

Chapter 14



Courtesy U.S. Department of Interior

Motors, sensors, and electrical circuits

Motivating *motors* (see examples in Hw 8, 9)



Complete the association with an English word that contains the Latin **mot** (move).

Note: Answers to these interactive questions are at www.MotionGenesis.com ⇒ [Textbooks](#) ⇒ [Resources](#).

Word	Definition
<input type="text"/>	$\vec{F} = m\vec{a}$ is an equation that governs this.
<input type="text"/>	Encourage, e.g., a carrot or a stick.
<input type="text"/>	Diana Ross' record label (Detroit).
<input type="text"/>	Aspirin-like painkiller to help arthritic people move around.
<input type="text"/>	Measure of the speed at which food passes through the digestive system.
<input type="text"/>	Antidiarrhetic drug that literally translates to low motility.
<input type="text"/>	Powerful feelings, e.g., love, hope, fear, joy.
<input type="text"/>	What happens to an engineer who mistakenly uses $\vec{T} = I\vec{\alpha}$ for 3D rotational motion.
<input type="text"/>	Hubbub or fracas.
<input type="text"/>	Changing (moving) location (hint: root locus and trains)
<input type="text"/>	Climbing a rung on the career ladder. Hint: knowing the golden rule for vector differentiation.
<input type="text"/>	The Latin word for "mover" (or "to move").

Summary

There are a variety of reasons to study motors, sensors, and electrical circuits:¹

- Motors actuate mechanical systems and generators create electrical power.
- Many sensors (e.g., accelerometers, proximity sensors) are *electromechanical systems*.²
- Circuits help shape signals from sensors and to motors/actuators.

This chapter uses *KCL (Kirchoff current law)*³ to analyze circuits in the time domain (the independent variable is time t).⁴ The dependent variables are *current* electrical current (amps) (i) and *voltage* (v). Resistors, inductors, and capacitors are modeled as *linear*, meaning current and voltage are related by a *linear* (algebraic or differential) equation and a resistor (R) or inductor (L) or capacitor (C) constant.

The following table summarizes resistors, inductors, capacitors, and DC (direct current) permanent magnet motors. Each element is shown with a representative picture and symbol and an equation that relates **current i through the circuit element** to **voltage v across the circuit element**.

¹Motors have many applications including computer hard-drives, DVD drives, toothbrushes, cell phone vibrators, Microwave/oven rotators, car starter motors, air-conditioner/refrigerator compressors, water pumps, etc.

²An *electromechanical system* is one that has both mechanical and electrical components.

³*KCL (Kirchoff current law)* can be easier to use and understand than *KVL (Kirchoff voltage law)*.

⁴Some engineers prefer to do circuit analysis using Laplace transforms with an independent variable s . The Laplace transform is particularly helpful for investigating steady-state response (transients in circuits are frequently very short duration).