

## A closer look at Componentry Upper limb prosthetics

When it comes to upper limb amputation and subsequent prosthetic fitting, little is understood about this very specialised procedure. The purpose of this article is to explain the types of prosthesis available, and to outline major advances in the last ten years.

The arm is second only to the face in the amount of neural activity required to carry out activities associated to daily living. In the past, prosthetic replacement has only been able to slightly compensate for the loss of such a complex organ, but as the age of 'mechatronics' (combination of mechanics and electronics) advances we are seeing prostheses with increased abilities become available to upper limb amputees.(1)

### CAUSES OF UPPER LIMB LOSS

The two most common causes of upper limb loss are:

**Trauma** – mostly secondary to road or work related injuries. Trauma usually equates to 75 percent of upper limb loss

**Surgery** - performed to remove a diseased or non functional part of the body.

These amputations occur at varying levels, with these levels being summarized below;

- **Fore-quarter amputation, occurring higher than shoulder**
- **Shoulder disarticulation, occurring at shoulder joint**
- **Trans-humeral amputation, occurring between shoulder and elbow joints**
- **Elbow disarticulation, occurring at elbow joint**
- **Trans-radial amputation, occurring between elbow and wrist**
- **Wrist disarticulation, occurring at wrist joint**
- **Trans-carpal amputation, occurring between wrist and knuckles**
- **Partial hand, an incomplete loss of hand**
- **Finger amputations**

### TYPES OF PROSTHESES

#### 1. NO PROSTHESIS

Experience has shown that those upper limb amputees who do not wear a prosthesis have experienced either of the following;

- Bad First Experience (poor comfort or poorly made)
- Unnatural Look
- Reactions from Others
- Development of One-Handedness
- Financial Concerns
- Unaware of Options
- Limited Functional Ability
- Lack of Sufficient Prosthetic Training

## 2. PASSIVE FUNCTIONAL OR COSMETIC



A passive functional or cosmetic arm is a lightweight, low function prosthesis that is used for the following situations:

- Cosmetic only arm
- Lightweight
- Inexpensive (NON-custom silicone)
- Provides opposition to sound arm

## 3. BODY POWERED / CONVENTIONAL



A body powered or conventional prosthesis is an arm that utilizes a harness and cabling to control a hand (also known as a terminal device) and an elbow unit. The harness system is controlled by gross body movements (scapular abduction, chest expansion, shoulder depression, extension, abduction, flexion, etc...).

Advantages of this type of system are;

- Heavy Duty Construction
- Proprioception
- Less Expensive
- Lighter in Weight
- Reduced Cost and Maintenance

Whilst the disadvantages are;

- Grip Force of terminal device is limited to shoulder strength and rubber band/spring tolerance.
- Range of motion is reduced due to harnessing.
- Poor Cosmesis due to harnessing and cable

- Possible Over-Use, Nerve Entrapment Syndrome due to harness

#### 4. MYOELECTRIC / EXTERNAL POWER



All muscles are powered by a very small electric charge that runs down the nervous system from the brain to the muscle to be activated. A myoelectric prosthesis utilizes this electric charge to control either a terminal device, a wrist or an elbow unit. Small electrodes are placed over certain muscle bellies, and their job is to pick up these charges and translate them into movement of the specific prosthetic component.

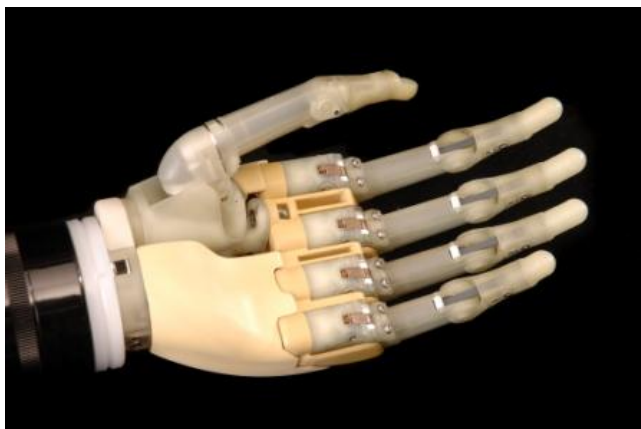
Advantages of this type of system are

- Greater Range of movement due to no external harnessing required
- Increased Cosmesis
- Greater Grip Force

Disadvantages of this system are

- Increased Cost and Maintenance (initially)
- Increased Weight (typically)
- Battery – charging and reduced water resistance

#### WHERE TO FROM HERE



In the last ten years we have seen two important factors play out when it comes to 'intelligent' prosthesis;

1. reduced size with increased power in battery technology, and
2. reduced size with increased performance of central processing units.

What this means is that prosthetic manufacturers are able to have smaller, lighter and quicker components available to upper limb amputees. In the last number of years we have seen devices like the I-Limb from Touch Bionics and the Dynamic Arm from Otto Bock being released that are superior in function when compared to older componentry. For more information regarding 'Intelligent' prosthesis please look at the websites listed below.

[www.touchbionics.com](http://www.touchbionics.com)  
[www.ottobock.com](http://www.ottobock.com)

1 Leonard, J.A., Meier, R.H. (1988). Prosthetics. In J.A. DeLisa (Ed.), *Rehabilitation Medicine Principles and Practice*, Philadelphia, PA: JB Lippincott.

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