Vehicle Simulations

- Reference:

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Introduction

- Vehicle simulations try to create the feeling of driving or flying a vehicle.
- The vehicle may be real or imaginary.
- **Simulating real vehicles is the bigger challenge!**
- That's because for real vehicles, the players tend to know a lot about these machines and want an experience that is at least visually similar to that of really controlling one. The machine's speed and maneuverability should be similar to reality.
- Imaginary vehicle simulations are easier to produce since you're free to create any kind of driving/flying experience that you like. You don't need to be restricted by such things as gravity, G-forces, fuel capacity, etc. Your game just needs to create the sense of movement and it is up to you as to the sorts of limitations that you would like to impose on that movement.

Flight and Driving Simulators

- There are two kinds of flight simulators:

  civilian flight simulators. These allow players to experience the joy of flight in a variety of different aircraft.

  military flight simulators. These allow players to fight in aerial combat.

- There are two kinds of driving simulators:

  organized racing simulators. These try to reproduce the experience of driving a racing car or motorcycle in an existing racing class (e.g., NASCAR, Formula 1, etc.).

  imaginary racing games. These allow players to, for example, driving madly through cities or the countryside or even fantasy environments.

Purists vs Casual Players

- **Purists** demand highly accurate simulations of real vehicles with all of their quirks and limitations.

  → For example, in a flight simulator, if you forget to retract the flaps after takeoff, then the flaps should be damaged by excessive airspeed with appropriate consequences.

- **Casual players** don't care about the details as long as they can fly, drive fast, and (depending on the game) shoot at things.

Is it really a game?

- Some vehicle simulations aren't games at all. There are no goals given to the player and no winners/losers.
- Such simulations only aim to let the player experience controlling the vehicle, so they don't have any rules other than the laws of physics.
- However, most vehicle simulations are competitive (e.g., a race or a battle).

Handling Damage

- Three possibilities for handling damage:

  Don't simulate damage. For example, if the car hits something, it simply bounces off, which tends to slow it down. However, the car is undamaged.

  Model damage using a single variable. When damage reaches a certain level, the vehicle stops running/crashes/explodes.

  Model damage accurately. This involves dividing the vehicle into areas, determining which area has been damaged, and deciding how that damage affects the performance of the vehicle. For example, a plane is still flyable if its tail has been destroyed, but it will be unstable and extremely difficult to handle.

Career and Campaign Modes

- Both military flight simulators and organized race-driving simulators often include a **career mode**, in which you create a pilot or driver and follow his career, racking up victories and collecting performance statistics.
- They also include **campaign modes**, in which a race driver tries to win in a real racing circuit, collecting points according to the official rules of the circuit.
- In military flight simulators, the campaign mode can work in various ways:

  Mission objectives must be met. The game offers a series of missions one at a time in which the player must achieve a specified victory condition before going on to the next mission; completing all the missions constitutes winning the campaign.

  Mission objectives need not be met. The player can play all the missions in order, whether she meets the mission objectives or not. However, if she plays though all of them without achieving enough mission objectives, she loses the campaign. This more closely approximates what happens in a real war. The better you fight on any given occasion, the more chance you have of winning the war in the long run, but you can still afford to lose the occasional battle.

Controlling the Vehicle

- To control the vehicle, the player needs to learn to:
  - → speed it up
  - → slow it down
  - → steer it to where he/she wants it to go without crashing into something
- For flight simulators, you can make controlling an aircraft
  - → simple requiring the player to know almost nothing about aerodynamics, or
  - → extremely difficult, modeling the behavior of an airplane accurately.
- Unlike a car, airplanes respond slowly to their controls.
- Because players are more used to driving a car, they will tend to overcontrol the plane: finding that it doesn't respond immediately, they'll push the stick farther and then wildly overcompensate in the opposite direction when the plane finally does much more than they intended in the first place.
- If you want a realistic challenge, then this behavior is desirable.

Military Flight Simulators

- In military flight simulators, the player not only has to fly an aircraft but must also try to achieve the mission's objectives.
- Dogfights are a bit of a chess game:
  - → twisting and turning through the sky
  - → hiding behind clouds
  - → diving out of the sun
  - → blasting away with bullets at short range
- Most military flight simulators offer a series of missions, often with primary and secondary objectives.
- The objectives are usually to shoot down enemy fighters or to destroy ground targets.

Civilian Flight Simulators

- Many civilian flight simulators are not really games in the competitive sense.
- Their goal is to let the player fly and try different things with the aircraft rather than to present him with a specific mission to accomplish.
- However, civilian flight simulator can still present a wide variety of challenges:
  - → flying at night
  - → flying in rain, fog, or strong winds
  - → using visual flight rules or instrument flight rules
  - → landing smoothly and safely, particularly in adverse weather condition

Racing Sims

- Organized racing simulations are like sports games in that they take their gameplay from the real thing.
- The challenge is to win races without crashing.
- In some games, the player wins prize money for doing well in a race, and the prize money enables her to buy better equipment.
- Of course, this produces positive feedback, so her artificial opponents must also improve to offer her a worthy challenge.

Perspective

- Views common to driving and flight simulators:

  Pilot's/driver's view.

  Cockpit-removed view. Unrealistic, but dramatic perspective in which the pilot or deriver's view is shown full-screen rather than being partially obscured by the cockpit. Critical instruments are shown as semi-transparent overlays in the corners of the screen (and even these can be removed).

  Chase view. In flight simulators, the plane always seems to be level and the world turns around it. In driving simulators, the chase view is usually somewhat elevated so the car does not obscure the player's view of the road in front.

  Rear, side, and front views.

  Free-roaming camera. For replay: player can move the camera anywhere in the world and tilt or rotate it to look in any direction.

Perspective

- Views unique to military flight simulators:

  Ground target view. View of target on the ground that is currently selected for attack. This view let the player watch incoming missiles or bombs arrive and see if they hit the target accurately.

  Bomb or missile view. This is the point of view from a recently released bomb or missile, as if it had a camera in its nose.

- Views unique to driving simulators (these are great for instant replays):

  Trackside view.

  Grandstand view.

  Blimp view.

User Interface Design: Analog Controls

- For serious simulations, analog controls are essential:
  - → force-feedback joysticks
  - → throttles
  - → control yokes
  - → steering wheels
  - → pedals
    - – rudder for planes
    - – gas and brake for cars

User Interface Design: Simplifications

- Simplifications are helpful in flight simulators. Although we lose some realism, the game will be easier to learn and play.
- In Military flight simulators, you will almost certainly want to reduce the number of instruments in the cockpit and the number of function that some of them perform.
- In almost all flight simulators: to simplify flight, the left-right motion of the joystick controls both the rudder and the ailerons simultaneously.
- Another common simplification: instead of requiring players of World War I and II simulations to plot their course by the stars at night, landmarks or dead reckoning during the daytime, they are given a map.

The Player's Role

- In a single-seat aircraft, the player is the pilot.
- In a bomber, you'll have to decide how you want to handle the various roles. For example, Megafortress required the player to manage five stations:
  - → pilot
  - → co-pilot
  - → navigator
  - → electronic warfare specialist
  - → offensive weapons officer
- Each stations had its own instrument panel and responsibilities.
- The player had to move constantly from one to another to check on conditions and respond to emergencies.
- At times when the player was away from the pilot's seat, the plane flew on autopilot toward the next waypoint.
- In racing-oriented driving games, the player's role is that of a racing driver most of the time, but the more serious simulations also allow the player to be a mechanic.

Boats and Ships

- Most boat simulations are of powerboats or jet skis, offering the same kinds of speed thrills that driving simulators do. However, powerboats can't turn as sharply as a car can.
- Powerboat simulations are usually races over a twisting course marked off by buoys.
- Jet ski or fantasy war vehicle simulations often have outrageous jumps and other challenges as well.
- Simulations of large vessels such as battleships and aircraft carriers move more slowly and deliberately, and, therefore, tend to be simulated not as individual vehicles, but as part of naval warfare simulations involving whole fleets (e.g., Harpoon).
- Submarine simulations such as 688 Attack Sub are fairly popular because of the specialized nature of their situation and because they can move in three dimensions.

Tanks and Mechs

- Tank games seldom implement the complexity of tank battles as they really happened.
- That's because real tanks don't move all that fast, have limited visibility, and carry only a few types of weapons, so they don't appeal much to the casual gamer.
- An interesting aspect of a tank is that it has a rotating turret, which enables it to shoot in a direction other than the one in it is facing.
- It can be difficulty to design a good user interface for this. You will need to provide a mechanism for rotating the turret that is separate from the mechanism that steers the rank.
- Real tanks have a commander, a gun crew, and a driver. You will have to find a way to let a single player control everything.
- A more popular alternative is the **mech**, a science fiction cousin to the rank that is usually depicted as a large armed and armored walking machine.
- Because mechs aren't restricted by reality, they can carry all sorts of imaginary weapons and hardware, and they can be optimized for single-player play.

Spacecraft

- There are few simulations of real spacecraft because spacecraft behave far too slowly and deliberately to make for an interesting game.
- Consequently, the majority of space simulations are science fiction.
- They typically consist of **fighter planes in space** (e.g., Wing Commander) or **capital ship simulations** (e.g., Star Trek games).
  - → Fighter types are simple action games, with only a few variables to manage (e.g., fuel, ammunition, damage, and shields).
  - → Capital ship types are more strategic, giving the player control of a wide range of weapons and other equipment.

Creating the Sense of Speed

- In driving simulations, the sense of speed is really important. Here are several ways to create it:

  Give the player a speedometer. This gives a logical awareness of speed, but not a visceral one. It might also help to have a tachometer so that the player can see that the engine is near its maximum potential.

  Vary the driving surface. Make the road a serious of continuously changing dark grays (e.g., a serious of narrow strips parallel to the road's edges). On roads (as opposed to racetracks), implement the dotted white line down the center.

  Include roadside objects. Have lots of trees, road signs, and bridges.

  Use sounds. These could include the sound of the engine, road noise (the sound that the tires make on the pavement), wind noise, tires squealing as they round corners, and the Doppler shift as the car passes, or is passed by, some noise-making object.

G-Forces

- Military aircraft can generate powerful G-forces.
- Most aircraft can sustain strong downward G-forces, but not upward ones.
- Pilots undergoing strong downward G-forces can **black out** as blood drains out of their heads.
- Pilots undergoing strong upward G-forces can suffer an experience called **redout** as too much blood flows into their heads.
- Many games simulate these conditions by fading the screen to black or to red.

Designing AI Opponents

- To design a variety of AI opponents, you can
  - → vary the performance characteristics of their vehicles
  - → vary the AI driver skill level
- Varying the performance characteristics of vehicles is a static kind of variation: once the player has figured it out, it is easily beaten.
- To create further variety:
  - → design the AI driver to get the best performance possible out of its vehicle
  - → since a "perfect" AI driver with a better car would be unbeatable, modify the AI driver's judgment so that it isn't perfect (e.g., it doesn't always shift at exactly the right time)