How HANDY Are You?
BUILDING A MECHANICAL HAND

Introductory Statement
Students will construct a mechanical hand.

Objective
To work as a team and to design, build and test a mechanical hand to pick up a 'wad' of paper.

Materials
Foam paper plates, drinking straws, scissors, duct tape, yarn or string, large paper clips, large tongue depressors, glue guns, hot glue gun sticks, pens

Key Question
What is a mechanical hand?
How does a mechanical hand work?

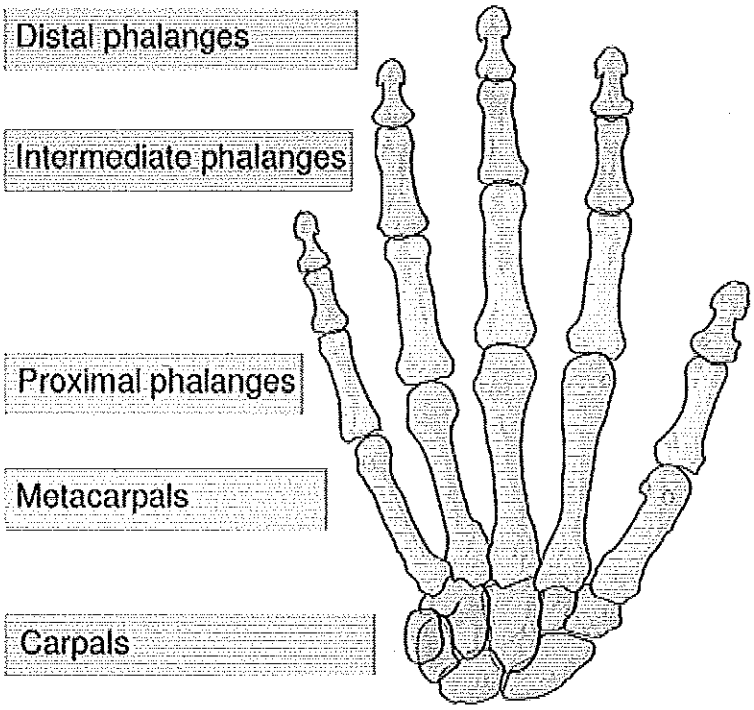
Key Terms
- **Joints:** A place or part at which two or more things are joined. A point of articulation between two or more bones, especially such a connection that allows motion.
- **Tension:** A force that causes extension or stretching
- **Compression:** Volume reduced by pressure; a 'squeezing' force
- **Muscles:** A tissue composed of fibers capable of contracting to effect bodily movement.
- **Ligaments:** A sheet or band of tough, fibrous tissue connecting bones or cartilages at a joint or supporting an organ.

Anatomy: How do the finger joints normally work?
The bones in the palm of the hand are called *metacarpal bones.* One metacarpal connects to each finger and thumb. The five fingers of the hand are made up of *phalanges*, small bone shafts that line up to form each finger and thumb.

The main knuckle joint is formed by the connection of the phalanges to the metacarpals. This joint is called the *metacarpophalangeal joint*, abbreviated MCP. This joint acts like a hinge when you bend and straighten your fingers and thumb.

The three phalanges in each finger are separated by two joints, called, *interphalangeal* (IP) joints. The one closest to the MCP (knuckle) is called the PIP, or proximal IP joint. The joint near the end of the finger is called the DIP, or distal IP joint. The thumb only has one IP joint between the two thumb bones. The IP joints of the digits also work like hinge joints when you bend and straighten your hand.

The finger and thumb joints are covered on the ends with *articular cartilage.* This white, shiny material has a rubbery consistency. The function of articular cartilage is to absorb shock and provide an extremely smooth surface to facilitate motion. There is articular cartilage essentially everywhere that two bony surfaces move against one another, or articulate.



Procedure

1. Using a foam paper plate, cover the bottom of the plate with duct tape.
2. Trace your hand (four fingers and palm, but no thumb) on the top of the plate.
3. Cut out the hand and finger trace.
4. Score, using a pen, each finger horizontally in three places to make the joints. Each finger should have three, equally spaced score lines. Slightly bend the joints to make them flexible.
5. Using a glue gun, glue pieces of cut straws to each space between the joints of the fingers and palm. The straws on each finger should line up vertically. **(BIG HINT: The straws represent the bones of the hand. The diagram above should really help).**
6. Cut four pieces of yarn.
7. Make a knot on one end of each piece of yarn.
8. Take a piece of yarn and glue the knotted end of the yarn to a fingertip. Thread the rest of the yawn through each straw of the fingers and palm. Repeat for each finger.
9. Glue large tongue depressor or paint stirrer to bottom of the back of the hand.
10. Bend large paper clip into a 'c' shape and glue/tape one end to the back of the hand. This will represent the thumb.
11. Try to pick up the paper 'wad'. Re-engineer your hand if necessary.
12. We will have a competition to see who engineered the best hand.