**Think and Discuss:**

What does it take for people to survive and thrive for millenia?

Architecture is one of the most significant ways in which human societies modified the natural landscape.

- What kind of traditional structures (recreational, social, ceremonial, residential) did your ancestors build?
- What factors determined the design of these structures?

How do modern cities compare to our traditional villages?

**Background**

Many cities act as *urban heat islands*, areas that experience higher temperatures than outlying areas due to human activities. Our warming climate will only make these cities warmer leading to intense heat waves, increasing energy consumption, elevated emission of air pollutants and greenhouse gasses, and compromising human health and comfort. During this activity, you will explore the ways cities can *mitigate* (make less severe) the *heat island effect* while considering urban planning.

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**Objectives**

Your team will build a neighborhood using materials provided and test the heat capacity of the neighborhood. You will draw cards that prompt your team to make changes to the neighborhood and test the impact these changes have on the temperature, as well as track the costs and profits of these changes.

Upon completing this lesson, students will be able to:

- Use the engineering design process to create a sustainable city to combat the heat island effect.
- Combine real-world science and equity issues for a nuanced discussion about the future of urban environments.

This activity was developed by NCSE Teacher Ambassadors Melissa Lau and Amelia Cook.

**Directions:**

1. The objective is to build a city with real building materials that can withstand high temperatures. Your city must include:
    a. Each section of the city (tray) must house 100 people.
    b. Each "floor" of a building (building block) holds 5 people.
        i. Buildings can be placed on sand or asphalt.
    c. Roads must connect one side of the city to the other; any pre-placed asphalt blocks represent these roads and cannot be moved.
    d. Each city section must include one parking lot; represented by an asphalt block.
    e. Water features should be included in the design.
    f. Parks can be made by filling a block with sand, then placing a leafy twig in the block.
    g. At least one commercial and one governmental building must be included. These buildings do not house residents and may be of any height and made from any material, but must follow the height limits in step 6.
2. First, lay out the ground using the asphalt block for parking lots or roads, water features, and sand for the rest of the squares. Remember buildings may be placed on either asphalt OR sand.
3. Use the turkey baster to carefully fill the squares that contain water features.
4. For parks, fill the square with and and place a leafy twig in the middle.
5. Fill in the rest of the squares with sand.
6. Now begin placing buildings - one floor will house (5) people (2-story building = 10 people, 3-story = 15 people, etc.). Buildings can be made of wood, glass or steel and should follow the zoning regulations:
    a. Wood structures can be built up to 3 stories
    b. Glass structures - 4 stories
    c. Steel structures - 2 stories
7. Once the neighborhood is built, use the heat source to add energy to the neighborhood similar to energy from the Sun. Heat your neighborhood using this suggested protocol:
    a. Use the infrared temperature gun to determine the baseline temperature of the neighborhood.
        i. Record the temperature of all (30) squares in Data Table 1.
        ii. Add up the readings and divide by 30 to determine the average temperature.
        iii. Record this Initial Average Temperature in Data Table 1.
    b. Heat the city from above for (2) minutes with the heat source.
    c. Turn off the heat source and record the temperature of each square again and calculate the average temperature.
        i. Record this Final Average Temperature in Data Table 1.
8. If any of the temperatures in the neighborhood rise above the MAX temperature determined by the teacher, you will need to re-design the neighborhood.
    a. If you redesign your neighborhood, repeat step 7 and record the "Second Attempt" in Data Table 1.

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9. The team then draws a card and changes their design to meet the requirements of the card. Any changes must be paid for by the team.
    a. Track changes and the flow of money in Data Table 2: Costs and Profits.
10. After any change to your neighborhood, repeat step 7 and record the temperature in Table 2 under “Neighborhood Temperature”.
11. The process continues until your team goes bankrupt or the neighborhood goes over the MAX temperature.

**Analysis**

1. Which change created the greatest decrease in the temperature of your neighborhood?
2. Which change created the greatest increase in the temperature of your neighborhood?
3. What influence do you think money has on the design of a neighborhood?
4. What influence do you think environmental conservation has on the design of a neighborhood?
5. What influence do you think climate change will have on future neighborhood designs?

**Discussion**

Urban heat stress poses a major risk to public health. Case studies of individual cities suggest that heat exposure, like other environmental stressors, may be unequally distributed across income groups. Extreme heat kills more Americans than any other weather event and has the greatest impact on our nation's most vulnerable communities. As climate change worsens heat waves, critical research and efforts are equitable solutions for those facing the greatest threats

Knowing that we shape our environments and that our environments shape us…what type of environments do we want to create for our future?

- *Urban areas commonly have few trees and green spaces and are predominantly made up of surfaces that are impervious or covered with buildings, thus leading to extreme temperatures. Roads, parking lots, and buildings are often constructed of materials that reflect less and absorb more of the sun’s energy. In addition, cities are typically designed to be dense and compact, which prevents adequate release of heat. Therefore, because urban design plays a large role in the creation of heat islands, smart growth development strategies provide an opportunity to reduce the heat island effect.*

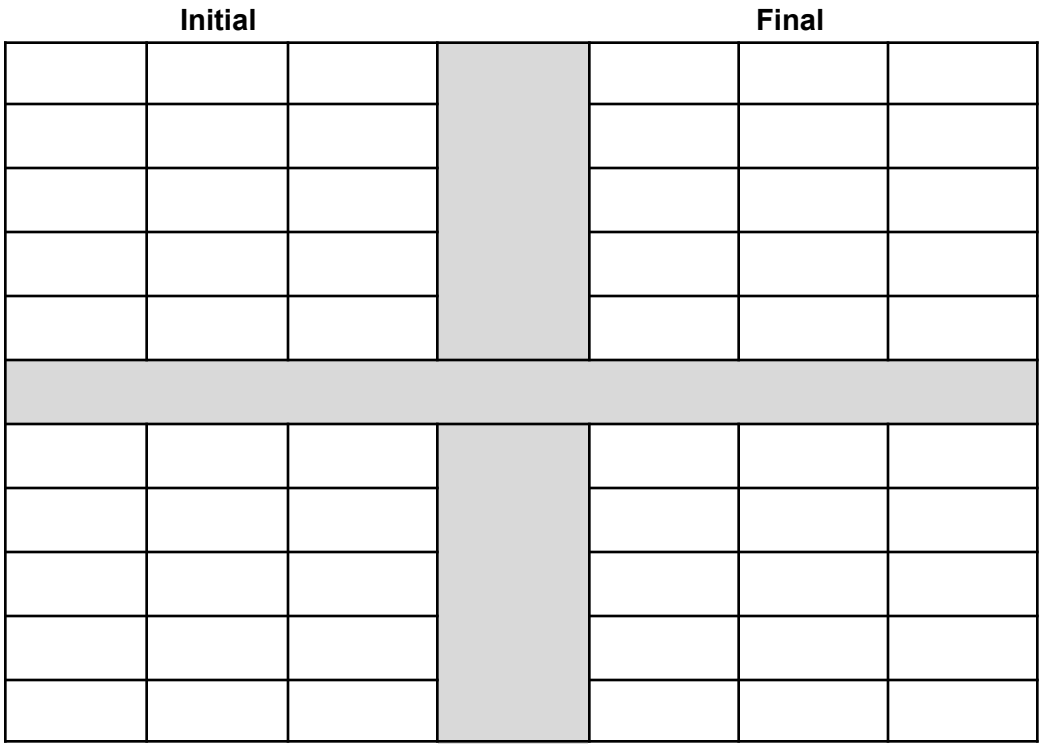
How can Indigenous traditional knowledge guide and inform urban design?

- *Indigenous Architectural Principles* (Douglas Cardinal):
    - Every step must follow a spiritual path guided by the elders in the community.
    - One must conduct oneself in a good way.
    - One must train oneself to always be in the service of others.
    - One must respect people's own traditional decision-making processes.
    - Architectural form is inspired by the spirit of nature.
    - When one plans for the future, one must plan for all life-givers for seven generations.

- Based on the experience of communities around the nation that have used smart growth approaches to create and maintain great neighborhoods, the Smart Growth Network developed a set of ten basic *Smart Growth Principles*, as follows:

    - Mix land uses, such as residential, commercial, and recreational uses
    - Take advantage of compact building design
    - Create a range of housing opportunities and choices
    - Create walkable neighborhoods
    - Foster distinctive, attractive communities with a strong sense of place
    - Preserve open space, farmland, natural beauty, and critical environmental areas
    - Strengthen and direct development towards existing communities
    - Provide a variety of transportation choices
    - Make development decisions predictable, fair, and cost effective
    - Encourage community and stakeholder collaboration in development decisions

**Data Table 1**




Data Table 1: Initial and Final Temperatures

| First Attempt | | | Second Attempt | | |
|---|---|---|---|---|---|
| Initial Temperature | Final Temperature | Redesign neighborhood? (Yes/No) | Initial Temperature | Final Temperature | Redesign neighborhood? (Yes/No) |
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Data Table 2: Costs and Profits

| Description of Card Drawn | Changes Made to Neighborhood | Balance Adjustment | | Balance | Neighborhood Temperature |
|---|---|---|---|---|---|
| | | Cost | Profit | | |
| | Neighborhood Built | | +$200 | $200 | |
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