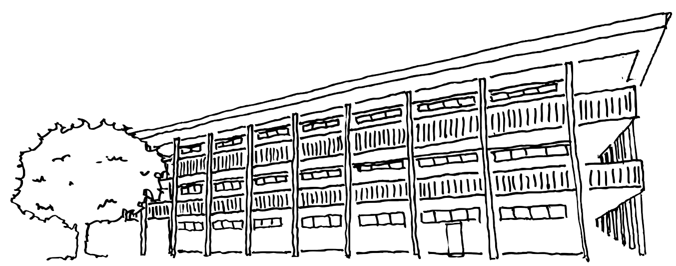


Building Level Attributes:

- Building Orientation
- Roof Color
- Façade Orientation
- Floor Level
- Construction Material
- Building Color

Façade Attributes:

- % of Fenestration
  - % Operable
  - % Glazing
  - % Louver
  - % Other
- Window Type
- Location of Windows
- Depth of Overhang



Collecting Relevant Data

Hawai'i Department of Education

Interior Environment:
- Temperature
- Mean Radiant Temperature
- Relative Humidity
- Illuminance
- CO_2 Levels
- Sound

Air Quality:
- CO_2
- CO
- NO_2

Energy Monitoring:
- Wattnode
- Pulse
- Current

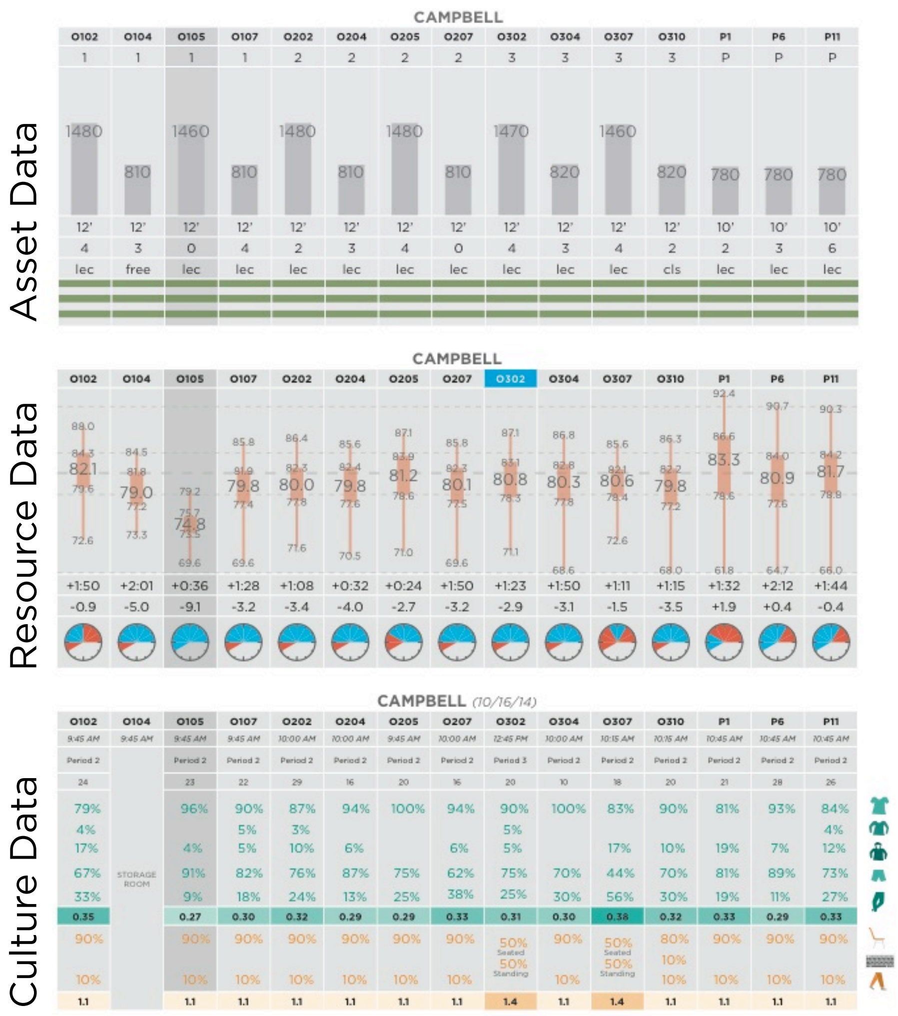
Outdoor Environment:
- Temperature
- Relative Humidity
- Wind Speed / Direction

Right Data

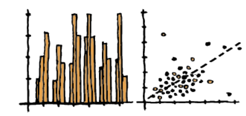
MKTHINK
the IDEAS company for the built environment

Data Analysis

Hawai'i Department of Education



Right Analysis

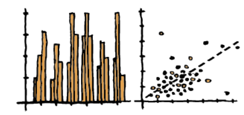


- Compare Asset, Resource, and Cultural datasets across all monitored classrooms

Data Analysis

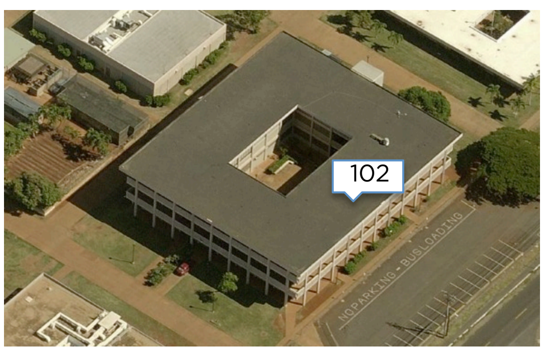
Hawai'i Department of Education

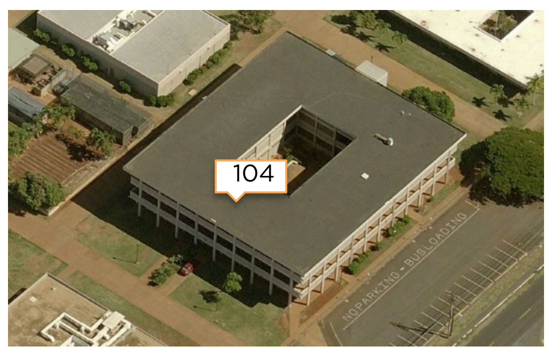
Right Analysis



Room 0102	
Orientation	SE
% Fenestration	25%
% Operable	100%
% Glazing	-
% Louver	100%
Windows Type	Ribbon
Depth of Overhang	8'
Ground Material	Asphalt
% Grass	5%
% Dirt	5%
% Concrete	-
% Asphalt	90%

Room 0104	
Orientation	SW
% Fenestration	25%
% Operable	100%
% Glazing	-
% Louver	100%
Windows Type	Ribbon
Depth of Overhang	8'
Ground Material	Grass
% Grass	80%
% Dirt	-
% Concrete	20%
% Asphalt	-



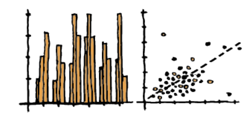


- Isolate specific attributes by identifying similar classrooms

Data Analysis

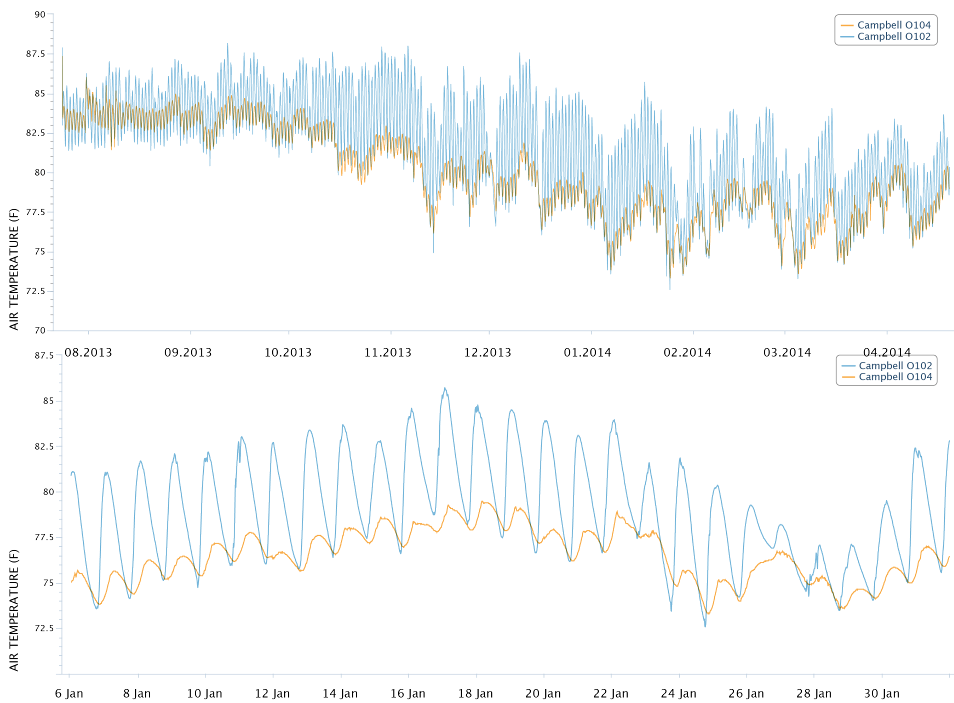
Hawai'i Department of Education

Right Analysis



Room O102	
Average Temperature	82.3°F
Min / Max	72.6° / 88.2°
Ground Material	Asphalt

Room O104	
Average Temperature	80.6°F
Min / Max	73.3° / 86.0°
Ground Material	Grass

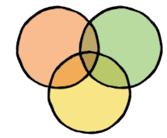


- Assess the affects of isolated attributes on interior classroom environments and on the perceptions of thermal comfort by classroom occupants

Recommendations

Hawai’i Department of Education

5 Right Decisions



- Design, implement, test, and evaluate the effectiveness (both cost- and technical effectiveness) of passive and mechanical heat abatement and increased ventilation strategies (e.g. nocturnal flushing, white roofs, mechanical cooling, sun shading, etc.)

- Measure the change in interior environments and the change in perceptions of thermal comfort as related to each implemented strategy

- Develop a system-wide thermal comfort master plan to determine which strategies to deploy at which buildings at which school sites