

## **Scene 1 – With Own Eyes**

You know about them as well as they know about you...They can see you and you can see them, too...

It's not difficult at all. If the weather is clear at night, just look up at the sky.

Sooner or later you might see one - a shining point flying silently among the stars.

Sometimes you can easily spot one and sometimes you might have to wait a long time. For example, in the summer you can easily spot up to a several dozen such little lights within just an hour.

They look quite inconspicuous... But appearances can be deceiving.

**Opening title...**

## Scene 2 – Room

You probably know it very well.

Every morning as the alarm clock goes off, you must get up.

Some might jump up just like a rabbit, even though it's seven a.m.

Whereas some would drowse away almost until midday.

But otherwise, it is probably almost similar.

You go to the toilet, some get a shower, another might just a wash. But all of us brush our teeth. Then you plod your way to the kitchen for some breakfast, like coffee, noodle soup or instant porridge...

Next comes checking your emails, social feed, pictures and messages from your friends and your foes as well.

You might be one of those who turn on the TV to see the latest world news or check the weather forecast to make sure what to wear today. Is a T-shirt enough? Will you need to carry an umbrella? Or will it be cold and snowing?

Whether you go to school or work, or just on a trip, you'll probably find the fastest way before you leave... You don't want to get stuck in traffic, do you?

...

This is most likely what our typical mornings look like.

But nothing would probably go so easily without the space technologies.

You don't believe?

## Scene 3 – Journey to Space

It has been a long-standing desire to imitate bird flight and see the world from above.

Why? Just for the adventure? Well, of course that too. But mainly because from the air we can see much further, even several hundred kilometers. And we can look at familiar things from above.

It took a long time, but we finally got a view like that.

The first hot air balloon took off in the 18<sup>th</sup> century – it went up two kilometers high.

Constructing a real aircraft was much more difficult. But we made it at the beginning of the 20<sup>th</sup> century. Suddenly we could fly up to ten kilometers high...

Then the rockets were invented.

Thanks to them our planet got its first artificial satellite in 1957. The Soviet Sputnik. It was a shiny half-meter sphere with four long antennas.

It was soon followed by other satellites of various sizes and shapes. They weren't just beeping radios anymore, but useful devices with more scientific and smarter instruments.

In 1958, Explorer was built in the United States.

Then followed Ariel from Great Britain. Alouette from Canada. San Marco from Italy.

French Asterix. Ohsumi from Japan. Dongfanghong from China.

In 1969, it was German AZUR studying solar particles and auroras. In 1978, Czech Magion explored the Earth's magnetosphere and ionosphere. In 2012, Polish PW-Sat testing elastic solar cells as well as an orbital decay technology, Hungarian MaSat 1 with a simple camera and Romanian Goliat with micrometeorite and cosmic radiation detectors. And in 2017 the Slovak launched their satellite, too, skCube, among other things, received very low frequency radio waves generated by lightning.

Building an artificial satellite is far from easy...

It's definitely not just a tin can rolling around the orbit!

On the contrary, they are amazingly complex devices containing a lot of important instruments. Just see for yourself!

The solar panels are the most often source of electrical energy.

But when a satellite gets into shade, it needs a battery as well.

The rocket engines ensure a stable orbit and correct its orientation in space.

The radio antennas receive commands and transmit observation data.

A satellite has various radiators installed on its surface foil to make sure they don't get frozen or burn down.

Inside, there's a main computer, an accurate clock and rocket fuel tanks...

And depending on its task, also the cameras or other necessary detectors.

Amazing devices, aren't they?

## Scene 4 – Where Do We Find Them

Space is about a hundred kilometers far from us.

Is it a little or a lot?

It depends. With a usual car, you can drive a hundred kilometers in less than an hour. And for those of you living in Berlin, Warsaw, Prague, Bratislava, Budapest or Bucharest, space is closer than the sea.

Getting to space isn't that simple, but eventually a small rocket or a special airplane can make it. The trouble is to stay there! Against the pull of gravity, you must fly fast to avoid falling back to Earth. Very fast! You must somehow reach a speed of at least 27 thousand kilometers per hour.

That's several times faster than the fastest supersonic plane. Only space rockets can do it.

No artificial satellite can fly lower than two hundred kilometers above Earth. It's because of the Earth's atmosphere. If it flew any lower, it would soon burn down...

At 4 hundred kilometers you can find the International Space Station giving temporary home to several astronauts. And also, some observatories monitoring Earth or secret military satellites.

A bit higher, several thousand kilometers from Earth, there are swarms of telecommunication satellites securing, for example, telephone or internet connection, the navigation satellites enabling airplanes and cars to find their position and in fact also us to find our position with our mobile phones.

The further from Earth you are, the slower you move along the orbit. Another group of artificial satellites is flying at 11 thousand kilometers per hour about 36 thousand kilometers from Earth. They complete their orbit around our planet in a day, so they appear to be hanging on the same spot above Earth. That's why they're called geostationary satellites.

Any idea who may benefit from that? Of course, the meteorologists and television companies. Because you can see half the Earth from such an altitude!

Apart from these three main groups of satellites – in low, medium and geostationary orbiting Earth – there are a lot of other satellites wandering around our planet.

Others travel much further... They break free of Earth's gravitational pull and set off for the planets or the smaller bodies of the Solar System. Five interplanetary probes have even reached the speed over 150 thousand kilometers per hour, so after a while, they will leave the Solar System forever...

## Scene 5 – Types of Satellites

The fact is that artificial satellites help us survive in a complicated world of tomorrow.

GPS, Galileo, Glonass or Baido... strange names, aren't they? It's projects like these that have redrawn our life lines. It's the swarms of artificial satellites that enable us to determine our geographical location and altitude with the accuracy of several dozen centimeters.

And as a result? There are about 150 thousand airplanes taking off every day and about 1 billion people fly over Europe every year! Airplanes can't just wait for takeoff or landing and have to fly along the best routes...

Navigation satellites are important for driverless cars and also for tractor drivers working in the fields, who can now optimize the use of fertilizers and be more environmentally friendly. You'd be surprised how much food on your table now bears the label of "space quality".

Now, talking about the weather. Just half a century ago meteorologists relied on only very vague instruments from ground stations and little information from ocean ships. Nowadays several dozen meteorological satellites monitor the world - literally live. Some of them are flying in low earth orbits – like the American NOAA – others observing the other half of Earth from an altitude of 36 thousand kilometers – like the European Meteosat, Russian Elektro, Japanese Himawari or Chinese Fangyun.

The same monitoring is connected with the space weather – like the activity of the Sun.

Artificial satellites help us use Earth's resources more efficiently. For example, they increase the efficiency of oil and gas production and monitor forests, the ice caps near the poles and even the ozone layer... undoubtedly, once they'll be the key factor in responding to climatic changes.

Every move we make is monitored by the spy satellites. They are not only looking at us but also following our mobile phones and radios, checking us with their radars and measuring the surrounding temperature.

Is it scary? Quite the contrary! It was the spy satellites that prevented the cold war of the second half of the 20<sup>th</sup> century from growing into a hot war. The great powers knew almost everything about each other and they couldn't cover up any surprise attack.

## Scene 6 – Number of Artificial Satellites

Let's go back to the beginning.

First you could count them on the fingers of one hand...

... then two hands...

... and then you had to add in your toes, too...

Nowadays there are more than seventy countries with their own satellites. And even private companies, groups of enthusiasts and dogged individuals invest in them.

We usually picture an artificial satellite as a big shiny box. The first satellites were huge. Some even as big as a bus weighting up to several tons.

But recently they've been building satellites which are smaller, cheaper and in fact bolder. The trend is a twenty-centimeter box weighting around one kilo called CubeSat.

And we hear about even smaller pico-satellites as big as a matchbox, printed on 3D printers...

The price of a space ticket is falling sharply, too... While we recently launched about a hundred artificial satellites every year, soon we'll be able to do the same every month...

There are several projects going on that will operate swarms of thousands artificial satellites! This is how Amazon, Starlink from SpaceX, Facebook or OneWeb want to offer the global Internet without any censorship.

Will the hundreds of tiny dots swarming in the sky be a symbol of technological progress or destruction of unspoiled nature?

And we mustn't forget space debris, various ruined rockets and non-functional satellites. We estimate there are over 100 million objects orbiting Earth with a diameter more than 1 centimeter.

What if uncontrollably flying debris objects start shooting down functional satellites, thus imprisoning us on the surface of our planet? For now, we are far from such a technical apocalypse, but we should keep reminding ourselves of this threat.

## **Scene 7 – Internationality of Projects**

Space exploration, industry and defense have always been a matter of national prestige.

At the same time, they are nice examples of international cooperation. For example, the International Space Station – it's the most politically complicated space project people have ever got down to.

It required the agreements between the space agencies of the United States, Russia, Europe, Japan and Canada. The crews are international... The training, logistics and development centers can be found in America, Europe and Asia.

Rockets taking up the parts of the International Space Station and spacecraft carrying cargo and human crews take off from American Cape Canaveral and Wallops Island off the east coast of the United States, from the Baikonur Cosmodrome, which is Russian but situated in Kazakhstan, from the Japanese island of Tanegashima and from the European spaceport near Kourou in French Guiana.

The main mission control center is in Houston, Texas and a spare one is in Korolev, Russia.

The European Space Agency is then a gateway to space for three dozen of countries. Every European spends as much on space projects as on a single movie ticket every year.

What do you think? Is it worth it?

## Scene 8 – Usefulness of Satellites

Large temperature fluctuations from  $-250^{\circ}\text{C}$  to  $+300^{\circ}\text{C}$ .

Long-term exposure to radiation.

Vacuum.

Extreme reliability requirements.

Astronautics needs new materials with absolutely unique properties. It's due to extreme conditions like these that satellites have to cope with. But the investment in their development pays off. As we get the most successful space technologies for our everyday lives.

Memory foam used in astronauts' seat in 1966 now fills up sleeping mattresses and running shoe insoles.

Algae oil used in food for long space flights have become more successful as a baby food additive.

A cordless drill was developed for collecting samples on the Moon, followed by handheld vacuum cleaners and screwdrivers.

Gold aluminium foil that keeps heat and cold out protecting the spaceships as well as the travelers lost in foul weather.

Food freeze-drying process wasn't invented by space chefs but they have improved this food preservation technique to save and store food in space for a long time.

Hearing aids, non-contact thermometers, better solar batteries, arch wire in dental braces straightening teeth, even toy air guns, low friction swimwear, miniature mobile phone cameras, scratch resistant glass, water filters, light-emitting diodes and smoke detectors... we could go on like this for hours!

You might say that most of these useful inventions sooner or later would have come up even without the expensive space flights... And you might be right. Yet, despite everything, our space observatories play a key role in defending our planet.

At least once a year, our planet dashes with a space object that explodes high above Earth's surface releasing as much energy as a small nuclear bomb. Once in a millennium, Earth collides with a space object 50 meters in diameter that can cause a local disaster.

But if the object is over 150 meters in diameter, big enough to fill up a usual football stadium, the energy released by such collision would give rise to vast fires covering Earth's atmosphere for a long period of time and would fatally interrupt the food chain on Earth.

Fortunately, our space guards are beginning to provide quite reliable monitoring of such potentially dangerous asteroids. Hopefully, one day we'll also have the technology to deflect such an apocalyptic projectile.

Protecting the future of mankind on the planet Earth is the biggest task scientists and space engineers are facing nowadays.

As space is a hostile place for life and in vacuum no one will hear you calling for help.

## **Scene 9 - Legacy**

We used to wander around the continents and oceans to expand our reach to every corner of our planet. Not long time ago, with heavenly riders, we conquered Earth's atmosphere.

And now... now we are becoming wanderers in a new vast world called the universe.

Satellite technologies help us every day.

They are the symbol of international cooperation across the continents.

They might enable us to live on this planet for another millennium.

But behind every success, there are hundreds and thousands of scientists and technicians working hard here on Earth. Together we are pushing the limits of human possibilities.

Our future does not lie only in the stars, but also in our hands.

Together we are no longer just earthlings – we are becoming spacefarers.

## **The credits**