TYPES OF GEARS

SPUR GEARS: Teeth parallel to the axis of rotation. Simplest type (and the type we'll mostly be studying)

HELICAL GEARS: Teeth inclined to axis of rotation: gradual engagement of teeth means they're quieter. Thrust loads develop.

BEVEL GEARS: Teeth on a conical surface. For transmitting power between perpendicular/ intersecting shafts

WORM GEARS: A screw-like worm's direction of rotation dictates the direction of rotation of a pinion / worm-wheel. Locking

Spur Gears

- Spur gears are used to transmit motion between parallel shafts
- They are usually cylindrical (flat); the teeth project radially.

Spur Gears

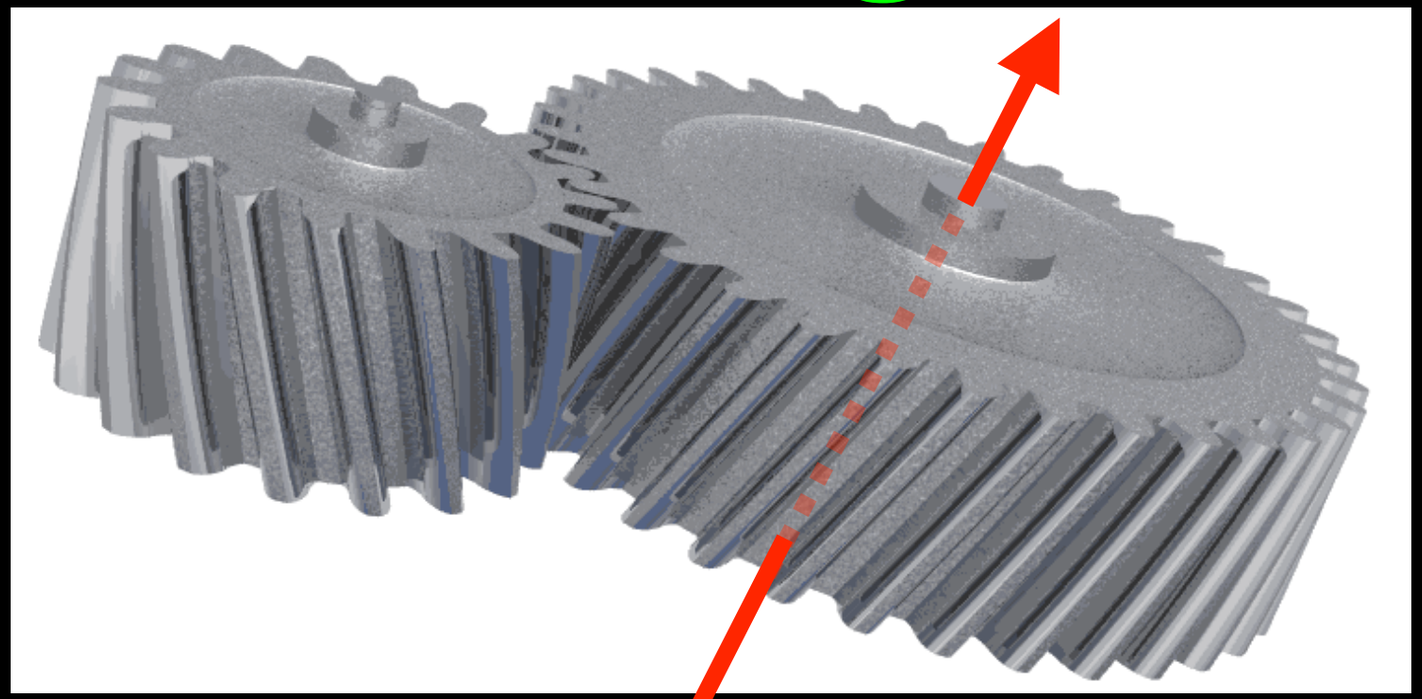
Spur gear with keyway and grub screw.

- Spur gears are prone to noise.
- If they aren't manufactured with high precision, gear meshing can be rough.

Helical gears

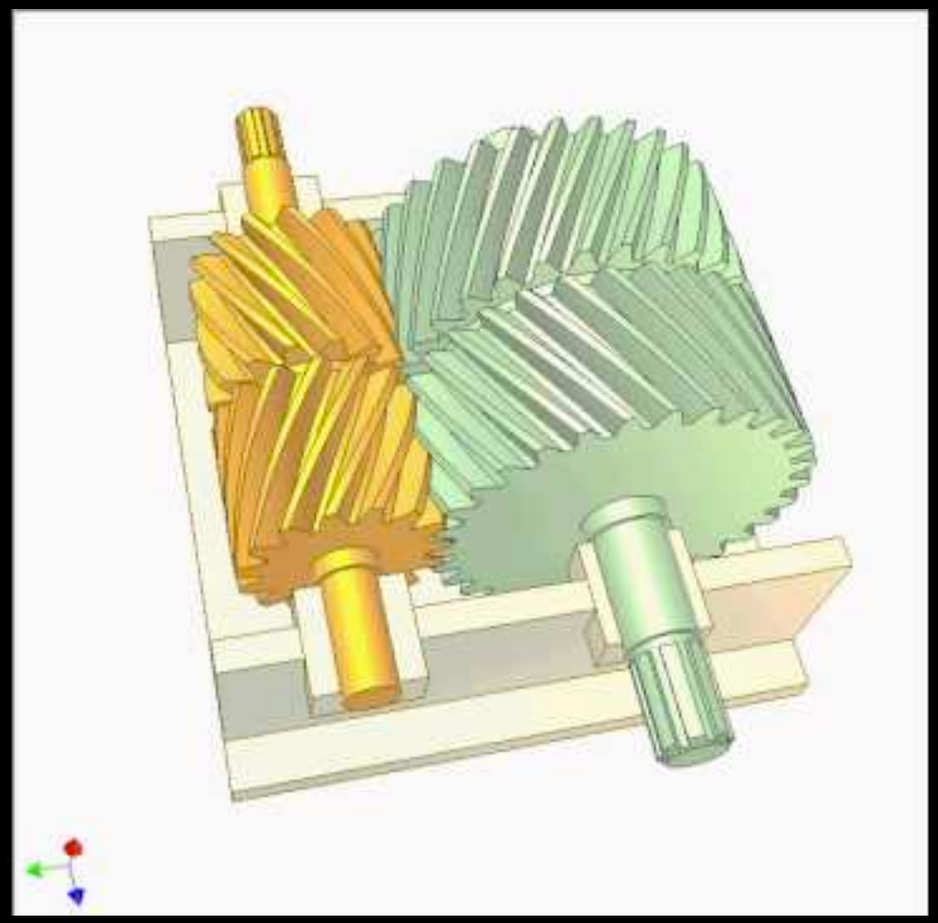
- Helical gears are an improvement on spur gears.
- The teeth are cut at an angle, allowing for a more gradual (and smoother) meshing between gears.
  - This allows for greater speed and reduced noise.
  - Also good for high torque applications: more tooth area in contact.

Helical gears



- Somewhat more difficult to manufacture than spur gears.
- When turning, tooth angle results in a thrust force along the axis of the gear.
  - Must be compensated for with an adequate thrust bearing.

Double helical gears

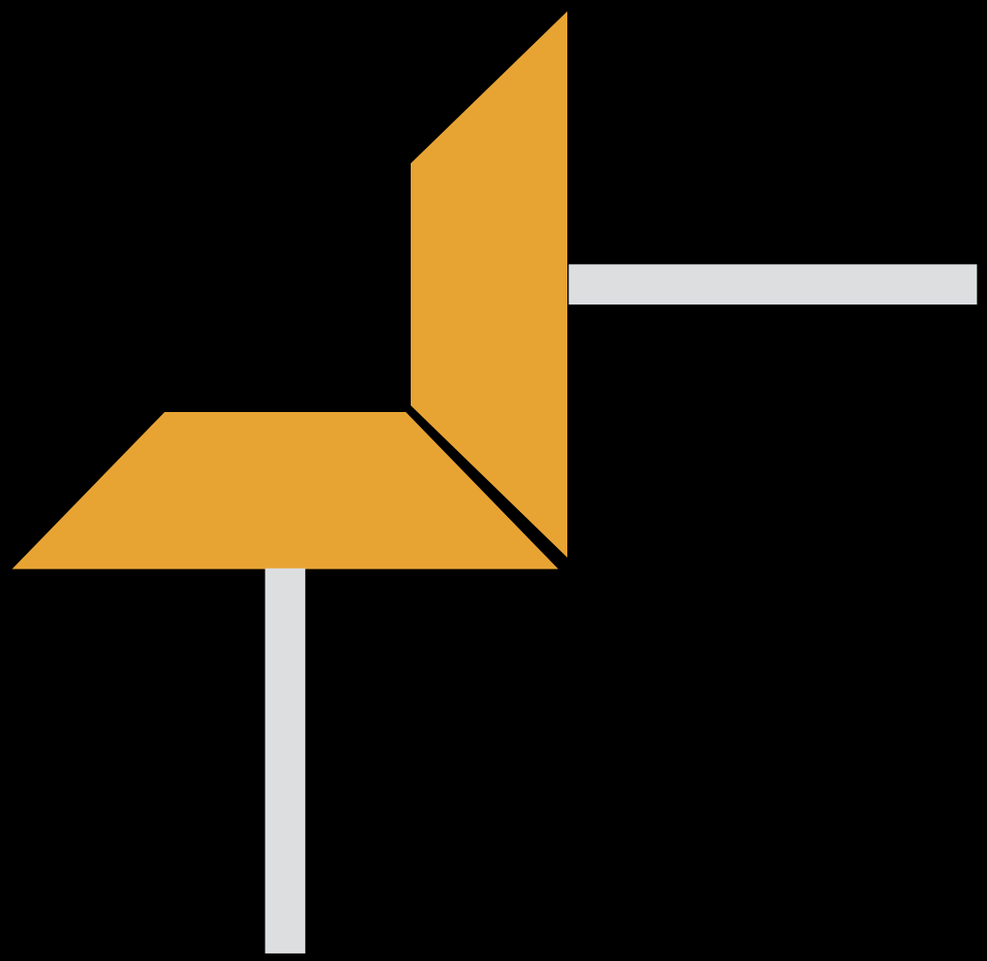


- Also known as herringbone gears.
- The teeth are ‘V’ shaped (a reflected helical gear).
  - These angles create opposing thrust forces, canceling each other out.

High speed & right angles with Helical gears

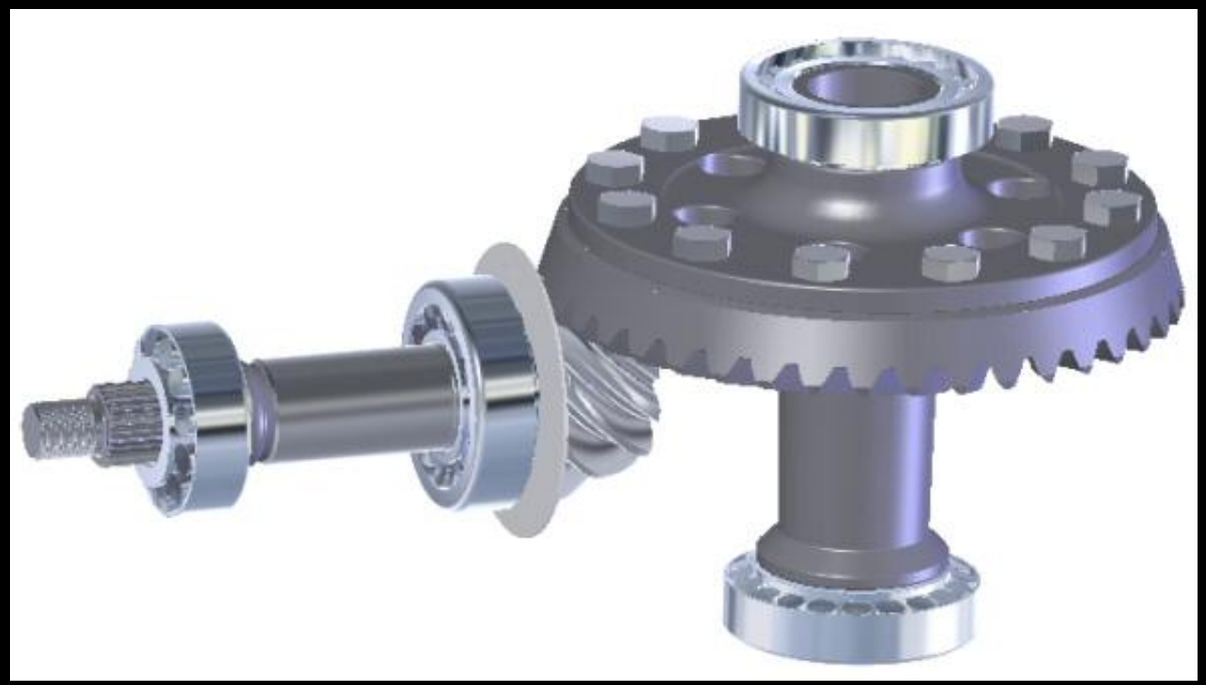
- With correct angles of gear teeth, helical gears can be used to adjust the rotation angle by 90 degrees.
- Helical gears: popular in high speed applications.
  - High speed: pitch line velocity > 1500 m/min; rotational speed of pinion > 3600 rpm

Bevel gears



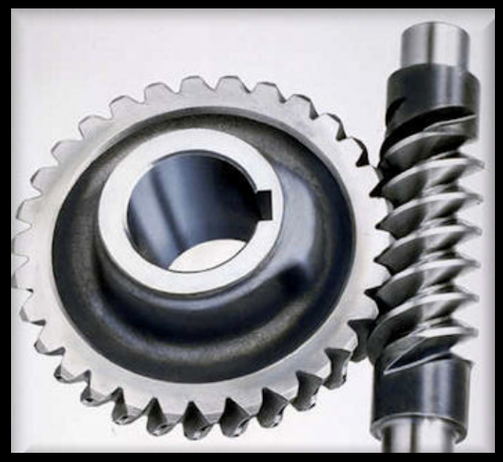
- Bevel gears allow for changing the rotation direction between shafts.
  - 90 degrees is common, though other angles are available.

Helical/Spiral Bevel gears



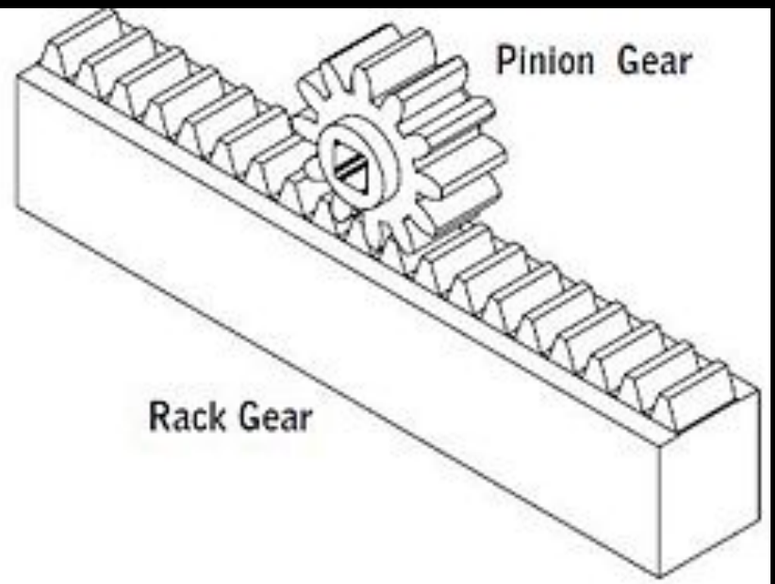
- For high speed applications, spiral (helical) bevel gears are used.
- Display “handedness” (Right hand = clockwise inclination of tooth from axis through tooth midpoint)
  - High-torque, high-speed applications (e.g., turboshafts on helicopters)

Worm gears



- Worm gears also allow for right angle power transmission between shafts.
  - The worm is a screw-like device with helical threads.
- Very compact size allows for high gear ratios.
- Worm gear can turn the spur gear.
  - Spur gear can’t (easily) turn the worm gear.
  - This allows spur shaft to be locked into place unless worm is being driven.
- Advantages: Low noise, high power transmission
- Disadvantages: Increased friction; requires higher starting torque.

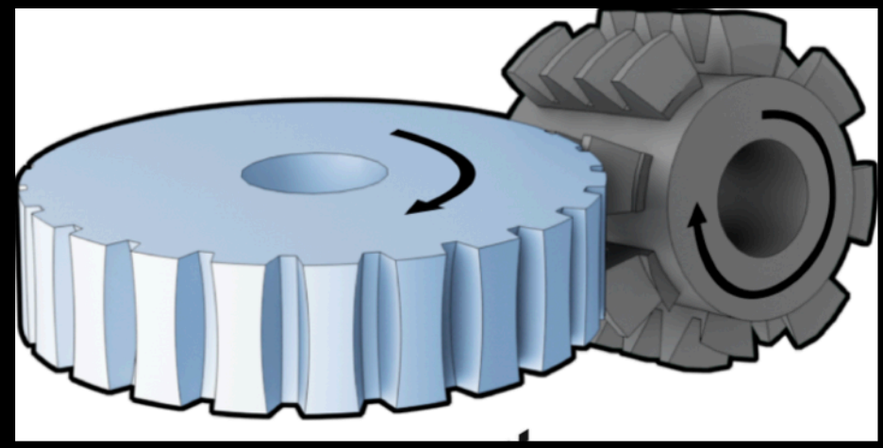
Rack and Pinion Gears



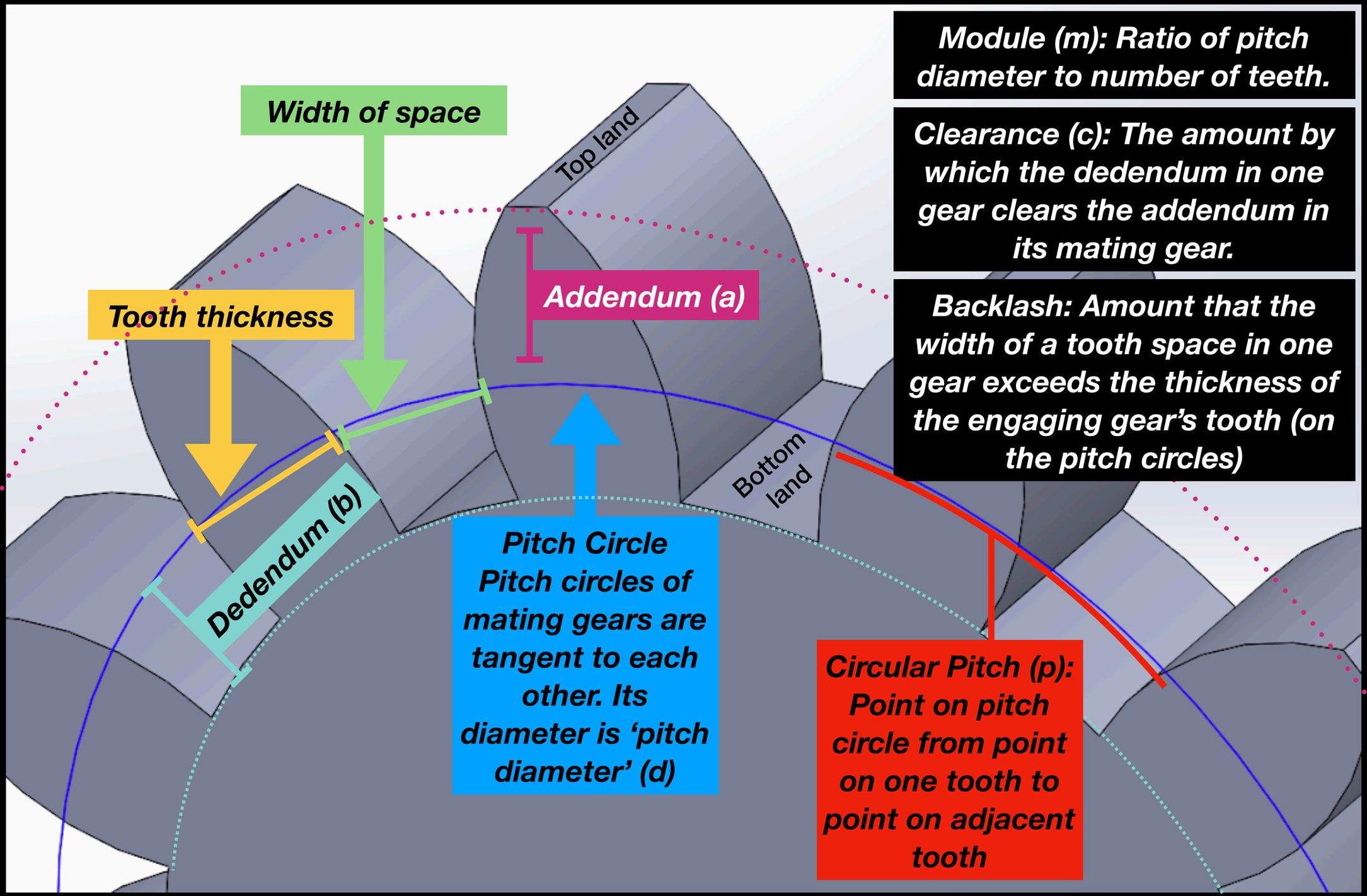
- One way of converting rotational motion into linear motion
- The circular pinion engages the teeth on the flat bar - the rack.
  - The rack is an ‘unrolled’ spur gear.
- Found in the steering mechanism of many cars.
- Must have some form of mechanical limit built in, to prevent rack from slipping past pinion.

Gear Manufacture

- Hobbing:
  - Fast to manufacture (multiple teeth formed at once). Very accurate profiles.
  - Can not produce ‘exotic’ gear tooth shapes
- Milling:
  - Dedicated cutter is used, teeth are cut one at a time.
  - Cheap tooling, relatively slow.
- Forming:
  - Metal is ‘pressed’ (moved away through plastic deformation)
    - Cheap but inaccurate - might require post-processing machining steps (e.g., turning to diameter)



GEAR NOMENCLATURE



Module (m): Ratio of pitch diameter to number of teeth.

Clearance (c): The amount by which the dedendum in one gear clears the addendum in its mating gear.

Backlash: Amount that the width of a tooth space in one gear exceeds the thickness of the engaging gear’s tooth (on the pitch circles)