STAR★net Hands-on

Tested & Approved STEM Activities

Space Forts

Exploring Computer Processing Systems

Activity Guide

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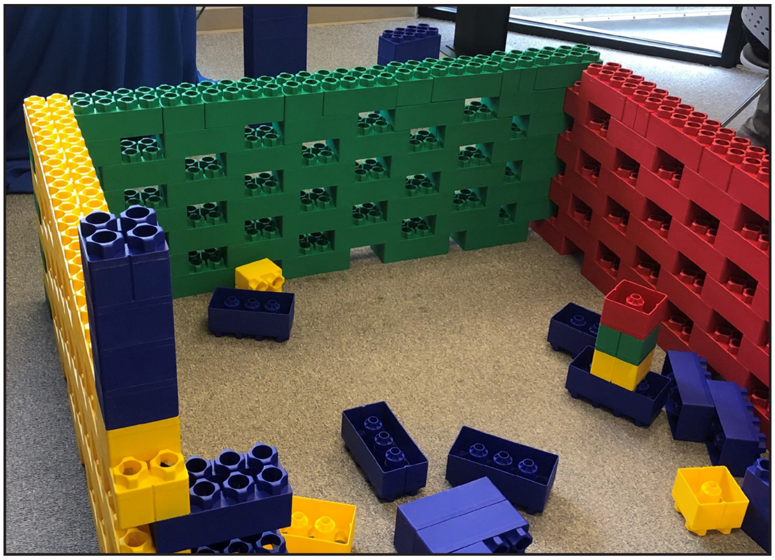
Space Forts

Hands-on STAR net



Activity Time

15-20 minutes

Intended Audience

Families or other mixed-age groups, including children as young as 4 years old *with assistance from an older child, teen, or adult*
School-aged children ages 6 and up
Tweens
Teens

Type of Program

- ☑ **Facilitated hands-on experience for teens and/or children under close supervision**
- ☑ **Station, presented in combination with related activities**
- ☐ Passive program (if instructions are provided)
- ☐ Demonstration by facilitator

Overview

Patrons learn about parallel and serial processing computer systems by racing the clock to build a fort with stackable blocks.

What's The Point?

- **A computer using a parallel processing approach can solve problems much more quickly than a computer using a single, serial processor (most of the time).**
- **Supercomputers use thousands of parallel processors to solve extremely complex problems in a fraction of the time required by single-processor computers.**
- **Space connection: Curiosity Rover has four processors: one for descent, one for ground functions, one is a backup for that, and one for motor functions.**

Facilitator Note: While no computers are used in this activity, patrons will learn how computer systems process information by working in teams to solve problems (like a parallel processing system) versus working alone (like a single, serial processor).

Materials

For each demonstration or each facilitated group:

- ☐ Stopwatch or similar timer

- ☐ Stackable blocks
  - ☐ If you're working with kids ages 6-10, consider using a standard set of Jumbo Blocks
  - ☐ If you're working with teens, consider using smaller blocks, such as LEGO bricks
  - ☐ 4 sets of 10 blocks – each should be a single, distinct color or similar shades (e.g. shades of blue)
  - ☐ One set of 10 blocks of each of the 4 colors

- ☐ 5 small bins or bowls to hold groups of blocks

Preparation

Before the activity:

Place blocks into bins or bowls (for groups of 5 participants)

– In the first 4 bins, place 10 blocks of the same (or similar) colors into the first bin, 10 blocks of a different color into the second bin, and so on. For example, bin 1 would contain 10 red blocks, bin 2 would contain 10 blue blocks, etc.

– In the 5th bin, place 10 blocks of each color (a total of 40 blocks).

Activity

1. Share ideas and knowledge.

- Introduce yourself. Help the participants learn each other's names (if they don't already).

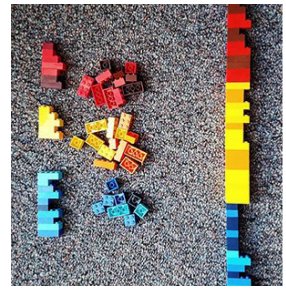
- Ask the participants to define a computer. How do they work? What are some ways computers help us?
  - Explain that computer systems can have serial, or single, processor systems or they can have parallel processor systems, and that they will be simulating how these two systems work by having a race to see who can complete the task first!

- Explain that there will be two teams: a paralleling processor group with four people, and a serial processor "group" of one person.

Activity (continued)

- The task for each group is the same: Assemble the blocks into a Space Fort! Each wall of the fort must be a single color.
  - Each of the individual members of the parallel processor group will work on building their own wall, and then the team will have a few moments to coordinate their work and combine their walls together to create the fort.
  - The one person in the serial processor "group" will complete the task alone.

- *Modification for older patrons: consider giving them the task of creating a "space rocket" instead of a fort by stacking blocks of the same color into one large tower.*



Credit: UCAR Center

Facilitator Note:
This activity demonstrates that the parallel processor is much faster at completing the task than the single, serial processor. The person who represents a single processing computer will only have part of the block-stacking task completed when the parallel processing group is done. This is a very unfair, uneven race; make sure the person who serves as the single, serial processor understands that she or he is in no way at fault for being much slower to finish the task. Optional: with younger participants, consider using yourself or a parent volunteer as the serial processor so nobody feels like they were at a disadvantage or gets upset for being the slower processing system.

2. Ready, Set, Build!

1. Explain the block-stacking task to the participants.

2. Arrange the participants into groups of five people per group
   - Assign roles within the groups: one person will be the single, serial processor. The remaining four people are the parallel processor group.

3. Provide participants with bins of blocks.

4. When participants and materials are in place, give the participants two minutes to discuss their plan for completing the task. Then, start the timer and tell the participants to begin the race of stacking the blocks!

5. When the individual processors in the parallel processing system have finished their sub-tasks (building the walls of a single color), note the time and tell them to work together to assemble their single-colored walls into a complete fort. Allow the single, serial processor person to continue working while the multi-processor group is combining their separate walls.

6. Note the time again once the participants in the parallel processing group have combined their individual stacks of blocks into a single, large, multi-colored stack (for teens and tweens) or combined their walls into a fort (for younger patrons). This represents the "task completion time" for the parallel processing group.

7. Once the serial processor person finishes their task, stop the timer and note the elapsed time.

Activity (continued)

Facilitator Note:
Reinforce the point that the parallel processor group completed the task far more quickly than the serial processor by leading another brief discussion to wrap up the activity. Be careful to note that the serial processor was set up to "fail" the race on purpose.

3. Conclude.

Draw on the participants' observations and reflections for the discussion:

- Compare the time it took the groups to complete the task. How much faster was the parallel processor?
- Ask participants to consider the time lost by the parallel processing group as they worked together to assemble their individual, single-colored stacks into the overall, combined stack or fort. Explain that computers also must take some time to recombine the work of their parallel processors. However, the small amount of time lost in working together was still worth the huge amount of time saved by having multiple processors dividing up the overall work.
- Ask the patrons if they think that even faster computers could be built with dozens or even hundreds of processors. Explain that modern supercomputers can have thousands of processors!

Background Information

Parallel processing systems take large numbers of data and process them all at the same time using many individual processors. A central processor is responsible for breaking down a large problem into smaller calculations, and then it assigns these calculations to multiple processors so they can work simultaneously. The coordination of these tasks results in some lost time, but overall a parallel processing system is much faster than a computer with only one processor doing all of the work on its own. Some supercomputers, such as NCAR's Cheyenne Supercomputer, have hundreds of thousands of processors!

Parallel processing computers are used to run models of highly complex systems, such as global climate models, supernova explosions in space, and modeling nuclear explosions.

Check out Curiosity Machine's video on parallel processing to learn more! https://youtu.be/1XGo8K1boH4

Next Generation Science Standards

Science and Engineering Practices

- Developing and Using Models
- Planning and Carrying out Investigations
- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking

Disciplinary Core Ideas

- 3-5-ETS1.A Defining and Delimiting Engineering Problems
- 3-5-ETS1.B Developing Possible Solutions
- 4-PS4.C: Information Technologies and Instrumentation
- MS-PS4.C: Information Technologies and Instrumentation
- MS-ETS1.A: Defining and Delimiting Engineering Problems
- MS-ETS1.B: Developing Possible Solutions
- HS-PS4.C: Information Technologies and Instrumentation
- HS-ETS1.A: Defining and Delimiting Engineering Problems
- HS-ETS1.B: Developing Possible Solutions

Crosscutting Concepts

- Scale, Proportion, and Quantity
- Structure and Function
- Interdependence of Science, Engineering, and Technology
- Influence of Engineering, Technology, and Science on Society and the Natural World

Computer Science Teachers Association Standards

- 1A-CS-02: Use appropriate terminology in identifying and describing the function of common physical components of computing systems (hardware)
- 1A-IC-16: Compare how people live and work before and after the implementation or adoption of new computing technology
- 1B-CS-02: Model how computer hardware and software work together as a system to accomplish tasks
- 1B-AP-16: Take on varying roles, with teacher guidance, when collaborating with peers during the design, implementation, and review stages of program development