The Chappe Telegraph and Long-distance Communication

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Children are well aware that shouting is an effective long-distance communication technique for talking to friends at the other end of the schoolyard, for instance. Indeed, this is often how children communicate orally at school. However, when they go home, they face quite a different situation. They could write to each other, but letters usually take 24 hours to reach their destination. Hence, this type of communication is not instantaneous. These days, children prefer to use the telephone or the Internet—sending text messages and emails, using online chat rooms and even webcams—to communicate with their friends. In other words, for children, communicating with their friends and other people around them does not pose any particular problems. The techniques available today make such communication possible.

Indeed, the communication techniques available today are so advanced and make the communication process so easy and immediate that students tend to take it for granted. Therefore, it is useful to give students an opportunity to explore the mechanisms that underpin long-distance communication and to get them to think about how they can use simple, readily-available resources to communicate. One way to do this is to set up a series of games, each of which recreates a given communication-related situation. For instance, how do we communicate in a noisy schoolyard? How does the teacher announce the end of recess? How do we reach a friend who is some distance away outdoors? What if the friend is in the next room and we can't see him or her? What happens when you tap on the water pipes that run from the top to the bottom of a house? Finally, students can imagine they are with people who speak a different language than they do, or who can't hear at all—how do the hearing-impaired communicate?

The history of communication

In order to provide a contrast with today's means of communication, and with the ultimate goal of helping students to place Claude Chappe's discovery in its historical context, the teacher can ask the class to research how people communicated before 'telecommunications' were invented.

The class can refer to movies, stories, documentaries and readings from history (such as the Greeks Aeneas and Polybus, for instance) or that describe ancestral customs (such as those of the Native Americans). Humans have been very inventive in their quest to communicate, using smoke signals, torch lights—remember the messenger of Marathon—, musical instruments, bird calls and even drumming on the ground to send messages. Once the students have gathered and summarised this information, the teacher may focus the unit on the 'elements of communication': transmitter, signal and receiver.

In the 1790s, the invention of the telegraph by Chappe revolutionised long-distance communication. Initially, students can get a better understanding of this revolution by looking at a picture of one of the Chappe telegraphs still in existence today or by going to a museum to see an old telegraph (like the one at the Arts et Métiers Museum in Paris). Due to the current revival of cultural and historical programmes, it is now possible to find near many schools ‘stations’—in other words, telegraph towers—that have been refurbished by telegraph enthusiasts.

Once students have exchanged ideas concerning communication techniques, the class may examine the context of communication, which is essential in determining the type of communication system developed. The students will learn that the telegraph was invented during a war—the French Revolution—and that this context sped up the construction of lines and the development of the network. Indeed, at that time—right in the middle of the Convention—French revolutionaries were at war with anti-nationalist and anti-patriotic fighters allied with England, Prussia and Belgium. The Conventionists, in their desire to fight a ‘modern’ war, were convinced that the telegraph was what they needed. As the northern part of the country was under the greatest threat, the first telegraph line built linked Paris with Lille. The telegraph was used until around 1850, at which time new techniques became available. Concerning this point, it is important for students to become aware that, even if a technical device meets a given need, it may not automatically be used. The means of communication used is always chosen according to constraints that must be determined and, whatever the case may be, cost-effectiveness, the only truly differentiating factor. This explains why, even when new solutions become available, older systems sometimes remain in use.

Hands-on activity: how does long-distance communication work?

At this point in the unit, the students may be asked to design a technical device, the function of which is to be determined. After exploring and conducting some research into long-distance communication, one way to proceed with the activity is to set up a competition where pairs of ‘transmitters’ and ‘receivers’ race to communicate a short message as quickly as possible. Children enjoy this type of hands-on activity, which stimulates the imagination. The students play the role of inventor and attempt to use the same approach an inventor would use. In order to make the task easier, the teacher can provide a wide variety of materials that the students can use as they wish. This type of task requires creativity and applied use of the elements of communication addressed earlier on in the unit. This hands-on approach provides an opportunity to design, build and improve prototypes while allowing students to gain an awareness of the necessary back-and-forth between objectives, materials and the prior knowledge they must apply.

The various attempts and proposals may then be shared with the entire class. It is likely that some groups will attempt to base their device on Chappe’s telegraph, while others will come up with more original solutions. Displaying the various inventions in class will allow the students to see the wide range of possible solutions and inventions. Comparing the different systems and their effectiveness will develop their critical thinking skills. Finally, a review of solutions initially put forward by Chappe that are similar to solutions developed by groups of students will allow the class to see that some of their suggestions were much like to the inventors’. This will reinforce students’ motivation to create, give added meaning to their work and the process behind it and introduce them to the world of science and techniques.

Building a replica of an historic instrument in order to better understand how it works

The teacher may also ask students to build a telegraph like Chappe’s based on sketches, pictures, historical documents, or reproductions. The materials used must be simple. Meccano rods or Lego parts, pulleys and string are usually effective. Using the original terms for the device (regulator, indicator, post, pulley, etc.) will make it easier for students to communicate during the design and building of their telegraphs.

Classroom research has clearly shown that the ‘mechanical’ aspect of building the device is the most difficult. Students must take into account a variety of factors, such as friction, stability and the overall balance of their structure. At this point, some additional research will help students to master balancing the rotating arms: They will learn to balance the force exerted on each side of the pulley; reduce the work by using mobile pulleys or hoists; and carefully measure the length of string pulled according to the number of mobile pulleys. The articulated, marionette-like structure and system of strings that students will design and then build will raise issues such as the movement of a lever, the relative positions of the axis, the resistance of the weight of the arm or leg, and how to determine the point where the strings must be attached and the action to be performed. Likewise, the sturdiness of the structure of the telegraph will encourage students to think about the distribution of force and the balance of the system. Students will thus have to confront a true scientific and technological problem, which they must solve by discovering the need to correlate the length of the string to be pulled and the position of the indicator arm.

By gradually improving the system, students will realise that the instrument, which gives the—false—impression that it is easily thrown together, in fact requires accurate, sophisticated adjustment. For instance, in order to position one of the arms in a given direction quickly and accurately, there are several possible solutions, some of which are more effective than others. The tension of the strings, the movement of the pulleys, the action of the operator moving the arms and the order of the symbols displayed are all problems for which students will have to find the optimal solutions. Each phase will entail unique solutions, resulting in telegraphs that have been perfected to varying degrees. Research into the different telegraphs built since the 18th century will confirm that the different telegraph sizes and systems used in France saw a number of developments before becoming standardised.

Introducing the issue of coding: Chappe’s solution

The issue of coding is addressed in the final stage of the unit. A coding activity will raise students’ awareness of the difficulties to be overcome and the choices to be made, thus allowing them to understand the true value of Chappe’s work.

A classroom role-play activity that gives students an opportunity to invent a written code is one way to do this. Such an activity would have students pass each other notes with messages that the others must intercept and decipher. The ‘invisible ink’ game is a well-known way of doing this. Changing words according to a given rule is another way. Once the concept has been introduced to students, the teacher may suggest a code using rods or toothpicks. Allowing students to work with these materials will provide an opportunity to think about the type of coding used by Chappe’s telegraph. One of the problems students will have to solve is the position of the rods. Which position is best? Should there only be horizontal and vertical rods? If not, how can rods be positioned diagonally?

Once the geometrical considerations have been reviewed, the class can discuss what it means to ‘disseminate information’. How can a series of signal positions be linked to a series of meanings? In Morse code, a series of signals may be strung together on the same line or in different positions. The dots may be rotated or their number increased so as to ensure that the signal keeps up with the flow of information. In Morse code, information is transmitted using a series of dots and dashes; however, it is possible to come up with other codes using other signals, such as shapes, colours or rods.

Given that Chappe's telegraph can display 2 × 7 × 7 = 98 different signals—two different positions for the regulator and seven for each indicator—it is useful to study historical readings that describe the inventor's experiments with coding. The primary school in Chambéry provided some valuable information with regard to this point. The class carried out a chronological review of Chappe's attempts and suggestions, ultimately arriving at a relatively complex code that provides a large number of options. Indeed, a code that is too simple can only transmit short, simple messages. By comparing Chappe's codes with the students' codes, which are often simplistic, students will gain an understanding of the inventor's perseverance and technical skill.

The invention process

The word 'invention' is too often associated with an inventor creating something from scratch, using his or her imagination as the only resource. Today, extensive research into the history of science has demonstrated that discoveries are usually the result of previous discoveries and work that produced partial or alternative solutions. In antiquity, long-distance communication experiments were carried out using torches and smoke signals. Later, the Romans used manned 'relay stations' to increase the distance from which the signals were visible. Chappe's innovation was useful in that it consisted of stations placed in open areas or on high ground and it entailed using a sort of telescope inspired by the astronomers' glasses developed once optics and optical instruments were perfected in the late 18th century. The instrument used in Chappe's system provided magnification of between 30 and 65 times actual size.

Based on this information, it would be interesting for students to examine how Chappe's work enabled him to develop the telegraph. In particular, it is useful for students to look at the stages in the invention process, which involved experimenting with different techniques such as the use of pendulums, sound, or colours. At this point, it is valuable for students to analyse the reasons why the earlier technical solutions were rejected, whether it was because they were not effective enough or because there were obstacles to using them. With regard to this point, the teacher may want to explain that Chappe's equipment was destroyed by concerned residents who were afraid of the strange structures—this will show students that an invention on its own is sometimes not enough to win the necessary support. The conditions in which the 'final' telegraph were used as well as how effective it was should also be examined. This will give students an opportunity to understand the problems associated with the optical and mechanical aspects of the signals and their transmission. The teacher may want to ask some of the following questions: In what conditions is the signal visible? What happens when the weather is foggy, snowy, or rainy? What happens at night? How long does it take to read and transcribe a message? With this type of code, how many different words can be formed? Wouldn't it be easy for spies to decipher the messages? In fact, these problems resulted in the advent of the electric telegraph a half-century later.

On a completely different level (given that inventions are created by human beings), it is important for students to understand that the techniques chosen are not the only issues at hand. The inventor is part of an environment that influences his or her choices and behaviours. Therefore, factors other than technique—and, of course the perseverance and stick-to-itiveness most inventors demonstrate—are involved in the completion and commercialisation of an invention. Bodies that approve inventions and make them 'official' are an example of this. Students may want to study how Chappe's invention was validated. In the readings, they will find that official recognition for Chappe's telegraph came from the Convention. However, in order for that to happen, Chappe needed some help. This is something that students can verify by looking at Chappe's biography. His brother Ignace, a member of the Legislative Assembly, was able to serve as an intermediary between the inventor and the authorities. However, he was not the only person who supported the invention. Chappe managed to find a number of other sources of support—something he had to do to sustain such a long adventure, which lasted from the French Revolution to the Second Empire. The people in an inventor's network and the relevant jurisdictions and authorities count at least as much as the invention's technical performance—so it takes more than just one person to see an invention through to success.

What is a communication network?

Today, students are aware of how the postal and telecommunications systems work (the post-office worker, the postman, the counter at the post office, postal trains, sending printed materials, telephones, phone boxes, phone company offices, telephone directories, telecommunications technicians, etc.). An initial review of students' prior knowledge on the subject will get them familiar with the concept of the network.

They will then be able to think about what kind of network was needed for Chappe's telegraph. In order to do this, they may use the telegraph they have built to transmit information using a code common to the class. This activity will move students beyond the equipment and how it is built and raise the issue of staffing and ranking. Each relay station required two attendants, one to operate the arms of the telegraph and one to use the telescope. The station had to be manned in this way 365 days a year from dawn to dusk. The directors, who supervised a division of stations, were the only people who had access to the vocabulary (or dictionary), which was absolutely confidential, and they alone were allowed to code, decode and transmit messages. The inspectors, who were usually from the aristocracy or bourgeoisie just like the directors, represented the telegraph administration and conducted a tour of all of the stations, often on foot—a journey that took between 15 and 20 days. They inspected the equipment and supervised and paid the station attendants, who earned half of what the director earned.

The concept of the telegraph line will also be addressed. A line consists of manned relay stations equipped with semaphores and telescopes at regular intervals. The star-shaped network of more than 5,000 kilometres that formed around Paris, ultimately linking 29 cities via 550 stations, was made up of such lines.

Students may attempt to analyse the benefits of this network, which, at the time, was much admired and copied throughout Europe. Indeed, the network enabled the quick, accurate transmission of information—except, as we have seen, in the event of rain, snow, or fog, which was one of the reasons for its ultimate decline. The vulnerability of the system to bad weather and the other technical disadvantages mentioned were not the only factors that resulted in the obsolescence of the device. Indeed, the network had been developed by the Convention, which found in it a solution to the problem of transmitting urgent messages in a time of war. At a time when the banking system had not yet been developed, it was the state that paid for building telegraph lines, stations and the network, and it was the state that paid station attendants' and inspectors' salaries. In exchange, the state kept the system for its own use only, a point on which it never wavered and which kept private citizens from taking an interest in the system. Logically, therefore, the state should have been in charge of maintaining the network. And yet, as soon as the war ended, the budget allocated to the network was cut. First Consul Bonaparte even shut down some lines for fear of revolutionary uprisings. Under the Restoration the lines were reopened and the transmission of national lottery results kept them running. However, as the state had ceased maintaining the station sites that had been commandeered for the war, the equipment, which, to an increasing extent was being left unattended, gradually disappeared from the landscape. At the same time, other, newer forms of communication, such as the electric—or 'Morse' telegraph, after the inventor of the code—were being developed.