Sim Urban: A Transportation Engineering Game

By Bryce Summers

Advisor: Jack Bringardner

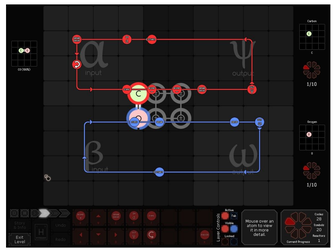
Motivation

Games

***Sim City*:** Land Use

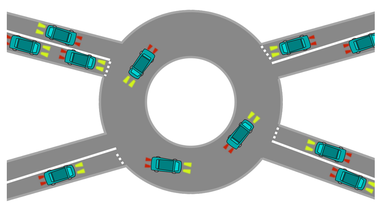
***Mini-Metro*:** Networks

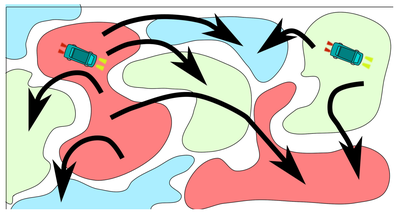
***Cities in Motion 2*:** Operations



Spacechem: Systems

Simulations



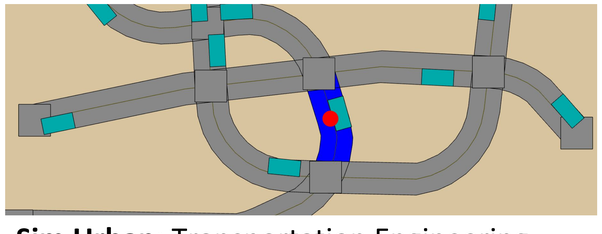


Micro: Simulate every car. **Macro:** Flow between regions.

Urban Systems have long been the subject of computer games in the simulation genre as well as professional simulations. Because transportation engineers and other urban professionals already rely on a variety of simulation models and software in their work, the community is open minded to using simulation games. Games have been used in related educational settings for quite some time, especially EA's *Sim City* game. We are making a computer game for teaching fundamental transportation engineering principles, which we hope to use in a national academic competition.

The Game

Sim Urban



Sim Urban: Transportation Engineering

Elegant User Experience:

- Players build and demolish roads and other elements through mouse clicks.
- Sophisticated Geometry and Topology algorithms provide instant feedback to users.
- Instant feedback regarding costs and system performance metrics.

Potential Game modes:

1. Urban Planning mode. Players design an efficient city over months and their success is based on metrics such as cost, global efficiency.
2. Real time mode. Players must respond to a scenario in real time.
3. Competitive mode. Players play as operators who compete or collaborate with each other in different scenarios. For instance they can create symbiotic companies.

Players make engineering decisions and see consequences:

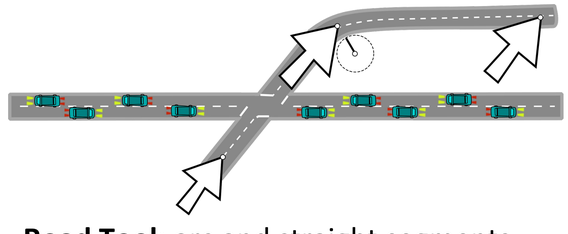
1. Build roads and allow private cars.
2. Build a fixed Route system such as a subway.
3. Invest in on - demand services such as Taxis or Uber.
4. Ban private cars and create a city wide self-driving car system.
5. Should they build bike lanes.

Educators can create custom scenarios:

- Uber's surge price is too high.
- There is a wheelchair convention or large sporting event in town.
- The city is on fire.
- The roads are covered with snow.
- Self - driving cars are invented.
- Plan a city from an empty plot of land on upwards.

Some Theory

Road Construction



Road Tool: arc and straight segments.

Let **E** be a graph embedding representing the topology of the road network.

Let **BVH** be a bounding volume hierarchy used for efficient collision detection.

Finally, **S** be an updatable scene graph, which stores the renderable geometry.

1. User tries to construct a new road of width **w** centered on polyline **L.**
2. Find critical points at endpoints and at the intersections with **E**.
3. Classify all of the critical points as intersections, control points, or endpoints.
4. Construct the geometry **G** based on critical points and arc interpolation.
5. Check if **G** is legal.
    a. Stop if **G** contains exceeds the maximum allowed curvature.
    b. Stop if **G** collides with the environment outside of intersections.
6. Destroy the intersected roads. Remove their collision geometry from **BVH**. Relocate the agents contained therein.
7. Topologically split the intersected roads, construct roads for each half of the split. Add their collision geometry to **BVH**.
8. Instantiate all of the non intersection critical points.
9. Topologically join all of the critical points along **L**.
10. Construct new roads between along **L**. Add their collision geometry to **BVH**.
11. Update agent pathfinding.

References

- http://www.redblobgames.com/articles/curved-paths/
- University of Minnesota STREET Simulation Modules
- https://www.remix.com/

Images from Bryce Summers and Referenced Game Owners