STEM CLUBS

NUMBER 1 FOR STEM

STEM ON SCREEN: SUITABLE FOR AGE 11-14

How do they make movies?

STEM Learning activity resources

SUBJECT LINKS

Science, design and technology, computing, engineering and mathematics.

STEM ON SCREEN: SUITABLE FOR AGE 11-14

How do they make movies?

STEM Learning activity resources

Introduction

This programme of activity is provided by STEM Learning, the largest provider of STEM education and careers support in the UK. It has been developed in partnership with Club leaders.

This programme is part of STEM on Screen, a set of three programmes exploring Science, Technology, Engineering and Maths in the movies.

How do they make movies?

Everyone loves a good movie, from flying cars, to hideous monsters and incredible costumes. But have you ever wondered how to create such movie magic? The secret to creating an amazing movie is just a few STEM Club lessons away.

This programme investigates how you can use Design and technology to master movie tricks, from creating your own prosthetic mask to investigating how false perspective can skew sizes.

Key information

AGE RANGE: 11–14

SUBJECT LINKS: Science, Design and technology, Computing, Engineering, Maths.

DURATION: A range of activities from 20 to 60 minutes – around 6 hours in total.

FLEXIBILITY: Complete the whole programme over a half term or choose individual activities to suit the needs of your Club.

RESOURCES: Each activity includes a list of the resources required and a comprehensive set of Club leader and student notes.

IMPACT MEASUREMENT: Each set of resources is designed to help evaluate and assess the progress of Club-based learning on Club members. A useful set of assessment tools are available at www.stem.org.uk/stem-clubs.

ACHIEVEMENT: students that successfully complete a complete set of activities can be rewarded with the downloadable STEM Clubs Certificate of Achievement. Successfully completing a set of themed activities enables students to enter for a CREST Discovery Award. Further information is available on the STEM Clubs website.

APPROPRIATE VENUES: Club leaders can run most activities in general spaces e.g. classrooms, halls, and outdoor areas. Some activities need to be conducted in labs and workshops – these are marked clearly in the Club leader guide and in the table below.

SAFETY: Each activity includes details about significant health and safety considerations, such as appropriate eye protection, gloves, etc. Club Leaders should ensure that all equipment is handled with care, particularly sharp instruments. Advice and guidelines are available from CLEAPPS and SSERC, or see the STEM Clubs handbook (page 20). We recommend that practical activities are risk assessed before commencing and Club Leaders must follow their employer or organisations policies. Other activities: Visit www.stem.org.uk/resources/stem-clubs/ for a wealth of ideas for STEM-related Clubs.

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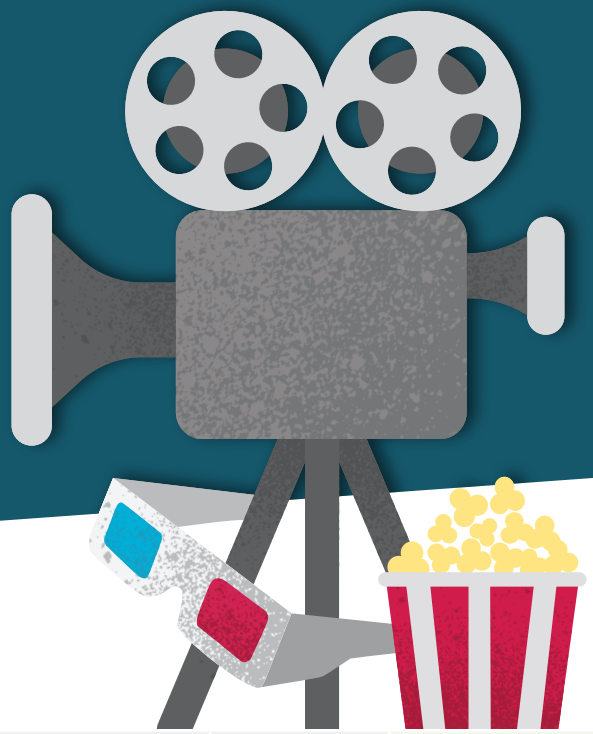
FURTHER SUPPORT: The STEM Clubs Best Practice handbook includes comprehensive support for leaders of all STEM-related clubs. It can be found at www.stem.org.uk/stem-clubs/getting-started



Activities

1	**GET THE LOOK:** Students use white glue or make their own bioplastic to form fake wounds and other simple prosthetic features and see who can make the most realistic features.	60 minutes	**Workshop required**
2	**GREEN SCREENS:** Students use a simple green screen app to explore chroma key compositing and create their own green screen video clips.	60 minutes	
3	**DOWN TO EARTH:** Students explore how stunt planners use giant inflatable bags to cushion stunt actors' landings and investigate how well they can control the landing of a 50g mass – and an egg.	60 minutes	
4	**JOIN THE DOTS:** Students apply their knowledge of anatomy to plan a motion capture map of where to apply bright dots on a person, to capture their motion in still photos or video, then film someone using their dots to compare their accuracy.	60 minutes	
5	**FALSE PERSPECTIVE:** Students set up and film a simple or more complex false perspective video clip and can explore in simple terms the Maths behind the technique.	60 minutes	
6	**SCALE SETS:** Students think like set designers and builders to create scale models for a movie in which students have changed size due to a mysterious accident in the science department.	60 minutes	
7	**ACTION APPAREL:** Students develop specifications for a textile superhero costume, thinking about comfort during 'action' shots, heat management and visual impact. They review possible material options before creating design sketches and a character mood board. Students can make a sample section or complete design as an extension activity.	60 minutes	
8	**STEADY SHOTS:** Students create a super simple steady cam and shoot test footage to see how even a simple system can smooth and control moving camera shots.	60 minutes	
9	**FOLEY FUN:** Students use a range of everyday objects and some simple sound processing to discover the range of Foley sound effects they can create.	60 minutes	
10	**GET CREST DISCOVERY AWARDS:** By completing all nine activities in this resource pack, your STEM Club members can get a CREST Discovery Award.		

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How do they make movies?

1 Get the look

Objective

In this activity, students use white glue or make their own bioplastic to form fake wounds and other simple prosthetic features and see who can make the most realistic features.

TOPIC LINKS

- Design and technology: properties of materials
- Biology: anatomy

TIME

60 minutes

RESOURCES AND PREPARATION

- white PVA glue, or
- white vinegar, corn or tapioca starch, glycerine (vegetable glycerine works fine), water, small pans, silicone spatulas, cooking hobs (or hotplate/camping stove)
- foil
- white, pink and red tissue paper
- brushes and small clay tools
- self-adhesive plasterer's mesh tape/drywall tape and scissors
- hairdryers with cool and cold settings (not essential but speed drying/cooling)
- safety goggles
- oven gloves or other heatproof gloves

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

Students should wear safety goggles and use oven gloves when handling the pan with their bioplastic.

Deliver this activity in your food lab. If possible, practise making and cooling the bioplastic in advance.

DELIVERY

1. Explain that students need to develop some make-up effects for a movie, which might be to make an actor look like an alien or to create the impression that they have been wounded.
2. Discuss some people with STEM roles who might help create these effects, for example: costume designer, prosthetic artist, make-up designer, make-up artist etc. Students can take on these roles if they wish.
3. For a faster, simpler approach (and to create smooth features), guide students as they create their effect by building up thin layers of white PVA glue on foil, drying each layer using a hairdryer on a cool or medium setting. Students can add tissue for texture and support and use clay tools to shape and add texture to the surface. Some students could form a shape out of layers of plasterer's tape and once they have built up a thin sheet of drying glue, lift this and cut or mould it over their shape, adding further layers of glue directly on top to finish their effect.
4. To create effects using students' own bioplastic (works best for uneven effects like wounds or monster features): working in pairs or threes, one student makes the bioplastic following the step-by-step instructions while their partner creates a shape out of plasterer's tape, as above. Once transparent, students can carefully pour their bioplastic over their mould on greaseproof paper (warning: this will be hot – students should use oven gloves to handle the pan). Students can use the spatula and clay tools to press and shape it into and over the mesh (after a minute or so it will be cool enough to shape with hands). Students cool their bioplastic using a hairdryer on the cold setting or put it in the freezer while they clear up. They can make more batches to add to their design if required.

5. Encourage students to relate these materials to polymers. Ask them to think about the different properties each polymer yields – which properties are best for making fake wounds?
6. As time permits, students can add effects to make their work as realistic as possible, or complete this as an extension.
7. Students showcase their effect and can vote on whose ideas are the most creative and realistic.

DIFFERENTIATION IDEAS

Support: Focus all students on making a simple thin skin effect from white PVA, like a cut or area of skin with boils and pimples on, which is quicker to make and dry. Students won't need plasterers' tape.

Challenge: Students make bioplastic while their partner or team creates a 3D effect out of plasterer's tape.

EXTENSION IDEAS

1. Invite a theatrical make-up artist to demonstrate how they use make-up for stage performances.
2. Students can finish painting and detailing their creations once they have fully dried.
3. Students can first create moulds for their effects out of clay or polymer clay, building up their effect by brushing on layers of white PVA glue or pouring in bioplastic (spray with a light layer of oil first as a release agent).
4. Students can vary the amount of starch (the polymer) and glycerine (the plasticiser) in their bioplastic to create different material properties, or add food colouring to the water.
5. Students could create test footage of their prosthetics.

TIPS

- Warning: bioplastic will be hot when made
- Thin layers of glue or bioplastic will dry/cool more rapidly
- Thick moulded effects will need to be completed in a later session
- Students can share hairdryers, drying/cooling more than one effect at a time
- Students should focus on making one simple effect each or per pair
- Have students making their wounds in a carousel fashion to spread out the use of materials

USEFUL LINKS

Basic concepts of prosthetic makeup (WARNING: realistic wounds and blood)

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How do they make movies?

2 Get the look

Your challenge

Prosthetic make-up transforms actors to help them portray someone with a wound, a different face or even an alien or mythical creature. What transformation could you create?

Create your own skin prosthetic and transform a friend's appearance!

WHAT YOU NEED TO DO

With white PVA glue

- build up your shape from thin layers of glue. Use a hairdryer to help each layer dry
- use tissue and clay tools to add textures and shapes to your creation

With a plasterer's tape shape

- use pieces of plasterer's tape to create a simple shape for your prosthetic
- don't make it too big. Build up your shape from smaller lengths of tape. Make sure the layers stick together
- use extra tape to stick your shape to the foil

With bioplastic

1. Wearing eye protection, measure these ingredients and add them to a cold pan:
   10ml white vinegar
   60ml starch powder
   10ml glycerine (make sure you scrape it all out of the measure)
   240ml water
2. Place the pan on a low/medium heat and stir with a silicone spatula.
3. The mixture will soon form clumps. Keep stirring until it changes to a clear gel. Stir for another few seconds until it forms a single lump.
4. Use oven gloves to take the pan off the heat. Spread with a spatula on greaseproof paper, foil or over a plasterer's tape mould. Do not touch the hot mixture!
5. Cool with a hairdryer or in the freezer, using clay tools to smooth or add details to the surface.

SAFETY: Wait for the pieces to cool before handling them!

These items are all made from polymers! Compare them – how are the textures different? Which are most realistic? Compare the properties these three polymers have –what are the similarities and differences? If you were to engineer a 'fake wound plastic' what properties would it need to have?

FUN FACTS

1. Early forms of plastic were made from casein, the protein in milk. The first synthetic plastic was nitrocellulose, patented in 1856 by Alexander Parkes.
2. Chemical engineers vary the properties of plastics by combining different polymer molecules and additive molecules, to get the strength, flexibility, density etc. they need for different applications.
3. 3D printing allows one-off objects to be made out of plastics like nylon or ABS. Some printers build up layers by melting a fine powder, while others melt a long fibre on a reel. But 3D printing is also possible using metals like steel, titanium and even gold and silver, for specially made parts and even jewellery.

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CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How do they make movies?

2 Green screens

Objective

In this activity, students use a simple green screen app to explore chroma key compositing and create their own green screen video clips.

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

TOPIC LINKS

Physics: light, colour

TIME

60 minutes

RESOURCES AND PREPARATION

- a green screen app, such as DoInk Green Screen (£2.99) for iOS or Filmora for an OS (free)
- a bright, preferably green backdrop such as green screen material, any bright, opaque, non-textured green fabric, or a roll of day-glo green paper. (You can use other colours but adjusting the sensitivity will be more difficult.)
- background photos in your devices' photo libraries (or students do an online image search during the activity)
- students should ideally wear a plain non-white t-shirt or other top in a range of colours
- deliver this activity in a brightly lit room. While not essential, use video lights if available.

DELIVERY

1. Introduce the activity. If possible, watch the introduction to green screens video clip (see Useful links) (1'56").
2. Discuss which STEM roles might help create green screen video technology, for example: programmer, lighting designer, optical scientist or engineer. Students can take on these roles if they wish.
3. Explain that students are going to create a brief green screen clip but first they need to calibrate the app for the backdrop colour you will use. If using DoInk Green Screen, guide students to select the camera for the bottom layer/track, so the chroma (rainbow circle) button becomes usable, and then set a background image in the middle layer by choosing a photo. Students adjust the chroma colour to match the backdrop and then adjust the sensitivity so both the actor and backdrop are equally visible. While this happens, discuss how the app works – by filtering out pixels that match the chroma of the background.
4. Students film themselves in front of the green screen using their chosen background image.
5. Students share their creations. As well as enjoying their creativity, help students evaluate how well they set up their scene, adjusted the sensitivity, etc.
6. Share ideas for what students might wish to plan and film next.

TIPS

- It's best to use a bright green backdrop as this provides maximum contrast against skin tones.
- Adjust the chroma colour first and then the sensitivity.
- Students can cover parts of their head or body with the backdrop material to make themselves invisible, for example to create the illusion of a floating head and hands.
- For Club leaders who have not done this before, it may be useful to try it out prior to the session to get familiar with the software.

DIFFERENTIATION IDEAS

Support: Create a ready-made album of a few suitable background photos in the photo libraries of the tablets students use – the more dramatic, the better! Test for chroma colour and sensitivity first so the app is ready to use.

Challenge: Students use your backdrop material to cover some items of furniture they can sit or stand on, to add to the illusion of being 'in' the image they are using.

EXTENSION IDEAS

1. Students can film and import some 'plain' green screen footage into a movie editing program and use more sophisticated tools to add still photo or video footage backgrounds.

USEFUL LINKS

How does a green screen work?

DoInk GreenScreen tutorial videos

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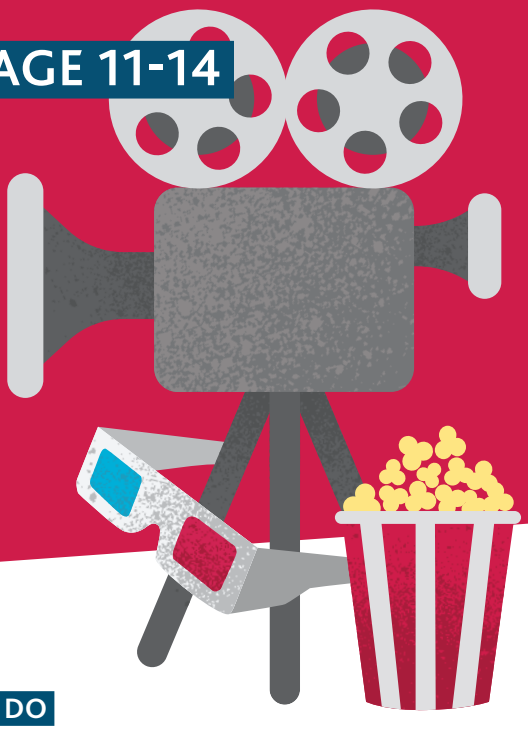
How do they make movies?

3 Green screens



Your challenge

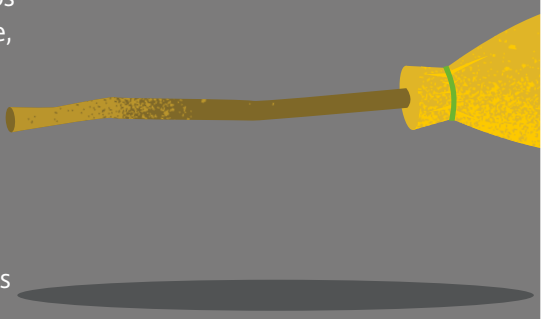
Green screen technology can transport actors to anywhere in a screenwriter or director's imagination. And with green screen apps, that can now include you! Where might your imagination take you?

Create your own green screen clip! Where will you go?

WHAT YOU NEED TO DO

1. Set up your backdrop so it's brightly lit and as smooth as possible. This makes it easier for the app to distinguish between the backdrop and yourselves.
2. Set the app to record video in the bottom layer (use the '+' sign next to it to choose) and then choose a background image to use in the middle layer.
3. Click on the rainbow icon. Set the chroma key to the same colour as your backdrop and then adjust the sensitivity so you can see your background image and yourself.
4. Think about how the app works – the background colour is the key – and share your ideas.
5. Plan what you will say and do in your clip, and then record your green screen adventure!
6. Share your clips and explore where you chose to go.

To find out more explore the DoInk Green Screen tutorial videos.



FUN FACTS

1. Concepts similar to green screen technology go back to the early days of film. At that time, studios would shoot two sets of footage, one with actors in front of a green background, and another of the scene they would be viewed in, which might be real or a 'matte' painting. Then, technicians would manually combine each pair of film frames to create the finished illusion.
2. The process uses a bright green background because it's the colour that most differs from actors' skin tones – but it means you won't see characters on screen in bright green costumes! It's been used on TV for years to help present the weather.
3. This process was used to create the invisibility cloak illusion in the Harry Potter films – the actors simply covered themselves in green screen material.

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How do they make movies?

3 Down to Earth

Objective

In this activity, students explore how stunt planners use giant inflatable bags to cushion stunt actors' landings and investigate how well they can control the landing of a 50g mass – and an egg.

TOPIC LINKS

- Physics: gravity; forces
- Design and technology: properties of materials

TIME

60 minutes

RESOURCES AND PREPARATION

- medium (around 25 x 50cm) clear polythene bags (cheaply available from internet auction sites) or sturdy bin bags
- tape and scissors
- 50g masses
- tape measures
- hairdryer(s) with cold setting (helpful but not essential)
- medium eggs (optional)

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity. Safety goggles should be worn.

DELIVERY

1. Introduce the scenario: students are stunt coordinators on an action movie set. They must prepare a landing cushion to help a stunt actor jump from a tall building.
2. Explain that in the past, stunt actors might land on a range of materials including foam blocks or stacked cardboard boxes. But today, they often land on a 'jump cushion' – a large inflated bag with a gap that opens to let a controlled amount of air out as they land. The gap size (and with real bags, how it opens) is carefully controlled to provide the right level of cushioning upon landing. Discuss how jump bags dissipate the energy of the falling stunt actor and what forces are at work.
3. In pairs, students should partly tape shut the open end of a bag, taping carefully from each side and choosing how much of a gap they will leave open in the middle. They inflate their bags (using hairdryers if available) and drop a 50g mass from 1m as instructed, adjusting the size of the gap by adding tape to each side or slicing it open again, until they decide that their jump bag deflates at just the right rate (this is up to them).
4. Teams report back on the opening size they have chosen. Review differences and ask teams with the smallest and largest gaps to explain their choice.
5. Teams see how high they can drop their mass while still fully controlling its landing.
6. Teams compete to see who can drop an egg from the highest point without it breaking on impact. (You may want to spread out some opened bags in case of breakage!)

TIPS

- **Students can hold their bag closed until after they drop their mass or egg but must have let go by the time it lands.**
- **Teams need to ensure their mass or egg falls at the centre point of their bag and could mark this point with a permanent marker.**
- **If the gap is too small the mass or egg might roll off before the bag deflates.**

DIFFERENTIATION IDEAS

Support: Have a couple of ready-made bags to demonstrate with – one with a 1cm opening and one with as large an opening as you can control.

Challenge: Ask teams to predict how high they can drop their mass or egg from.

EXTENSION IDEAS

1. See if students can time how long the bag takes to deflate (once landed on from a set height) at different opening sizes, and plot a graph of their results.
2. See how high you can go! Use a stairwell for your tests and try using larger (e.g. 50cm x 75cm) bags.
3. Students can design a simple flap valve that keeps air in until the mass or egg lands on the bag, taping the open side fully shut.
4. Use a data logger to track the movement of the egg – can you use it to quantify how good your landing cushions are?

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How do they make movies?

4 Down to Earth

Your challenge

You're the stunt coordinator for a big action movie! It's your job to make each stunt look amazing, but also keep the stunt actors safe. You're planning the big jump that will form part of the movie's main action sequence.

Investigate how to control a stunt landing and protect your stunt egg!

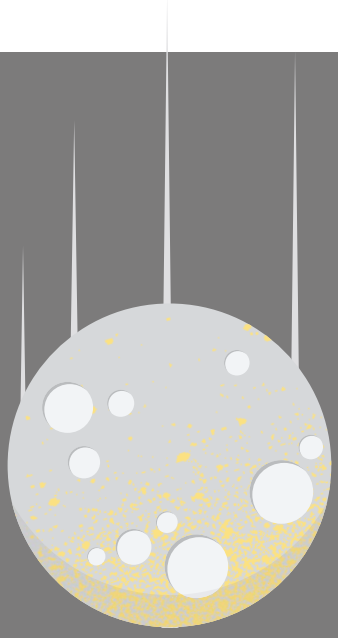
WHAT YOU NEED TO DO

Stunt actors land on giant jump bags that are designed to deflate at just the right rate to control their landing. Build and test a jump bag for a mass – then test it with an egg!

1. Control how fast your bag will deflate by taping the opening to leave a gap in the centre.
2. Make sure your gap is symmetrical about the centre so the bag deflates evenly.
3. You may be able to inflate your bag with a hairdryer. Make sure it is on the cool setting.
4. Drop a 50g mass from 1m onto your inflated bag. Adjust the size of the opening until you are happy with how fast it deflates. The criteria for this are up to you!
5. It's time for the big jump! Take turns to test your jump bag with an egg. Take care to drop your egg from above the centre point of the inflated bag. Observe carefully how close to the ground your egg gets before it slows down.
6. How high dare you go? Think about how far from the ground the egg got before slowing down. See how high your stunt egg can jump from!

FUN FACTS

1. Someone falling in a spread-eagle shape like a skydiver will reach terminal velocity in about 12 seconds. They would need to jump from more than 450m up to reach that velocity before landing!
2. Doing so isn't a good idea though – they would hit the jump bag at around 122 miles per hour.
3. Things in orbit are actually in free fall, it's just that the shape of their trajectory follows the curvature of the Earth. Even the moon is in free fall around us.



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How do they make movies?

4 Join the dots

Objective

In this activity, students apply their knowledge of anatomy to plan a motion capture map of where to apply bright dots on a person, to capture their motion in still photos or video. They then film someone using their dots to compare their accuracy.

TOPIC LINKS

- Biology: skeleton, anatomy
- Physics: light

TIME

60 minutes

RESOURCES AND PREPARATION

- some students will need to wear dark clothing that's not loose, like leggings and a long-sleeved t-shirt or sports top
- paper and pens
- glow-in-the-dark spots (about 20 per person) or tape (about 1–1.5m per person), cheaply available from internet sellers
- clear tape
- scissors
- cameras (smartphone cameras work well)
- torches or bright lights (helpful but not essential)
- data projector (helpful but not essential)
- this activity works best in a room in which you can black out all or most light. If this isn't possible, use white stickers instead of glow-in-the-dark spots.

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

DELIVERY

1. Discuss how animated characters or non-human characters are brought to life in movies. Examples include Maz Tanaka (*The Force Awakens*), Rocket (*Guardians of the Galaxy*), Caesar (*Planet of the Apes*), Hulk (*Avengers*) and even the penguins in *Happy Feet*. Highlight that in all these cases, the crew captured the motions of real actors and mapped them to the animated bodies of each character to create realistic performances.

2. Students should form small teams. Discuss what STEM roles might help create realistic motion capture: motion capture engineers and technicians, programmers, lighting engineers and designers, camera operators and many more. Students can take on these roles if they wish.

3. What are the crucial parts that create movement in our muscular and skeletal systems? Give students access to a picture of the muscular/skeletal system. In their teams, students should discuss and agree where they would place 20 markers on a person in order to capture their movements as accurately as possible. Students must prioritise to select the areas that are most important to common movements. They draw a simple human silhouette and mark 20 spots to create a 'map'. Teams share their maps, justifying them in terms of bones and joint locations and how people move.

4. Teams position glow-in-the-dark stickers or pieces of tape on a team member in close-fitting, dark clothes, following their map.

5. Students 'charge' the stickers by shining a torch or phone torch on each one for a couple of seconds. Discuss the energy change taking place.

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6. Turn out the lights so the room is as dark as possible. The person in each team completes three movements or actions (repeating if necessary), which their team films.

7. Turn the lights on. If possible, share video clips. In turn, teams suggest what their team member did to see which teams could most accurately track movement using their motion capture map.

TIPS

- Position one sticker on each set of toes, six on the outside of joints (ankle, knee, hip, wrist, elbow, shoulder) on each side, one on each hand, two on the head (chin, forehead), and two on the torso (belly, upper sternum under throat). For safety, clear a space for performers.
- Performing students should use large, clear, fairly slow movements to represent common, easy-to-recognise actions. For still photos, turn off the flash.
- Warn students in advance that you will be doing this activity and to bring in suitable clothing that can ideally go over their school uniform.

DIFFERENTIATION IDEAS

Support: Choose three actions and let the performer in each team know what these are. Have tape ready-cut into 1–2 cm lengths. Use the tip above to instruct students where to position their stickers. Use more stickers mid-way along each limb (e.g. upper and lower arm/leg) and more on the torso.

Challenge: Some teams could place smaller stickers on hand joints or 'map' a face in detail (ensure performers close their eyes when the team charges their stickers), to capture finer movements or emotions like smiling, laughing, frowning etc.

EXTENSION IDEAS

1. Give students 50 markers to create a more detailed map and compare the accuracy of the motions this can capture compared to using 20 markers.
2. Students could import their video into editing software and, frame by frame, add lines to join the dots and create an animated stick figure.
3. Students could use animation software to create a simple animated character, basing their movements on what they capture.

USEFUL LINKS

- What is motion capture?
- Example motion capture marker locations (using more than 20 markers)

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How do they make movies?

4 Join the dots

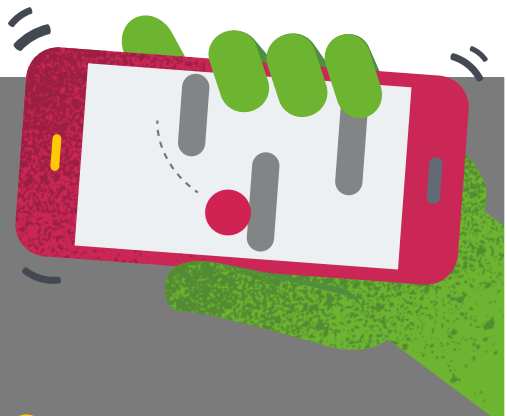
Your challenge

Which computer-generated character would you like to be? Motion capture allows you to act out the motions (and emotions) of almost anyone – or anything. But it all depends on accurately capturing your motion.

Identify the best places to position motion capture markers, capture some action and see if you can tell what's happening!

WHAT YOU NEED TO DO

1. In your team, think about which areas of the body are most essential for normal movement. Look at a diagram of the skeletal/muscular system – use it to locate where these points specifically lie.
2. Prioritise the most important points and decide where you will place 20 markers to capture one team member's body movements. Draw a simple silhouette of a person and mark 20 places on their body to create a 'map'.
3. Share your ideas, linking them to bones, joints and how a person moves by bending, flexing, twisting etc. If you need to, change your map.
4. Carefully stick 20 glow-in-the-dark markers onto one team member. If needed, use longer bits of clear tape to ensure the glow-in-the-dark material won't fall off.
5. 'Charge' the stickers using a torch or phone LED so each one glows brightly. What energy changes are taking place?
6. In the dark, film your team member as they complete three everyday actions or tasks.
7. If you can, share your clips with the group. Suggest what you think your team member was doing!
8. Discuss what you've learned about capturing motion. What could you do differently or better next time?



FUN FACTS

1. Glow-in-the-dark stickers use phosphors, a group of substances that can absorb light energy and then re-emit it slowly over time.
2. Before motion capture, rotoscoping was used to capture realistic actions to use in cartoons. An actor would be filmed and each frame projected onto glass and traced onto paper. Each tracing could be turned into one animation cell of the character in action.
3. Your phone probably has an inertial sensor that can track motion – that's what's used for games where you tilt the phone, and to track your movements in fitness apps.

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CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How do they make movies?

5 False perspective

Objective

In this activity, students set up and film a simple or more complex false perspective video clip and can explore in simple terms the Maths behind the technique.

TOPIC LINKS

- Maths: ratio and proportion; geometry
- Physics: light

TIME

60 minutes

RESOURCES AND PREPARATION

- one or more classroom tables
- one or more low stage plinths, larger in length and width than the tables, or use pe benches, the top section of a gymnastic box or similar.
- white sheets or cloths (or pairs of cloths of the same colour)
- items for on the table
- measuring tapes
- masking tape
- equipment to film video clips
- you will need space to deliver this activity, for example a drama studio, hall or sports hall.

HEALTH AND SAFETY:

Health and Safety: A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity. Safety goggles should be worn.

Take care that students are properly lifting any heavy items. They should bend at the hips and knees rather than the back, and keep the item close to their bodies. Ensure students do not stand on very high plinths or benches to avoid risk of injury from falls.

DELIVERY

1. Introduce the activity: movies use false perspective shots to create the illusion of things being a different size to real life, to allow actors to play bigger or smaller characters, or to integrate a scale model into a live scene.
2. Students form small teams. Discuss what STEM roles might help create a false perspective scene for a movie: production designer, special effects designer, cinematographer, camera operator etc. Students can take on these roles if they wish.
3. For a simple approach, or for initial practice before the more complex scene, watch the first video clip (see Useful links). Using the ideas, students arrange foreground and background items and people to plan and film a brief clip, for example of a shrunken human or giant interacting with furniture or normal-sized people.
4. For a more complex approach, students follow the instructions on the Student guide to create a 'split table' effect: watch the second video clip in the Useful links section. Students line up a plinth behind a table, cover both with sheets, then position the camera, table and plinth to best create the impression that the table and plinth are one, like in the video. Students plan a brief scene, placing normal items on the table, and people on the plinth, then film their clip.
5. Teams take turns sharing their clips. Discuss how teams could improve the realism of their shots or create something even more impressive.

DIFFERENTIATION IDEAS

Support: Use the simple approach or have a table and plinth prepared for students to use.

Challenge: Review the 'Maths of forced perspective' link below. Explore the relationship between size on camera and distance from the lens. Find two students who are the same height. Student 1 stands halfway between foreground and background as a 'reference distance' r. Measure this distance from the camera. Student 2 stands in different positions, from foreground to background. Students take a photo each time and measure student 2's distance from student 1 (+ ve if further away, – ve if closer). Students measure student 2's perceived height on each photo (using student 1 as a reference) and plot a graph of perceived height v distance from student 1 to find the relationship. They can use this to predict where to position a student relative to someone else, who for example needs to be one third or twice real size.

EXTENSION IDEAS

1. Students can find other forced perspective photos or video clips online and plan how to recreate them.
2. Students could model a forced perspective scene in Minecraft or create a physical forced perspective model using scrap and art materials.

TIPS

Students can use masking tape to create inconspicuous 'marks' on the floor, plinth and table to show where to stand or move – this helps to line up people and props in the foreground and background when looking through the viewfinder, which is critical in making the scene look realistic.

USEFUL LINKS

- Video 1: simple forced perspective
- Video 2: an example of split table forced perspective
- The maths of forced perspective

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How do they make movies?

5 False perspective

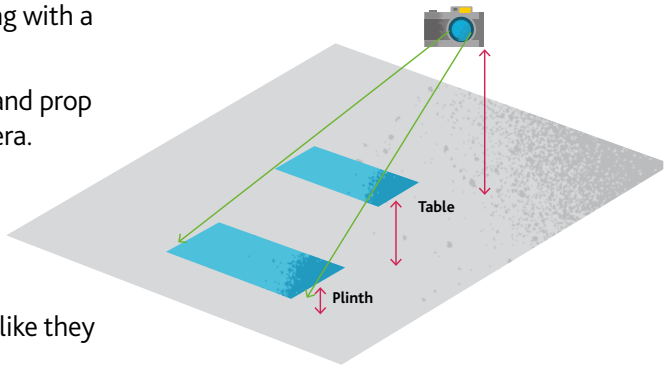
Your challenge

Ever wanted to be really tiny? What about a giant? With false perspective, you can! Well, almost. Movie-makers use false perspective to create the illusion that people or objects are a different size. What illusion could you create?

Plan and film a short false perspective shot that fools your audience!

WHAT YOU NEED TO DO

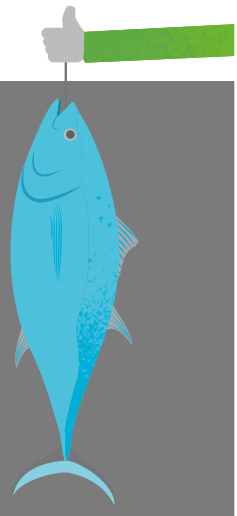
1. For a simple approach, create a shot where someone shrinks or grows huge. They could talk to a normal-sized person or look like they are doing something with a prop – it's up to you!
   - plan how far each person and prop needs to be from the camera.
   - help each person look convincing, for example by lining up how they look at one another, or how they look like they are holding a prop.
   - create your shot and share with the others.
2. For a more complex shot, cover a table and plinth in matching cloths.
   - line up the camera, table and plinth so it looks like there's just one table:



   - position normal props on the table, and people next to the table and on the plinth.
   - as above, help each person to look and move in just the right direction so they look convincing when they interact with table props or other people. What will you get your normal and tiny people to do?

FUN FACTS

1. Essential for the more detailed Maths of forced perspective are radians, a unit of angular measure. There are 2π radians in a complete circle.
2. Radians make some kinds of Maths and Physics much easier. For example, angular velocity (how fast something spins or circles a centre point) is measured in radians per second.
3. As well as in movies, people have sometimes used forced perspective to fool people with made-up news, such as giant animals they have seen or caught!



STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How do they make movies?

6 Scale sets

Objective

In this activity, students think like set designers and builders to create scale models for a movie in which students have changed size due to a mysterious accident in the science department.

TOPIC LINKS

- Maths: fractions, scales, ratios and proportion; measurement
- Design and technology: design, modelling

TIME

60 minutes

RESOURCES AND PREPARATION

- rulers, measuring tapes, pencils etc.
- corrugated and thin card
- suitable tape and glue
- calculators (or students can use the app on their phones)

Alternatively, students could use 3D design software to create their designs and in a later session print, cut or 3D print their designs. Club leaders are recommended to have the support of a D&T specialist with experience of 3D printing and CAD during this activity. Or they could get training from a specialist and practise with the tools in advance.

Plan in advance some suitable objects from within your STEM Club room to model at different scales. This might include furniture, equipment or the room itself.

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

DELIVERY

1. Introduce the scenario: students are in the production team for a film in which the actors have changed size and need scale models to use on set. Depending on whether the characters have shrunk or grown (or both!), students need to identify a good scale for their set models.
2. (Optional) Watch the video shown in the Useful links below (4'35").
3. Students form small teams. Discuss what STEM roles might be involved in scale set design: production designer, set designer, model maker, production engineer etc. Students can take on these roles if they wish.
4. Review scale and proportion, for example if people are ¼ normal size, students would need set items at 4:1 scale. If they have grown to twice normal size, they will need set elements at 1:2 scale.
5. In teams, students decide how much their characters have grown or shrunk (or agree as a group, so every model is to the same scale). Teams choose an object to model. They measure it carefully and sketch a plan with the correct scale dimensions.
6. Teams model their object out of card or create a model using a 3D CAD program.
7. Teams present their scale models and compare how they look together.
8. If time permits and equipment is available, students can shoot some brief test footage on their phones or school tablets.

continued over...

STEM CLUBS

NUMBER 1 FOR STEM

DIFFERENTIATION IDEAS

Support: Choose objects with a simple shape, and a simple scale like 1:2 or 10:1. Students work in pairs.

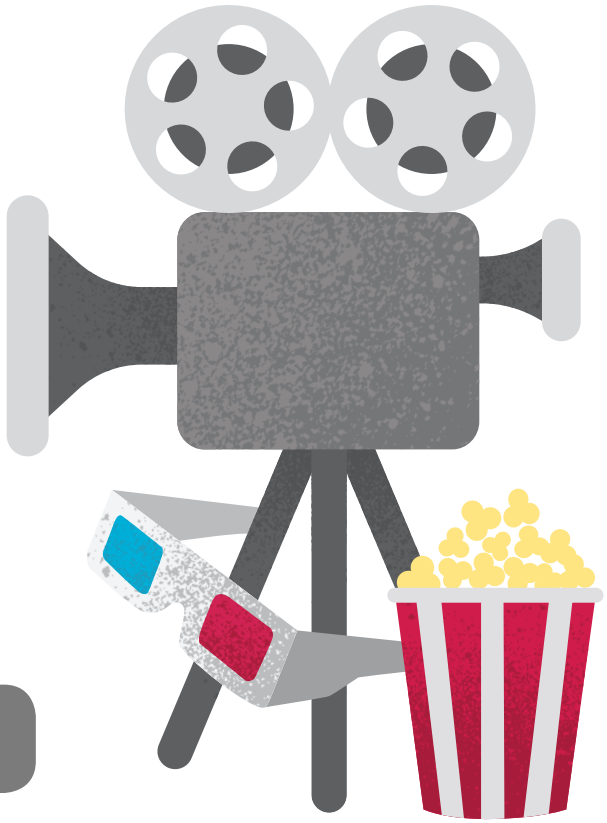
Challenge: Students can work in larger groups on a more complex object, sharing the tasks.

EXTENSION IDEAS

1. Students could consider how to make textile objects to scale, like a pencil case or item of clothing, thinking about how the texture, thickness or flexibility need to change.
2. Teams can complete their scale models in more detail, adding colour, finishes, etc.
3. Explore scale motion by filming students' objects falling over and then changing the playback rate in video editing software. (Filmmakers multiply their normal frame rate of 24 by the square root of the scale they are working at. For example, a 1:48 scale miniature would be filmed at 166 frames per second (6.9 x 24), to approximate realistic motion under gravity.)

TIPS

- Agree a scale for all teams to use if you'd like students to build a 'set' by combining their objects.
- Explain that students need to work rapidly to create a simple version of their object, and not get hung up on details.



USEFUL LINKS

Lord of the Rings 'bigatures'

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How do they make movies?

6 Scale sets

Your challenge

You're designing the set for a movie being filmed in your school. Thanks to a mystery accident in your science labs, the main characters have grown – or shrunk! You need to recreate some key objects from your lab to begin modelling a realistic set and props.

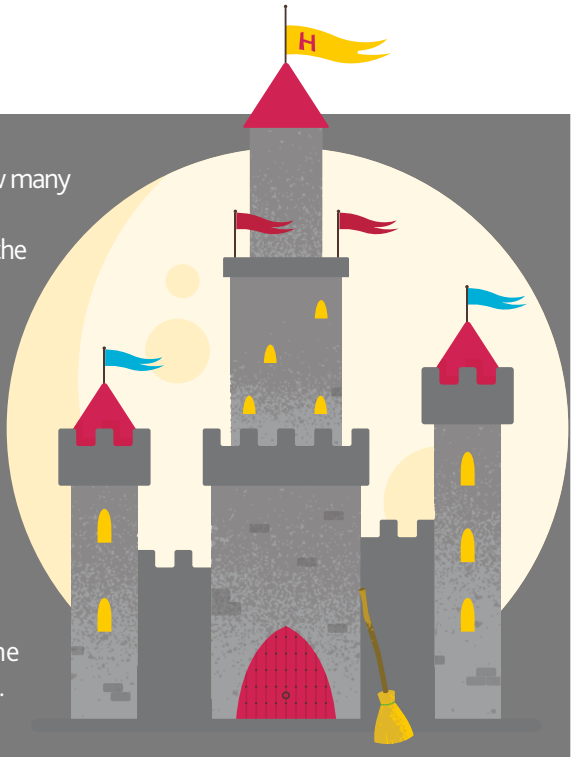
Measure and recreate at scale something from your STEM Club location to use as a movie prop.

WHAT YOU NEED TO DO

1. Decide what happened to the students in your movie! Did they grow or shrink? By how much? Identify the correct scale for your model.
2. Choose what scale model you'll create. Measure the object carefully and sketch a scale diagram to follow.
3. Work together to carefully make your scale model. Don't get hung up on too many details: it's more important to get the overall shape and size correct.
4. Present your model and see how it looks alongside what other teams have created.
5. If you have time, shoot some test footage with your models!

FUN FACTS

1. Filmmakers have to change the frame rate (how many frames are shot per second) when working with moving models that are affected by gravity, so the motion looks accurate. To find the right frame rate for your scale, multiply the normal frame rate of 24 by the square root of the scale you are working. For example, a 1:48 scale miniature would be filmed at 166 frames per second (6.9 x 24), to create realistic motion.
2. Some models are huge! The model Hogwarts used in the Harry Potter films is 15 metres across and includes 2,500 fibre optic lights. Some of the model buildings made by WETA for the Lord of the Rings movies are as much as 9 metres tall. WETA calls them 'bigatures'.



STEM CLUBS

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How do they make movies?

7 Action apparel

Objective

Students develop specifications for a textile superhero costume, thinking about comfort during 'action' shots, heat management and visual impact. They review possible material options before creating design sketches and a character mood board. Students can make a sample section or complete design as an extension activity.

TOPIC LINKS

Design and technology: textiles, design, properties of materials

TIME

60 minutes

RESOURCES AND PREPARATION

- a range of fabrics that offer different functional performance: stretch, opacity, weight, texture, breathability
- paper and pens for design sketches
- A4 card and glue to create a character mood board
- tools and equipment to optionally begin to make a sample of the suit design
- optional internet access for research

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

DELIVERY

1. Introduce the scenario: great costumes help to bring movie characters to life on screen, especially action or superheroes. But those costumes can't just look good: they need to perform well for the actors who must wear them for long periods, sometimes performing difficult and strenuous activities on camera.
2. Students form small teams. Discuss some possible roles that might help design and create a character costume: costume designers, prop designers, fabricators, machine operators, visual designers etc. Students can take on these roles if they wish.
3. In their teams, students identify how costume textiles need to perform, e.g. they need to be stretchy, breathable, tough, sweat resistant, able to be decorated, etc. They share ideas and can suggest suitable textiles that meet these criteria. Clarify that any costume will combine a range of textiles with different properties.
4. Teams create a character and sketch a suitable costume design at the centre of what will become their character's 'mood board'. Using the range of sample textiles, teams identify a suitable textile for each part of their design. They add textile samples to their mood board and label it with their ideas and justifications.
5. Teams present their character and mood board, justifying their textile choices in terms of each textile's functional characteristics for use on set.

DIFFERENTIATION IDEAS

Support: Simplify the brief to focus on one element of a costume, like a top or mask.

Challenge: Ask teams to identify the right way to cut and join textiles, for example for strength or to avoid seams that chafe during use.

TIPS

- Include a discussion of how characters with STEM-related jobs or female action or superheroes are portrayed on screen.
- Students can use their costume designs to challenge what they feel are negative stereotypes.
- When teams present, ask other students to act 'in role' as actors and ask questions about what the costume will be like to put on, wear, perform in etc.

EXTENSION IDEAS

1. Students use the suggested link, and their own research, to find out more about how costumes are designed for films and TV.
2. Students develop their designs more fully, identifying how to join different materials and how to allow it to be put on and off using zips, poppers etc.
3. Students could plan and make their design, cutting patterns and fabricating their costumes.
4. Students could explore how to create waterproof joins.

USEFUL LINKS

Fashionista: superhero costume design

STUDENT GUIDE: SUITABLE FOR AGE 11-14

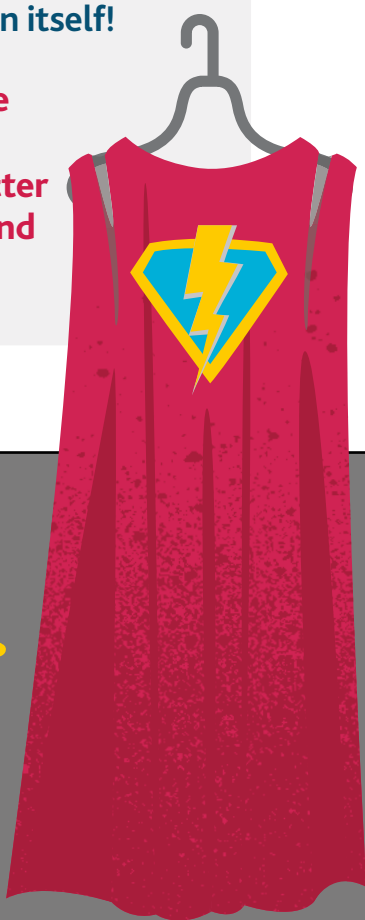
How do they make movies?

7 Action apparel

Your challenge

Designing a superhero costume is no easy task: the designers and makers must produce something that looks great on screen and works well when worn on set – a superhero task in itself!

Design a costume for an action or superhero character that will look – and perform – great.



WHAT YOU NEED TO DO

1. Think of how a costume needs to perform on set. What might it be like to put on or off, to wait in and to perform action stunts? Develop a list of simple requirements for materials.
2. Sketch a character and create a mood board that showcases your design and textile choices.
   - **a.** How does your costume design reflect the character's role and personality?
   - **b.** How does each element of the costume need to perform?
   - **c.** What textile will you use for each element?
   - **d.** How will you join textile sections together so the costume is strong and comfortable?
3. Present your mood board and justify your ideas, explaining what textiles you have chosen and why. You need to 'sell' your design to the director and the actor who will wear it!

To find out more visit Fashionista: superhero costume design or search for ideas.

FUN FACTS

1. Many costumes are digitally screen printed with patterns and 3D textures to create an illusion. Captain America's suit in Captain America: The Winter Soldier looks thick and heavy-duty but is actually a stretch fabric that was easy for Chris Evans to perform in on set.
2. As many as 20 or 30 identical costumes are sometimes produced for key movie characters due to how often they are damaged during filming – and not just in action movies!
3. Sky Movies customers voted Keira Knightley's green dress in Atonement the best movie costume of all time.

STEM CLUBS

NUMBER 1 FOR STEM

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How do they make movies?

8 Steady shots

Objective

Students create a super simple steady cam and shoot test footage to see how even a simple system can smooth and control moving camera shots.

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity. Safety goggles should be worn.

TOPIC LINKS

- Design and technology: creating a working prototype
- Physics: mass, inertia

TIME

60 minutes

RESOURCES AND PREPARATION

Each small group will need:

- 15 x 60cm thick corrugated card (cut so the corrugation tubes go along the length)
- a milk bottle cap
- double-sided tape
- 2 x ~6cm strong rubber bands
- ~80cm screw or nail (optional – does not need to be sharp)
- a ruler, craft knife, pair of scissors and craft mat
- sticky tack or masses (about 60–90g)
- optional: old smartphone or other small camera or action camera

You may wish to build a test version yourself before delivery. Adapt to suit smartphones, a small school camera or an action camera with sticky mount, or use wood to create 'dummy' phones to test each rig.

DELIVERY

1. Introduce the scenario: lots of movies use Steadicam shots to track the characters as they move and to add interest and drama. Could students capture similar shots using a phone camera and a few bits of cardboard?
2. Students form pairs or threes. Discuss what STEM roles might contribute to developing and using Steadicam shots in movies and TV, for example: mechanical engineer, electrical engineer, designer, cinematographer, camera operator, camera technician etc. Students can take on these roles if they wish.
3. Guide students through the process to make their simple Steadicams using the Student guide. Teams should split the work and find ways to complete steps or tasks at the same time where possible. Ensure students put both rubber bands on the horizontal part before slotting it into the two vertical parts – essential so it holds a phone in place.
4. Review the design. The milk bottle cap acts as a pivot for the Steadicam when a screw is held and placed in the centre of the cap (students can use a finger but this won't pivot as easily). Discus how the phone creates a turning moment about this pivot. How can students create a second turning moment to balance their rig? (Students can add mass at the bottom of the rig. This also increases inertia – the rig's resistance to movement when the person moves.)
5. Teams practise using their Steadicams without a phone. They can lightly touch or hold the longer side of the horizontal support, to gently control the motion.
6. Only if you have a soft surface like soft grass or gym mats to walk over, students can, if they wish, attach their phone to the holder and take test footage, walking slowly.

continued over...

STEM CLUBS

NUMBER 1 FOR STEM

TIPS

- Students use their own phones at their own risk and must take care to move slowly and carefully (this also ensures a better shot).
- Ensure students make thin cuts for the slots that hold the vertical and horizontal parts together.
- The vertical slots for a phone should be just narrower, for a tight fit.
- Ensure students put both rubber bands on the horizontal part before slotting it into the two vertical parts – essential so it holds a phone or camera safely in place.
- Test the steady cams over gym mats, outside on dry grass or other soft surface.

DIFFERENTIATION IDEAS

Support: Pre-cut cardboard to length. Make and demonstrate a sample for students to copy. Have a technician or older helpers available.

Challenge: Ask students to think of how they would improve the design.

EXTENSION IDEAS

1. Students can design and 3D print a plastic phone or camera holder for the top of their Steadicam.
2. Once they are used to using the system teams could plan and film a longer tracking shot following a student around the school or other location.

USEFUL LINKS

- What is motion capture?
- Example motion capture marker locations (using more than 20 markers)

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How do they make movies?

8 Steady shots

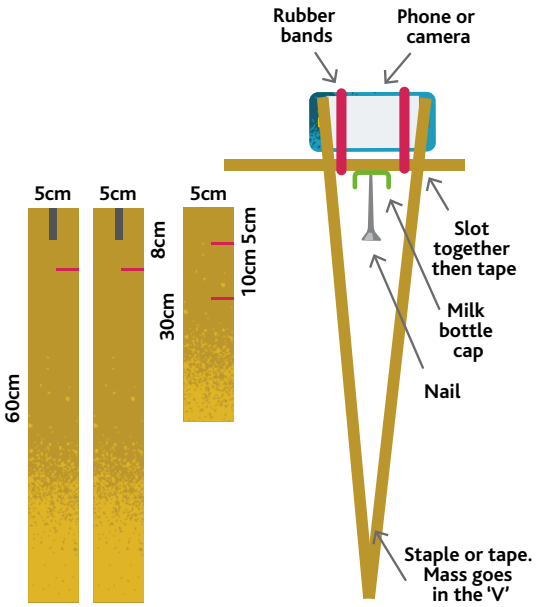
Your challenge

Steadicams create dramatic but smooth moving shots. What moving shots could bring your own movie ideas to life?

Build a super simple Steadicam for a camera phone and film some test footage.

WHAT YOU NEED TO DO

1. Cut the three main parts from card.
2. Cut a thin slot in each long part, 8cm down one side and halfway across.
3. Cut two thin slots in the short part, halfway across: one 5cm from the end and the other another 10cm away.
4. Cut two slots about 5cm deep in the middle of the top of each long part. These should be a little narrower than a phone, so it fits tightly.
5. Put the two rubber bands over the short part. Slot this into the two long parts. Make sure the rubber bands are in the middle – they will hold a phone in place. Tape the parts together.
6. Staple or tape the two long parts together at the bottom. Tape a 50 – 80g mass in the bottom 'V' (adjust this later for balance).
7. Using double-sided tape, stick the milk bottle cap in the middle of the underside of the horizontal part.
8. Place the tip of a nail or screw, or just your finger, in the milk cap. This creates a simple gimbal that lets your Steadicam move freely.
9. Practise walking around with your Steadicam. You can lightly touch the horizontal 'handle' to control its holder's movement.
10. If you wish, use rubber bands to secure your phone to the camera holder. Over soft ground only, plan and shoot a brief clip to see how well you can control the camera to create a smooth shot as you move slowly.
11. Test your steady cam over a soft surface
12. Present your Steadicam shot to the group!



FUN FACTS

1. Adding mass to the bottom of your Steadicam also adds to the system's inertia. That is, its resistance to changes in motion.
2. Motorised gimbals use inertial sensors to measure changes of direction, and servo motors to move the gimbal the opposite way. This provides automatic camera stabilisation for drones and other camera systems.

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How do they make movies?

9 Foley fun

Objective

Students use a range of everyday objects and some simple sound processing to discover the range of Foley sound effects they can create.

HEALTH AND SAFETY:

A suitable risk assessment using guidance from CLEAPSS and SERCC should be written and adhered to for this activity.

TOPIC LINKS

Physics: sound

TIME

60 minutes

RESOURCES AND PREPARATION

- audio software such as Audacity (free and suitable for Windows, Mac OS and Linux).
- microphones

Items to use could include:

- cellophane
- rice
- straws
- water
- cups
- corn flakes or puffed rice cereal
- fabrics

DELIVERY

1. Introduce the scenario: students are producing a movie and want to include some great sound effects that will add to the drama and help bring their story to life.
2. Students form teams. Discuss what STEM roles might work on a movie's sound: recording engineer, sound designer, Foley (sound effect) artist, etc. Students can take on these roles if they wish.
3. Together, create a brief storyline: allow the first team to suggest something simple that happens in the movie that might lead to dramatic consequences, for example 'they open a door'. Then let the other teams take turns to suggest what happens next. Write each suggestion in a list on your board. Explain that each team needs to create one or more of the sounds that would accompany their part of the storyline.
4. Explain that sound effects are often a combination of physical effects that are recorded, and sound processing to alter their pitch or other qualities. Show students the items and review the key elements of the software. Link these to wavelength, frequency and intensity.
5. Teams use the items, plus their voices and anything else they can use from your STEM Club location, to record some basic sounds. They use Audacity (or your preferred software) to process the sound, varying its pitch, adding reverb or echo, or layering sounds by adding new tracks.

6. While one student (or yourself) narrates, using your list to guide them, teams take turns to play their sound effect.
7. Give teams time to explain how they created their sound, thinking in terms of how they have altered the sound's wavelength, frequency or intensity using the software. You could vote on which one students think is best or most realistic.

DIFFERENTIATION IDEAS

Support: Assign a simpler sound and suggest items to use, like dropping rice on a table to create the sound of rain, which students can process in Audacity. Some students may prefer to stick with producing physical sounds.

Challenge: Ask students to create a complex sound that combines different sounds in layers.

EXTENSION IDEAS

1. Film a video clip of students walking around the room performing simple tasks, or a short piece of scripted drama. Students re-record the sounds using their new Foley skills.
2. Research how real Foley artists have created sounds for famous movies and TV shows.
3. Students could create their own sound bank of saved audio files to use as Foley sounds in future videos or live school performances.

TIPS

- Keep things simple and don't let students get too ambitious. It's best if each team focuses on just one or two sounds.
- When using Audacity students can:
  - Use the 'Effect' menu bar item to choose and control effects, like echo and reverb
  - Change the speed and pitch by choosing 'Effect' > 'Change speed' or 'Change pitch'
  - Remove unwanted silence by highlighting that part of the track then using the 'cut' scissors button
  - Play their sound backwards using 'Effect' > 'Reverse'
  - Add a new track using 'Tracks' > 'Add new...' to overlay more than one sound

USEFUL LINKS

Audacity free audio processing software for Windows, Mac OS and Linux

STUDENT GUIDE: SUITABLE FOR AGE 11-14

How do they make movies?

9 Foley fun

Your challenge

Sound effects really bring a movie to life and even everyday sounds like rain or walking are added to a soundtrack for maximum effect. But how much drama could you create using everyday items – just like real Foley artists do?

Create some dramatic sound effects to use in a movie!

WHAT YOU NEED TO DO

1. Contribute one idea to the simple storyline for which you'll create sound effects – the more dramatic, the better!
2. Explore the items you can use to make a sound. Often, the best sounds come from items that have nothing to do with what's making that sound. For example, crumpling cellophane sounds just like a fire! What items can you use as the starting point for your sound?
3. You may be able to record and process your sounds using software like Audacity:
   - **a.** Make a recording of your sound. Once you're happy with it, use the scissors tool to trim off any gaps at the start of end of your recording.
   - **b.** Try changing the pitch or speed until it sounds more realistic.
   - **c.** Add reverb, echo or another effect for more drama. You could even reverse your recording!
   - **d.** Practise using your sound to create the effect you want.
4. As someone narrates the action, play your sound to bring the action to life.
5. Explain how you created your sound. Which sound effect is the best?

FUN FACTS

1. Sound effects are known as 'Foley' sounds after Jack Foley, a sound effect artist at Universal Studios in the 1950s who created many of the techniques still used today.
2. Our brains are wired to connect sounds with emotions. Dragging nails down a blackboard or wall is so annoying because the sounds are in the frequency range our ears are most sensitive to: 2000–4000 Hz.
3. Movie and videogame soundtracks are carefully designed to produce the right emotions by using tempos, beats and melodies that make us happy, sad, excited and more.
4. The Wilhelm Scream is a sound recording that's been used in over 360 movies since the 1950s, including every Star Wars film. For directors and sound designers, as well as some movie buffs, it's a popular 'in joke' to listen out for.

Worksheet

Notes

CLUB LEADER GUIDE: SUITABLE FOR AGE 11-14

How do they make movies?

10 Get CREST Discovery Awards

By completing all nine activities in this resource pack, your STEM Club members can get a CREST Discovery Award.

ABOUT CREST

CREST is a scheme that inspires young people to think and behave like scientists and engineers. It is student-led, flexible and trusted. CREST helps young people become independent and reflective learners. With no set timetable, projects can start whenever you want, and take as long as you need.

HOW TO GET YOUR CREST DISCOVERY AWARDS

It's easy to get your members' Discovery Awards, simply:

1. Sign-up for a free account - https://my.crestawards.org/
2. Have each member complete a CREST Awards Discovery Passport
3. Create a project eg. "How do they make movies", "Movie music" or "Witchcraft and wizardry"
4. Upload names
5. Upload two or three passports and any accompanying work
6. Assess individuals, have they:
   a. Completed around five hours of work on the project?
   b. Participated fully in the project?
   c. Reflected on their learning?
7. Type in your delivery and payment details.

TAKING THEIR WORK FURTHER

If members want to take activities further, they can work towards a CREST Bronze or Silver Award.

CREST Bronze Awards require around ten hours of enquiry, project-based work, and Silver Awards require thirty hours of work at GCSE or equivalent standard. Using one of the activities for inspiration, they choose a question or topic to investigate.

Guidance on how to run CREST Bronze and Silver Award projects is available on the CREST Awards website www.crestawards.org.

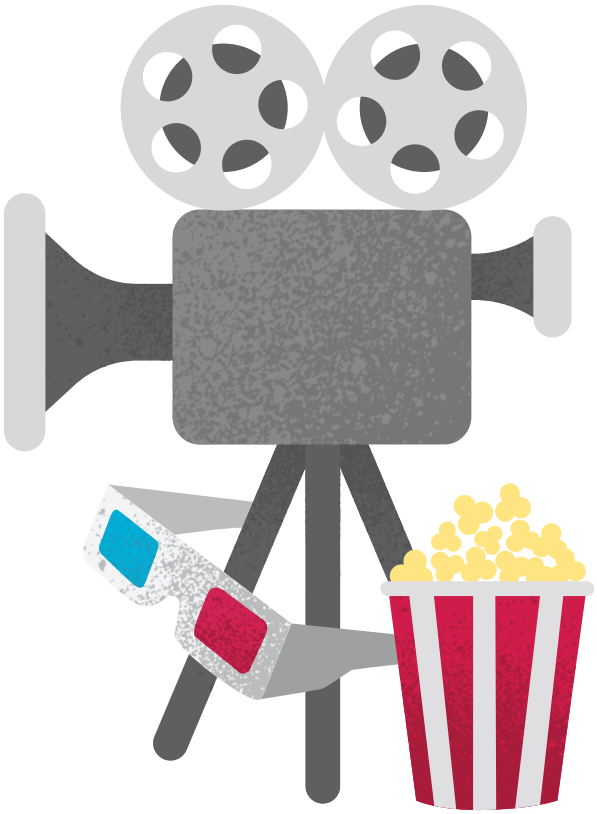
Notes

STEM CLUBS

NUMBER 1 FOR STEM

STEM Clubs Programme, led by STEM Learning

Achieving world-leading STEM education for all young people across the UK.



For more information on the programmes and publications available from STEM Learning, visit our website **www.stem.org.uk**