Longman Structural Readers: Non-Fiction
Stage 5

Man and Modern Science

Norman Wymer

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Chapter 1

SENDING MESSAGES AND PICTURES BY SATELLITE

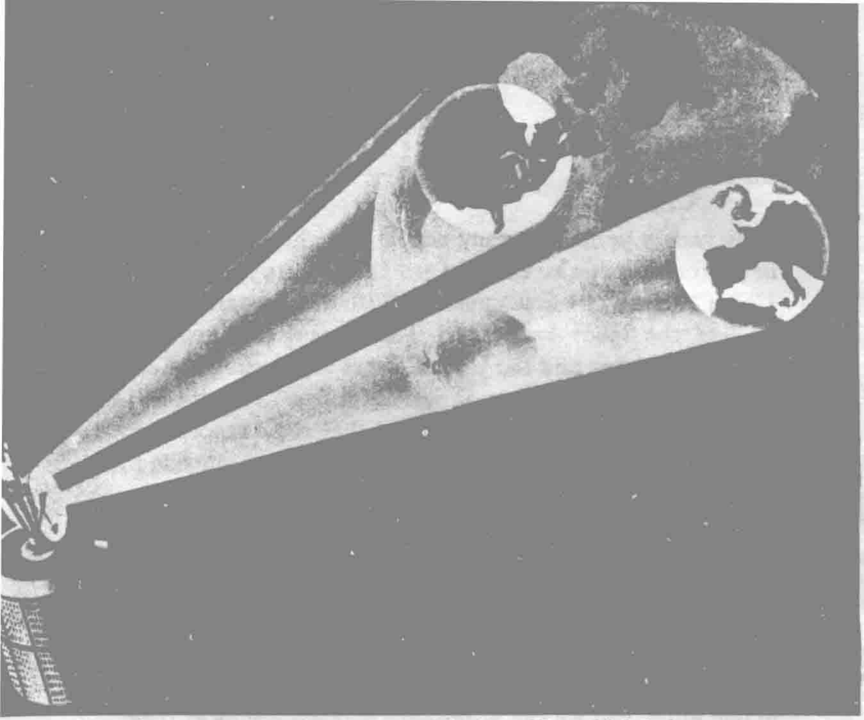
Only twenty years ago, many people thought that men could never travel in space. Then on 4th October, 1957, the Soviet Union launched its first 'sputnik'. With this first artificial satellite, the Space Age arrived. Today many satellites from both the Soviet Union and the United States are circling the earth.

These artificial satellites do various things. Most of them have been launched to help scientists, and they radio reports back to earth. It is easier to observe the stars from space, outside the earth's atmosphere; so some satellites do this work. Others send reports about the upper atmosphere and observe the weather all over the world. We shall look at them in the next chapter.

Again, other satellites are for telecommunications – for sending messages over long distances. Every minute of the day and night, telecommunications satellites are relaying messages around the world. Television programmes now cross the oceans in one jump, and we can watch international events as they happen. This was not possible before these satellites were invented.

Of course, for many years we have been able to receive international radio programmes from distant countries. Their signals are transmitted into the sky, and they are reflected by gases in the ionosphere. In this way they can go round the 'curve' of the earth. Television signals cannot do this, because they must be transmitted on very short radio waves. Television waves are not longer than about five metres, and sometimes they are much shorter than this. Because they are so short, they have a very high frequency – at least sixty million cycles per second. Their frequency is so high that the waves cannot be reflected by the ionosphere. Instead they pass through the ionosphere and go out into space. So TV signals can travel only in a straight line, and they cannot go round the curve of the earth.

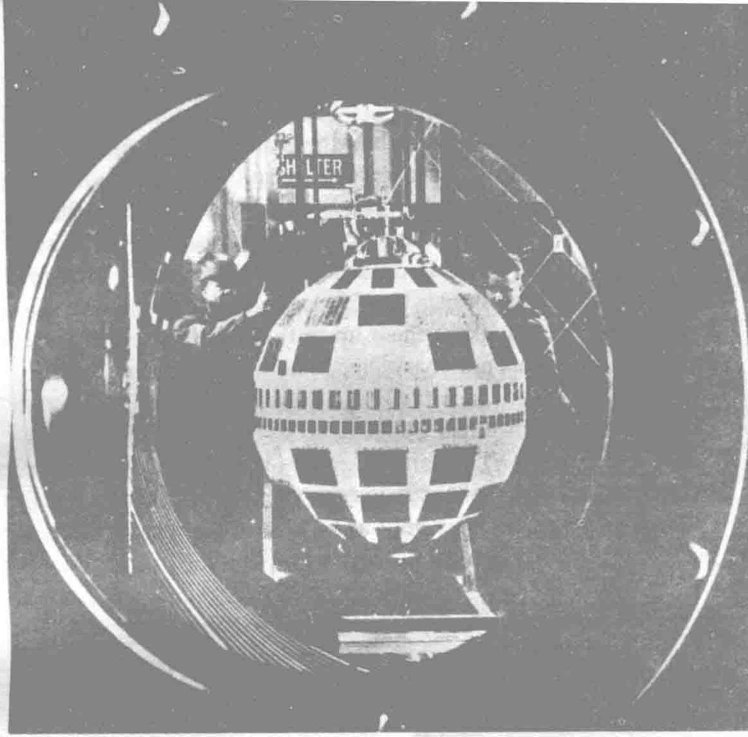
Relay stations are necessary to send television programmes a



No relay stations are necessary with a satellite which is between two earth stations.

long way. These stations must not be more than fifty kilometres apart. So, for example, in order to send TV programmes 5,000 kilometres across the Atlantic, about a hundred relay stations would be needed. They would have to be on ships, and this would cost a lot of money.

Artificial satellites gave an answer to this problem. With a satellite, no ground relay stations are necessary. Instead, there are only two 'earth stations', with the satellite between them. The message goes from one earth station to the satellite. Then it goes from the satellite to the other earth station. On 18th December, 1958, the United States satellite 'Score' sent the first communication from space. A tape-recorder in the satellite recorded signals from one earth station. The machine then transmitted the signals back to earth. So relay was possible. But



Telstar was the first proper telecommunications satellite.

there was a difficulty: the signals had to be recorded before they could be relayed. This needed too much time.

A quicker relay system was tested on 12th August, 1960, with the satellite 'Echo I'. This satellite was about 1,500 kilometres above the earth. The United States made several experiments with it. First, a radio signal was transmitted from California. The signal was reflected by the metal of the satellite. It was clearly received in New Jersey, five thousand kilometres away. Then telephone calls were relayed between California and New Jersey. For the last test, a photograph was transmitted, and again the results were good.

On 10th July, 1962, the United States launched 'Telstar I'. This was the first proper telecommunications satellite. It could relay radio and TV programmes, and – at the same time –

telephone conversations and other messages. It was very small, although it contained about 15,000 instruments and parts. Several years were needed to build it. If it had not worked well, a very large amount of money would have been wasted.

This satellite did not relay messages only by reflecting them, or by recording them first. It sent the signals back to earth as soon as it received them. Because it was about 5,500 kilometres above the earth, the signals that it received were very weak. So it amplified them, making them up to thirty million times stronger. It did this automatically, so no one had to control it. For power, it made its own electricity from sunlight.

Britain and France had both agreed to help in the United States experiments. The three countries built 'earth stations' to transmit and receive the messages via active Satellites.

The British station was built at Poldhu in Cornwall. This place was already famous in the history of radio. In 1901 the

Marconi used very simple equipment in his experiments.

Italian engineer Guglielmo Marconi had built a large radio station there. He was trying to send radio signals across the Atlantic for the first time. When everything was ready, he went to St John's in Newfoundland, on the other side of the Atlantic. With two other men, he built a receiving station at Cape Cod. Things were very difficult. The station was an old building with broken windows. The aerials were fixed to the roofs, and strong winds often blew them down. Marconi almost had to stop his experiments.

Few people except Marconi thought that the experiments would bring results. He listened anxiously for the Poldhu signal, which was the letter 'S' in Morse code (*pip . . . pip . . . pip*). At first he could hear nothing. The men at Poldhu transmitted the signal many times. With great difficulty, Marconi at last heard the three 'pips'. Radio communication had arrived! Today, people cannot understand how the Poldhu signal crossed the Atlantic. Although Marconi used the best instruments of that time, they were not very good.

Sixty years later, the Telstar experiments at Poldhu had a very different station. Here everything was powerful and new, and the instruments were in a big strong building.

When Telstar was launched, the engineers could not make their tests immediately. They had to wait until the satellite had reached the right position. In order to relay signals, a satellite must be between the two earth stations. The curve of the earth cannot hide the satellite from either station. As a satellite moves through space, it transmits 'tracking signals'. Instruments in the earth stations follow these signals. So the stations know when the satellite is in range – that is, when both stations can 'see' it.

Telstar was not in range until the evening of its first day. During the day, the ground engineers checked and tested their instruments. As soon as the satellite was in range, the United States transmitted some test signals. But when the British engineers received them, the pictures were very poor. No one could understand what they were.

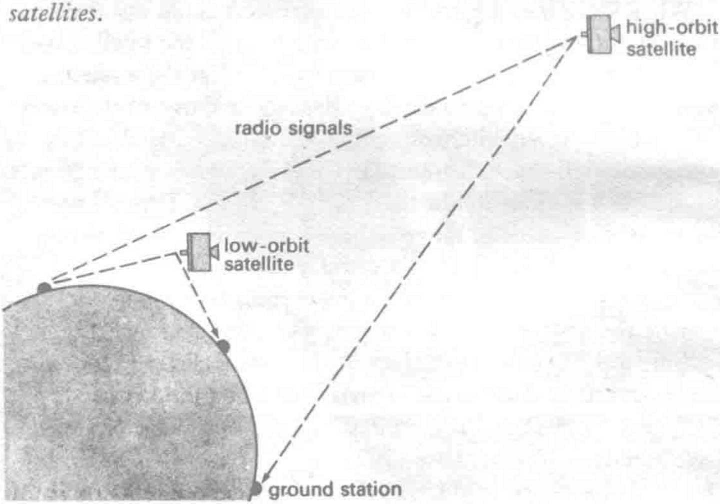
The disappointed engineers repeated the experiments three hours later, when Telstar was in range again. They were still very bad. There was a fault at the British earth station.

All the instruments were tested again, but the fault was not there. Then the engineers said that it must be in the aerial. They worked on the aerial all night and most of the next day. When they made another test the picture was good and clear at last.

The first public tests were made on the next evening, 12th July. First, the United States sent a television programme to Europe. There was more trouble: there was no sound, and only part of the picture was seen. Suddenly, the pictures got brighter and the sound was heard. Everything was all right. The people in Europe were able to see various scenes that showed life in the United States. After eighteen minutes, Telstar flew out of range.

Later, the British earth station sent programmes to America. First they transmitted various pictures of life in London. Then the engineers tried a very bold experiment. Television stations

Three or four high-orbit satellites could give telecommunications between most countries. They travel more slowly than low-orbit satellites.



in nine European countries sent pictures to the British ground station. They were relayed across the Atlantic by Telstar. Television stations in most parts of the United States and Canada then transmitted the programmes to people's homes. The results were very good.

Other tests showed that Telstar could also relay 600 telephone conversations and about a thousand telegrams. Most important, it could relay messages both ways at the same time. This was very encouraging. Radio, and cables under the sea, could carry hundreds of messages, but this was not enough. Telecommunications satellites could give many more 'voice channels'. The satellites had so many channels that the cost of each one was quite low.

So the United States formed an international satellite communication group, and other countries joined this. They decided to launch more telecommunications satellites. They would be like Telstar, which could amplify and relay messages immediately.

There were two ways of doing this. In one way, the satellites could circle the earth at quite a low height. This is like Telstar. But in a low orbit, a satellite must travel very fast. The pull of the earth is still quite strong. If it travelled more slowly, a low-orbit satellite could not stay in orbit. At a height of five thousand kilometres, the international group would need thirty-six small satellites. With this number, there would always be one satellite between the ground stations.

The other way was to use high-orbit satellites. They can travel more slowly because the earth's pull is not so strong. At 35,700 kilometres, a satellite needs to make only one orbit in twenty-four hours. This is the same time that the earth takes to turn once. So a satellite in this orbit seems to stay always above the same place. Three or four high-orbit satellites over the Equator could give telecommunications between most countries. But at this height, radio signals take about 0.3 seconds to travel between the two ground stations. In a telephone coversation, a speaker waits 0.6 seconds for his answer. This is quite a long time. Of course, this is not important for other signals like television programmes or telegrams. In the end, a high orbit was chosen.

Then plans for building and using the satellites were needed. In August, 1964, another international group was formed. This was INTELSAT, which means 'International Telecommunications Satellite Consortium'. ('Consortium' is another word for 'group'.) Nineteen countries joined INTELSAT, and their first satellite was launched in 1965. It was called 'Early Bird'. Although it was not much bigger than Telstar, it had 240 'voice channels'. Most underwater cables have only 128 channels. Later satellites had 1,200 and even 2,000 channels.

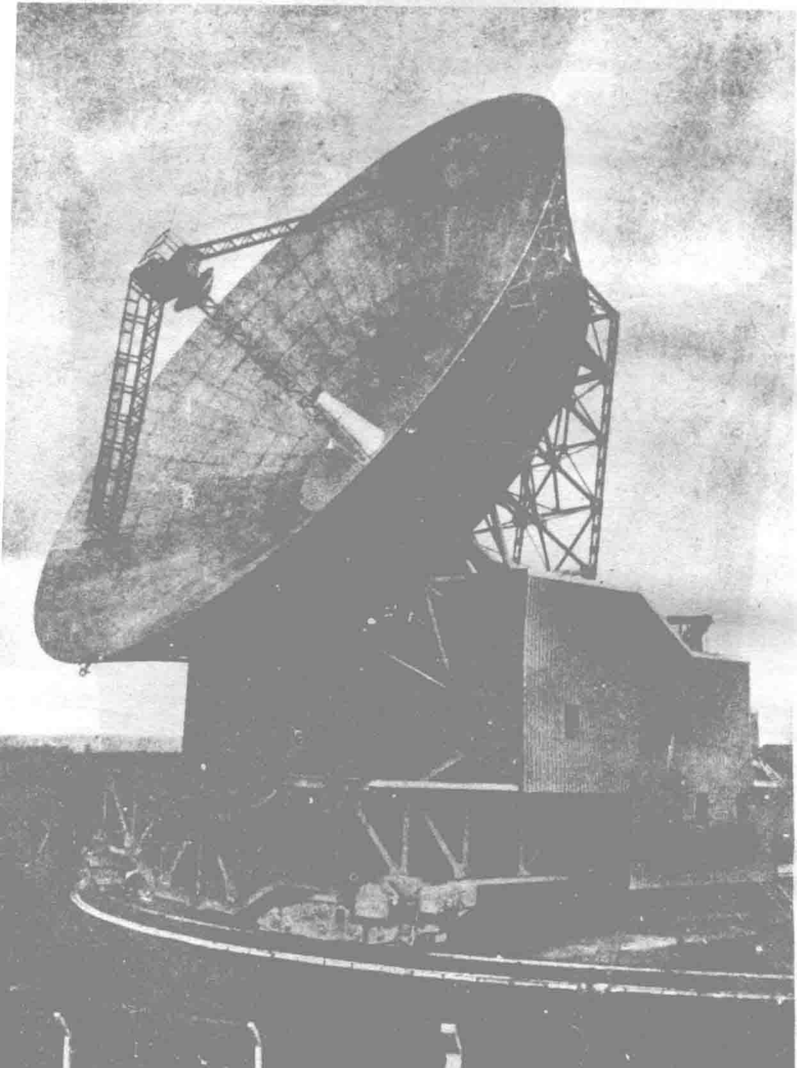
In 1964, the United States, the Soviet Union and Great Britain made several experiments together. The United States satellite 'Echo 2' was used for thirty-four tests between England and the Soviet Union. The ground station in England was the large radio-telescope at Jodrell Bank, near Manchester; in the Soviet Union the station was at the Gorky University Observatory. The United States and the Soviet Union are also doing other space work together, for example in space medicine.

The Soviet Union's own first telecommunications satellite, called 'Molnia-1', was launched on 23rd April, 1965. Its orbit was unusual: its shape was like an egg. At its highest point, it was 40,000 kilometres from the earth.

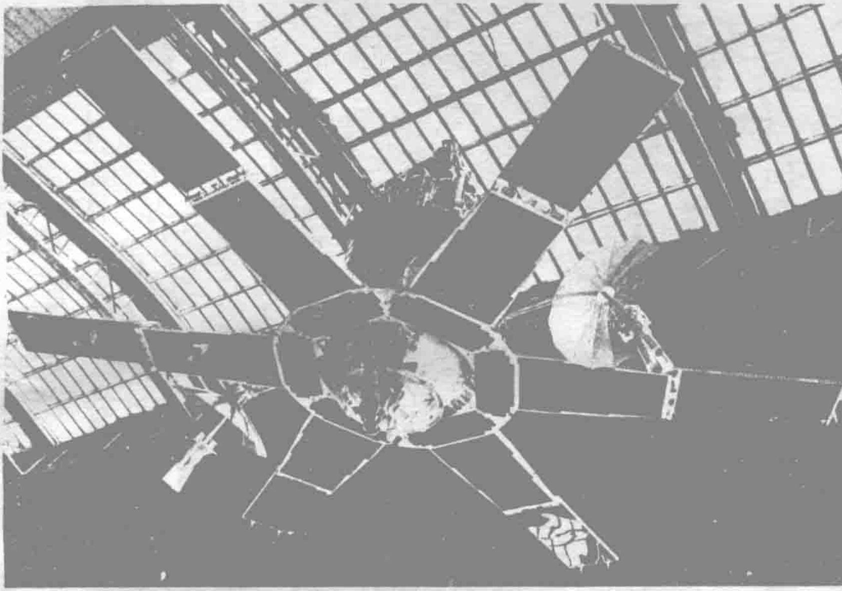
We have seen that a high-orbit satellite can seem to stay above the same place. This means that there is communication all the time. Also, the cost is less, because the aerials can be fixed: they do not have to track the satellite. But the orbit must be at 35,700 kilometres over the Equator. A satellite in this orbit cannot reach places that are north of 70° North. In the Soviet Union, communication is necessary beyond this. The egg-shaped orbit can cover all parts of the country. It does not cover them all the time, of course; but it can reach the same places at the same time every day. This is controlled from the ground, by radio signals to the satellite.

More Molnia satellites were put into orbit. At first, there were communications between Moscow and Vladivostok only. Later,

Early Bird.



Signals from satellites are received by radio-telescopes like the one in this picture.



Molnia 1 was the first Russian telecommunications satellite.

receiving stations were built in many distant places. They are called the 'Orbita' group. Now there are Orbita stations in Siberia, the Soviet Far East, the Far North and in Soviet Central Asia. More than 20 million people who live in these places can watch television programmes from Moscow.

So man's adventures in space can help the lives of ordinary people. Telecommunications satellites are one way: today between sixty and seventy countries belong to INTELSAT, and there are more than sixty ground stations for satellite relay. Now, in the next chapter, we shall look at another way in which satellites are useful.