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