# Rigid Body Dynamics: A Graphical Simulation

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## Abstract

Dynamics is defined as the study of the interaction between masses based on the laws of physics. The goal of my project is to design and program a fully functional, efficient, rigid-body dynamics simulation capable of supporting objects of variable shape and mass (Fig 1).

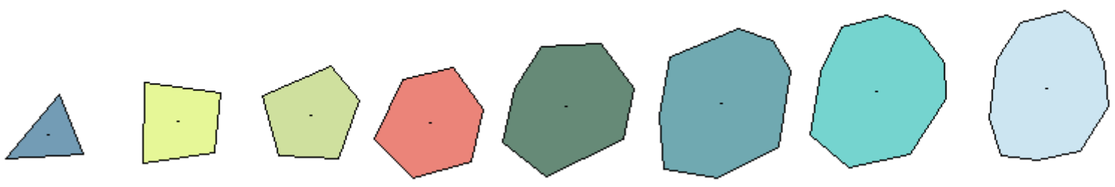

*Figure 1: Examples of shapes that the simulation currently supports, all convex polygons.*

## Development

The majority of the work in my simulation was divided into two areas: the code behind the dynamics, and the graphics and interface of the simulation itself. The greatest difficulty in programming this simulation was handling collision response. When two bodies collide, the resulting impulse acts on both the linear and angular aspects of the bodies. Although the math behind these collisions is very complex, I needed for the simulation to be fast, as it would be running real-time. Additionally, I focused on making the graphics and interface simple and intuitive, allowing the user to create, delete, and move bodies throughout the world.

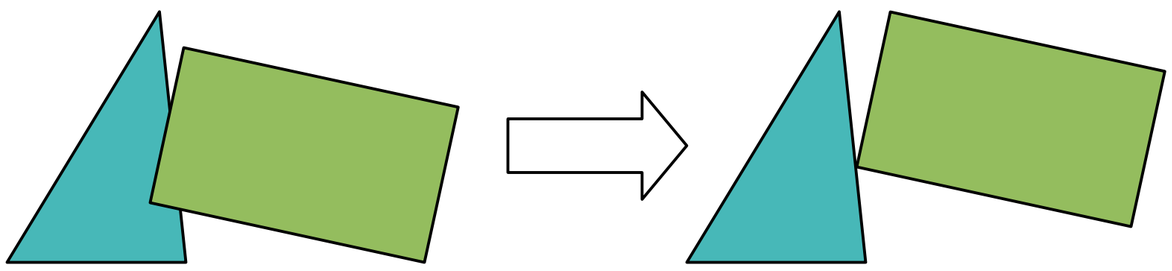

*Figure 2 : An example of a resolved collision using the separating axis theorem.*

## Collisions

Collision detection in this simulation is done through application of the separating axis theorem. This theorem postulates that, if there exists a plane between two objects, then the two objects must not be colliding. While at first this seems like a very simple observation, it becomes infinitely useful once one realizes that there exist a limited number of axis to test for separation between two objects. These axis of separation are generated by finding the perpendicular normal vectors of every edge of a polygon. Then, using basic vector maths, its possible to determine whether the two polygons intersect over the axis, and resolve the collision (Fig 2).

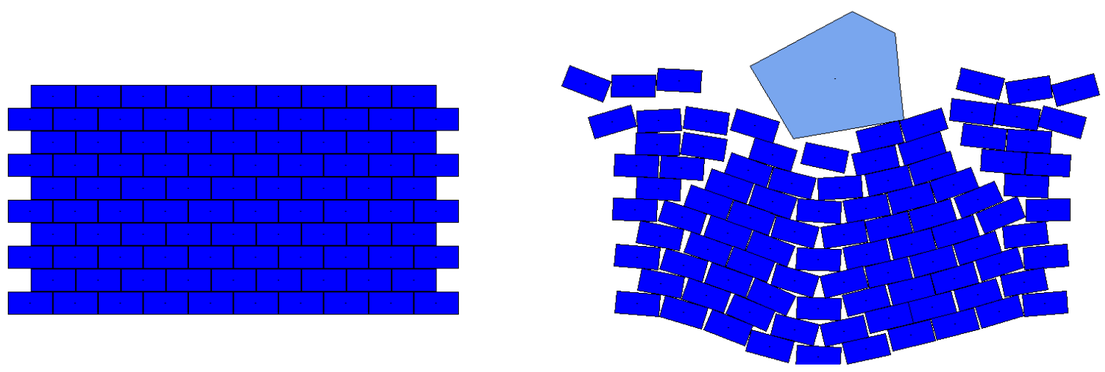

*Figure 3: The resulting collision between a wall of "bricks" and a large polygon*

## Dynamics

Using an impulse-based system, the dynamics simulation generates impulse for every collision that occurs. In a simulation of a large number of bodies, this means that there are a great number of impulses generated every frame of the simulation (Fig 3). One problem with this is that impulses can be conflicting in some cases, resulting in bodies in the simulation that are misrepresented. To fix this problem, I implemented a correcting method that essentially forcibly seperates each body before applying impulses, once again based on the seperating axis theorem.