



What is a Machine?

Chapter 8, Section 2

# Essential Questions

- ★ How does a machine make work easier?
- ★ What is the force-distance trade-off that occurs when a machine is used?
- ★ What are some examples?
- ★ How is mechanical advantage calculated?
- ★ Why aren't machines 100% efficient?

# History of Work

Before engines and motors were invented, people had to do things like lifting or pushing heavy loads by hand. Using an animal could help, but what they really needed were some clever ways to either make work easier or faster.



# Simple Machines

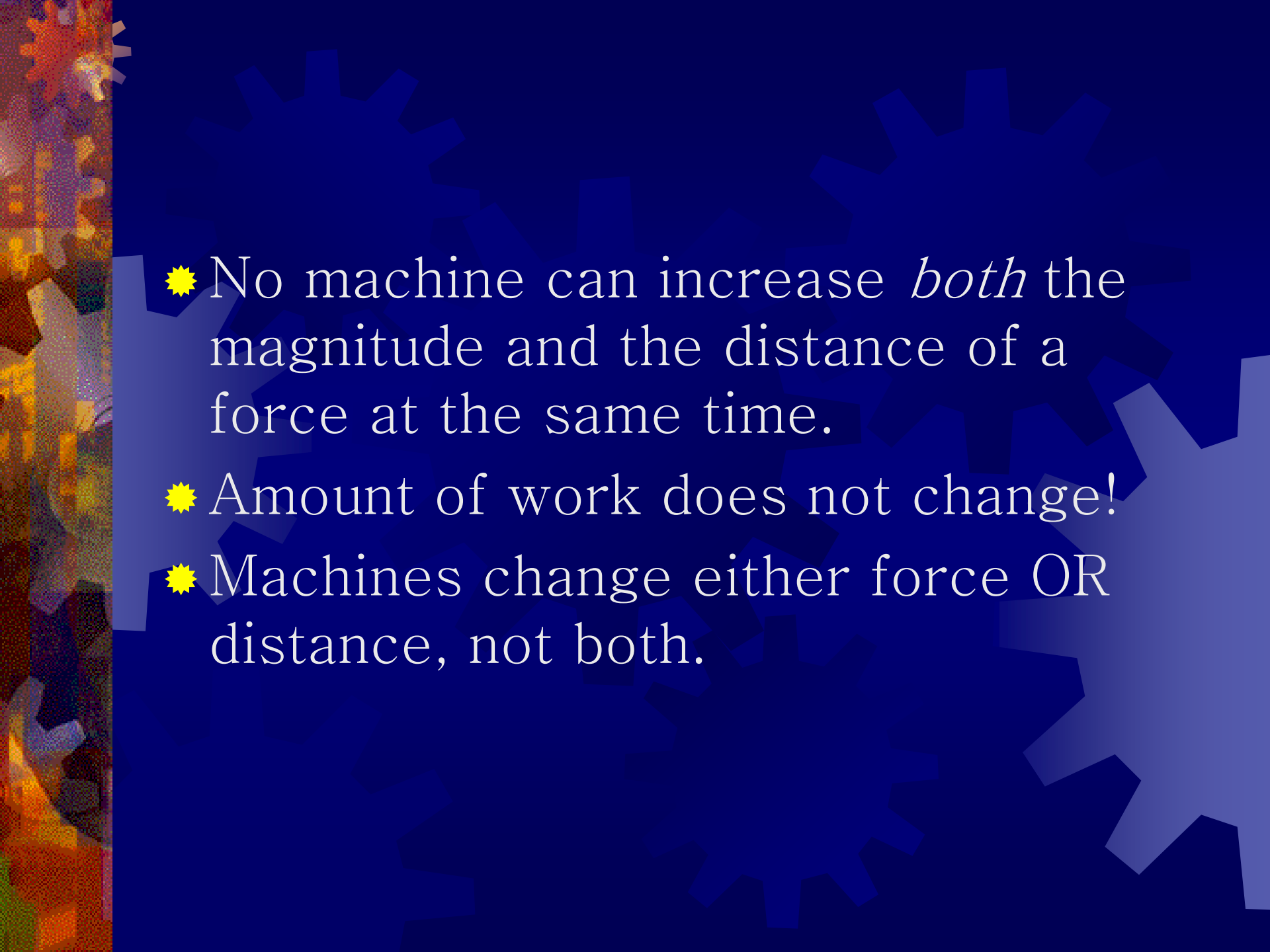
- ✱ A machine is a device that helps make work easier to perform by accomplishing one or more of the following functions:
  - ✱ Changing the size of a force,
  - ✱ changing the direction of a force,
  - ✱ transferring a force from one place to another, or
  - ✱ increasing the distance or speed of a force.

# Work In, Work Out

- ☀ Work input – the work you do on a machine
  - ☀ the force you apply is the *input force*
- ☀ Work output – the work done by the machine on an object
  - ☀ The force which is applied to the task through a distance is the *output force*

# How Machines Help

- ✱ Machines do *not* increase the amount of work done.
- ✱ Work output = Work input
  - ✱ Remember:  $W = F \times d$
- ✱ Machines allow force to be applied over a greater distance
  - ✱ That means less force will be needed for the same amount of work

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- ✱ No machine can increase *both* the magnitude and the distance of a force at the same time.
  - ✱ Amount of work does not change!
  - ✱ Machines change either force OR distance, not both.

# Mechanical Advantage

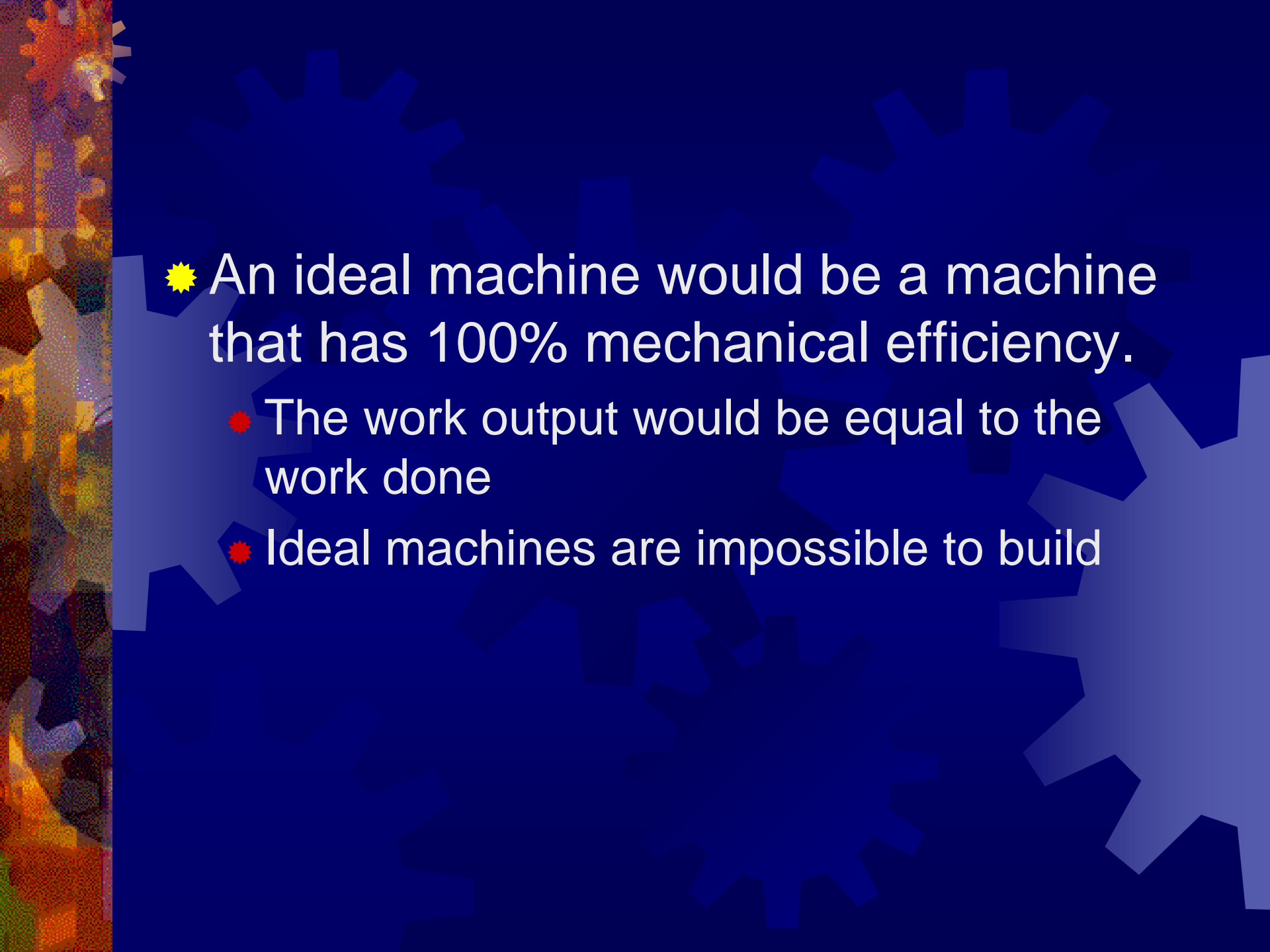
- Mechanical Advantage (MA) is the number of times a machine multiplies force
  - MA compares input force to output force

- $$\text{MA} = \frac{\text{output force}}{\text{input force}}$$



# Mechanical Efficiency

- ✱ Work output of a machine can never be greater than work input.
- ✱ The less work a machine has to do, the more efficient it is.
- ✱ Mechanical efficiency compares work output with work input.
- ✱  $ME = \frac{\text{work output}}{\text{work input}} \times 100$

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- ✦ An ideal machine would be a machine that has 100% mechanical efficiency.
    - ✦ The work output would be equal to the work done
    - ✦ Ideal machines are impossible to build