COMAP'S
EXPLORING MATH MODELING IN AND OUTSIDE OF THE CLASSROOM WEBINAR SERIES

Webinar #2
**Modeling with Context:**
**Authentic Problems to Foster a Modeling Mindset**

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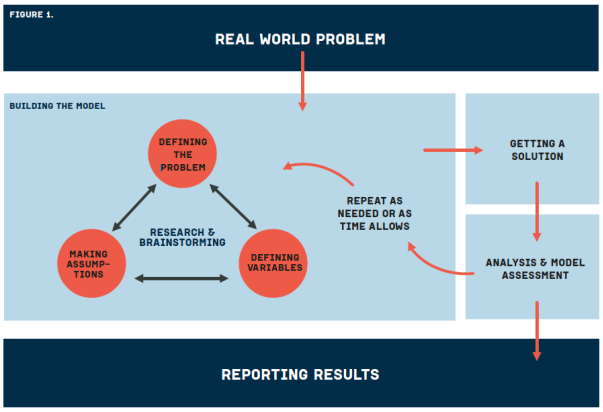
# GOALS

- Introduce the Modeling Process
- We All Have Problems!
  - Getting Started: Modeling Resources – Contests
  - Student Voice and Choice
  - Identifying local problems
    - Parking Lots
    - Lunch Lines
  - Developing a Modeling Mindset – Introductory Steps
    - Indirect Measurement Activities
- Additional Resources

# The Modeling Process




# Getting Started

MODELING COMPETITIONS

- CoMAP www.comap.com
  - High School Mathematical Contest in Modeling (HiMCM)
    - First contest in 1999
  - Mathematical Contest in Modeling (MCM)
  - Interdisciplinary Contest in Modeling (ICM)

- SIAM https://m3challenge.siam.org/
  - Mathworks Math Modeling Challenge (M3 Challenge)
    - First contest in 2006

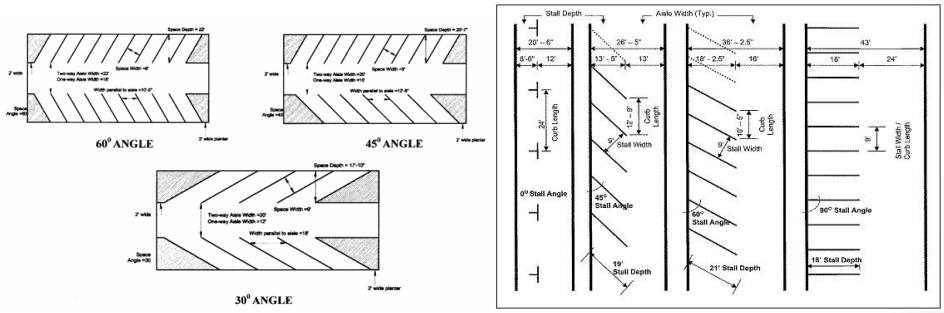
# Student Voice and Choice

- Modeling empowers students to make real decisions
- Modeling gives each student the opportunity to participate according to their strengths
- Modeling engages all students by offering problems that are of genuine interest and / or concern to students
- Modeling validates student efforts by ensuring that there is an authentic audience (“client”)
- Modeling provides context for math and its applications

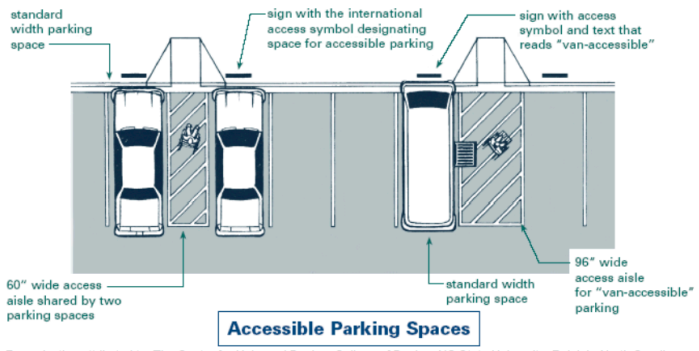
# We All Have problems!

- Problem: Parking Lot Design
  - High school wishes to redesign school parking lot
  - Opportunity to have input
  - What is an “optimal” design – what are we trying to optimize? Number of available spaces? Traffic flow?
  - Other considerations:
    - Bus traffic
    - Handicapped parking
    - Lighting
    - Snow Removal

# Types of Parking Spaces




# Accessibility Requirements (NH)




*Reproduction attributed to: The Center for Universal Design, College of Design, NC State University, Raleigh, North Carolina.*

# Accessibility Requirements (NH)

| TOTAL PARKING SPACES PROVIDED | REQUIRED MINIMUM NUMBER OF ACCESSIBLE SPACES |
|---|---|
| 1 to 25 | 1 |
| 26 to 50 | 2 |
| 51 to 75 | 3 |
| 76 to 100 | 4 |
| 101 to 150 | 5 |
| 151 to 200 | 6 |
| 201 to 300 | 7 |
| 301 to 400 | 8 |
| 401 to 500 | 9 |
| 501 to 1,000 | 2% of total |
| More than 1,000 | 20 plus one for each 100 over 1,000 |

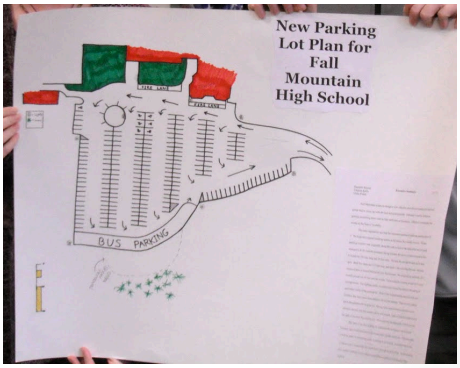
*Source: Committee on Architectural Barrier-Free Design, State of New Hampshire*

- The amount of accessible parking spaces that must be provided is based on the total number of spaces in each parking lot.
- At least one parking space must be van-accessible, and for every 6 (six) accessible parking spaces, there must be one van-accessible space.

# Results

- This was the first opportunity that students had to make real choices in how to solve a problem. While many found it intimidating at first, the students were energized by having the opportunity to present their solution to the School Board

# Results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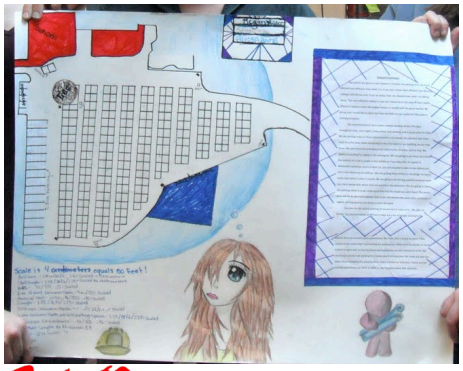
# Results

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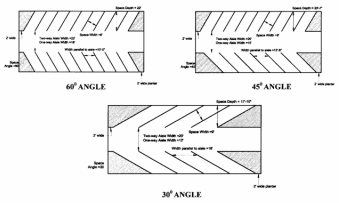
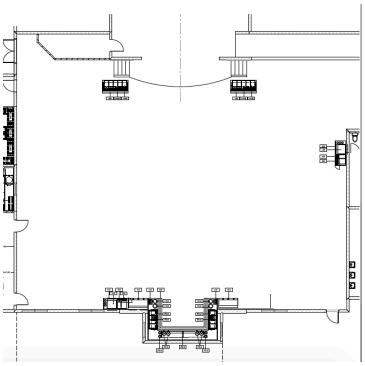
## If I had to do it all over again…




- For a first activity, I would recommend focusing on one aspect of the design – such as optimizing the number of parking spaces by exploring different types of parking spaces.

## We All Have Problems!

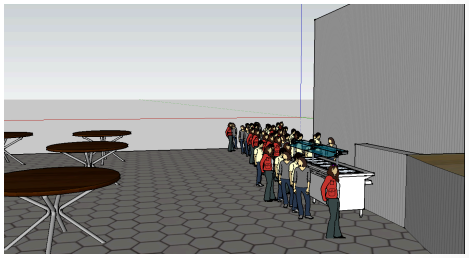


- Problem: Lunch Lines
- Newly opened cafeteria (2015)
- Long lunch lines
- Some students skip lunch

# Restatement of the Problem

Problem:

The amount of time it takes to have lunch, from entering the queue to being served, discourages students from going to the cafeteria and eating the provided lunch.



Goal:

To analyze data and determine the factors that hinder the flow of the service queue.

To find a method of making the lunch experience at Oxbridge more efficient and enjoyable.

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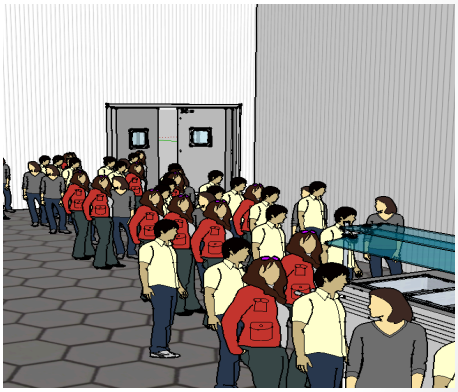
# Definitions

- **Service Queue:** Line before service center
- **Service Center:** Food/service counters
- **Oven:** The process of receiving service
- **Cook Time:** The time it takes to receive service
- **Line 1:** Closest to outside door
- **Line 2:** In far corner next to kitchen
- **Line 3:** Closest to inside door
- **Transfer Time (conveyor):** Time it takes to travel from any exit to any line



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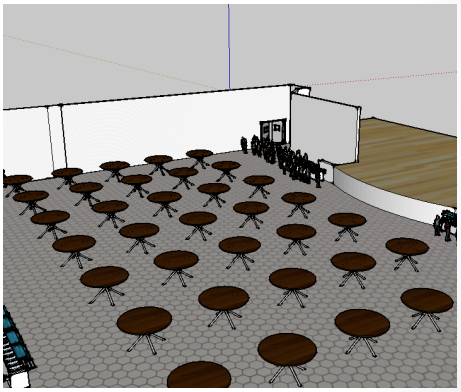
# Assumptions

- There is no cutting.
- An individual will choose the line that has the least number of people.
- Lunch is served before 11:20 to people who are in the cafeteria.
- Not every person at Oxbridge eats lunch.
- The line will eventually diminish.
- People will only get one plate of food at a time.
- People will get seconds at random times (usually during the second half of lunch), so they will get back in line.
- The second half of lunch is negligible.
- Salad Bar and Drink Tables do not have an impact on the lunch lines.
- Many students do not eat lunch because of the length of the lines.



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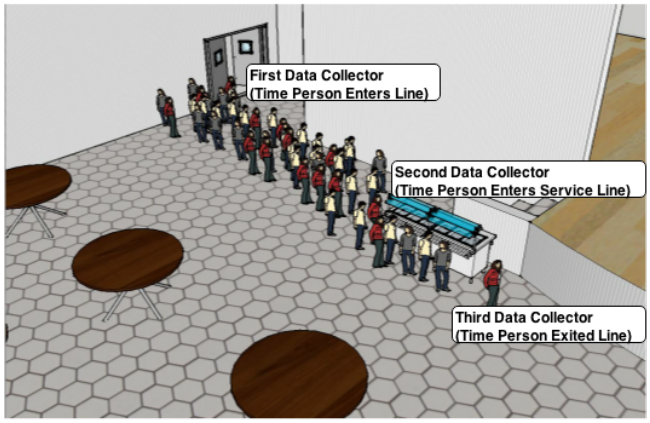
# Data Collection

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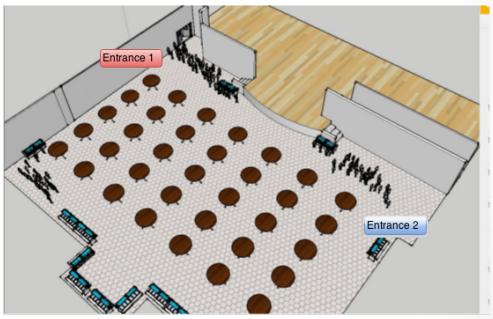
# Data – Transfer Time

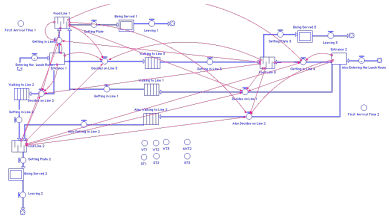
| Exit→ Line | Transfer Time (seconds) |
|---|---|
| Outdoor Exit→ Line 1 | 5 |
| Outdoor Exit→ Line 2 | 22 |
| Outdoor Exit→ Line 3 | 27 |
| Indoor Exit→ Line 1 | 27 |
| Indoor Exit→ Line 2 | 34 |
| Indoor Exit→ Line 3 | 9 |

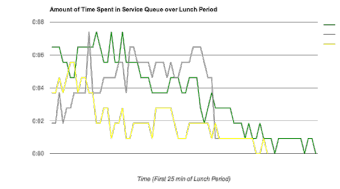
***Average Walking Speed Used: 4.16 feet/second



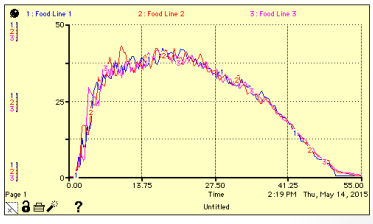

# Results – Base Model

*STELLA Software*

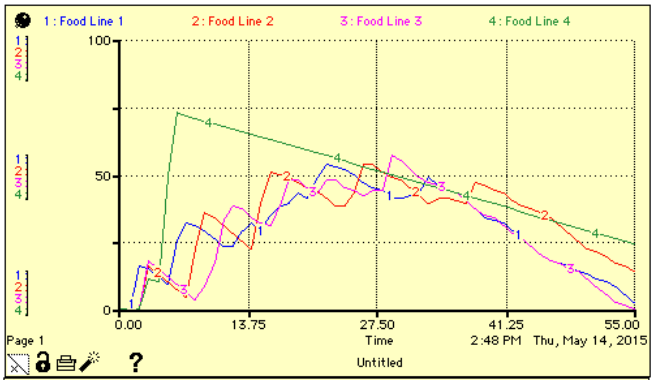




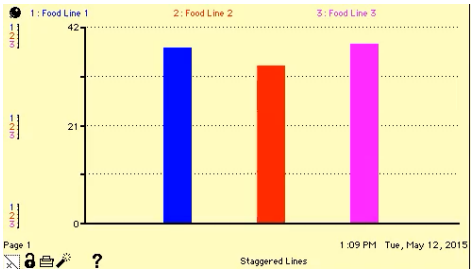


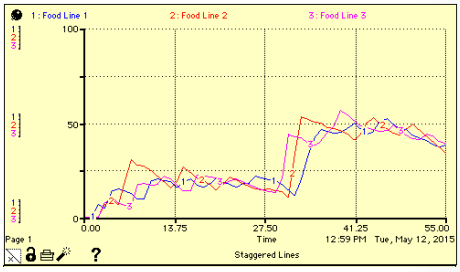


# One Solution: Add a Line



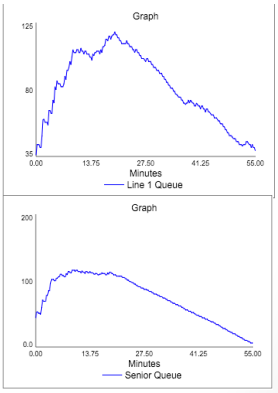

# Alternate Solution: Staggered Lunch Times



# 2019 update

Senior Lunch Line


# 2020 update?

- Students eat in their classroom
- Three lunch stations set up throughout both buildings
- How to get all students / staff through the lunch line while maintaining social distance in the hallways
- Sadly, the math class was not asked to design a solution…

## Student perspectives

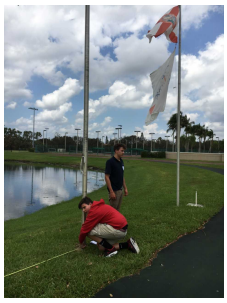
- "Everything is applicable. Everything. There was not one thing we did in this class that could not be taken and used in real life."
- "The projects were so much fun and relevant to problems in society, which made them really interesting!"
- " I loved the hands on aspect of it, and the fact that it went where it went. I also liked that we worked with Oxbridge problems."
- "The projects were interesting and you actually saw how math was used in the real world. It also taught me how to write reports and executive summaries."

## Developing a Modeling Mindset

- Teachers who are interested in incorporating modeling into their classroom can start with smaller, more accessible activities
- Smaller, "bite-sized" activities can be a great way to introduce students to modeling
- Less intimidating than a full project
- Build student curiosity

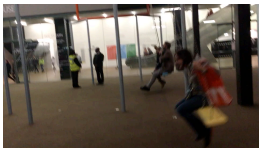
# Developing a Modeling Mindset

Mini-models: Indirect measurement



*What size should this flag be?*

*How far was the photographer from this bridge?*



*How tall is that swing?*

# Additional Resources

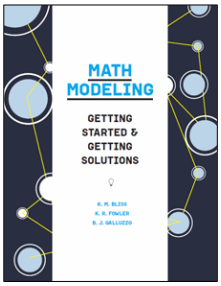
**MATH Models**

**http://www.mathmodels.org/**

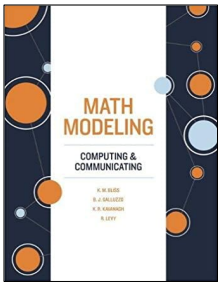
**Math Modeling Hub**

**https://qubeshub.org/community/groups/mmhub**

# Additional Resources








# Questions, Comments, Discussion

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