Grasping at Straws

Scenario
Your team has been employed by a medical bionics company. You are required to design fingers for a bionic hand that will give independence back to patients who have lost a hand through injury or illness. Specifically, your team will be developing the fingers and thumb (digits) for this artificial hand.

Aim
The aim of this half-day activity is to design and build cost-effective artificial fingers and thumb for the bionic hand so that a number of tasks can be completed.

What to do
Your team is required to build articulated fingers and an opposable thumb and attach these to the wrist mount provided. Construction materials include straws of differing sizes, plastic sticks, string, masking tape, rubber bands, wooden sticks, etc. During testing, the hand is required to pick up objects of different sizes and weights, and make specific gestures from the American Manual Alphabet.

Rules
The bionic hand must have a minimum of three digits (two fingers and an opposable thumb), and no more than five.
The finished hand must fit inside a disposable glove, and will not be tested if it does not remain inside the glove.
The digits must be made only from the materials provided and function like a human hand.
The digits can only be manipulated by operating control strings during testing. Digits should return to an open state when the control strings are released. Unused and undamaged materials can be returned for additional points before testing begins.
You are not permitted to rebuild your bionic hand during the final testing, though minor repairs can be made.
Your team must return the wrist mount or else you won’t receive a score!

Scoring
During testing, points are awarded for:
• Looking and working like a real hand (aesthetics);
• Successfully completing the functionality tests (dexterity);
• The weight-carrying ability of the hand (strength);
• Return of materials (lean manufacturing).
• Cleaning up at the end of the activity (safety)

Tips
The bionic hand that your team builds should mimic the behaviour of a real human hand. It may require more than one person to manipulate the digits effectively. Think about how you will work as a team to do this.
Take care when inserting the bionic hand into the glove; don’t break the hand or the glove. Side-cutters are supplied to make fine holes and cuts in straws. Unused materials can be returned for additional points, so don’t damage them unnecessarily.
The American Manual Alphabet used in part 4 of testing

A B C D E
F G H I J
K L M N O
P Q R S T
U V W X Y Z
STUDENT NOTES
Grasping at Straws

The problem
The aim of this activity is to build and operate a bionic hand that is dexterous, strong and inexpensive.

Your team must build fingers and a thumb for the hand so that a number of tasks can be completed, including picking up objects of different sizes and weights, and performing gestures from the American Manual Alphabet.

Duration
This activity runs for a half day.

Terms
There are some terms used in this activity that you may not be familiar with:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tendons</td>
<td>Tendons are the tissues that attach muscles to bones.</td>
</tr>
<tr>
<td>Ligaments</td>
<td>Tough flexible tissue that connects two bones at a joint.</td>
</tr>
<tr>
<td>Muscles</td>
<td>Tissue in the body that is made up of fibres. Muscles contract and relax to produce movement.</td>
</tr>
<tr>
<td>Bionic</td>
<td>An artificial, typically electromechanical, body part.</td>
</tr>
<tr>
<td>Opposable thumb</td>
<td>A thumb placed opposite the fingers of the same hand. It allows grasping of objects that is a characteristic of primates.</td>
</tr>
</tbody>
</table>

Materials
In addition to a plastic wrist mount (to which the digits are attached), scissors and side cutting pliers, teams will be given the consumables shown on the scoresheet. Please note that unused materials can be returned for credit.

Rules
1. The bionic hand must have at least three digits (two fingers and an opposable thumb), and no more than five.
2. The final hand must fit inside the disposable glove provided so it can be tested. It will not be tested if it does not remain inside the glove.
3. The digits must be made from the materials provided and function like a human hand.
4. The digits must be manipulated by operating control strings during testing.
5. The digits should return to an open state without physical manipulation.
6. Unused and undamaged materials can be returned for additional points.
7. Minor repairs and adjustments may occur between tests but rebuilding the hand during the testing is not allowed.
8. The undamaged wrist mount must be returned at the end of the session otherwise your team will not receive a score!
**Scoring**

Towards the end of the session a series of tasks will be set up for your bionic hand to complete.

During the testing, points are awarded for:

- Looking and working like a human hand. For example, it must fit inside a standard disposable glove (aesthetics);
- Successfully completing the functionality tests (dexterity);
- The weight-carrying ability of the hand (strength);
- Return of materials (recyclability);
- Cleaning up at the end of the activity (safety).

**Tips**

- The diagram below is an example of one possible construction of the bionic fingers.

![Diagram of bionic fingers construction]

- Take care when inserting the bionic hand into the glove; don’t break the hand or the glove!
- Small side-cutter pliers are supplied to make fine holes and cuts in straws.
- The human hand is made up of 27 bones, 14 of which are found in the digits. Each finger has 3 individual bones and the thumb has two bones. These bones are connected by joints and ligaments, and these joints can only move in one direction, towards the palm and back to a ‘resting’ position. The digits cannot bend backwards at the joints. The bionic hand that your team builds should mimic the behaviour of a real human hand.
- Muscles and tendons are also important for hand movement. In particular, each digit contains long worm-like muscles that allow the hand to flex and extend.
SCORE SHEET

Grasping at Straws

Part 1: Aesthetics

Circle the scores if successful.

Number of fingers (does not include thumb):
- Two fingers: 0
- Three fingers: 50
- Four fingers: 100

Digits return to open position without manual manipulation: 50

SUBTOTAL (A) ________

Part 2: Dexterity and Strength

To score points the object(s) must be held for 5 seconds. Each team gets two attempts.

Circle the scores if successful.

- Pick up juggling ball: 20
- Pick up rubber ball: 40
- Pick up single standard straw: 50
- Pick up, not scoop, a bunch of standard straws from the box: 25

SUBTOTAL (B) ________

Part 3: Materials

<table>
<thead>
<tr>
<th>Item</th>
<th>Maximum per group</th>
<th>Points per refunded item (R)</th>
<th>Number refunded (N)</th>
<th>Points Earned (R x N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sticks - Wood</td>
<td>5</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber bands</td>
<td>10</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Straws - Standard</td>
<td>5</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straws - Jumbo</td>
<td>5</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masking tape</td>
<td>4 x 1m</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Sticks - Plastic</td>
<td>5</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>String - Nylon</td>
<td>2.5m</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Cotton wool</td>
<td>5 balls (As required)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Plasticine</td>
<td>1 stick (As required)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Wrist Mount</td>
<td>1</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SUBTOTAL (C)
Part 4: Gestures

The following gestures are from the American Manual Alphabet.

Begin by attempting the gestures highlighted in grey below. Circle the gesture and award 10 points for each letter correctly signed. If time permits, attempt the other gestures.

Number of correct signs _______ from above x 10 = SUBTOTAL (D) _______

Bonus
Maximum of 10 bonus points for clearing up the work area SUBTOTAL (E) _______

Penalties
Instances of rude signs or dangerous behaviour _______ x 100 = (F) _______

**NOT RETURNING THE WRIST MOUNT = ZERO POINTS AWARDED**

FINAL SCORE (A + B + C + D + E) – F =

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