# Royal Robotics

Lesson Plan – Mechanics: Drive Bases

Sean N. & W. Hinze

Definition: In science terms, Mechanics is the branch of physics that deals with the action of forces (a push or pull) on matter. In Technical terms, Mechanics is putting together the physical parts of a machine, testing them for function and problem-solving when troubles arise.

Concepts & Principles:

Understanding some of the science of mechanics can help the hands-on mechanical work:

The most important concept is **forces**. A force is a push or a pull on an object. There are four aspects that impact a force, first is the direction of the force, second is the magnitude or how strong it is, third is the size and weight of the object being pushed or pulled and finally the starting point of that object (is it still or moving?). These aspects have to be taken into account when designing any machine.

Applying Forces is essentially the point of all machines. Machines are essentially a system of parts designed to transfer or modify forces.

Example 1 (transfer force): Pneumatic piston moves mechanical swing-arm which hits a soccer ball causing it to move.

Example 2 (modify force): the up and down motion of the pistons in a car motor are changed into the rotary motion of the wheels.

Another concept it is helpful to understand is **inertia**. Inertia is the resistance to change in motion, essentially if still-stay still, if in motion, stay in motion. Inertia is proportional to mass, so the bigger or heavier an object the higher its inertia and the more force required to change its motion.

Demo: Penny tower – flick a penny at the bottom of the stack, one moves others stay.

Inertia was a large factor when we did the Lunacy game in 2009. The field was played on a slippery surface so it became a challenge to apply forces to get the robots moving, turning and stopping as desired. Another factor in that game was friction. . .

**Friction** is caused when two objects come in contact and one or both are moving. Friction is caused by the fact that matter does not have a completely smooth surface, even if there are no visible cracks, ridges and bumps, the molecules grab at each other, slowing motion unless there is constantly applied force to overcome this resistance.

In machines, friction can have both a positive and negative effect on the task you are trying to achieve. For instance, if there was no friction between a wheel and the road (such as when there is ice), then the car does not move or stop well. In this case friction is useful and needed, and the lack of it is the problem. Then in the case of an axle running through a wheel, friction is a problem as it slows and grabs the wheel, in this case friction is decreased by using bearings and grease.

Application:

Most robots that we build start with the Drive base. This is the part of the robot that moves it around the field. Most drive bases use wheels for motion. How many wheels and what type can change depending on what type of field the robot is maneuvering through.

# Royal Robotics

Lesson Plan – Mechanics: Drive Bases
Sean N. & W. Hinze

Types of wheels are usually chosen largely because of friction – whether you want more or less:

- high friction – soft rubber surface, ridges for gripping
- normal - harder rubber, but smooth surface
- slippery – hard plastic surface, slick feel
- omni – little wheels/rollers, inset at 90 degrees to rotation of wheel for easy side to side movement
- mecanum (picture, don't own any yet) - little wheels or rollers inset at 45 degree angles, which gives 4 multi-directional movement.

There are some things that are occasionally used besides wheels, such as ball casters or a roller (sometimes used for balance)

Drive system configurations are usually chosen depending on the elements of the game challenge, which determine the requirements for maneuverability, speed and power. A game that requires the robot to be strong in pushing or pulling would get a different drive system than one that gets points for quickly moving itself or objects about the field.

Common types of drive bases (powerpoint):

- 2-wheel drive (front, center or rear wheels): Only two of the wheels have power whether front, center or rear, all other wheels or castors are unpowered. Positives include less motors used and simple to build and program. Center-2 wheel drives can turn quickly, but have less power and can be squirrely going straight a low speed. Negative is lower power/speed overall.
- 4-wheel drive: similar to 2-wheel drive but all 4 wheels have own motor which allows for more power. When combined with Mecanum wheels can allow travel in all four directions.
- Tank Drive: All wheels on each side are chained or geared to work together, may have treads over wheels (like a tank) or not. Tank drive allows more power and grab without using more motors.
- N-wheel drive (same slide as tank): modification of tank drive – uses 6 wheels on each side and center wheel is slightly lower than ends which allows rocking onto only 4 wheels for turns (lessening friction).
- 5 wheel drive: This is the use of a normal 4 or 2 wheel or tank drive system using omni wheels, then adding a fifth wheel in the center going at 90 degrees to normal movement. This allows the robot to be driven sideways. Uses at least 3 motors. Plusses include more range of motion. Downside is more complex build and program.
- Holonomic: four wheels in each corner but angled at 45 degrees across the corner. Each wheel has its own motor so they can each change direction in order to travel in any of the four directions. Also can turn in place and drive diagonally. Downside is more use of motors and harder to program and not as fast in straight directions.
- swerve drive: All wheels have power and can rotate in any direction. This gives maximum maneuverability. Very difficult to build and program.
- hybrid drive (octocanum): This is a new concept where there are essentially two different drive systems on the robot and there is a method to switch which one is in contact with the floor.

Supplies: pennies, wheels, powerpoint of drive systems