Problem Space: Environmental Science Education
- Redesigned educational standards stress:
  - Systems-based approach
  - Human-environmental interaction
  - Need new tools to support content changes
  - Many problems are rooted in spatial configurations
- Green Infrastructure: Adding natural spaces to urban landscapes to support:
  - Groundwater sustainability
  - Pollinators

Current Approach: Agent Based Models
- Tool frequently used by scientists for understanding human-environmental systems
- School standards stress importance of gaining familiarity with authentic tools

Prior Work:
Many successful educational Agent Based Models (ABMs) already exist, but user interfaces tend to belong to two classes:

- **Programming-based UIs**
  - UI designs impact how software is used in classroom:
    - Instruction time
    - Exploration style
    - Spatial manipulation

- **Slider-based UIs**
  - Let students into activity quickly
  - Allow for creativity

Our Approach

Paper-to-Parameters (PtP)
- Students place paper symbols on a wall as input
- PtP uses computer vision to recognize symbols
- Symbol identity and location converted ABM input
- ABM projected on classroom wall

Advantages:
- Instruction time focused on content material, not how to use software
- Supports open-ended scenario construction without need to program
- Supports whole-class learning activities with a single computer
- Spatial manipulations accomplished by moving “puzzle pieces”
- Similar to paper-based practices in urban planning

Initial Study
**Goal:**
Need to support efficiency in spatial manipulations to build the student’s understanding of spatial interdependencies.
When manipulations are efficient, wider/deeper exploration of the problem space can occur.

**Task:**
Students may be expected to design yards containing 15-30 items; want to test placement efficiency.
- We timed task of placing 16 items to match a given configuration, under 2 conditions:
  - PtP method
  - Programming locations directly (the current standard approach)

**Results:**
- Average item placement time:
  - PtP: 4 seconds per item
  - Programming: 31 seconds per item
- Total time to place 16 items:
  - PtP: 1 minute 11 seconds
  - Programming: 8 minutes 8s

Future Work
**Research:**
We believe tangibles:
- Change the nature of collaboration
- Change the problem solving efforts
Thus, a user study comparing a dual-mouse drag-and-drop interface for the simulation with the tangible interface for the simulation is planned
- Pairs will perform an urban planning task together

**Technical Development:**
- Using OpenCV to eliminate the need for the thick borders around the images required by ARToolkit
- Integrating the simulation and OpenCV input for real time manipulation.