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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…

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

…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

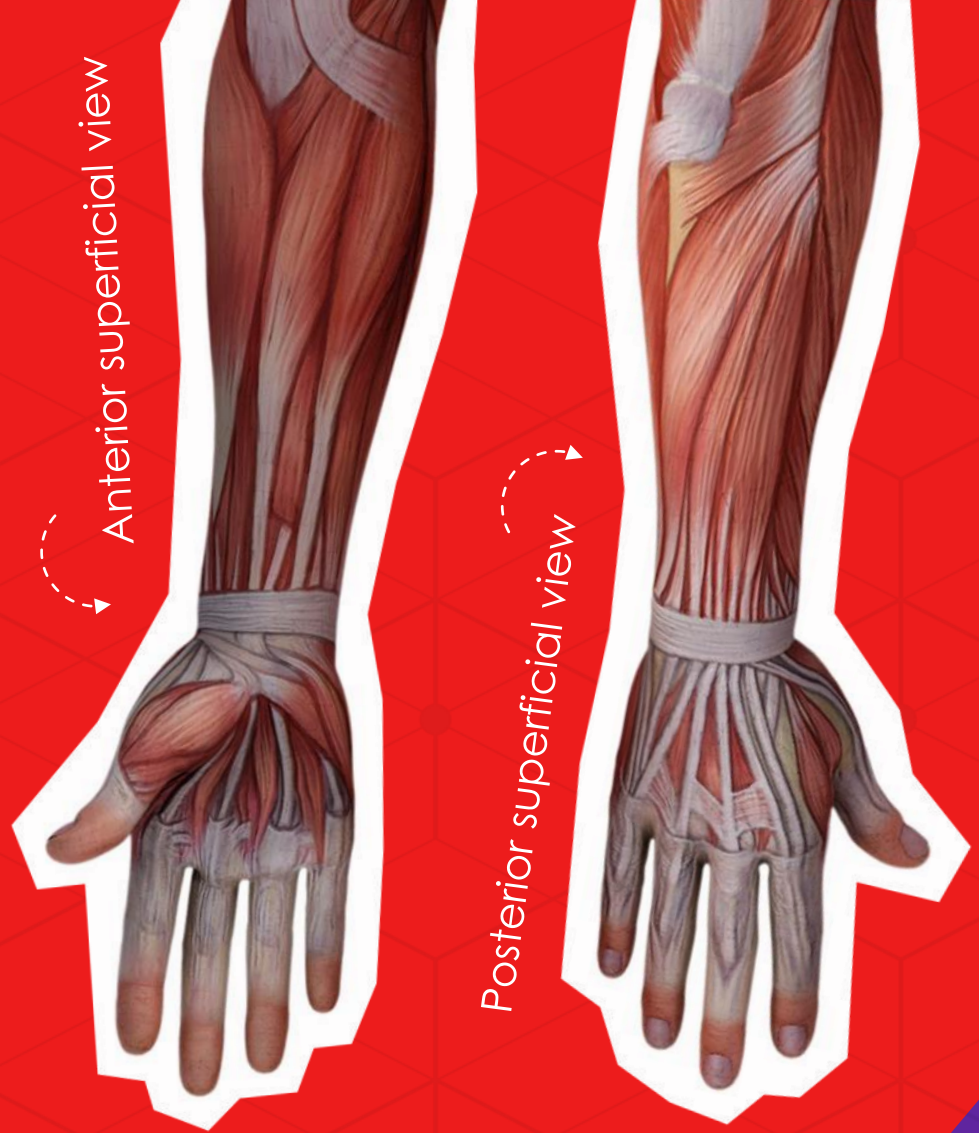
Supportive, *movement*

> Bones

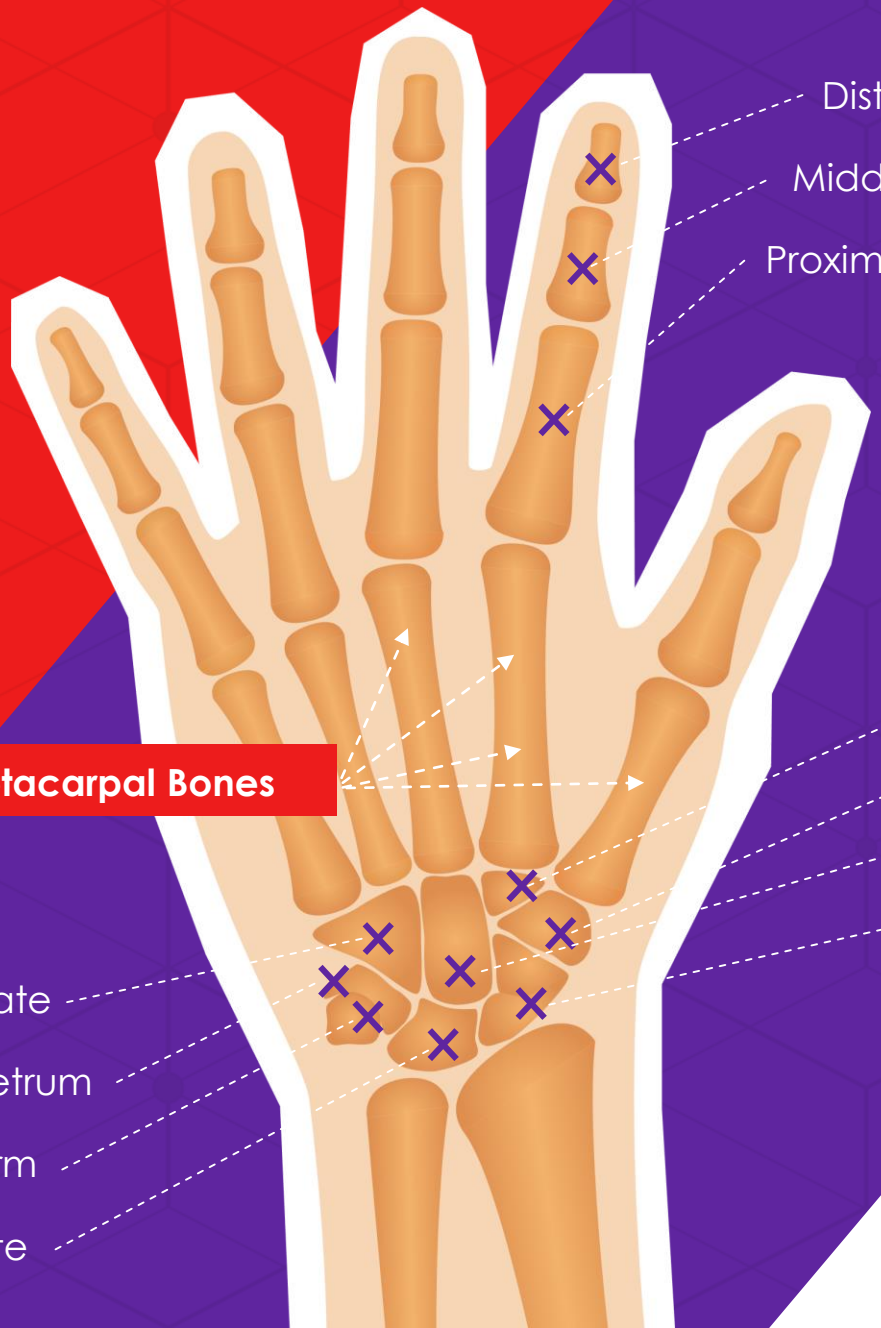
Protective, supportive, movement

> Skin

Protective, supportive



> **Carpal Bones**



> **Metacarpal Bones**

Hamate
Triquetrum
Pisiform
Lunate

Distal
Middle
Proximal

> **Phalanges**

> **Carpal Bones**

Trapezoid
Trapezium
Capitate
Scaphoid

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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

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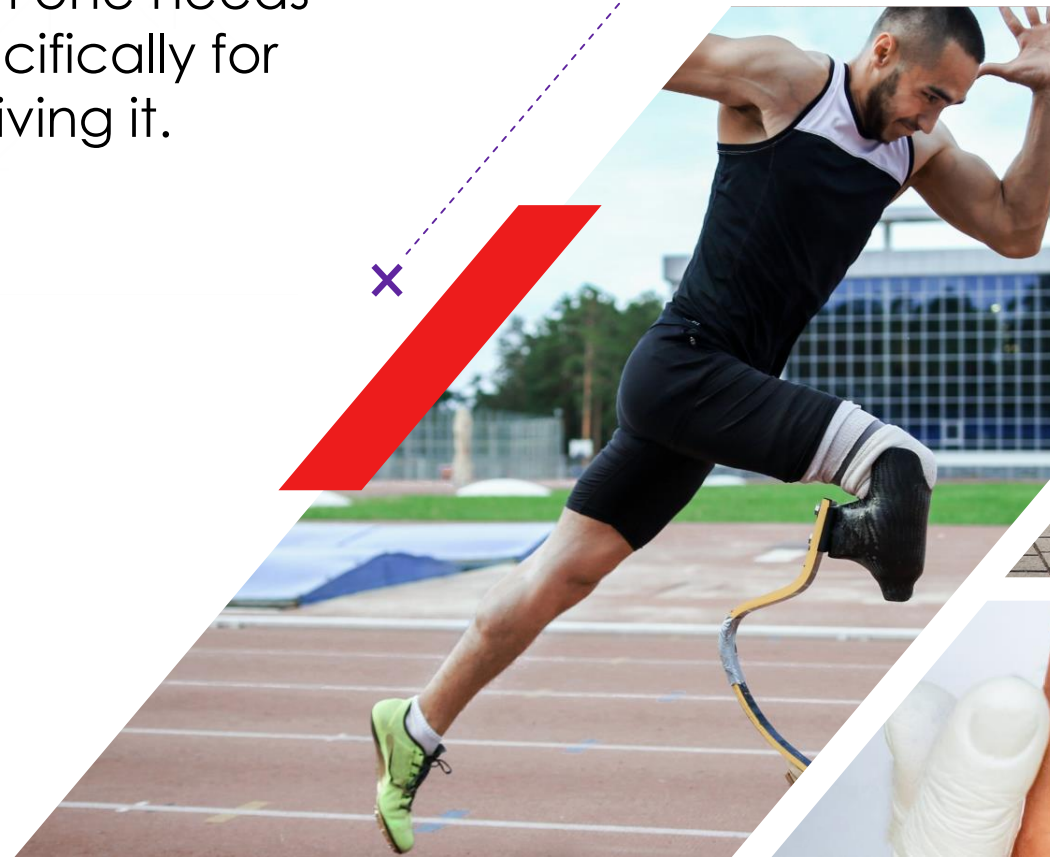
Every limb is different…

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



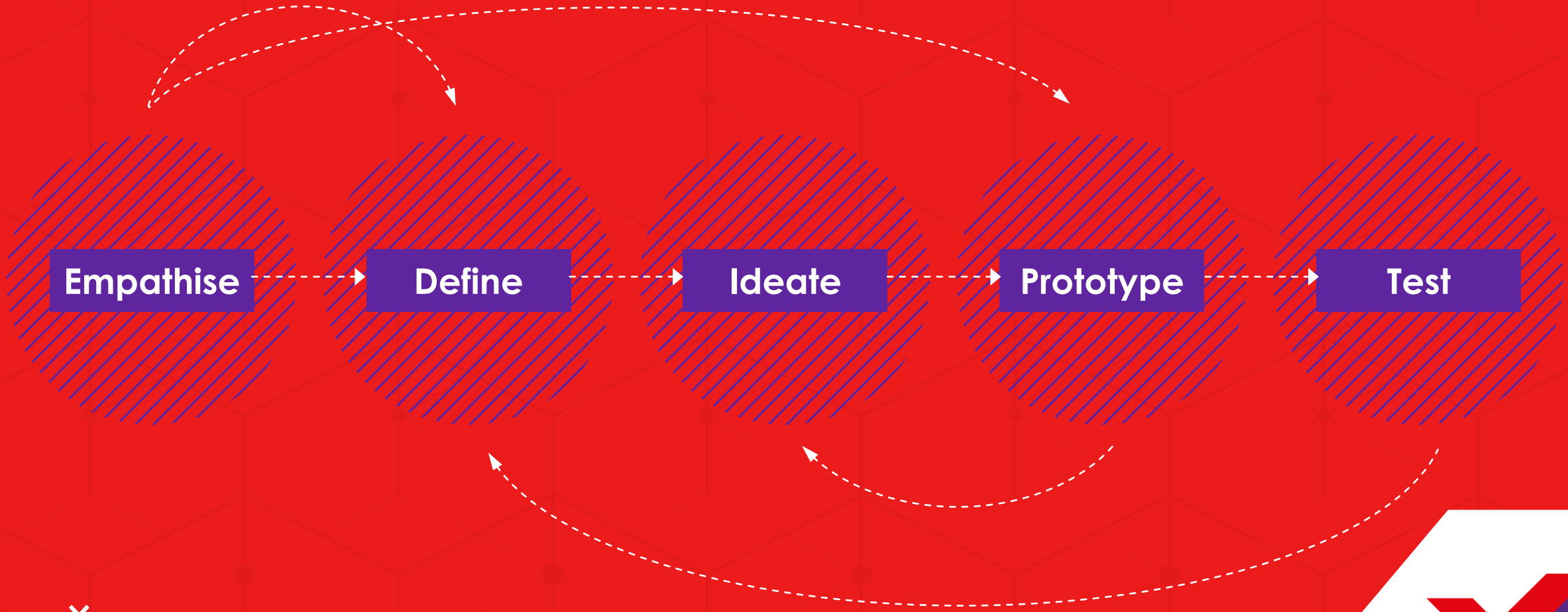
What problems does this cause?

- Expensive
- Long waiting periods
- No room for error

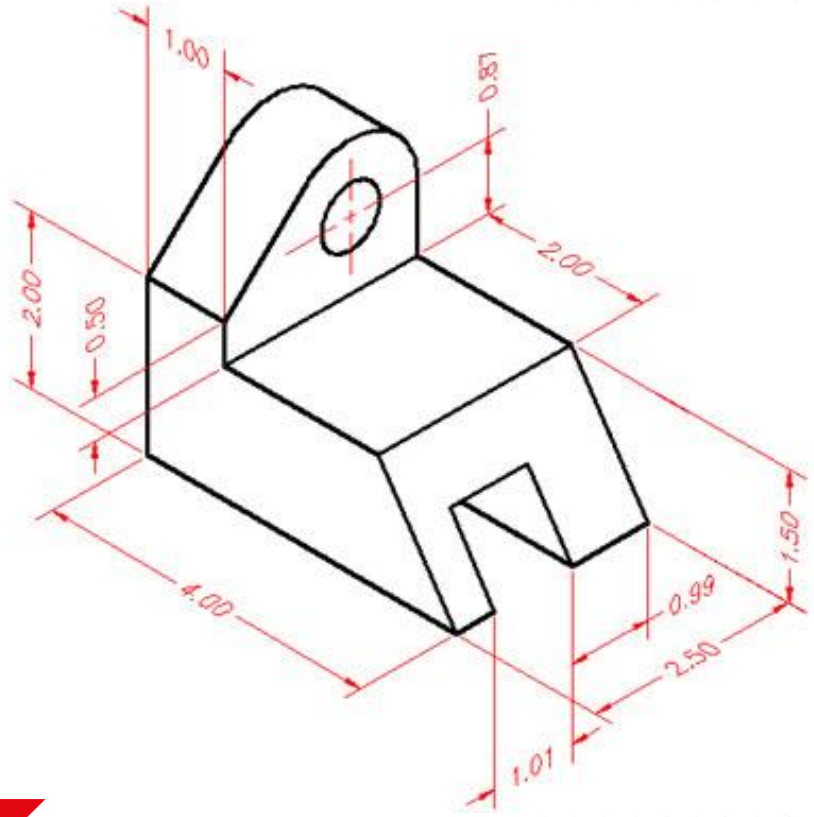
How can you solve these problems?

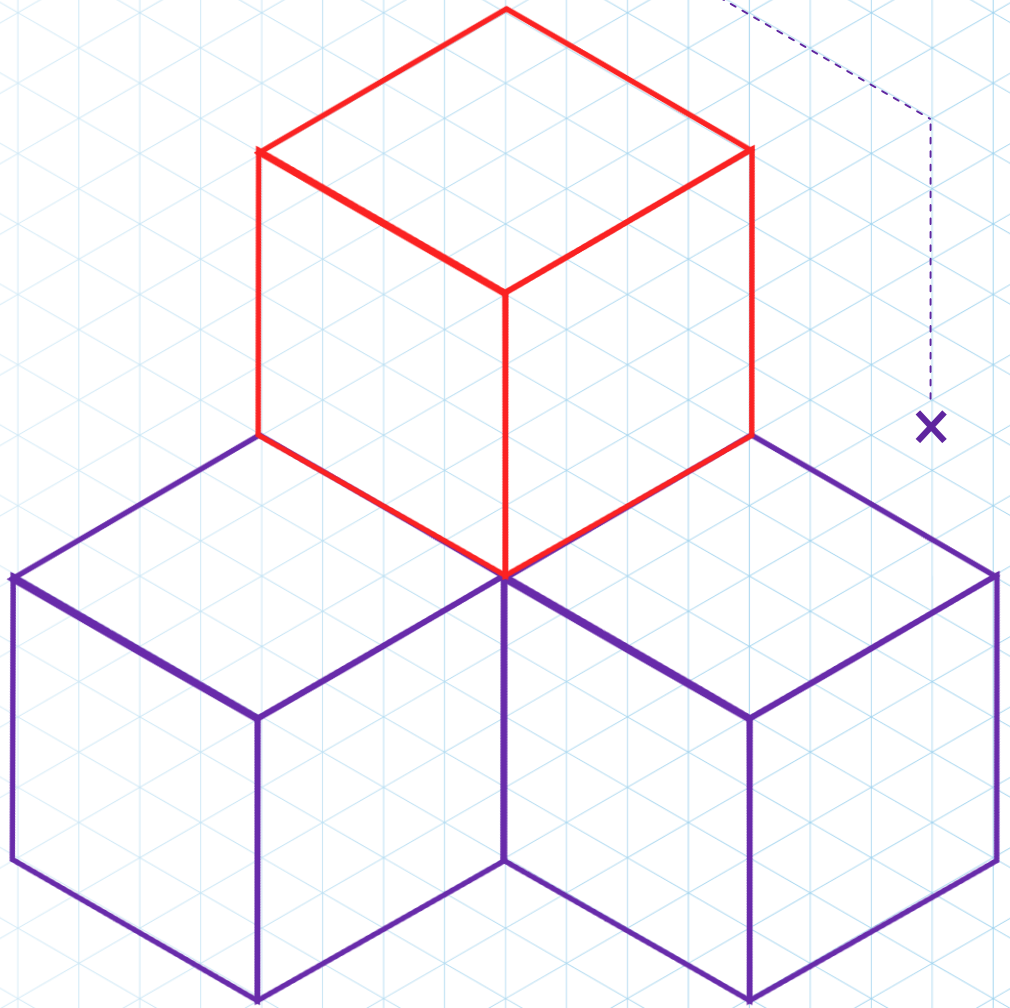
- Finding cost-effective materials and techniques
- Efficient processes
- Getting the first measurements correct
- Improving the design before it's built

Five phases of the design thinking process



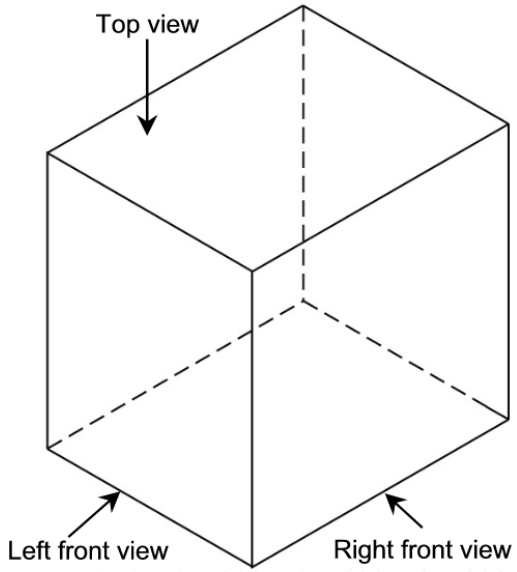
Isometric drawing

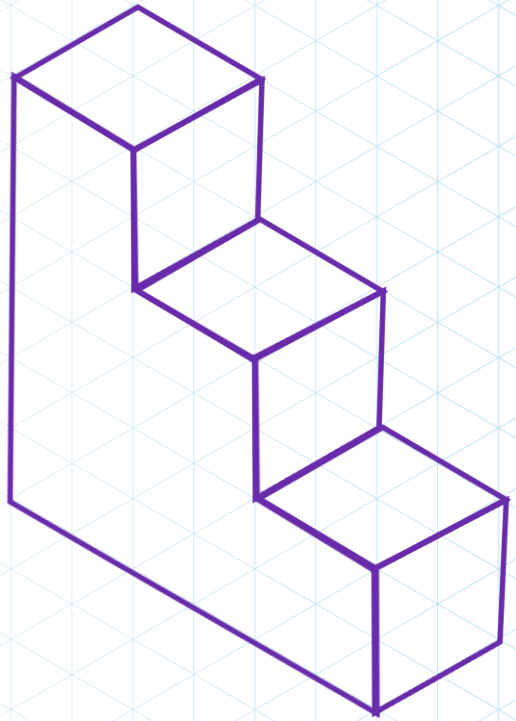


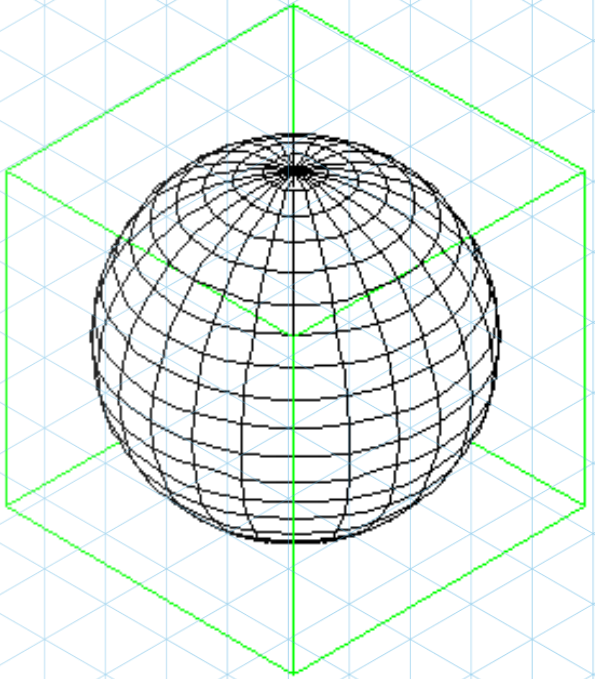


Can you draw an isometric…?

- > Cube
- > Stairs
- > Sphere
- > Misc.





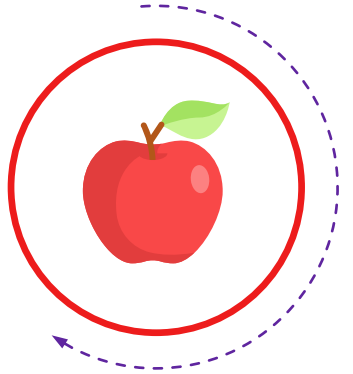


Waiting for a prosthetic

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…

- 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

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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

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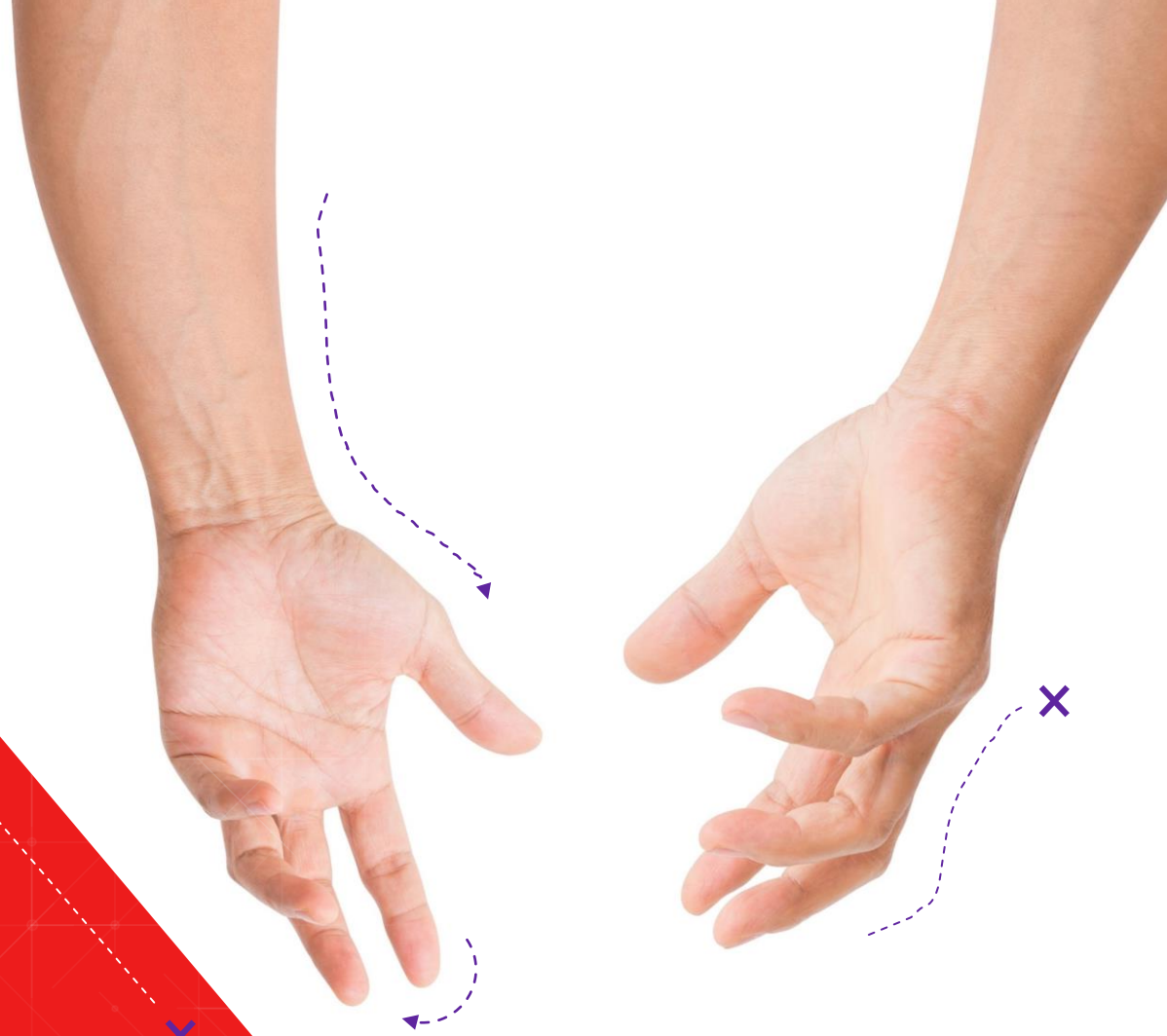
LESSON 2

Look at your arm and hand as you…

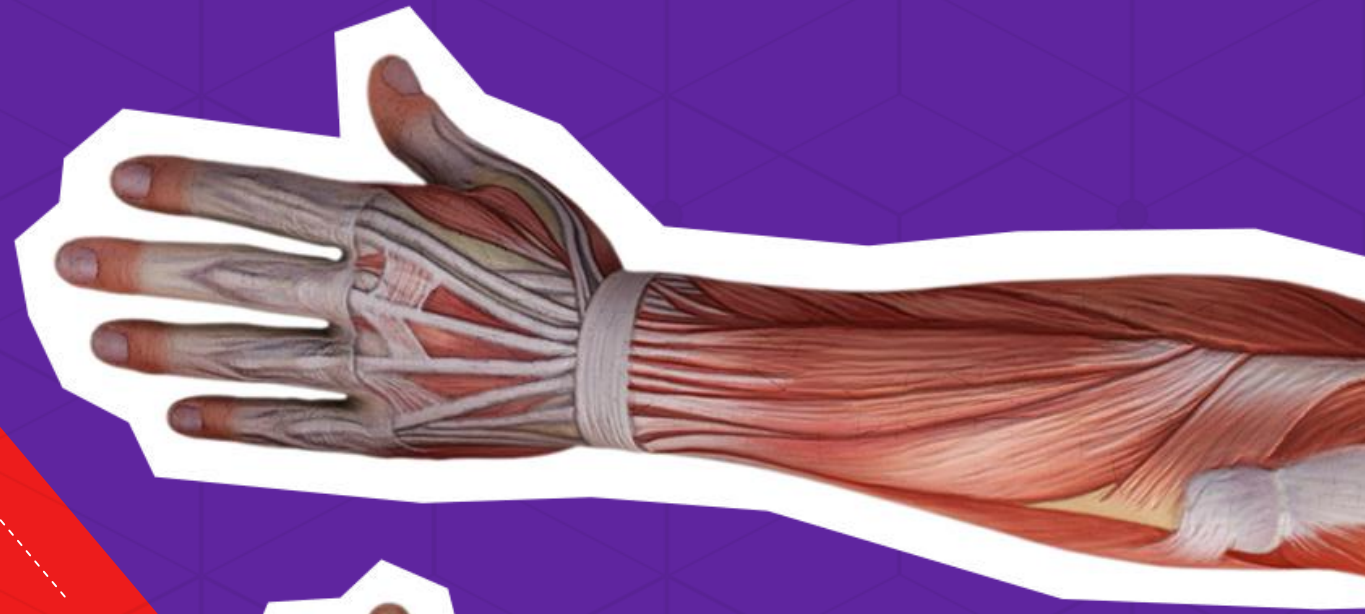
- Pick things up
- Put things down
- Wave to each other
- Shake hands with each other
- Write with a pen



> What can you see?

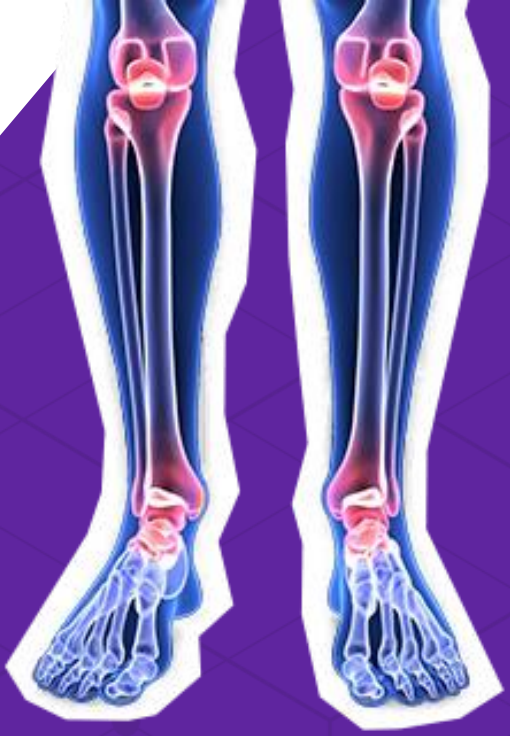
Find out…

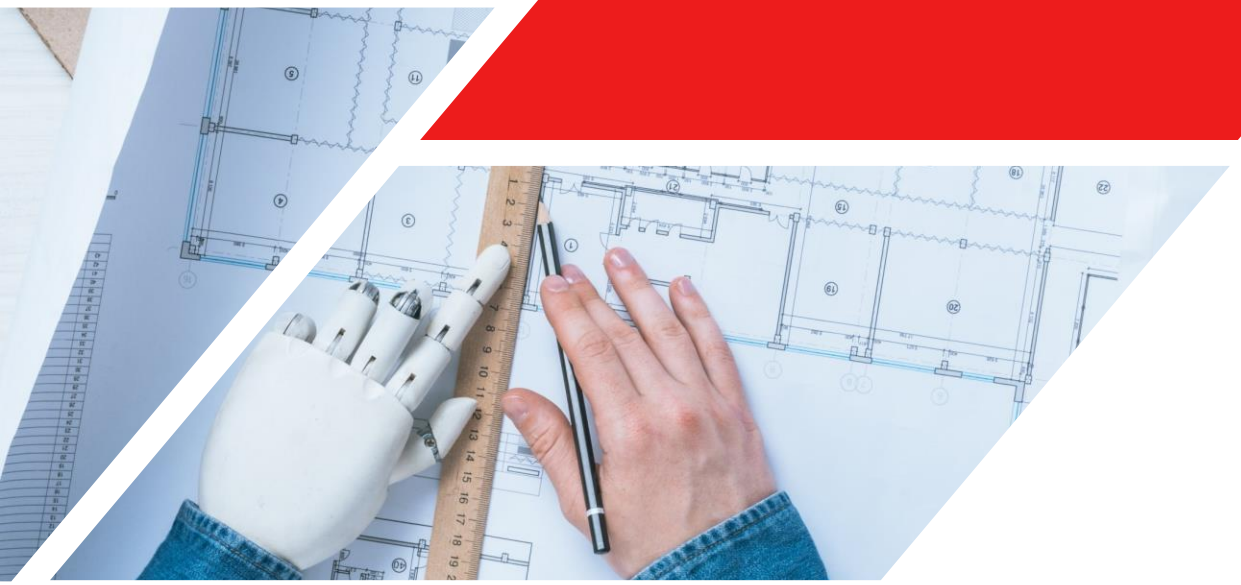
- How many joints are there in your arm and hand?
- What type of joints are they?
- What ‘function’ do they help the limb perform?

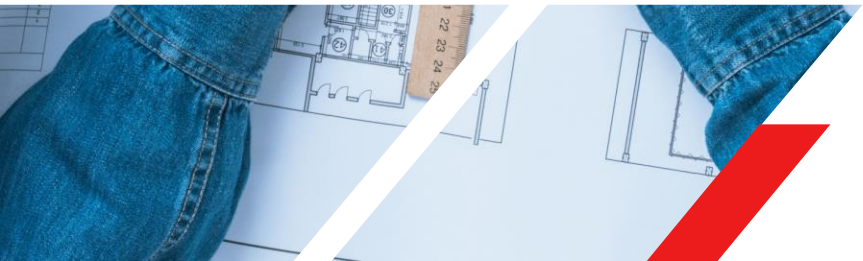


A ‘joint’ is…

- 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

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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

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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

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

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

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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