



IMAGINE

# THE POWER OF PROSTHETICS

Secondary Biomechanical  
Engineering Lessons 1 & 2

> an RS Components **Imagine-X** resource

# LESSON 1



[Play intro video for biomechanical engineering –  
secondary]



## A prosthetic is...

- 
- An artificial or 'fake' body part
  - Used in place of a missing biological or 'real' body part
  - Sometimes can be used to fill the function of a missing, or damaged body part



# Prosthetics can be...

## **Non-functional**

Just for the 'look'

## **Body-powered**

- ✘ Made functional by another part of the body (through levers and pulleys etc.)

## **Brain-powered**

Powered by electrical signals from the brain – like a real limb would be



# Instead of skin, muscles, and bones...

## BONES

Lightweight metal such as titanium  
or aluminium alloy

## LIGAMENTS AND MUSCLES

Plastics such as polyurethane  
and carbon fibre

## SKIN

Foam or material





## Quality of life...

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*The standard of health,  
comfort and happiness  
experienced by an  
individual or group*



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...what would happen  
to your quality of life if  
you needed a prosthetic,  
but didn't have one?

# Why are prosthetics important?

- 
- Better conduct of day-to-day activities (eating, gaming, dressing etc.)
  - Help people lead 'normal' lives
  - Good for self confidence and body image
  - Increase mobility (moving around without help)





# Each part of our **musculoskeletal** system does something for us



- For support  
(keeps our bodies together)
- For protection  
(keeps our organs safe)
- For movement  
(makes our bodies move)



# What do our musculoskeletal components do...

> **Muscle**

*Movement*

> **Tendons and ligaments**

*Supportive, movement*

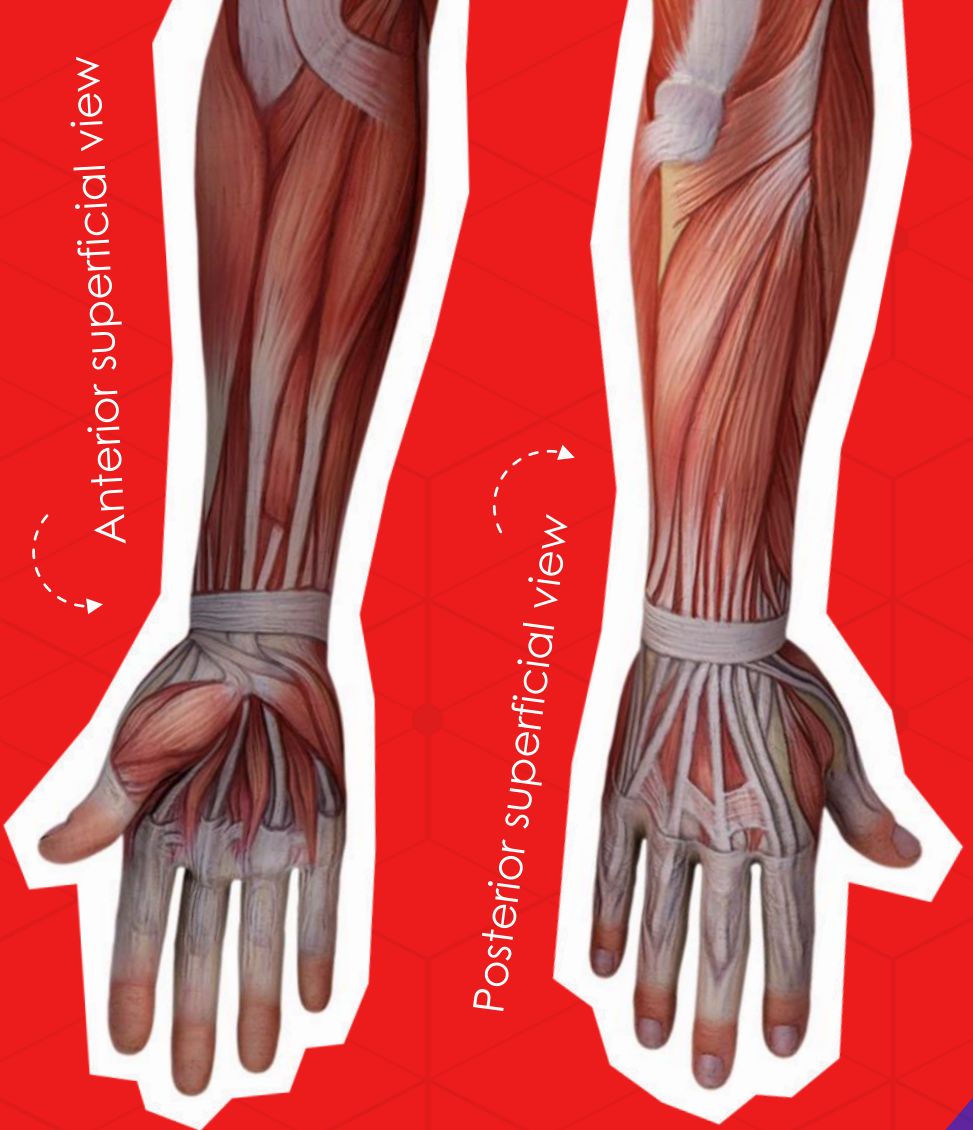
> **Bones**

*Protective, supportive, movement*

> **Skin**

*Protective, supportive*





> Metacarpal Bones

> Carpal Bones

- Hamate
- Triquetrum
- Pisiform
- Lunate

> Carpal Bones

> Phalanges

- Distal
- Middle
- Proximal

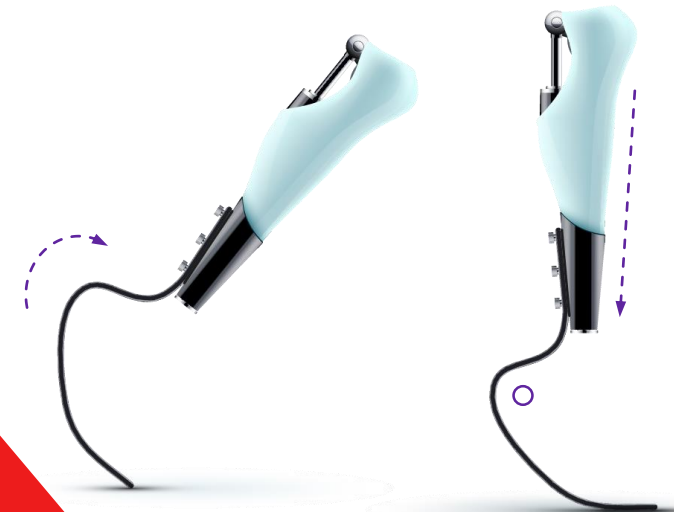


<https://www.youtube.com/watch?v=FVIpeUIpFf0>

# How would you design a prosthetic limb?

> Think about...

- Which human parts are missing/need replacing
- The specifications (measurements) of the person receiving the prosthetic
- Which parts need to move, and which need to be 'fixed'
- The functions they need to perform
- The specifications of the healthy/non-missing limbs



# Every limb is different...

Prosthetics can't be 'mass produced' each one needs to be made specifically for the person receiving it.



# What problems does this cause?

- Expensive
- Long waiting periods
- No room for error

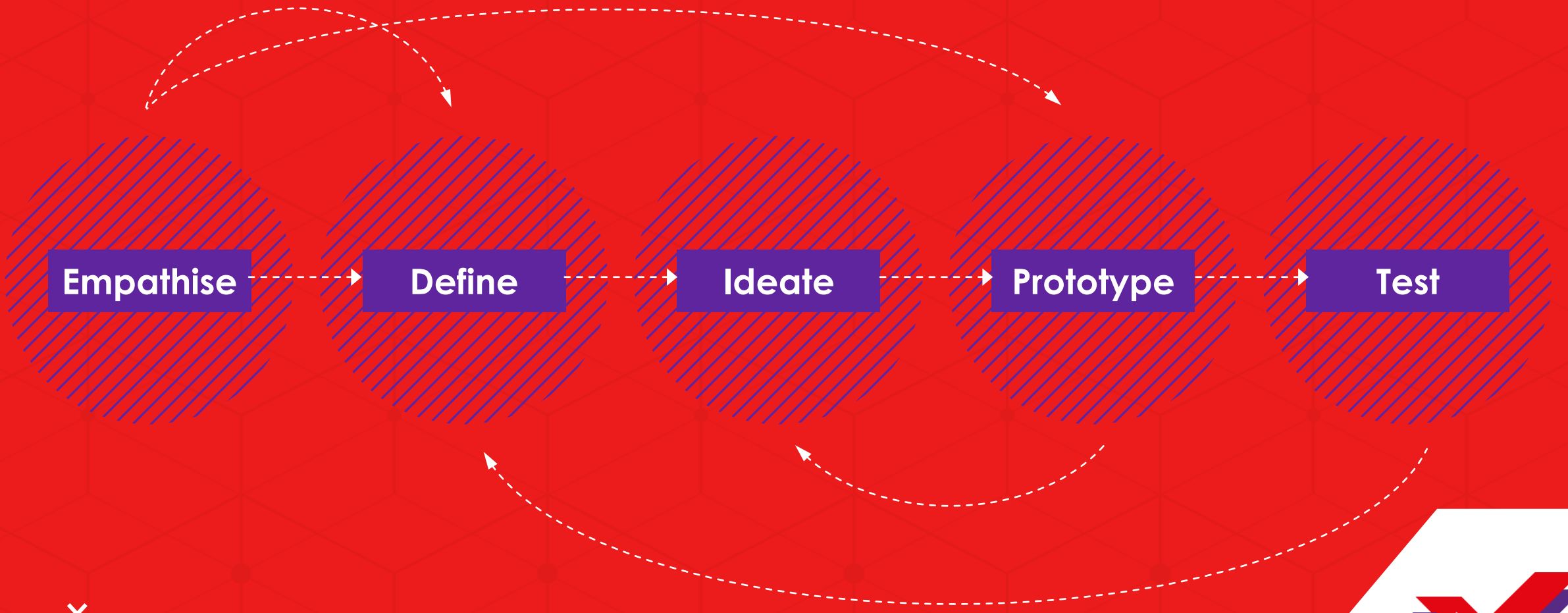
# How can you solve these problems?

- Finding cost-effective materials and techniques
- Efficient processes
- Getting the first measurements correct
- Improving the design before it's built





# Five phases of the design thinking process



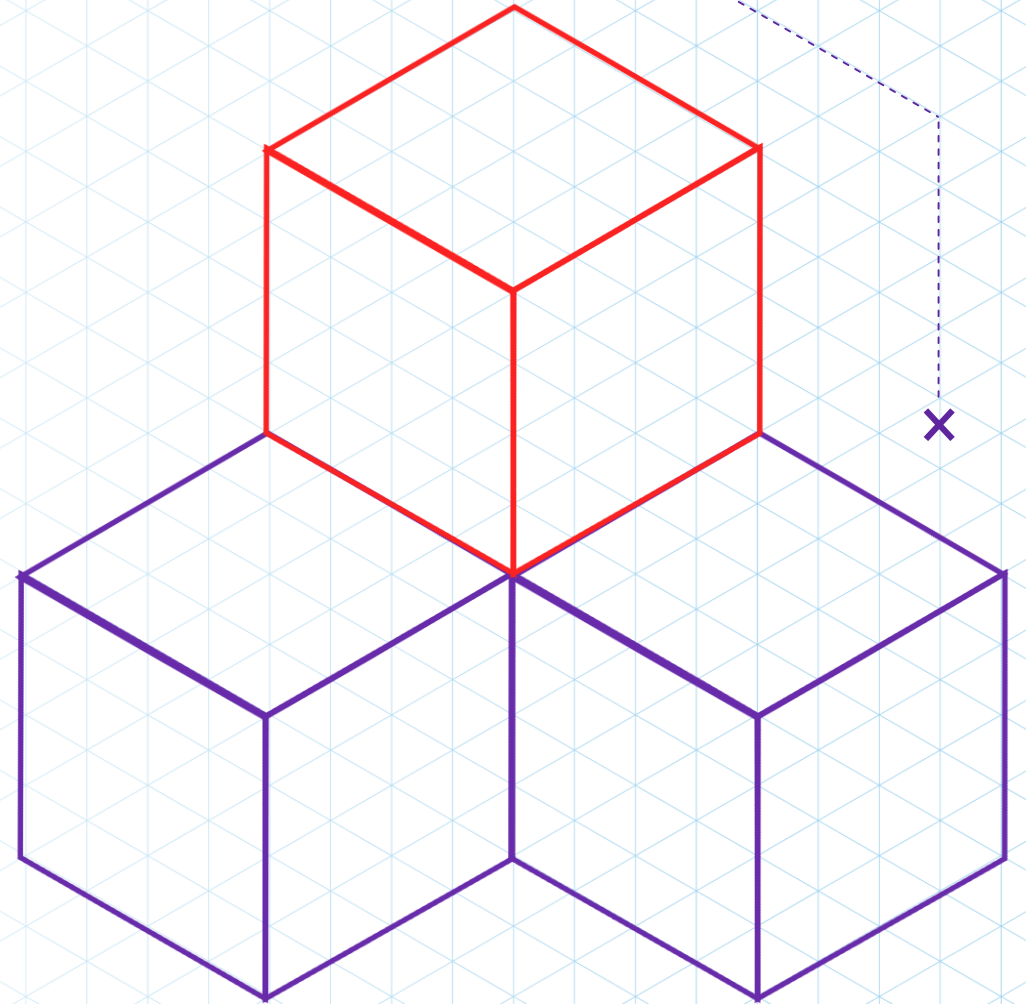
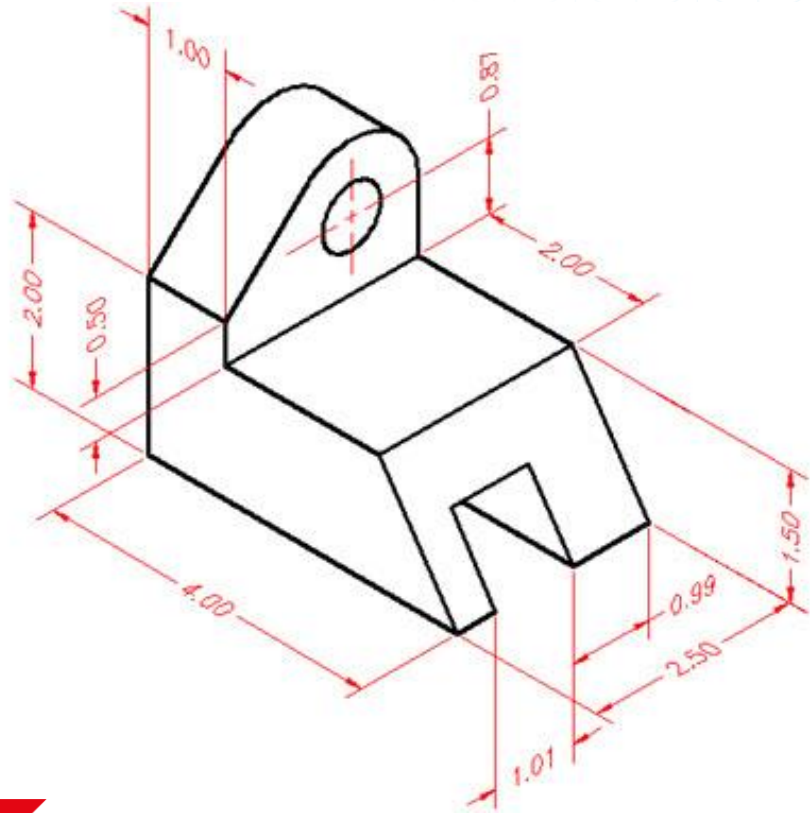
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# Isometric drawing



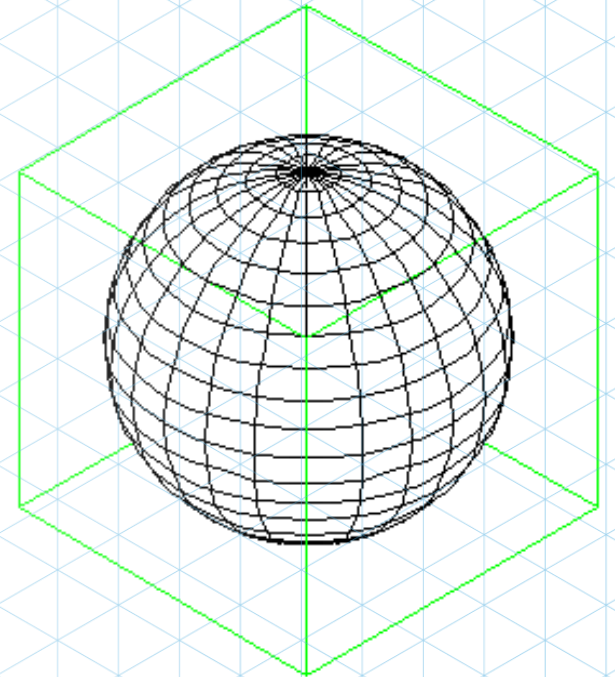
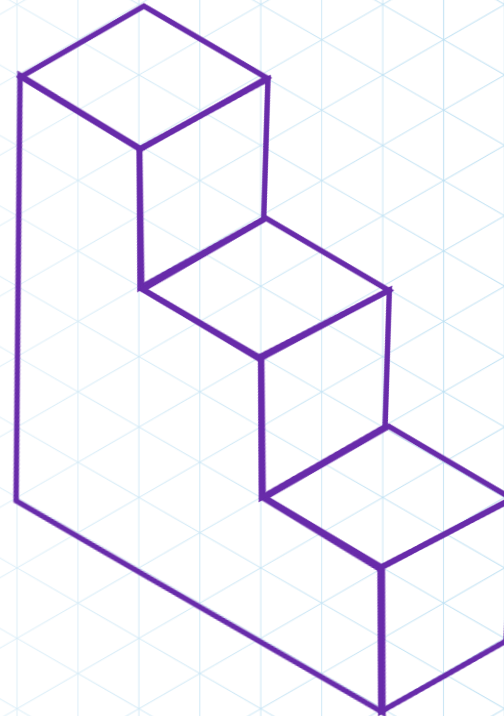
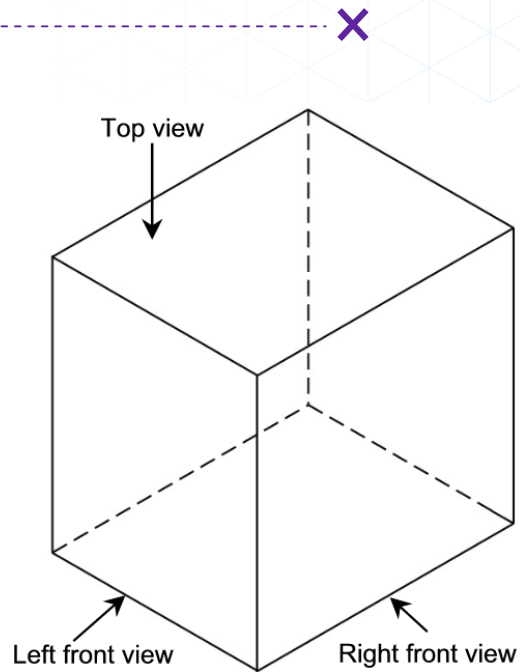
# Can you draw an isometric...?

> Cube

> Stairs

> Sphere

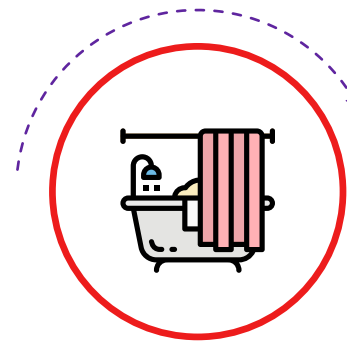
> Misc.



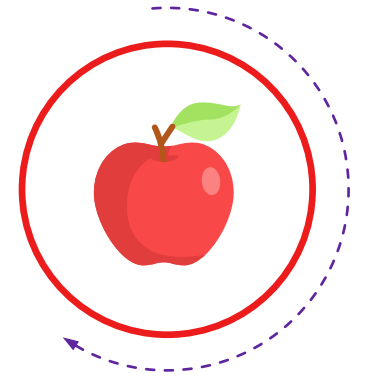
# Waiting for a prosthetic

What impact would needing but not having a prosthetic limb have on your life?

> Think about...



Your day-to-day life  
(eating, travelling, dressing, washing etc.)



Your education



Your career



Your social life



# In the Third World

In some countries, the waiting list for getting a prosthetic is very long.

> How big an impact on...

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- Your day-to-day life (eating, travelling, dressing, washing etc.)
- Your education
- Your career
- Your social life

> If you had to wait:

- 1 year
- 5 years
- 15 years



# Reducing the wait...

What can you do, when designing a prosthetic limb, to reduce the waiting list?

- Reduce the cost of the materials
- Improve the process of measuring, testing and building (being more efficient)
- Develop faster and less wasteful methods of building

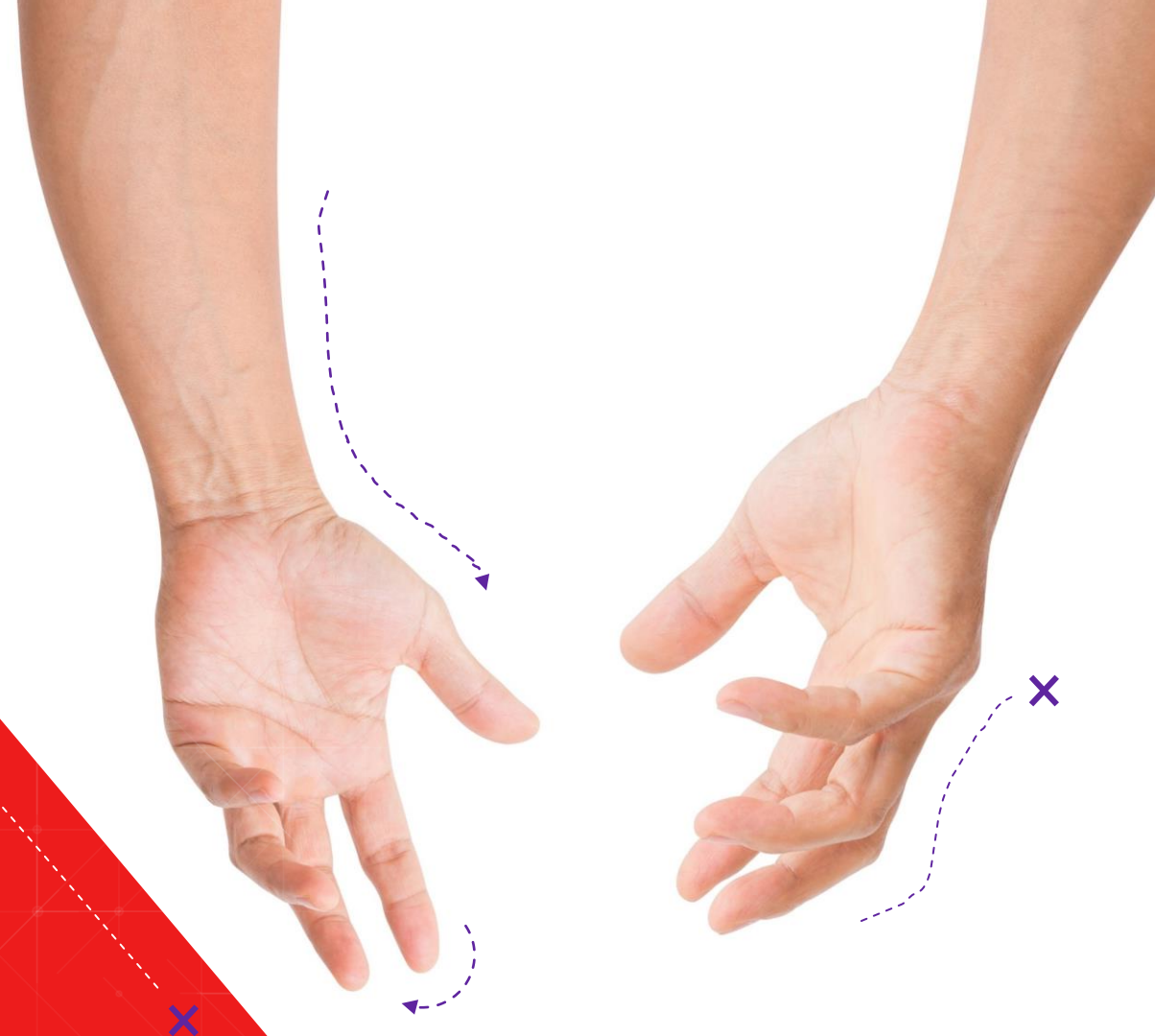


# LESSON 2



# Look at your arm and hand as you...

- Pick things up
- Put things down
- Wave to each other
- Shake hands with each other
- Write with a pen



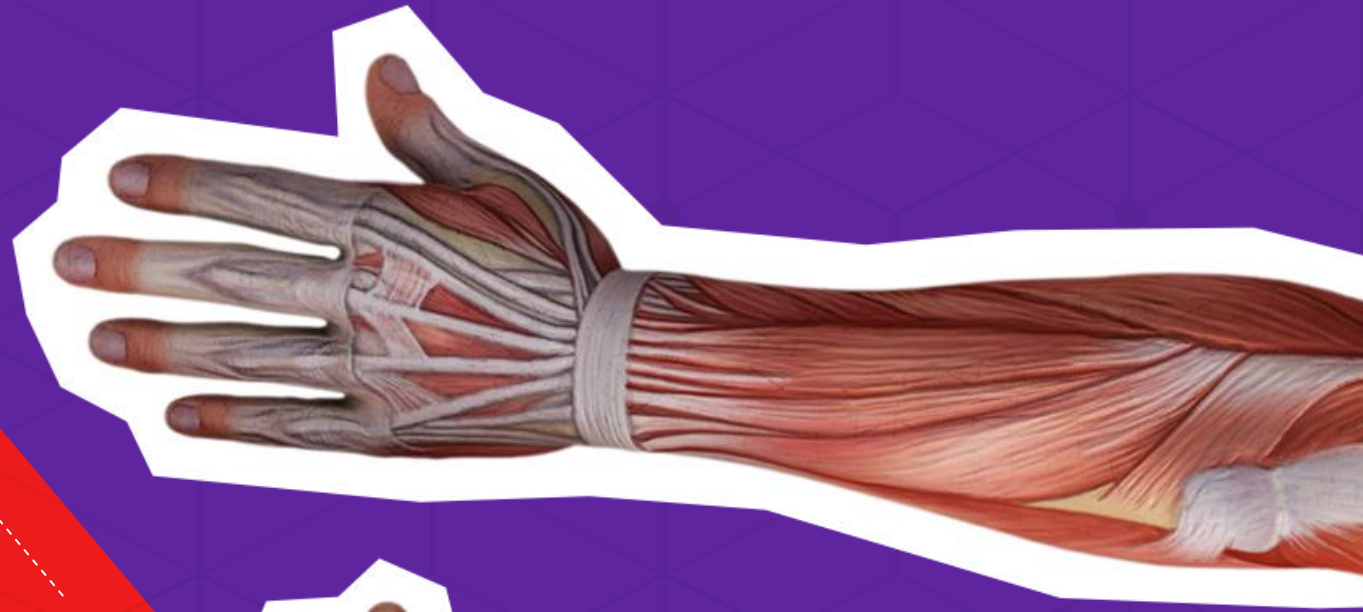
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What can you see?



# Find out...

- How many joints are there in your arm and hand?
- What type of joints are they?
- What 'function' do they help the limb perform?



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# A 'joint' is...

- A structure in the body
- They are where the pieces of your skeleton fit together
- 80% of them can *move*
- They support movement



# Your task

One of the members of your group has lost an arm! You have to design a prototype prosthetic limb, complete with:



> Skin

> Muscles

> Ligaments & tendons

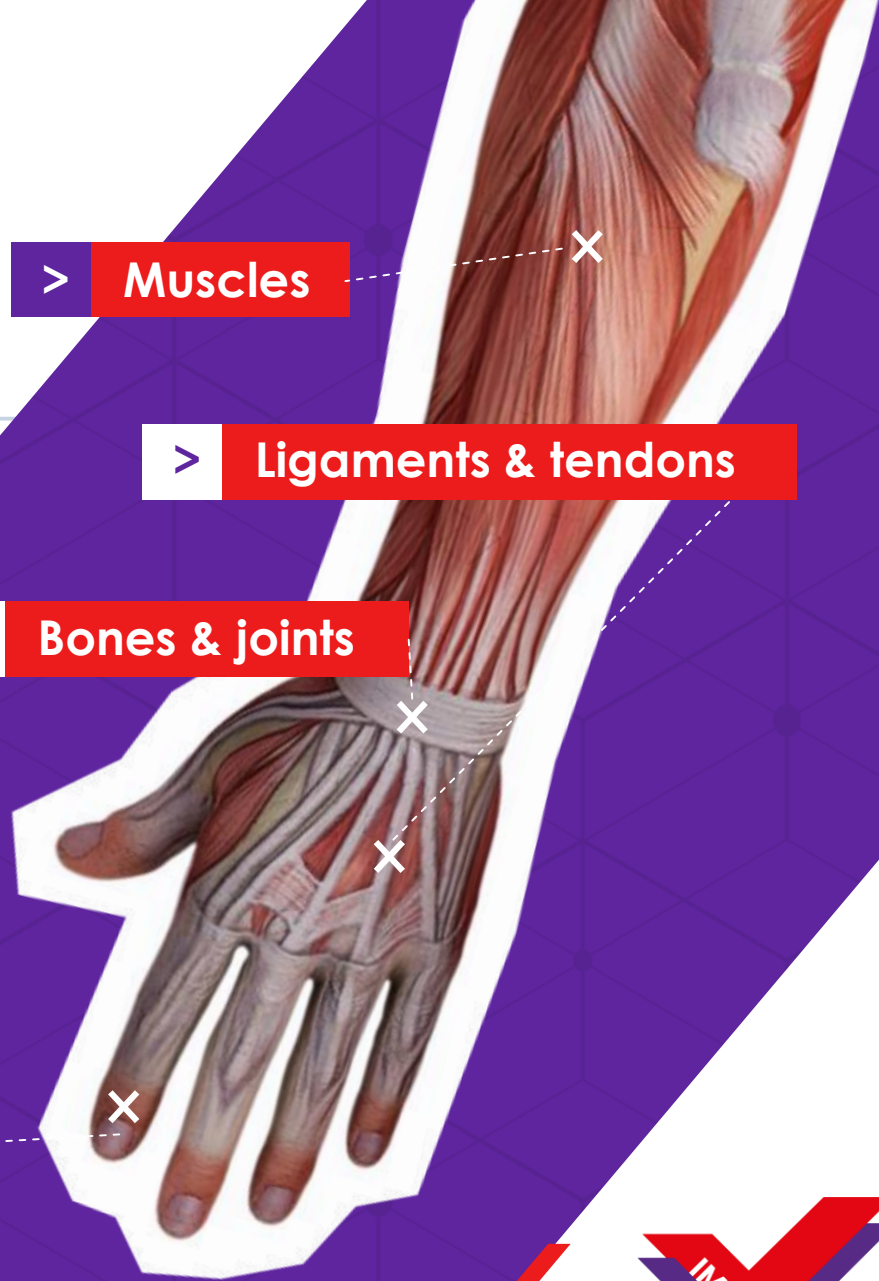
> Bones & joints

... which works just like a normal arm



# Prototype prosthetic cheat sheet

1. Pick an arm from someone in your team
2. Measure:
  - the 'healthy' limb (the new one will have to be as close to that as possible)
  - the 'stump' of the 'missing' limb
3. Design a new arm based on those measurements, featuring
  - Skin
  - Muscles
  - Ligaments and tendons
  - Bones with joints



# Instead of skin, muscles, and bones...

## BONES

Lightweight metal such as titanium  
or aluminium alloy

## LIGAMENTS AND MUSCLES

Plastics such as polyurethane  
and carbon fibre

## SKIN

Foam or material



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# Mashable explains

[https://www.youtube.com/watch?time\\_continue=3&v=Vx0Z6LplaMU](https://www.youtube.com/watch?time_continue=3&v=Vx0Z6LplaMU)

# 3D printing... prosthetics!

- Prosthetics can be made to exact specifications
- The materials are cheap
- It is easier to test/prototype – with more room for error





# Let's talk... Enhancements

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There are several ways prosthetic limbs can be upgraded to enhance the body's function.

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How would you  
**'enhance'** your  
prosthetic arm?

# Thoughts to takeaway...

- Why prosthetics are important?
- What would happen if you didn't have access to them?
- How can the waiting list for prosthetics be reduced?
- How can your biomechanical skills be used to help people?







## 'Biomechanics' is...



*... the science behind the movement of a living body, including how muscles, bones, tendons, and ligaments work together to produce movement.*





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[uk.rs-online.com/stem](http://uk.rs-online.com/stem)



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