Lesson: Running Towards Change

By Tara Jacklin, 2024 Nobleman Scholar

This lesson is inspired by the *History Bits* video "Marathon of Hope."

Grade Level: 3/4, 5/6, 7/8

Themes:

- Arts, Sports & Culture
- Industry, Invention & Technology
- Other: Disability Studies

Subject Area: Social Studies/History

Lesson Overview:

Using the *History Bits* video, "Marathon of Hope," students will learn about Terry Fox. With supplementary index cards, students will also explore the history and development of lower limb prostheses.

Time Required: 1-2 class periods

Historical Thinking Concepts:

- Identify *continuity and change*
- Analyze *cause and consequence*
- Take *historical perspectives*

Learning Outcomes:

Students will:

- Compare and contrast different models of prostheses and explore changes over time.
- Assess the advantages and disadvantages of different types of prostheses.
- Analyze and explain the effects of different historical events on the development of prostheses.

Lesson Activity:

BEFORE THE VIDEO

We recommend doing some pre-activities to introduce the historical thinking concepts used in the main activity (see **Appendix I** for more background information on prostheses and Terry Fox.).

- Introduce vocabulary:
    - **Amputee** – a person who has had all or part of a limb removed (amputated) or is born without a limb.
    - **Prosthesis** – an artificial substitute for a body part that is missing. The plural form is prostheses.
    - **Prosthetics** – the field of research and expertise in designing and building artificial limbs. The term prosthetic can also be used as an adjective (example: prosthetic limbs).
    - **Residual limb** – the remaining part of the limb after amputation.
    - **Socket** – the part of the prosthesis into which a residual limb will fit.
- Lessons corresponding to *Kayak*'s DisAbility issue: Consider these to facilitate best conduct when discussing disability in the classroom. It is important to steer students away from words such as "normal" and "weird." These words promote isolation and exclusion.
- Introduce a discussion about why someone might need a prosthetic limb. An estimated 227,000 Canadians have an amputation of a limb or extremity. Amputation may be required as a result of a disease such as cancer, or because of an accident or injury. People can also be born without a limb, a condition called congenital limb difference.
- Explain to students that the decision to wear a prosthetic is personal and that some amputees may choose not to wear such a device.

WATCH THE VIDEO

Watch the *History Bits* video "Marathon of Hope." Ask students to pay attention to Terry Fox's prosthesis. Why did Fox undergo amputation? How was his life different and the same after the amputation? For what activities did he wear a prosthesis, and how were those activities impacted?

AFTER THE VIDEO

This activity features the use of index cards (**Appendix II**), which are provided. The prosthesis cards feature facts and images for different prostheses over time. The context cards provide information about historical events that have influenced the development of prostheses. These cards can be used in various ways, but the aim is to promote discussion.

Listed below are some conversations that can be prompted by the cards, organized around specific historical thinking concepts:

- **Identify continuity and change** – Have students organize the prostheses along a timeline and discuss how the technology has developed.
    - How do materials used in prostheses change over time?
    - When do we see the most changes taking place? When do we see the fewest changes taking place?
    - How has the way prostheses work changed over time? How has it stayed the same?
- **Analyze cause and consequence** – Introduce the context cards and have students discuss how world events have influenced the development of prostheses (*Note: not every prosthesis card has a corresponding context card*). Have students consider:
    - Why would war prompt the development of new prostheses? (The comic "Beyond War" in the DisAbility issue of *Kayak* can help students understand some of the injuries soldiers experienced during war.)
    - How did new technology and materials affect the development of prostheses? How did these changes affect users?
- **Take historical perspectives** – Assign groups of students a prosthesis card. Have each group consider the time period and context for their card, then create a pro/con list for their prosthesis and present their thoughts to the class. Ask students to consider:
    - What does the prosthesis allow users to do?
    - How do the materials affect the prosthesis and the user experience? Are they more comfortable? Stronger?
    - How much does the prosthesis cost? Why is it that price?
    - Have students arrange the prostheses cards on a scale from purely functional to purely aesthetic (i.e. how they operate vs. how they look). They will likely arrange them in different ways. Have them discuss why.

Additional Resources:

Disability

- "Teaching about Disability in Your Classroom," Canada's History.
- DisAbility issue (September 2022) of *Kayak: Canada's History Magazine for Kids*.

Terry Fox's Prostheses

- "Terry Fox Anniversary," CBC Archives.
    - Interview with Terry Fox and Doug Aylward by CBC's Joe Mullins (2:27 – initially learning how to use the prosthesis; 3:45 – problems with leg during the run)
- "Terry Fox and the Development of Running Prostheses," The Canadian Encyclopedia.

About Prostheses

- "Being an amputee. DO I HAVE A PROSTHETIC LEG?" Pnina Ullrich, YouTube.
- "The Basics of a Below-knee Prosthetic Leg," Adaptable, YouTube.
- "Our War Amputee Members," The War Amps.

Why not a Prosthesis?

This lesson has focused on prosthetic limbs and why people choose to use them. But some amputees choose not to! Below are some amputees discussing that choice.

- "Why dont you wear an artificial Leg?" @iamtylersaunders, Instagram.
- "MY PROSTHETIC ARM: Living with One Hand," Kelsey Ryan Hartman, YouTube.
- "Why I Don't Wear A Prosthetic Arm: The Real Reason," Living With One Hand, YouTube.

Appendix I: Teacher's Notes

Overview of Terry Fox

In 1977, Terry Fox was diagnosed with osteogenic sarcoma (bone cancer). His right leg was amputated above the knee to prevent the cancer from spreading. Prior to his surgery, his high school basketball coach gave him an article on Dick Traum, the first amputee to run the New York City Marathon with a prosthesis. Traum was the inspiration for Fox's Marathon of Hope.

Terry Fox began the Marathon of Hope in St. John's, Newfoundland and Labrador, on April 12, 1980. His goal was to run across Canada to raise money for cancer research; he had an ambitious goal of raising one dollar for every Canadian. He ran 5,373 km in 143 days – an average of 42 km per day. He was forced to stop his run in Thunder Bay, Ontario, on September 1, 1980; his cancer had returned and infected his lungs.

Terry Fox died on June 28, 1981. His unfinished run has inspired Canadians to continue in his name. To date, more than $850 million has been raised for cancer research through the annual Terry Fox Run.

An Overview of Prostheses

There are many types of prostheses, including prosthetic limbs, cochlear implants, or replacement hip joints.

The purpose of prosthetics has changed with time and prosthetic legs, in particular, can vary widely in design. Some, like the Shengjindian leg, prioritize function over appearance. There is no attempt to hide the prosthesis. Others, like the Anglesey leg, are crafted to closely resemble a natural limb, focusing on appearance at the cost of some functionality.

The decision to wear a prosthesis, and if so, which type, is personal and reflects an individual's needs, priorities, and values. For example, a lot of American Civil War veterans were known to refuse a prosthesis. A "pinned sleeve" showed the wearer had lost a limb, suggesting bravery and sacrifice, something they did not want to hide for the sake of appearing "normal."

In modern times, the prosthetics industry focuses on user functionality and comfort. This has led to the development of body-powered devices, which activate when the user physically moves the prosthesis. Finally, there are myoelectric devices, which are powered by more subtle signals such as muscle movement. These can be used both in regular prostheses or activity-specific prostheses such as running blades.

Terry Fox's Prostheses

Fox worked with prosthetist Ben Speicher to try to design a prosthesis that would work for running. There were two main problems to overcome: how to make the prosthetic move fast enough for a run, and how to have it absorb the increased shock that comes with moving fast.

Image credit: Canadian Museum of History / 2017.3.2, 2017.3.1, 2017.3.3

Above are three of Fox's prosthetics that are now in the Canadian Museum of History's collection. The one on the left was an initial design in 1979, which absorbed shock like a pogo stick. That design was eventually abandoned.

The team ultimately came up with the prosthesis in the centre, which Fox used after 1979 until his death. This was the prosthesis he used to run the Marathon of Hope. It did not absorb shock very well, and had to be kept straight when running. The elastic on the front helped pull the leg forward, but most of the power came from Fox's hip muscles. This resulted in a fairly slow "swing phase." Fox's characteristic "hop and skip" gait was a result of him accommodating for this slow phase, though the gait did help absorb some of the shock of running.

Given these challenges, the War Amputations of Canada consulted Guy Martel, head of prosthetics and orthopedics at Chedoke-McMaster Hospital. This resulted in the prosthesis shown on the right, which was not completed until 1984, three years after Fox's death. This model featured a knee joint, spring-loaded mechanism within the calf, and pneumatic shock absorbers to improve the running motion and better emulate a living leg. This would have eliminated the need for Fox's hop and skip.

Today, professional athletes use prosthetics made of stronger but lighter materials. In 1984, American inventor Van Phillips developed the first running blade. Instead of trying to design a prosthesis that resembles a human leg, he focused on designing a prosthesis that replicated what a human leg does. A running blade helps absorb shock, stores that energy, and then releases it to provide forward momentum. While Terry Fox's running prosthesis weighed 4 kg, a modern equivalent weighs around 2 kg.

Cheat Sheet for Index Cards

Context Card(s)	***Prosthesis Card***	***Details***
First and Second Industrial Revolution	Hydraulic Leg Hanger Limb Anglesey	The industrial revolution inspired inventors. They built on other improvements. They used materials and methods used in industry.
American Civil War	Hanger Limb Anglesey	Several improvements were directly linked to trying to improve the lives of veterans. An unprecedented huge loss of limbs among soldiers, coupled with the public's patriotism led to a desire to create new prosthetics.
World Wars	Stabilex Anglesey	
Rubber Boom	Hanger Limb Jaipur Foot	The entry of rubber into European industry spurred innovation. The meeting of rubber and Indian culture led to a prosthesis which would meet the unique expectations of that culture.
Aerospace Developments	Professional Runner Blade	Carbon fibre was invented before space travel but the aerospace industry's improvements have trickled down into the construction of prosthetics.
Terry Fox's Marathon of Hope	Terry Fox's Prosthesis Professional Runner Blade	See above in **Terry Fox's Prostheses**
Digital Age	Microprocessor leg 3D-printed	The digital age sees both the most expensive prosthetic technology and the most democratized. Microprocessor limbs are becoming increasingly responsive, though they are not yet as advanced as science fiction portrays. Meanwhile 3D-printed limbs are increasingly becoming freely available to download and print.

Prices of Modern Prostheses

The relative price of the prostheses on the index cards are represented by one to three dollar signs. Historic prices are very different from modern day, especially from periods without standard currency. Therefore, the dollar signs represent the affordability of that particular model at the time. Fewer dollar signs would be more affordable, while more dollar signs would be more expensive.

Name	***Estimated Cost (USD)***
Jaipur Foot	$40
Microprocessor Leg (also called myoelectric)	$20,000-$70,000
Professional Runner Blade	$20,000+
3D-printed	$50-$2,000
Hydraulic Leg	$10,000-$40,000

War Amputation Statistics

- **American Civil War:** Although the exact number is not known, about three quarters of all of the operations performed during the war were amputations (approximately 60,000 surgeries). Source
- **First World War:** During the First World War, more than 172,000 Canadians were wounded. Of the wounded who survived, 3,461 men and one woman had a limb amputated. Source
- **Second World War:** Of the soldiers in the U.S. Army wounded in action during the Second World War, about 15,000 (2.5%) required major amputations. Source

Appendix II: Index Cards

Jaipur Foot

The Jaipur foot was made to help people in India do everyday things like sitting cross-legged. It is waterproof, so it works well in muddy and wet areas of India. It can also be made quickly with local materials. You can even paint the toenails!

$ | 1975 | Rubber, plastic

Courtesy of Nadya Peek through Wikimedia Commons.

Microprocessor Leg (also called myoelectric)

Some prosthetic legs have computer parts inside them. These sensors (called microprocessors) help to ensure that the prosthetic moves to match the user's movements. This means that users don't have to control the leg themselves.

$$$ | 1997 | Plastic, electronics, metal, rubber

Courtesy of US Army through Wikimedia Commons.

Terry Fox's Prosthesis

The prosthesis Terry Fox used during the Marathon of Hope was not designed for running or for so much use. He had to keep his prosthesis straight and wait for it to swing in front of him, causing his unusual "hop and skip" gait. He was worried he would wear out his prosthesis on his marathon. He travelled with several backups in case one broke down.

$$ | 1981 | Fibreglass

Courtesy of the Canadian Museum of History / 2017.3.1.

Professional Runner Blade

While a running blade doesn't look like a human leg, it works like one. A running blade takes the power of the runner pushing down on the ground and releases it up and forward. Running blades are made from carbon fibre, a very strong material that can handle the constant up-and-down movements.

$$$ | 1984 | Carbon fibre

Courtesy of US Army through Wikimedia Commons.

Shengjindian Leg

This prosthesis was buried with the body of its user, around 2300 years ago. This wooden leg had leather straps to tie it to the user's thigh. The horse hoof at the bottom of the leg would help grip the ground. The strap left marks on the wood. These wear-marks mean the leg was well-used.

$ | Circa 300 BCE | Wood, horse hoof

Courtesy of Turpan Museum and HaziiDozen through Wikimedia Commons.

Capua Leg

Before modern medicine, people usually died after losing a limb. This is an example of an unusually old prosthetic leg. It dates to Roman times. The use of brass on the outside was likely to mimic skin colour as brass polished to a metallic tan colour.

$$ | Circa 300 BCE | Plaster, brass

Courtesy of Science Museum Group / A646752.

Wooden Leg

This was a very basic prosthesis. It did the job and was cheaper than one that looked more like a human leg. Many amputees said this type of prosthesis was better for walking than the more realistic-looking ones.

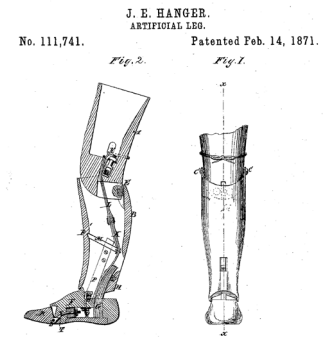
$ | Circa 1800s | Wood

Courtesy of Science Museum Group / A205286/2.

Hanger Limb

James E. Hanger was one of the first soldiers who had a leg amputated in the American Civil War. He designed his own prosthesis and created a prosthetics company that still exists today. Hanger replaced some of the wooden and metal parts of the Anglesey leg with rubber. This cushioning made it more comfortable.

$$ | 1871 | Wood, rubber

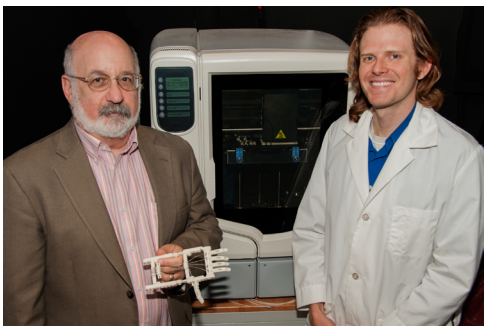

J. E. HANGER.
ARTIFICIAL LEG.
No. 111,741. Patented Feb. 14, 1871.
Fig. 2. Fig. 1.

Courtesy of US Patent US111741A.

3D-printed

3D printing is affordable and easy to use. The stronger the plastic used, the more expensive the prosthesis will be.

$ | 2008 | Plastic



Courtesy of Food and Drug Administration through Wikimedia Commons.

Hydraulic Leg

Hydraulic technology uses pressure and liquids to transfer forces. The hydraulics inside help bend the leg, meaning less work is done by the user. The outside of the limb is plastic, making it lightweight for the wearer.

$$ | 1961 | Plastic, metal

Courtesy of Science Museum Group / 10683179.

Stabilex

Prosthetics for soldiers who lost a leg in the Second World War were made of light metal. The limb stays straight until the user puts pressure on the toes, which causes the leg to bend.

$$ | 1946 | Metal, wood, leather

Courtesy of Science Museum Group / 1981-1709.

Anglesey

The first prosthetic to bend like a human leg was created in 1815. This type of limb uses strings inside the leg to control when it bends. The model shown is from sometime between 1915 and 1925. Artificial legs from this time were usually wooden.

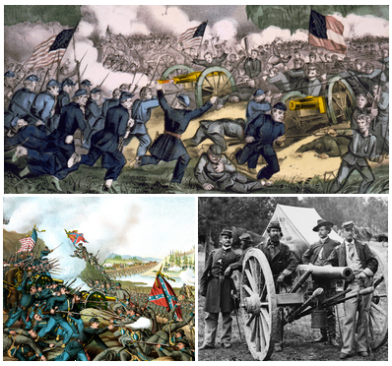
$$ | 1815 | Wood

Courtesy of Science Museum Group / 1999-444.

American Civil War

1861-1865

The **American Civil War** was fought between the Northern (the Union) and Southern (the Confederacy) states in the United States of America. Huge numbers of soldiers were wounded in battle. Medical care was much worse than it is now. About 60,000 men underwent amputations (one in thirteen soldiers) during the war.



Courtesy of Excel23 through Wikimedia Commons.

World Wars

1914-1918; 1939-1945

In the **First World War**, over 30 nations fought with 60 million soldiers deployed. Of the 138,000 Canadians wounded in battle in the First World War, 3,461 men and one woman had a limb amputated. As medical care and surgery improved and soldiers could be transported faster, more of them survived amputations.

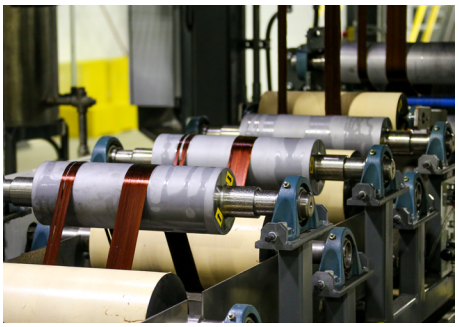
The **Second World War** saw just as many amputations, with more than fifty nations in the world fighting, and more than 100 million soldiers deployed.

Courtesy of Library and Archives Canada / 4113911.

Aerospace Developments

1950s onwards

Materials used in space exploration need to be strong and lightweight. Carbon fibre was originally made for cars and later used for airplanes and eventually spacecraft. Better computer technology from the space industry has also helped make better prostheses.

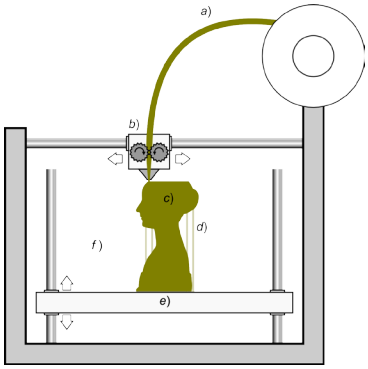


Courtesy of Oak Ridge National Laboratory through Wikimedia Commons.

Digital Age

1970s onwards

We are living in the **digital age**, a time when storing information became more important than making items you can touch. With modern computers, phones, and the internet, we can easily and instantly send information.



Courtesy of DOI:10.1111/cgf.12781.

First and Second Industrial Revolution

1760-1914

For most of history, humans made things by hand. The **Industrial Revolution** saw the creation of machines that took over this work. Steam power and later electricity allowed factories to make more things faster. Eventually, machines produced huge numbers of things at once, called mass production. Industry started using people to work on assembly lines, where they put together one part each to create a finished item.

Courtesy of Robert Stieler, BASF Werk Ludwigshafen.

Rubber Boom

1879–1912

Europeans learned about rubber from Indigenous peoples in South America. As Europeans began to see the many ways they could use rubber, they needed more and more of it. They enslaved South American and, later, African people to grow and harvest rubber plants. Eventually, Europeans took seeds to other colonized territories such as India and set up large farms called plantations.

Courtesy of M.arunprasad through Wikimedia Commons.

Terry Fox's Marathon of Hope

1981

Terry Fox's **Marathon of Hope** and the trouble Fox had with his prosthetic leg inspired change. Inventors created a much better model. It had a knee joint, springs, and shock absorbers. If he'd had a leg like that on his run, Fox wouldn't have had to use the tiring "hop and skip" motion. Modern prosthetic legs are much lighter, too. Fox's weighed 4 kg, while a modern one weighs around 2 kg.

Courtesy of Canadian Museum of History / 2017.3.2, 2017.3.1, 2017.3.3.