NASA

And International Cooperation

through the missions to Mars

and

the International Space Station.

By Marge GILLE

Introduction

People have always been fascinated by space projects. Everybody watched Neil Armstrong's first steps on the Moon. The international community covered this great event. It was the first time that a man stepped on another planet than Earth. This international fascination for space projects opened the path to international cooperation. Some countries already had their own space agencies and others, who could not afford it, tried to cooperate with other countries.

At the same time this mission to the Moon was purely American, launched from the United-States and sending only American astronauts to the Moon. It was the Cold War period and there was an atmosphere of competition between the West and the East blocks.
The political stage underwent a fundamental change. The USSR split and the East block was dismantled. Russia lost its strength and power and the cold war was ended. It eased the relationships between the United-States and Russia, a new dialogue started. Their distension had become so extreme that it had to cease before the crises would turn into an international conflict anyway. It opened the path to cooperation between the two countries. The Americans were delighted because they had won the contest of the Moon and were then ready to work with the Russians.

In space matters, the two countries started to think about working together and soon started the Phase-1 Program. The Americans would fly to Mir and even provide a module to be docked to the Russian Space Station. Cosmonauts and Astronauts would work on scientific projects on board and experience long duration stays on orbit on a permanent station. The United-States and Russia had already the project of building an Americano-Russian station which became the International Space Station when other countries joined the project. Now 16 partner nations work together on the ISS assembly through seven Space Agencies, NASA, RSA, NASDA, ESA, CSA, ASI and INPE respectively belonging to the Unites-States, Russia, Japan, Europe, Canada, Italy and Brazil. The ISS remains mainly Americano-Russian even if Europe and Japan also have their own laboratories on board.
The Assembly started in 1998 and was planned to be completed by 2006. The ISS is the first International Space Station ever built. Once completed, the specialists on board will be in constant contact with the Ground and will share the results of their research with scientists

and Universities on Earth. The countries having a laboratory on board, the United-States, Russia, Japan and Europe, will be permanently represented on board but not the other countries since only seven specialists can live on board. The ISS can not house more than seven people for space and safety reasons. "The ISS will enable nations to work together to perform scientific and technological investigations and encourage the commercial use of space." The ISS partners will permanently use their laboratories and lead scientific research in correlation with people on Earth. It will be the first time that American, Russian, European and Japanese scientists will live and work together on orbit. Some of the research will be dedicated to future space projects. The ISS was also seen as a stepping stone to Mars and a testbed for human exploration of space.

But the ISS is not the only International Space Project. Nowadays there are less and less purely American missions. NASA encourages the participation of other space agencies in the projects they initiate. The international community was only a spectator when the first man stepped on the Moon. It was an American achievement. Now countries around the world want to participate in the trip to the next Planet to be explored: Mars.

In the beginning, the race for Mars looked really similar to the race for the Moon. Americans and Russians were competing against each other to be the first ones to reach the Red Planet. But in this field again the Americans succeeded better than the Russians who failed in most of their attempt in reaching Mars.
The Cold War ended and Russia was lacking of money anyway. They worked with the Americans on a common project. This mission was launched by the Russians and failed. Now many countries, and among them Russia, participate in all the missions to Mars in elaborating scientific equipment to fly on the American rocket. Unfortunately one of these missions also failed. The next mission was to be launched this year. Mars had always puzzled scientists and its similarity to Earth became even more striking with the recent photos of its surface. They also believe that there was once water and life on the Red Planet which explains why Mars was chosen among the other planets of the solar system. It will hopefully be more interesting than the Moon.

The next exciting mission will be the Mars Sample Return Missions and of course the international community is willing to participate in this project and France more than any other country. The last step would be to send a human mission to the Red Planet and many space agencies expressed their interest in such a project. No country but the United-States stepped on the Moon. The United-States and its partners intend to step on Mars. Would Russia also participate in this mission? How will all the partners cope with working together on orbit and share their scientific payloads? Would they cope with sharing the same spacecraft for six months on their way to Mars?

Missions to Mars

The first missions to Mars: a historical background

Introduction

The Soviet Union and the United-States began to have an interest in Mars during the cold war. There had been a competition for the first man in Space. The Soviet Union won this contest. Then the United-States sent the first man on the moon. The Soviet Union had to win the next challenge: to go to Mars.

So both countries sent several missions to the Red Planet. Unfortunately for the Soviet Union, the Americans were again more successful. Throughout the missions, the political contest changed and both countries started to think differently.

There was no suspense in the "race" to Mars, which is the main difference with the missions to the moon. The United-States soon imposed its supremacy while the Soviet Union was struggling and achieved little. With the end of the Cold War, the racers stopped competing and even eventually became partners.

The projects 1M and Mars1 against Mariner 4.

In October 1960 the Soviet Union launched their first spacecraft, on the 1M mission, to go to Mars. So they tried to outrun the Americans but the third stages of each rocket failed. This was the first failure, but unfortunately not the last, of the Soviet Union’s struggle to go to Mars. They did not give up and tried again two years later. As a matter of fact, the Soviet Union launched Mars 1 in November 1962. Since their first attempt failed they really hoped for a success this time. But as the spacecraft was at a distance of 106 million kilometres from Earth, its transmission disappeared. Mars 1 never reached Mars. At least this time the launch had been completed. The Soviet Union achieved more on this mission but it was still not enough since the spacecraft did not reach Mars.

During this time, the United-States launched several missions called "Mariner" to explore the solar system. Their first mission to Mars, Mariner 4, was launched in November 1964.

After a seven and a half months cruise it reached Mars in July 1965. Its aim was to take pictures of a determined area of the Martian surface. Contact with Mariner 4 was lost in December 1967.

It was the first time that Mars was observed at close range, what the Soviet Union had aimed at with its Project 1M and Mars 1 missions. Mariner 4 carried a television camera and 6 other science instruments to study the interplanetary space between the orbits of Earth and Mars. Once flying by Mars it started its study of the Red Planet, its atmosphere and its vicinity.

22 images covering 1% of the planet were taken during this mission. They show a moon-like cratered terrain. Later missions showed that it was typical of the restricted area pictured by mariner 4. Actually, the photos taken by Mariner 4 disappointed the scientists. The Moon was proved to be a sterile planet. So if Mars looked like the Moon, it may not be as interesting as they expected. Scientists were looking for something new and exciting to study. But the photos taken were showing a moon-like planet so of no interest for them.

The canals observed by Giovanni Virginio Schiaparelli and then by Percival Lowell were proved to be optical illusions. There was no trace of apparent water on Mars. This observation also disappointed the scientists.

Mariner 4 did not start the American and now international interest in Mars. It showed that Mars was similar to the Moon. At the time there was an interest in interplanetary exploration in general. As a matter of fact, Mariner missions also included missions to Venus.

The United-States were still competing with the Soviet Union as far as Space projects were concerned. So maybe they went on with exploring Mars only motivated by the activity of the Soviet Union and because there was a new challenge to win. In another contest, the United-States may have given up their projects and missions dedicated to the observation of Mars. However the Soviet Union and the United-States programmed other missions to Mars which would show another aspect, and a lot more interesting one, of the Red Planet.

Project M-69 versus Mariner 6 and 7.

The United-States achieved a success with Mariner 4. Four years later the Soviet Union launched a 2 spacecrafts mission, known as M-69, which, like the 2 first ones, failed. Even if the Soviet Union already seemed to be really out of the run, the government would still try to

achieve its goal: going to Mars and bring back exceptional photos and information about this planet.

The Americans went on with their solar system observation program.

The same year the United-States launched a dual spacecraft mission to Mars. The Americans succeeded again. It seemed that the more the Soviet Union failed, the more the United-States succeeded.

Mariner 6 was launched in February and Mariner 7 in March 1969. Mariner 6 reached Mars in July and Mariner 7 in August 1969.

They were designed to fly over the equator and the southern hemisphere. Their purpose was to study the Martian surface and atmosphere.

Mariner 6 took 49 far encounter pictures and 26 near encounter pictures. Mariner 7 took 93 far and 33 near encounter pictures.

The near encounter pictures covered 20 percent of the Martian surface. Phobos, one of the inner and larger of Mars' 2 tiny moons, was also spotted by the television cameras on board of the 2 spacecrafts.

The UV and IR emissions as well as the radio refractivity of the Martian atmosphere were measured.

The pictures taken by Mariner 6 and 7 show a surface very different from the Moon surface and this was really one of the most important Mariner's revelations. As a matter of fact it showed polar caps and new geologic features as huge concentrically terraced impact regions, collapsed ridges and craterless depressions. After that the scientists really started to be interested in the Red Planet. More intriguing features of the surface were revealed by the new photos taken during these missions. Mariner 6 and 7 woke the curiosity of the scientists and more missions to Mars would definitely be planned. Now, the United-States were even more willing to invest in this type of project and were convinced that these new features of the Martian surface may hide something even more intriguing. Considering the polar caps, scientists even hoped for the presence of water on Mars.

The Americans really discovered something interesting and it also motivated the Soviet Union to go on with its projects to Mars.

Project M-71 and Mariner 9: the Soviet Union still believed in success.

In May 1971 the Soviet Union launched a 2 spacecrafts (Mars 2 and Mars 3) mission, M-71, to Mars.

They included an orbiter and a lander each.

Mars 2 crashed on the Martian surface. Mars 3 reached the surface but it soon fell silent.

The orbiters of Mars 2 and 3 circled the planet for 8 months sending pictures back to Earth. This was a semi-failure since the landers did not achieve their goals but it was a semi-success since the Soviet Union received information from the orbiters. This was quite encouraging compared to the first Soviet failures. But the United-States had already had their full success missions and were achieving another one with Mariner 9.

The Americans launched Mariner 9 in May 1971. It was supposed to be a dual spacecraft mission but Mariner 8 failed. Even the United-States sometimes fail…The Soviet Union was still winning the "failure contest" though…

So Mariner 9 achieved more work than it was supposed to do because it also fulfilled Mariner 8 tasks. It was the first spacecraft to orbit another planet. During the previous missions the spacecrafts just flew by Mars without really getting on orbit around the planet. Mariner 9 circled Mars twice each day for a full year. So this mission represented a great American achievement and Mariner 8 failure was soon to be completely forgotten.

The main goal of Mariner 9 was to study the temporal changes in the Martian atmosphere and on its surface with infrared and ultraviolet instruments. The imaging was delayed by a dust storm which proved to be one of the largest global storm ever observed on Mars. It lasted for a month.

In spite of the dust storm, the mapping of 70 percent of the planet was realised thanks to the pictures taken during this mission.

The spacecraft also gathered data on atmospheric composition, density, pressure and temperature as well as on the gravity and the topography of the Martian surface.

Altogether Mariner 9 took 7329 images covering the entire planet. The spacecraft turned off in October 1972. Because it succeeded in global mapping of the surface, scientists had now an overall view of the planet. It was the first mission which gave detailed views of Martian gigantic volcanoes, valleys, polar caps, a grand canyon stretching over 4800km across its surface and its satellites Phobos and Deimos. It also provided very interesting information on

global dustorms, Martian surface eolian activity and showed what looked like relics of ancient riverbeds carved in the landscape. But Mars still appeared as a dry, dusty and lifeless planet even if the new features observed on the red planet surface seemed to have been carved by water in the past.
Afterwards the landing sites for the following missions were chosen in areas where dust storms were most unlikely to occur.

Mars 4 to 7 and Viking. The United-States win again.

Even if the Soviet Union failed in its first attempts to go to Mars it did not stop trying.
Mars 4 and 5 were launched in June 1973. Mars 4 missed the planet and Mars 5 took images on flyby when the Americans had already succeeded in putting a spacecraft on orbit around Mars.
Mars 6 and 7 were launched in August 1973. Mars 6 landed on the Martian surface and sent back data to Earth. Mars 7 missed the planet. If the Soviet Union achieved some success here, it was still far from the United-States.
They did not give up and worked on a project to return on the Martian soil in the mid-seventies. They could still beat the United-States on that ground. Unfortunately the project proved impractical. So they lost again…And the Americans had not brought Martian samples back to Earth yet. This is a project belonging to the 21st Century. So the Soviet Union would certainly not have reached their aim in the mid seventies.
Two years later, in 1975, the United-States launched a new dual spacecraft mission called "Viking". Viking 1 and 2 consisted of an orbiter and a lander each.
The goals to be achieved during that mission were to:

- obtain high resolution images of the Martian surface,
- characterise the structure and composition of the atmosphere,
- search for evidence of life.

The Viking team spent 8 years on this project.
Viking 1 was launched in August 1975. It reached the Martian orbit in June 1976. Viking 2 was launched in September 1975 and reached the Martian orbit in August 1976.

The first month the orbiters were taking pictures of the Martian surface to determine an appropriate landing site for the landers. They then performed their own scientific investigations and worked as communication relays with the landers.
Viking experiment revealed a complete view of Mars, its volcanoes, lava plains, immense canyons, cratered areas, wind-formed features and evidence of surface water.
The planet could be divided in two main regions: the plains located in the North and the cratered highlands of the South.
The landing sites were constituted by iron-rich clay.
The biological experiments gave no evidence of any life on Mars.
Viking gave the composition of the Martian atmosphere. It contains CO2, N2, Ar, O2, CO, Ne, Kr and Xe.

The other experiments showed that the variation of temperature over a given day was similar to the variation of temperature of certain areas on Earth. It also showed that the dust storms were seasonal and that they transported atmospheric gases between the polar caps. The dust storms were more likely to occur in the southern hemisphere during the winter.
In general these missions gave more detailed information than the previous missions. The scientific instruments had become more sophisticated with the time. The more information the United-States gather, the more success they have over the Soviet Union. This information would be of use to other Nations who would then consider participating in the American projects.

Because of the common points and similitude between the Earth and Mars observed, a greater interest was taken in the study of the Red Planet.

Viking was a turning point in the study of Mars. Until then scientists hoped that there might be some life on the Red Planet. The new detailed pictures of Viking seemed to show that there had been water once on Mars. Why did the water disappear if there was water before? Water on Earth means life. Was there any life on Mars before? Would there still be life underground?
Every mission made the scientists more curious. The more they get information, the more they want information.

This mission was a good foreshadow of the future. It was a success, both as a flight project and as a scientific investigation.

So in the beginning of the Mars adventure, the missions were purely American or entirely Russian.

The United-States and the USSR played a sort of ping-pong game as they did for the first man on the Moon. The Americans won the game once more.

Because of the end of the Cold War and because Russia failed in most of its projects to Mars, both countries worked together and with other countries. International cooperation started after a similar competition led by the East and West masters. The Russians had wasted a lot of time and money on their missions to Mars and now they got and took the opportunity to cooperate constructively with the Americans.

Because of the Soviet failures and because the tendency now is to cooperate rather than to compete, there will be no race for the first man on Mars as there was for the first man on the Moon. Maybe this time it would even be an international mission. The Cold War and Space Exploration competition between the West and the East blocks are definitely over.

The United-States really think about cooperating with other nations in Space Exploration.

NASA had suffered short-cutting in its Budget since the start of the war in Vietnam. Viking was an incredible cheap mission compared to its results, scientific equipment and experiments. For example the spacecrafts could reach Mars in less time but it would cost more. NASA had to optimise its expense. Cooperation brings, among other advantages, more fundings and more brains which means more possibilities and performance.

Actually, some scientists would have liked to achieve more during the Viking missions and blamed the insufficient budget. Compared to its budget Viking was a great success and gave the opportunity to bring additional information back compared to previous missions. But still the scientists felt frustrated because they believed that a lot more experiments and observation could have been led throughout these two missions. Viking is still on Mars.

Because of the past missions success and the information already collected by the United-States, other Nations start to be interested in Mars.

Of course if there is any kind of cooperation in the following missions, the United-States would have to share the privilege, honour and international recognition for detecting life on Mars if there is any.

Mars 1992 Observer and Mars 96: cooperation and failures.

The 1992 mission was launched by the United-States but failed. The United States had worked on this project in cooperation with Austria, France and Canada. By chance, the failure of the mission did not discourage the international partners who still cooperate on the missions to Mars or participate in other projects as the ISS. This failure was very disappointing compared to the success of Viking. A purely American mission launched in 1975 reaches its aim and an international mission, gathering more means, technology and brains fails. But the Martian adventure had just started. More successful and unsuccessful missions would be launched afterwards.

In November 1996 Russia launched a mission including an orbiter, 4 landers and 22 scientific instruments. The mission failed. This was the last try and failure in the East.

This was also the first mission on which Russia and the United-States cooperated marking a turning point in the political atmosphere and relationship between the two countries.

Different countries start to work together. Even Russia and the United-States cope with cooperating with one another but Mars 1992 Observer and Mars 96 both failed. This was not an encouraging start. But still, because of what was revealed about the Red Planet through previous American missions and the study of Martian meteorites on Earth, Other countries start to have an interest in Mars and express their will of participating in missions to Mars.

Mars Pathfinder and Global Surveyor.

In 1996 the Americans launched a new mission to Mars which consisted of an orbiter called Mars Global Surveyor and a lander with a micro-rover named Mars Pathfinder.

This mission was to test new key technologies and concepts to be of eventual use in future missions. Every new project now prepares the following one. There is a real continuity in NASA’s work concerning Mars exploration. The general objective of this mission was actually to collect information about the characteristics of the Red Planet environment for further exploration.

This project was managed by the Jet Propulsion Laboratory for NASA. JPL is located in California. This Centre is to play a crucial role in every mission including the use of robots.
The science instruments on board Mars Pathfinder and Global Surveyor are to study the Martian atmosphere, surface meteorology and geology as well as the form, structure and elemental composition of Martian rocks and soil. The aim was to gather information on the early evolution of the crust, on the development of weathering products and on the early environment conditions.
Previous missions investigated the same parameters. Because NASA always chooses a new and very different landing site the new and more precise data (thanks to the new technologies) can be compared to the ones of the former missions. This is how scientists have learnt about the dust storms for example. They know now when and where they are more likely to occur.

Mars Pathfinder.

Mars Pathfinder landed on Mars in July 1997 in the mouth of a channel called « Ares Vallis ».
Mars Pathfinder was also called Mars Environmental Survey since its main goal was to characterise the Martian environment for following missions.
The lander entered the Martian atmosphere without going into orbit around the planet and took atmospheric measurements on its way down to the Martian surface.
The lander and the rover operated until communication was lost for unknown reasons in September 1997.
Denmark and Germany participated in different stages of the lander's realisation. Foreign countries started participating in the projects. They mainly provided equipment and specific technologies. But this cooperation seemed still quite timid. Foreign countries would hopefully like to be more involved in future projects.

The rover, also called « Sejourner », was a six-wheeled vehicle. It started its work 2 days after the landing.
It was controlled by an Earth-based operator using the images taken by the rover and the lander to orientate the micro-rover. The communication delay between Earth and the rover was 10 to 15 minutes.

Sojourner analysed nearby rocks and soil. It transmitted information on the magnetic properties and soil mechanics of the surface. Its alpha-proton X-ray spectrometer (APXS) investigated the petrology and geochemistry of surface material.
It also gave the first view of the Red Planet surface from the ground in taking black and white and colour pictures.

The lander's main task was to support the rover. It transmitted views of the rover and its immediate surroundings to Earth.
It also had scientific instruments on board which were an imager (IMP), an atmospheric structure instrument and meteorology station (ASI/MET) and a deep space network (DSN).
The IMP gathered information on the surface morphology and geology at meter scale.
The ASI/MET gave data on the atmospheric structure as well as on diurnal and seasonal meteorological variations.
The DSN transmitted information about the rotational and orbital dynamics of Mars.

Mars Global Surveyor.

The orbiter or Mars Global Surveyor was launched in November 1996 and inserted Mars orbit in September 1997. It is still on orbit.
Its main work is to make pictures to allow a new mapping of the Martian surface. A mapping phase lasts a Martian year.
Austria and France participated in the achievement of this project.
The Global Surveyor is fulfilling its second mapping phase and will enter into its relay phase. That means that the orbiter is then used as a radio relay for the remainder of its on-orbit lifetime. It then uses its relay antenna.

Global Surveyor is also equipped with scientific instruments as an inertial measurement unit (IMU), a laser altimeter (MOLA), a thermal emission spectrometer (TES) a magnetometer and electron reflectometer (MAG/ER) and a camera (MOC).

The IMU contains gyroscopes and accelerometers to measure angular rates and linear accelerations.
MOLA collects data allowing the mapping of the topography of the planet.
TES measures infrared radiations to determine the general mineral composition of patches of ground. It also scans the Martian atmosphere to provide data for the study of clouds and weather.
MAG/ER measures the global magnetic properties of Mars which gives information on the internal structure of Martian rocks and soil.
The images taken by the Mars orbiter camera could be compared to the ones taken by Mariner's and Viking's orbiters to study the evolution of chosen sites on the surface. MOC is a 2 wide and 1 narrow angles camera.

The success of this mission was crucial for NASA. No mission to Mars had been launched with success since "Viking".
The lander operated nearly 3 times its design lifetime of 30 days.
The rover Sojourner operated 12 times its design lifetime of 7 days.

Thanks to the precision of the new pictures and studies of the Martian surface scientists have good reasons to think that there was once water on Mars. Unfortunately the analyses done during this mission gave no evidence of life on Mars.
If samples of Martian soil and rocks could be brought back, more precise study and analyses could be done on Earth to determine actual or former presence of water on Mars.
If men could go on Mars they could make further investigations that robots were not able to do up to now. These will be the two main scientific issues for the following missions.

Conclusion

In 1960 when USSR launched project 1M they were still in a political conflict with the USA. At the time of the Cold War the two countries had a very tensed relationship. The Americans and the Soviets were running for military supremacy. But they were also competing against each other on fields like the conquest of Space. They were on a race to the Moon and Mars.

USSR was to lose both contests. As a matter of fact, most of the missions the Soviet Union launched to Mars failed and when they succeeded they achieved but little and did not discover anything amazing throughout their missions.

In the beginning Soviet and American missions followed each other as questions and answers and showed that the two countries were fighting over success. When the USA reached the Moon it gave additional motivation to the USSR to work harder on its missions to Mars.

Most of the Soviet missions failed when the United-States achieved a lot through the missions they launched to Mars. The political tensions between the two countries started to weaken.

In 1996 the Americans and the Soviets worked together on a project. Even if Mars 1996, launched from Russia, failed, it was a turning point in Space exploration History. Before, even if the relationships between the two countries were improving, we could not tell if the Cold War was really over. In 1996 since they were able to cooperate on the same project it really meant that the situation had changed.

Until then the two countries had been competing with each other and now they were cooperating. Nowadays they tend to communicate and cooperate more and more in many fields such as in Space exploration. This was only one step towards much bigger projects as the International Space Station.

Even if all the former missions and particularly the Viking missions gave a lot of crucial and new information about Mars and its atmosphere, further studies needed to be done. For example they had not gathered enough information to conclude that there was no chance at all to find any trace of life on Mars or to send people to this planet. Scientists still believed that they could discover something in the depths of Mars.

New technologies also enable scientists to get better results. A lot of pictures were taken during the Viking missions, but modern cameras take more precise pictures and give a better overview of the Martian surface.

Through all these missions, NASA gathered a lot of information enabling them to work on future projects as Mars Sample Return or even Human missions.

Foreign countries already started cooperating with NASA on certain missions. But they did not really share the work with NASA. The Americans hope that they will attract foreign countries to work on future projects. As a matter of fact, the previous missions were about getting information about the Red Planet. This might not have seemed really interesting to the other countries.

The next missions will be about returning samples from Mars to Earth. As it sounds a lot more exciting, foreign countries may be a lot more interested in this type of missions. France already manifested its interest for these missions.
The most exciting part of the exploration of Mars will be sending people to the Red Planet.
Foreign countries will certainly want to participate in this outstanding project. So international cooperation seems directly linked to the popularity of the missions and of course to what they would gain out of it and the advantages for them to participate in any project.
Sending humans to Mars sounds terribly challenging which explains why people and foreign governments will certainly be interested in this mission.

If some of the features of the Martian surface proved to be interesting because they seemed to confirm the hypothesis that there was once water on Mars, this is not the only reason why scientists from around the world are deeply interested in the red planet.
So why Mars? “Mariner” missions also explored Venus. The United-States have since focused their interest in Mars. Why is this planet in particular more interesting than others?
What really motivates NASA and its partners to plan missions to Mars?
Why do they think that they may find living organisms or evidence that there was life once on Mars?
Why do they want to bring samples back to Earth and certainly send astronauts in the future?

Why Mars?

Introduction

After racing for the moon, The United-States and the USSR started to be interested in Mars and they soon launched more and more missions to the Red Planet without speaking about human missions this time. Once again, the Americans won the contest. But why did both the Russians and the Americans focus their attention on Mars. Why would Mars be more interesting than any other planet of the solar system?

At the time, scientists had observed intriguing features and changes on the surface of Mars. They even believed that there was water on the Red Planet. So they hoped finding life on Mars and it seems to be the real issue which made scientists choose Mars and no other planet of the solar system. The Martian environment seemed to be the most favourable to living organisms. Scientists also found many similarities between Earth and Mars.

Since then scientists have been looking for proof or evidence reinforcing their hypothesis. They believe that they have eventually found the clue they were looking for in meteorites which seemed to come from Mars and landed on Earth.

Missions to Mars are still launched and new and more precise photos are sent back to Earth which also seems to show that there was once water on the Red Planet.

So Mars was first chosen because it appeared as the most hospitable planet of the solar system. And new evidence reinforced the hope of the scientists to find traces of life or even still living organisms in the depths of the planet. As a matter of fact experiences trying to prove the presence of life on Mars were led on its surface during the past missions but they all failed. So scientists now believe that if there are any living organisms they are underground since the surface seems sterile. They are convinced that there are traces of past life on or inside Mars since they studied carefully the "Martian" meteorites.

But are the evidences they found really reliable? Did they set up their beliefs on facts and careful observations or only on feverish hopes and ready-made interpretations? Because, of course, it would be amazing to eventually find any trace of life on any other planet than Earth since up to now we thought that life only existed on our planet.

Early observations: a historical background.

Mars is the planet of the solar system which is the most similar to Earth. Mars undergoes seasonal changes which occur in the same way as on Earth.
The Red planet has also got polar caps that melt in the summer.

These similarities are so striking that scientists started to wonder about the existence of life on Mars as early as the nineteenth century. As a matter of fact at that time the Italian astronomer Giovanni Virginio Schiaparelli discovered on the Martian surface a network of fine lines, large and smaller dark areas and light-yellow surfaces that he called respectively « canals », « oceans », « lakes » and « continents ».
The astronomer Percival Lowell built a theory explaining the existence of canals on Mars in 1906. He thought that they had been built by intelligent life to transport water from humid to dryer areas.

Schiaparelli and Lowell both observed changes on the Martian surface according to periods of time that corresponded to the earthen seasons.
In the spring and summer a greenish hue on the surface could be observed whereas yellowish-brown hue appeared in the winter.
Schiaparelli and Lowell suggested that this change of colour was related to vegetation growing on Mars.

At that time scientists already thought that the discovery of life on Mars would be crucial to understand the evolution of Earth.
The country who would detect the presence of life on Mars would be highly honoured internationally which explains why the United-States and the Soviet-Union competed to reach this goal.

The first stage of Mars exploration has now been accomplished and no trace of vegetation, canals or life has been found yet.

Some features of the surface could be dried-up courses of waterways and others extinguished volcanoes. If there was water once on Mars what happened? Why did the water disappear? Did primitive or intelligent life exist in the past? If yes do they still exist?
Some even distinguished a sculpted face on the surface. Brian de Palma even made a movie, "Mission to Mars" after this belief. A recent photo showed that it was…only a hill…

The Martian surface just looks like a lifeless desert but scientists hope to find something interesting underground…

Some scientists think that they can already prove the existence of life on Mars.

Meteorites which might have a lot to tell. Tales or reality?

On Earth where there is water there is life. The issue of presence of water on Mars is then crucial. No water has been found on Mars directly but some meteorites which landed on Earth seem to have an interesting story to tell.

In 1998 a meteorite was found in the town of Monahans, Texas. This meteorite was said to contain « water from the birth of the solar system ».

Scientists found « purple-tinged » salt crystals inside. The salt was apparently formed 4.5 billion years ago. The water enclosed in it is supposed to be of the same vintage. The scientists have only found a minuscule amount of fluid but it is of crucial importance since it is the first time that water was detected in a meteorite. « This water is the first real sample of the solar nebula gas, the gas from which all the planets formed » stated Robert N.Clayton of the University of Chicago.

This meteorite has been named after the city where it has been found: Monahans.
Monahans 1998 is a meteorite belonging to the ordinary chondrite type. It is a fragment of an asteroid.

The first explanation for the presence of water in Monahans 1998 would be that the asteroid, from which the meteorite comes, acquired water after the rock formed. That means that the asteroid must have been in contact with a lot of water.
Now the big issue is to determine where the water on Earth comes from. Is life on Earth unique? If so, there seemed to be so much water before in other parts of the solar system, why did life only develop on Earth?
This also reinforces the hypothesis that there was once water on Mars and maybe on other planets.

Scientists had searched for primordial water in space rocks but as yet they have not found any. The water was found by scientists Bodnar and Zolensky in November 1998.
Before some water had been found in rocks but it came from Earth environment's contamination. As Bodnar states, « the fact that the salt was purple was evidence that [the water] was in it when the rock was in space ».
Recently formed salt crystals are colourless.

After finding water in Monahans 1998, scientists studied meteorites more carefully. They found purple salt crystals in « Zag », a meteorite found in Morocco in 1998. The salt crystals also contained water.

Bodnar thinks now that water « is much more common in ordinary chondrite meteorites than people have recognised. »
The problem is that the salt crystals are really tiny and so are the samples on which the scientists work so that they might not have noticed the crystals and even less the fluid enclosed in them.

The presence of water in chondrite meteorites is really intriguing and might bring a new explanation for the presence of water on Earth. What is sure now is that there was a lot of water in the past in the solar system in other places than Earth as in the Martian environment. So life might have developed somewhere else even if it did not survive.

Monahans 1998 was a wonderful discovery which brought more questions than answers. The observations made during the Mars Pathfinder seem to show that there was once water on Mars.

Recently, scientists found new evidence of life in a meteorite. "An international team of researchers working with a Martian meteorite found in Antarctica discovered magnetite crystals arranged in long chains within the potato-sized space rock." And according to them, such a chain could only have been formed by "once-living organisms". But this meteorite is just supposed to come from Mars and shows evidence of past life. These chains only witness the presence of very small bacteria anyway.

Mars Pathfinder: a year later…

A year after the landing of Mars Pathfinder on the Martian surface scientists gave the results of the experiment and analyses made by the lander and the rover.

The analyses made by Sojourner and the pictures taken by the MOC seem to show that the area of « Ares Vallis » may have been awash 3 to 4.5 billion years ago. But at the same time it seems that this area has been dry for 2 billion years. « Several clues from Pathfinder data point to a wet and warm history on Mars », according to Golombek.

It is true that the rover found rocks that were conglomerates of smaller rocks. Also, the hills that were observed on the horizon of the landing site and known as « Twin Peaks » look like « streamlined islands shaped by water ». There is no water anymore but there is still wind activity which continues the eroding process.

The chemical analyses of a number of rocks by the APXS reveal quite unexpected results that scientists still try to explain. The landing site was constituted by volcanic type rocks with high silicon content, very similar to earthen andesite. These rocks appear as very different from meteorites supposed to come from Mars and which landed on Earth.
At the same time Sojourner worked on a very limited surface. The « Mars meteorites » might come from another part of the planet.

According to the analyses of the APXS the rocks analysed have all the same composition. But the photos show different types of rocks. And there are other enigma. On Earth andesite forms in tectonically active regions. There is no trace of such activity in Ares Vallis. So on Mars andesite must come from another process. Scientists expected basalts anyway. Andesite is maybe characteristic of this area of Mars.

The further the scientists investigate the more they can state that there was once water and warmer temperatures favourable to life on Mars. Even if the composition of the meteorites said to come from Mars and the analyses made by the rover do not correspond, scientists still believe that they come from Mars. They also believe that one of them contains traces of former life.
Another meteorite which might have an even more exciting story to tell…ALH84001 or a Martian found frozen in Antarctic.

ALH84001.

ALH84001 sounds like a code of a secret mission. Well, it is nothing more than a meteorite, a space rock if you prefer, which was found in 1984 in Antarctica. From outside it just looks like a rock but inside…it contains gas that reminds scientists of the Martian atmosphere and worms-like forms which have been interpreted as fossiles of micro living organisms. Have we discovered the first form of what we have ever called the « Martians », inhabitants of Mars? We seem very far from our imagination's versions. This form of life could be detected only through a very powerful microscope. So it does not really look similar to our lovely green creature "E.T" or to the dangerous monsters of H. G. Wells.

The Viking mission to Mars was the first mission to look for life on another planet. Some meteorites which fell on Earth contain precious gases matching with the Martian atmospheric gases measured by Viking in 1976.
Because the samples of gas trapped in some meteorites have exactly the same chemical and isotopic compositions as gases in the Martian atmosphere, the scientists concluded that these meteorites came from Mars.

There could be another place in the solar system with exactly the same components in the same proportions but the similarity is still striking.
ALH84001 has several characteristics as its distribution of oxygen isotopes and mineralogy which make scientists believe that it is a Martian rock but it does not contain gases matching the Martian atmosphere.

What is really puzzling is that ALH84001 contains features that could be evidence of past biogenic activity. Mckay and Everett Gibson discovered these shapes first while studying the meteorite through a powerful microscope.
Scientists noticed the presence of carbonate globules formed at temperatures favourable for life and indigenous reduced carbon within Martian materials. They have also found bio minerals similar to those formed by magnetotactic bacteria on Earth and elongated tubular features that look like fossils of micro bacteria. Now scientists are really waiting for the Mars sample return missions to prove them right or…wrong.

Since the hypothesis of past biogenic activity on Mars is a subject that started many controversies. Some built theories for and others against the case for life on Mars.

ALH84001 contains 2 types of organic carbon, one coming from Earth contamination and one not consistent with terrestrial contamination. So this means that this organic carbon fell onto Mars but it does not give any evidence of Martian life. The organic carbon detected could already be inside the meteorite before the impact with Mars.

Scientists also detected olivine near the carbonate globules. Olivine is formed at high temperatures not favourable for life. At the same time living organisms were found in the rifts under the ocean where the temperature is very high and where life was not expected at all. So actually traces of life might be found near the features of the Martian surface which look like extinguished volcanoes.

It has been proven that bacteria-shaped objects can form without biology. A bacterium can not be recognised by its shape alone. It could be simply amorphous precipitates or features on etched mineral surfaces for example.

Magnetite and carbonate globules could be formed during an intense impact shock event if the rock contained evaporate minerals before.

While studying meteorites scientists found water, traces of bacteria and so on…but these meteorites had been proven to have been Earth contaminated afterwards.

One argument against the original theory that fossil-like features of bacteria had been found was that no bacteria of that size existed. They said that the features were far too small. Since bacteria of that size (6nm diameter bacteria) have been found on Earth.

Bacteria from the site where the meteorite was found were grown in laboratories and some of them deposit crystals of calcite as they grow. So the meteorite could definitely have been Earth-contaminated and the carbonate globules could have been formed after landing on Earth.

Another Martian rock, called Nakhla, also shows the same type of carbonate modules. So it seems to confirm that these features do not come from Earth contamination or the two meteorites would have been contaminated in the same way.

So there are many different ways to interpret what scientists found in ALH84001. Even McKay, who really believed in his theory about having found traces of life in this meteorite, doubted his conclusions afterwards. As a matter of fact, he later stated "there may be contamination that we had not corrected for. There may even be some Antarctic microbes in there."

Only the Mars sample return missions or even human exploration on Mars will tell us which hypothesis was the good one. Nevertheless what was found in ALH84001 is very intriguing and restarts the debate about the existence of life on Mars.

The study of this meteorite indicated that it crystallised 4.5 billion years ago and that it spent 16 million years in space before falling in the Antarctic. That means that the rock crystallised when Mars was a warmer and supposedly wetter planet so when it was more hospitable for life. Actually, it is not the fact that the carbonate modules may be bacteria which is really

interesting. If they are bacteria, there might have been other forms of living organisms on Mars, when the Planet was warmer and wetter and this starts to be very interesting. On Earth, living organisms were found in very inhospitable areas and they were coping with extreme conditions by using geochemistry rather than photosynthesis for energy. So scientists hope that traces of life remain on Mars, even if the planet is rather inhospitable now.

ALH84001 was said to contain traces of past Martian life in 1996 and this might be proven to be true in 2008 when the first samples from Mars will come back to Earth.
Life forms similar to the supposed bacteria fossilised in ALH84001 may still exist on Mars if there is some liquid water underground, as some researchers theorised.
Earth seems to be the only planet with liquid water in the solar system although there might be some on Europa underneath the ice covering parts of the planet but this theory has not been verified yet. So scientists look more for traces of past life than for living organisms.
Experiences have already been led in former missions to Mars. Some nutriments were brought and spread onto the Martian surface. The result of these tests were negative. So at least there seem to be nothing living on the Martian surface which explains why the samples which would be brought to earth would come from underneath the surface. The rover would dig as much as possible to get some interesting and maybe more significant samples.

Mars was not only chosen because of its similarities to Earth and the findings linked to the first missions and meteorites. It is also the most interesting and accessible planet.

Mars: a hospitable planet.

In the search for life in the solar system Mars is the planet where life is the most likely to have developed.

Mercury is far too close to the sun. It is exposed to extreme radiations and temperatures. So it is also much too hot.

Venus is also far too hot. Its surface undergoes extreme pressures. So it is definitely not a candidate. No picture of its surface could be taken since Venus is cloud-covered. So anyway Venus was since the beginning more hostile than Mars. Since it is also not too far Mariner missions were launched to explore Venus.

Jupiter, Saturn, Uranus and Neptune are gas giants. The pressure of their surface is far too great to allow any landing at all.

Pluto is really too cold and also too distant from Earth.

Europa, Jupiter's moon, and Titan, Saturn's moon, seem to represent interesting targets. The conditions on these planets do not seem to be hostile to life and it must be possible to land on them. But they are further away than Mars and also seem more inhospitable than Mars.

Mars is already very far away from us. This is an issue in the prospect to send humans to Mars. The Moon was much easier to reach but was also less interesting. We know that there is no life on the Moon.
The distance means that it is more risky. It will take a longer time to reach Mars and that means that « emergency » return will be impossible.
But still it is the nearest planet among the interesting ones. Its surface allows landings. It is not too cold or too hot even if the actual conditions on Mars are different to the conditions on Earth.
Mars also has an atmosphere and polar caps. The pressures measured on its surface do not seem extreme.

So Mars' similarities to Earth, its proximity and the findings in Meteorites make this planet a very good and interesting candidate in the search for life in the solar system.

Conclusion

Some of the features of the Martian surface seem to show that there was once water on Mars. Where there is water on Earth there is life. So there are good chances to find traces of living

organisms on the Red Planet. But now the Martian soil seems dry and sterile. So the only reliable evidence seems to be the Martian surface itself and its "canals" and "canyons".

But what scientists found in meteorites is not clear. First of all, nobody can assert for sure that these meteorites come from Mars. Some enclose gas matching the composition of the Martian atmosphere. Some only look like the ones containing the gas.

It is the case of ALH84001. This meteorite does not contain any gas but only looks like another meteorite which supposedly comes from Mars. And nobody can assert for sure what they found in this meteorite and it is ridiculously small anyway. So ALH84001 does not seem to be reliable evidence.

But scientists of NASA already convinced their colleagues, the public opinion and foreign countries. Now the international scientific community focus their interest in Mars. Everybody forgot about the Moon.

The Moon is near and cheap to go to. The Americans now know how to reach it safely. They still do not exactly know how they will send men to Mars and even robot missions failed up to now.

One of the reasons why no expedition is sent to the Moon is that the missions to Mars are very expensive and no money is left for the Moon. It is a shame because contractors are interested in the Moon but not in Mars. The missions to Mars are launched mainly thanks to the governmental budget.

By chance, Europe and Japan think about sending robotic missions and then maybe astronauts to the Moon but the public opinion is now turned towards Mars. The Moon is no big issue. Men already landed on it but nobody apart from robots went to Mars.

Actually nothing seems in favour for Mars. A mission to Mars is expensive. We do not know much about Mars and its environment. Health care would definitely be a problem being so far from Earth. Nobody can supply a reliable station to stay on Mars or a reliable rocket to come back to Earth. But still, NASA and its partners hope to find the solutions to these problems and they intend to send humans around 2018.

The Moon is near and its resources could be carried on. It could even be used as a stepping-stone to Mars. For example, a station could be tested on the Moon and then used on Mars afterwards. But the Moon is sterile. Scientists are sure that there are no life or traces of life on the Moon. But concerning Mars they hope for life or traces of life.

So the big issue which led the international community focussing their interest in the Red Planet is finding life on another planet of the solar system. And Mars is not too far from Earth compared to other planets of the solar system. So men could possibly be sent there. No adventure is really great in Space if it is not accomplished by men.

The future missions will confirm or contradict the hypothesis of the scientists and they really wait for the Mars Sample Return Missions which may bring back crucial information to Earth.

Recent and current missions and the development of international cooperation in space projects concerning Mars.

Introduction

After a period of tension between the Americans and the Russians, the two countries start to work together on different projects including missions to Mars.
European countries and Japan also start to interest themselves in Mars. Europe would not launch a mission on its own to Mars yet. So ESA starts working with NASA even sometimes providing scientific payloads for certain missions. Japan launches missions on its own but also cooperate with NASA.
Now there is no challenge, no race between any country anymore. It would be useless and very expensive for every country to launch its own missions. The Space Agencies from around the world work together, cooperate, complete each other's work. They understood the advantages of cooperation. They do not loose time and money anymore.
But NASA is still the supervisor. They organise and gather the efforts of the other countries. The missions are still mostly American. Their partners help, provide funds and payloads but they do not share the work and the cost with the United-States. Their contribution in the different projects seems very small compared to the American one. Only the relationship between the USA and Japan may be called cooperation. The other country worked more "for" than "with" NASA up to now.

Planet-B

Planet-b is a Japanese mission which was launched in July 1998.
The main goal of the Nozomi Orbiter is to investigate the upper Martian atmosphere and its interaction with the Solar environment.
The spacecraft carries US scientific instruments and Nasa provided a Neutral Mass Spectrometer, an Ultrastable Oscillator and the tracking support during the launch cruise and Mars Orbit Insertion phases of the mission.

Nasa regards Japan as a stable partner and NASA and NASDA are to work together on future missions to Mars.
As mandated by the National Aeronautics and Space Act of 1958, NASA is to conduct its activities so as to « contribute materially to […] cooperation by the United States with other nations. »

The 98 mission :a failure.

The purpose of the 1998 mission was to study « Volatiles and Climate History » of Mars. This mission will not search for life on Mars.
The volatiles we speak of are the substances that tend to be liquid or gases at room temperature (25°C). The principle volatiles on Mars are water and carbon dioxide. These volatiles and their dynamic behaviour and history are one of the main reasons why Mars is an interesting place to study. They also represent an important resource which could be used during future human missions. An experiment of the ’01 mission will tend to use the Mars atmospheric carbon dioxide to produce oxygen.
The ’98 mission included an orbiter (Mars Climate Orbiter) and a lander (Mars Polar Lander) but no rover.

Mars Climate Orbiter.

Russia and the United Kingdom participated in this mission. NASA definitely tries to develop cooperation with other countries. On this mission the share of the work did not prove to be constructive.
The Mars Climate Orbiter was launched on December, 11, 1998. It was supposed to be a 2 years mission and the orbiter would have acted as a relay station for 5 years assisting Mars Polar Lander and the ’01 mission lander in data transmission. Its goal was to gather information on the cycles of the Martian dust, water and carbon dioxide.
The spacecraft's main bus was 2.1m tall, 1.6m wide and 2m deep. Its weight was 629kg with the inclusion of fuel.

The scientific instruments on board were a MARs Colour Imager (MARCI) and a Pressure Modulator InfraRed Radiometer (PMIRR).

MARCI comprises a wide angle (WA) and a medium angle (MA) camera. The WA camera should have taken daily global Mars images. The MA camera should have been taking pictures of the surface at intervals with high data rates. This would have enabled scientists to study the seasonal changes in the Martian surface. The MA camera would also have taken pictures of atmospheric features such as clouds. So it would also have given information about the interaction between the atmosphere and the surface of the planet.

PMIRR would have provided information about the carbon dioxide added and removed from the 2 poles each Martian year. One Martian year corresponds to approximately 2 years on Earth. It would also have given detailed information about Martian atmospheric temperatures, dust, water vapour, clouds, condensates and the surface radiation balance.

Loss of the Orbiter

Several events and mistakes led to the loss of the orbiter. When this project was started more training should have been planned.

The fact that the mission was held in cooperation with Great Britain did not help. Cooperation has been a positive experience in the past. The problem here is that since American and British people speak nearly the same everyday language they might have not realised that they were not speaking the same scientific language. Cooperation included hard training and intense communication between the different countries working together. As a matter of fact the "root cause" of the loss of the spacecraft was "the failed translation of English units into metric units in a segment of ground-based, navigation-related mission software." (Nasa's release 99-134. 10, 11, 1999. Headquarters, Washington, DC.) So millions of dollars, an amazing scientific effort and important information for future missions have been lost simply because of an unforgivable and very silly mistake: a failed translation of units.

Because of the success of the past missions the scientists may have felt a bit too confident in the '98 project. They have taken less care and might not have checked every instrument thoroughly and the overall good working of the mission. There might have been a lack of

communication, not only between the different countries working on the project, but also within the American team and between the engineering groups.
At the end of September the flight controllers of the mission were already thinking about abandoning the search for the Mars Climate Orbiter. They considered that the spacecraft was lost.
This should have warned the team taking care of the lander but it might have been already too late.

Mars Polar Lander

More foreign countries participated in the conception of the lander. Denmark, Finland, Russia and Germany worked on different elements of the scientific equipment of Mars Polar Lander.
The Mars Polar Lander was launched on January, 3, 1999.
The spacecraft was 1.06m tall and 3.6m wide and its total weight was 576kg.
Lander was to carry 4 science instruments :

- Deep Space 2 Microprobes,
- Mars Volatile and Climate Surveyor (MVACS),
- Mars Descent Imager (MARDI),
- Light detection and ranging (LIDAR) and Mars Microphone.

The 2 small microprobes would have separated from the lander just before it would have penetrated the Martian atmosphere and would have slammed into the surface instead of landing. They were supposed to penetrate the subsurface 2 meters deep and then release their science package. This experiment was to determine if there was any water ice in the subsurface of the planet. They would also have measured the temperature variations.

MAVCS comprised a surface imager, a robotic arm, a meteorology package and a thermal and evolved gas analyser.

LIDAR is provided by IKI, the Russian space research institute, under the sponsorship of RSA, the Russian space agency. This is the very first Russian instrument to fly on an

American planetary spacecraft. American equipment had already flown on a Russian mission. Unfortunately, this mission, called Mars 96, failed.
LIDAR will look for ice and dust clouds.
Mars Microphone is the first privately funded instrument from a non-profit organisation :The Planetary Society. NASA actually tends to develop cooperation with all sorts of organisations. Usually they work more with industries and universities. Non-profit organisations seem to be interested in participating in the missions and seem quite helpful in the matter since they provide equipment like the microphone on this particular mission. So non-profit organisation might participate more and more in Space exploration.
This microphone will listen for any sound that might be detected on the Red Planet.
The LIDAR system consists of a laser sounder. It has 2 sounding modes, an active and an acoustic. While on the active mode, only LIDAR works. While on the acoustic mode, LIDAR and the Planetary Society's Microphone work in correlation with each other.
The Martian atmosphere is different from the Earth atmosphere and sound is not propagating in the same way so the results might have been surprising. Most of the noises which would have been recorded would have been linked to weather patterns as wind.

The landing site chosen for that mission was situated in the South polar region. As a matter of fact, thanks to its colder conditions at high latitudes, the probability that the lander will be able to come into contact with volatiles and geologic units is increased. The polar layered deposits may contain records of past climate variations on Mars. This landing site was chosen with the help of the '96 mission orbiter. Its camera (MOC) and its laser altimeter (MOLA) gave precious information to the '98 mission working team.
On a mid-summer day the maximal temperature expected is –5°C and the minimal –60°C. Near the end of the mission the temperatures would oscillate between –90°C and –30°C.
The polar caps are a permanent phenomena but their superficial layers melt in the summer. Surprisingly enough, the 2 caps are very different. The North cap is mainly composed of water ice and is 10 times larger than the south cap which is composed of carbon dioxide ice. Why do they differ so much ? This is a peculiarity which has not yet been explained.
The 2 first days after the landing would have been dedicated to a functional checkout and to the establishment of the communication with the orbiter. So the routine science work would have started the second day after the landing. The lander was to search for near-surface ice

and possible surface records of cyclic climate change to characterise Martian seasons. It was also supposed to study the evolution of the carbon dioxide and the dust on Mars. The science phase was expected to last 90 days.

Loss of the Lander.

The lander might not have been lost for the same reasons as the orbiter. The orbiter was to assist the lander in data transmission. The mission could still succeed without the help of the orbiter. It failed though. Scientists say that they do not understand why they lost contact with the lander. Maybe it is really difficult to explain or scientists simply do not want to explain what happened. Two failures on the same mission might be a bit difficult to assimilate and hard to face.

The lander fell silent on December, 3 as it was about to enter in the Martian atmosphere. The engineers were still quite confident at the time. Richard Cook, the Mars Lander Project Manager stated that he was "very confident the lander survived the descent. Everything looked very good. I think we're a long way from getting concerned. It is not unexpected that we would not hear from it during the first opportunity".

"Mars Polar Lander, phone home". Scientists have been trying to get a signal from the lander without any success. The international scientific community had immediately felt concerned. Even countries that had not participated in this particular project had offered to help confirm any signal. Netherlands, England and Italy have been listening since but they have not received any answer yet. So cooperation may even be spontaneous sometimes! Americans do not have any hope to get in contact with their lander anymore and the efforts of the foreign countries did not succeed.

They now think that false information may have been transmitted from or to the lander and that it finally crashed on the surface of Mars. They now try to compare the successful missions to the unsuccessful ones to understand and try to prevent mistakes in the future. The shame is that this mission would have brought very crucial information as far as human missions are concerned.

This project was to go faster and better and be cheaper than the previous ones. Nasa might have spared too much time and money on the project. Since the mission failed they finally lost a lot of time and money. This must be very frustrating for the people who have worked very

hard over several years on this project. The '01 mission has to be a success. At least engineers learnt a lot about the possible mistakes they have to avoid now. It hopefully did not discourage international cooperation.

The 2001 mission.

To really interest other countries and investors NASA must do preliminary missions. Until the ’01 project the missions will have focussed on observation. The foreign investors will be interested in something new and really challenging like the sample return missions. On the ’01 mission NASA already tries to work with other countries on the scientific instruments which will be launched.

Cooperation is ever a challenge because different countries have different scientific languages and logic. It is also hard to work together and keep deadlines. It has already been a problem in the past and particularly for the 98 mission.

On this mission the United States will cooperate with Russia. This type of cooperation benefits to NASA which has then access to Russian capabilities and it also aims at strengthening the political base between the two countries. In this case NASA promotes the interests of the United-States Foreign policy.

The ’01 mission is also one more step towards human exploration of Mars.

Unfortunately, because of the failure of the last mission, this mission may be delayed until the scientist gain confidence in the success of their missions. To its "faster, better, cheaper" motto Nasa will have to add "successful" next time.

The lander

Denmark, Germany, Russia and Switzerland will participate in this mission by providing scientific equipment.

Mars Surveyor ’01 Lander is scheduled for launch in April 2001.
The lander will carry the following scientific instruments :

-APEX : Athena Precursor Experiment,

-Mini-TES : Mini-Thermal Emission Spectrometer,

-MECA : Mars Environmental Comptability Assessment,

-MIP : In-Situ Propellant Production on Mars,

-MARIE : Martian radiation environment experiment,

-RAC : Robotic Arm Camera.

The APEX experiment also comprises the APEX Lander Instrument Suite which is composed of 4 scientific instruments : Pancam, mini-TES and a Moessbauer and an Alpha-Proton-X-Ray Spectrometers.
Pancam is a high resolution stereo multispectral panoramic imager.

Mini-TES will characterise the Martian terrain from the lander using thermal infrared spectroscopy. If mini-TES proves to be a satisfying experience it will also be used on the rover of the ’03 mission by helping to select the samples to be collected, stored and eventually returned to Earth.
Russia and Germany are working together on the development of the Moessbauer spectrometer which is an in-situ instrument to determine the mineralogy of Fe-bearing rocks and soils.
Scientists want to obtain Moessbauer measurements on Moessbauer calibration targets, on multiple surface and subsurface soils, on airborne dust and on rocks to study their mineralogy and assess its diversity.
The alpha-proton-X-ray spectrometer is also an in-situ instrument and its function is to determine the elemental chemistry of rocks and soils.

MECA will investigate the hazards on the surface of Mars which could prevent human exploration because they would be dangerous for astronauts.
MECA comprises an atomic force microscope via a MIcro and NAno System Technology (MINAST), an optical microscope, an electrometer and patch plates.
MINAST is a concept being developed by Switzerland.

Germany and the United-States are working together on the optical microscope.
The patch plates is a nano experiment challenge developed by students sponsored by the Planetary Society.

MIP is very small (40 cm large, 24 cm wide and 25 cm high) and light (8.5 kg) but it is a very new and revolutionary concept.
The primary objective of MIP is to be a life support system in producing a propellant. To fulfil this goal MIP contains a Mars Atmospheric Acquisition and Compression (MAAC) and an Oxygen Generator Subsystem (OGS) experiments. MAAC is to acquire and compress Martian atmospheric carbon dioxide. OGS will produce propellant-grade pure oxygen from carbon dioxide. OGS is to demonstrate that it is possible to produce oxygen from Martian atmospheric gases in the Mars environment. It will be the first time that propellant will be produced on an interplanetary mission. No such experiment had been done on the Moon. MIP has been tested in a chamber simulating the Martian atmospheric conditions and it worked.

Carbon dioxide makes up more than 95 percent of the Martian atmosphere. So it must be easy to collect this gas since its concentration in the atmosphere is of such importance.
This time MIP will just produce oxygen but it will not store it. If the experiment succeeds, a bigger MIP would be built for the ’03 mission and this time the oxygen produced would be stored. A rocket might even be launched using the propellant produced.
The scientists will check if the experiment works by measuring the voltage and pressure inside and between MAAC and OGS.
Even if there is a dust storm MIP should work. The process would just be slowed down.
MIP is not reusable, it is really just an experiment which is supposed to last 21 days.

Oxygen is a good propellant. This experiment is crucial to future human exploration. The Spacecraft sending the astronauts would completely consume the propellant on board during the cruise and evolution around Mars. It is then obvious that propellant must be produced on Mars for the crew to come back to Earth. If the original spacecraft was transporting the propellant required for the whole trip it would cost a lot more and less scientific equipment could be taken on board because of the additional weight.

If MIP is proved to work on Mars it will enable future robotic and human missions to rely on propellants produced and stocked on the Red planet. It would also be used on Earth to produce pure oxygen to provide hospitals, for instance.
The goal of MIP is to conduct long term operations on Mars.

MIP also contains other experiments which are MATE (Mars Array Technology Experiment), DART (Dust Accumulation and Repulsion Test) and MTERC (Mars Thermal Environment and Radiator Characterisation).

MATE has on its surface several types of solar cells. This experiment is to measure the spectrum at the Mars surface and to identify optimal solar arrays for future power systems to be used on Mars. MIP will not receive its power through MATE but through the lander.

DART is to investigate the properties of dust and to test techniques to mitigate the settling of airborne dust onto solar array surfaces. To mitigate the dust DART will use tilting and electrostatic repulsion.

MTERC is to measure the night sky temperature and to demonstrate the performance of radiators to design some for future long-term operations on Mars.

MARIE the fifth scientific instrument, will characterise the aspects of the near-space radiation environment. The aim is to determine if the radiation of the Martian environment would represent a risk for human explorers.

RAC is constituted of a robotic arm and a stereoscopic panoramic imager called « Pancam ». To adjust the camera the scientists will use a sundial that will be sent with the lander.
NASA is in a very co-operative phase. Do they also want to cooperate with Martians ?
The sundial motto is « Two Worlds, One Sun ». Its design has been inspired from schoolchildren ideas. « Mars » will be written on it in many actual and ancient languages (just in case the Martians would speak one of them). The artist Lomberg combined stick figures of

Earth people drawn by children with other space-related motifs. A message will be carved on it :

« People launched this spacecraft from Earth in our year 2001. It arrived on Mars in 2002. We built its instruments to study the Martian environment and to look for signs of life. We used this post and these patterns to adjust our cameras and as a sundial to reckon the passage of time. The drawings and words represent the people of Earth. We send this craft in peace to learn about Mars' past and about our future. To those who visit here, we wish a safe journey and the joy of discovery ».

At least the sundial will be an original calibration target or test pattern for the panoramic camera.

But are we still scared by the threat foreshadowed long ago by H.G.Wells ? Apparently, all we could fear would be a bacterial invasion…

The rover

The rover of the '01 mission will be similar to the Sojourner of the 1996 mission. So it will be a six-wheeled rover slightly modified for this mission.

The orbiter

France and Russia participated in the conception of the orbiter.

The Mars Surveyor '01 Orbiter is scheduled for launch in March 2001.Once on orbit it will support communication with the '01 lander.

The orbiter will carry the following instruments :

-THEMIS : THermal EMission Imaging System,

-MARIE : Martian radiation environment experiment,

-GRS : Gamma Ray Spectrometer,

-HEND : high energy neutron spectrometer.

THEMIS is to determine the mineralogy and morphology of the Martian Surface using a high-resolution camera and a multispectral, thermal infrared imaging spectrometer. It will have to

map the entire planet. It will also support the lander's operations and help choose landing sites for future missions.
THEMIS analyses and mapping will determine the past or present hydrothermal and sub-aqueous environments and the temperature anomalies associated with them. This will be helpful to identify sample return sites for the '03 and '05 missions. As a matter of fact on Earth there is life where there is water. So it seems more interesting to bring back samples from areas where there would still be water or where there used to be some in the past.
THEMIS will utilise the same infrared spectral region as the Thermal Emission Spectrometer of the '96 mission but at high (100m) spatial resolution. It will then provide a direct link to the global and hyperspectral mineral mapping from Mars Global Surveyor.

MARIE is used in conjunction with a similar instrument on the lander to determine and model the effects of the atmosphere on the radiation-induced hazard on the surface. This is the only experiment which appears on the lander and on the orbiter.

GRS is composed of a gamma-ray sensor and 2 neutron detector systems comprising HEND.
It will achieve a global mapping of the elemental composition of the surface and determine the abundance of hydrogen in the shallow subsurface. A large quantity of hydrogen has been found on the shallow subsurface of the Moon. Scientists want to know if there is some on Mars as well and in what quantities. This hydrogen might be used in future missions. This instrument is really interesting because it can generate a full analysis of a major-element as oxygen and determine the concentration of other elements with a 10% precision.
GRS will study more closely the polar caps. It will determine their composition and the evolution of their thickness throughout the seasons.
It will also map the distribution of water, determine its near surface stratigraphy and study the nature of the cosmic gamma-ray bursts. It will have a close interest for suggested lake beds or ancient ocean bottoms because they might have collected significant salt content so it will give crucial information as far as sample return and human missions are concerned.
It will also give information on the distribution of volatiles in the Martian atmosphere, on past climate and on the geochemical evolution of the planet. In studying the composition of erupted magmas on the surface it will give a fair idea of the composition of the Martian

interior. Mars Pathfinder results suggest that rocks may be silica-rich. This mission will determine if the highlands are the source of the silica-rich rocks.
GRS is the rebuilt replica of the instrument which was lost with the ’98 Mars Climate Orbiter and is to fulfil the investigations which had been programmed for the failed mission.

HEND is a Russian Instrument.

So more countries participated in this project. NASA coped with developing international cooperation. Foreign countries which had participated in former projects seem more active in the realisation of this mission. Partners may become a bit more excited about this project because it really seems to be a stepping stone to Human missions. If some of the scientific equipment proves to function, it would then be used for future missions including Human missions as MIP. This mission will also confirm if there would be any hazard for people on the Martian surface or in the Martian environment. The success of this mission seems crucial for two reasons. After the failure of the last mission, NASA and its partners really need a success. It is also a preparation for Human missions. Key technologies would be tested and analyses would be led. No crew could be sent unless they could be sure to go and return from the Red Planet safely and that they would encounter no danger while on the Martian surface.

Conclusion

Every recent mission was not a success. Planet-B comforted the Americans and the Japanese in their efforts to work together. So considering the Americano-Japanese cooperation, this mission was a great achievement and it was also completed.
On the contrary, the '98 mission was a big failure. In that case, it is actually cooperation which partly led to a failure. Many mistakes were done during this mission and both the orbiter and the lander were lost. NASA even lost contact with the microprobes.
A lot of countries had contributed and worked on this project. NASA tried not to loose the support of the American public opinion and of its international partners. But this was definitely a very disappointing failure. Fortunately, it did not discourage the foreign space agencies and the NASA scientists working on the '01 mission. On the contrary, The '01 mission will certainly be modified to cover some of the experience which should have been

led during the '98 mission. Now scientists also know about the mistakes to avoid and what they must concentrate on to prevent any new mission from a disastrous failure.

Cooperation really changed through the recent missions. A lot of countries started to interest themselves in Mars but they did not seem to be ready to invest a lot in missions to the Red Planet yet. The recent studies of meteorites and the possibility of finding life on Mars increased their interest and their motivation to participate in American projects.

The Americano-Japanese cooperation really started with the Planet-B mission. Japan is a very interesting partner. This country has not a lot of experience concerning Space but the Japanese can share interesting technology with their partners. Japan also has a lot of money to invest in Space and has its own launch capability. On the contrary, Russia has a lot of experience in space but not much money to invest in big projects at the moment.

The USA, Japan and Russia did not work together on a mission to Mars yet but they all participate in the ISS.

The partners of ESA only provided some instruments or payload in the last missions. They did not participate in Mars missions on the same footing as the USA. However, France decided to become an active partner and share the work and the cost of the Mars Sample Return missions. As a matter of fact, the participation of CNES and ESA would enable the return of two samples instead of only one by the United-States. So up to now, the contributions of NASA' s partners were not great but they seem motivated to participate actively in future projects. But in that respect, money is a big issue. Other countries have a less important government budget than the United-States. So their participation demands great financial efforts compared to their means.

So recent missions seem to have opened the way to a more active cooperation between the international partners. Even if the USA, Japan and Russia seem to be the most active in space nowadays, Europe and other countries may be willing to launch their own missions or participate more in American, Japanese or Russian projects. And why not end with an International Space Agency coordinating the efforts of all the partners?

Mars Sample Return Missions

Introduction

Up to the '01 mission to Mars, NASA will remain the leader supervising the elaboration and the launch of the missions to the Red Planet. European countries, Russia and Japan started to interest themselves in Mars. But their contribution appear rather small compared to the American one.

The Mars Sample Return Mission is a great challenge. It attracts more foreign countries because the international scientific community is persuaded that there was once water and life on Mars. They even hope finding living organisms in the samples which will be brought back to Earth. This issue may have convinced the French about the importance of such mission and they eventually decided to offer a large contribution to this project. When considering the State Budget of France, the American realise that they really do a great effort. As a matter of fact, if France participates in the Mars Sample Return missions, two samples instead of one will be brought back to Earth.

But this project seems as exciting and appealing as dangerous to the scientists. As a matter of fact they do not know enough about the Red Planet not to fear a probable contamination of Our Planet. NASA already treated samples of another planet: the moon. But in this case, only the contamination of the sample was feared. So the partners would have to conceive and build a capability preventing the samples, the people manipulating them and the exterior from any contamination of any sort.

The analyse of the sample will enable the scientist to determine if there would be any hazard for human beings on the Martian surface and in its environment. So the Mars Sample Return Missions seem crucial to the human missions. NASA intend to send astronauts to the Red Planet but they are still not sure if such a project can be launched or not. The samples may tell about the possibility or the impossibility of sending people on such a long trip.

Overview

This project is mostly an American idea in the beginning. Since scientists discovered a meteorite which seemed to come from Mars and which contained traces of life it became even more interesting to get samples back from Mars. Of course a Mars sample return mission included previous projects. Everything began in 1996 with the Surveyor program. The first part of the program would include three "reconnaissance" missions. Scientists then aimed at surveying Mars globally and choosing appropriate landing sites. They also wanted to practice in-situ science on the surface, improve the telecommunications and navigation infrastructure and demonstrate the need of future technologies throughout the missions. Unfortunately, some of these aims have not been achieved yet because of the failures of the Mars Polar Lander and of the Climate Orbiter.

The Mars sample return adventure will really start with the '03 project.

The Japanese mission "NOZOMI" which was mentioned before is also part of this program.

Issues

The Americans intend to launch a vehicle to Mars in 2003 and France would then launch Ariane 5 in 2005. The two sets of samples collected during these two missions would be returned to Earth by 2008. If the French do not participate in the project, the American samples would still be brought back to Earth by 2008.

The goal of the '03 and '05 missions is to select two samples of one kilogram each. The two samples will be taken out of very carefully chosen and different areas, ones which look like ancient ground or surface water environments. At first 5kg will be extracted from the ground and 1kg will be taken out of that amount. Compositional analysis will be led before the selection of the samples which would be brought back to Earth. This is really not much and if the International partners give up their participation in that project only one sample of one kilogram will be brought back to Earth. So concerning this particular project cooperation with other countries is really a crucial issue.

Through this mission and others, scientists aim to understand how Mars evolved and its resources for future exploration. They would then try to link their studies to observations made on Earth's climate change and processes. The biological history of Mars as well as its physical and chemical environment might help scientists to understand how our Planet itself is evolving.

Scientists are still looking for past or present traces of life on Mars on this particular mission. The studies of different meteorites increased their curiosity and hopes concerning this subject since they revealed "circumstancial evidence of possible prior life on Mars" and traces of water. The observation of some Martian surface features tend to reinforce the hypothesis that there was once water on the surface of Mars. On Earth primitive life appear wherever there is water and energy and even in extreme environments so primitive life might be found on Mars. However a scientist, Bruce Jakosky stated that " the probable low abundance of life on Mars, if any, will make this difficult" and " the chance of picking up rocks containing fossils or even life during sample-return missions is small." But scientists might be lucky and they will look for life were it is more likely to be anyway. At the same time looking for life on Mars sounds like looking for a needle in a hay stack.

The last big issue is contamination. The samples returned to Earth might be contaminated by our environment and might also contaminate it. Among the meteorites which landed on Earth, some had been contaminated by the terrestrial environment which led the scientists to wrong conclusions and findings. So it would be most preferable to avoid this kind of problem and to preserve the biological and geological integrity of the samples. We also do not know enough about the Martian environment to be absolutely sure that it represents no risk of contamination to us. A laboratory to study the samples on Earth has been worked out taking this data into account.

If this project is concentrating on the possible existence of life on Mars. Current life will be looked for where water would be found on the surface of Mars. Traces of extinct life or fossils will be looked for near features on the surface looking like ancient canals or lake. This project will also help to determine if the Martian environment might be dangerous for humans or not, thanks to the in-situ experiments. The analyses of the samples will help identify the best locations for future long term missions which may involve men. It uses key technologies which could be used for human missions on Mars if they prove to be efficient during the Mars sample return missions. This might also explain why France shows such an interest in that mission. Everybody is looking forward to human missions to Mars and would like to participate in this great project.

What the different Partners would provide

NASA is in charge of most of the ’03 mission. If one of the partners quitted the whole project there would be only one American sample return mission in ’03. NASA would retain overall management of the two missions anyway.
For the ’03 mission NASA provides the lander, the rover, the Mars ascent vehicle, the rendezvous and docking equipment and the Earth entry capsule.
Of course the spacecraft would be launched from the United-States using the American rocket Delta 3.
The mission also comprises a micromission bus also delivered by the United-States.

CNES, the French space agency would be in charge of most of the ’05 mission. The aim of the Americano-French cooperation is to bring 2 sets of samples from Mars back to Earth instead of one.
CNES would provide an Orbiter capable of bringing two sets of samples back to Earth, the Ariane 5 launch vehicle and science instruments. This mission would be launched from Kourou in French Guyane.
France would also assume Piggyback launches as early as 2003 and provide NetLanders in 2005.

ASI, the Italian space agency, would provide a drill and other robotic elements for landers as early as 2003, a telecom relay on Mars Express and its operations and a radar sounding experiment on Mars Express. ASI would also possibly provide a sample canister locating and positioning in 2004.

ESA, the European Space Agency, would provide the Mars Express Orbiter in 2003. Mars Express would be equipped with radar which is a very important science instrument since it would mainly be used to study any source of water on Mars. So here cooperation also seems a crucial issue because of the importance of the additional material that foreign Space Agencies would provide. ESA would also possibly provide a sample canister locating and positioning in 2004 and a landed science package called Beagle2 through BNSC , the British space agency.
Inside ESA the share of the work is still not really defined which explains why certain scientific equipment appears twice in the previous list. The role of different partners working on a same project is always very difficult to organise and even more if they belong to different

organisations belonging to different countries. So the international cooperation on these missions already seems quite complex. The problem of the fundings for the mission inside ESA and particularly for CNES has not yet been solved.

So each mission would operate through an orbiter which would be linked to a lander including a rover. The rover would dig into the Martian surface in order to collect interesting samples to be brought back to Earth.
The two missions would be launched, as scheduled, in '03 and '05 but the two canisters of samples would be brought back to Earth in '08, as we already have mentioned. So the first canister of sample would stay in orbit while the rover sent on the '05 mission would collect samples to fill up the second canister. The orbiter would then receive the second canister of sample and be brought to earth. The canisters will protect the samples from radiation and from the Earth's atmosphere which means from contamination.
Payload would be added to the lander in these missions including technologies to be tested and would be linked to future missions as the Human missions. The lander would operate for 90 days.
NASA scientists have already determined where the best landing site would be to receive the canisters and where to build the facility to treat them. As a matter of fact, to avoid any risk of contamination of the samples, the facility has to be near the landing site of the canisters. The scientists chose the Great Salt Lake Desert in Utah as a landing site.

The main problem for NASA up to now is that France has not agreed officially with any project. In one word, nothing is settled. So NASA just assumes its partnership with CNES but they are not really sure that they can rely on it yet.
As a matter of fact, they also work on a project with only one sample return mission. But they definitely hope for three sample return missions before thinking about sending a crew to the Red Planet. Anyway, the initial project includes several robotic micromissions to test different technologies and learn even more about Mars. The number of these sub-missions also depends on the money engaged by NASA and foreign Space Agencies in the general project. It also depends on the participation of the French. Regular launches of Ariane 5 would be used in including micromissions into the vehicle itself, what we called piggyback launches previously. Every French or American micromission will intend to promote new

telecommunications and technologies and will in this sense prepare human missions as well. As a matter of fact the concept of the micromission could be very useful in human missions since it would enable NASA or CNES to deliver small payloads through a low-cost capability to Mars before or after sending the main spacecraft with the crew.

NASA looks for other partners such as NASDA. Japan is already contributing indirectly in this sample return project through its Planet-B mission and in providing material for the sample return missions, but it could also take part in the mission concerning the Mars samples. If more means and technology are gathered, the project would become more elaborate and it may give the possibility to bring additional samples back to Earth.

NASA also encourages industries in participating in the missions since they often have the means and the technologies to do so.

NASA advertises for their projects to get the support of American people, American industries and foreign countries. Their aim is to "bring excitement to every home" around the world so that every home would be like bringing money to them. If they get the support of the people, they think that they would automatically have the support of the States and of foreign Governments. They want to engage the public with an evolving "Mars Exploration Story".

Every future mission will actually be considered as International with NASA considered as a major partner.

The laboratory

Scientists have already dealt with extra-terrestrial rocks when they received samples from the Moon. The difference was that they did not fear to be contaminated by the moon rocks so the Moon rock facility has been built to protect the samples but not the people working on them. Anyway the Moon Rock Laboratory is 30 years old so it is high time to build a new and modern capability. In the new laboratory both scientists and rocks will have to be protected. This facility would be used as soon as 2003 when the Solar Wind of the GENESIS mission will be returned to Earth. It would also be used to treat the Comet sample from the STARDUST mission which will land on Earth in 2006. It would finally be used in 2008 for the Martian samples. So NASA definitely needs such a facility.

The main problem in that case would be to share the samples with France. If CNES is to play an important role in the Mars sample return missions, France will want free access to the

samples and maybe have scientists working in the Laboratory. Until now, France and the United States have still not found the best solution to this problem. The first proposition made by the Americans did not please the French. Nasa wanted France to be treated as any American University or research centre. In that case the French would have to ask for access to a sample and wait for an agreement from NASA. But compared to its governmental budget France would invest a lot in the Mars sample return missions. Moreover with their help two samples instead of one would be brought back to earth. So France is not really happy with the American system. They ask for free access to the samples. The two countries have already negotiated but did not agree on a final solution. Both countries will have to define protocols to practice subsampling which relies on compromises from both of them. The main problem is the fact that the facility which will receive the samples would be an American laboratory. It would be far too expensive for the French to build such a facility and it would not be that useful for the French anyway. So one of the solutions might be that the American allow French scientists to work on their facility.

The Americans feel quite unsure about the participation of France in the Mars sample return projects. No final agreement has been signed and the United-States also fear a change of government in France. So they still think and prepare two different projects: one including the participation of France and one allowing the return of one sample only. The main problem with cooperation is the trustfulness of the partners. France has ever been a trustful partner to the United-States in the past. But the United-States also realises that this project represents a very big budget for the French government. Cooperation about a future project is never easy. This particular project will not occur before 2003 so the final decision might be taken by people other than the ones who are negotiating right now.

Whatever happens, at least one sample will be brought back to Earth by the Americans. The American public opinion was in favour for the Mars sample return missions. After the two failures in 1999 Americans seem less trustful in the missions to Mars. However they still seem excited about a possible return of samples from Mars. But they also fear the unknown and in that case contamination. NASA scientists have worked on the elaboration of a facility preventing the samples from being contaminated by the terrestrial environment and preventing the scientists and the terrestrial environment from being contaminated by the samples.

NASA already assured the quarantine and the curation of the moon samples. The quarantine of the Martian samples will be led in a very similar way. The laboratory in which the samples from Mars will be treated will be different to the Moon Rock Laboratory. As a matter of fact no contamination of the terrestrial atmosphere by the moon rock samples was feared as we mentioned before. Here the laboratory has to take this risk of contamination into account. If there are living bacteria in the samples as some scientist believe, they might feel very well on Earth and proliferate. Even if people are very sceptical about this issue, no risk can be taken. So the aim is to take as many precautions as possible to avoid scientific mistakes and to protect our Planet. The curation facility would also be used for the solar wind coming back from the Genesis mission in 2003 and for the comet samples of the Stardust mission which will be brought back to Earth in 2006 as we already mentioned it. So they would have to start building the facility right now but no final decision has yet been taken. Three years is not a lot of time to build such a facility as it would have to be tested and improved before any sample could be studied inside it.

The samples will be examined, catalogued and observed to determine if they contain any trace of life. Once sterilised, if the samples are proved not to contain any trace of life, they would be transferred in the curation facility. Some of the samples would then be distributed to American and international universities or research centres exactly as with the moon rock samples.

Inside the facility, the contamination of the samples and of the environment would be prevented by different levels of pressure, airlocks and a chemical shower at the entrance of the laboratory. A test facility belonging to NASA already exist in White Sands.
The fact that the facility would be located in the United States already seems to be a problem for the main partner of the Mars sample return mission, that means France. No final decision concerning the facility has been taken yet anyway which might be explained by the bone of contention opposing France to the United-States.
These missions are called the Mars Sample return missions because they will focus on this particular aim. But of course, other samples would be brought back to Earth through human missions.

Link to the human missions

Some objectives to be attained during these missions seem directly related to the human missions.

Further studies of the physical and chemical environment of Mars will be led in order to measure the risks to which human explorers would be exposed and to consider the natural resources of the Red planet which they may be able to use. So the surface and subsurface of Mars will be studied more carefully during the Sample return missions.

More pictures of Mars will be taken to get an even better idea of the configuration of certain precise parts of the surface. The water features beneath dust and debris will be examined since water is the big issues linked to the possibility of finding any living organism on Mars. Instruments to locate, access analyse and then maybe utilise water will be sent during these missions. Scientists will also try to identify the processes which created channels on Mars. They will also have to detect and map the motion of polar terrains since the '98 mission failed. As a matter of fact, the lander of this mission was called Mars Polar Lander since it was supposed to land on a pole and study it carefully. Moreover the poles look like a very possible location for finding water. The aim is to find a source of water which could be used by people during human missions. Scientist actually believe that vast quantities of liquid groundwater may be found at depths between 3 to 5 kilometres.

During every future missions, as in the next one which will be sent in 2001, NASA and its partners will try to demonstrate technologies, as MIP, which will be critical to human exploration and which require testing in the actual Mars environment in order to gain sufficient confidence for their use in an operational system. If MIP works, a bigger experiment would be sent and used on Mars to launch a rocket during the Sample Return missions. So the evolution of the new capabilities will also be crucial.

The telecommunication with Earth and between orbiters and landers will have to be improved as well. An Earth-Mars internet network will be tested and will finally support the Sample Return missions and would also be very useful for human missions. NASA intends to launch a "Mars GPS" which would be very useful for the crew, and even more in case of dust storms for example. It would be better for the astronauts to be able to use such a system so they

would be able to orientate themselves in any situation and there would be no fear of getting lost.

The improvement of the communication network would also allow an increase in scientific data return.

People around the world would be able to virtually participate in Mars Exploration through internet. So it would also induce a public outreach and an international education program. Interest in Mars Explorations would then increase on a world-wide scale.

Conclusion

What NASA scientists found in the so-called "Martian rocks" really puzzled and excited scientists around the world.

CNES expressed its will to participate in this project as much as the United-States to enable them to bring back to set of samples back to Earth which would double the chances to find something really interesting in the Martian Earth.

But this mission is still a project and no settled agreement was signed by the two countries and space agencies. Because of the expense that it represents for the French state, the Americans really feel unsure about their participation. So NASA works on two projects, one including the French contribution and a purely American mission.

It would a lot more interesting to bring more samples coming from many very different places and extracted at different depths of the Martian ground. It would multiply the chances of finding what scientists are looking for: traces of past life. The Martian surface is now dry and its environment seems quite hostile so the chances of finding living organisms are meagre.

But the great challenge and the big issue laying beyond this very important step to the Red Planet is the human missions. What if the analyse of the samples reveal any hazard or danger preventing NASA from sending astronauts to Mars? They are already working on such a project. They elaborate a station, try to find a way to produce propellant on the Red Planet and so on…But they are not sure that the Martian environment is safe for human beings. What if the samples do not bring any element witnessing former life of Mars but only evidence that no people can be sent there?

Anyway, the Mars Sample Missions are far from being launched. Only one may be achieved. And a capability to treat the samples must be built and tested first. Scientists estimated that

eight years would be needed to set such a laboratory up. We are already in 2001 and the first samples were supposed to be brought in 2008 back to earth. So it seems that these missions will have to be delayed anyway. And this leave more time to France to give its participation up. At the moment, all the efforts of the space agencies seem to be concentrated on the International Space Station which already suffers from big delays. So now the issue is not only the French participation but also the year of the first launch. Until when will these missions be delayed? Would then the opportunity of 2018 for a human mission to the Red Planet be missed? Do NASA and its partners really intend to launch such a mission?

Future Missions

Introduction

The future missions will focus on the capabilities needed for human exploration of Mars and the aim is to send a crew before 2018. But this seems still a long way away since nothing has been settled for the Mars Sample Return missions yet. Moreover outposts missions would have to be launched between the Mars Sample Return missions and human missions to test and improve key technologies and equipment to be used for missions sending a crew and to learn more about the Red Planet. One of these missions would look for and study ground water on Mars. This type of information would be very useful to orientate the research which could be led subsequently on the Red Planet. Teams inside NASA already work on this project even if no official decision has been taken yet. So they already have a clear idea of the challenge it seems to represent.

Human missions

Why would NASA take the risk of sending astronauts to Mars?
Until now purely robotic missions were led. But robots, even when they are very sophisticated, have their limits.
Moreover, NASA scientists seem persuaded that they have a chance to find traces of life on this planet. They base their convictions on the study of a meteorite supposedly coming from Mars. As already mentioned, some meteorites contain gas which are also present in the Red Planet atmosphere. But the meteorite in which they found "traces of life" does not contain any gas. It just happens to look similar to other meteorites enclosing this gas.

So there might be living organisms or traces witnessing any former presence of life on Mars because there seemed to be water once on this planet. But we can not rely on this meteorite as a proof or a clue that there was once life on Mars. So NASA seems to use the study of this meteorite as a pretext for human missions and to seduce the American public opinion as well as to convince foreign countries to participate in this tremendous project. The samples from

the Martian subsurface which will be brought to Earth in 2008 may bring crucial information about the issue of life on Mars.

Since the start of Space History the Americans tended to explore other planets of the solar system. Until now they have sent astronauts only to the moon. But after this great success they had to achieve more…flying to Mars! As a matter of fact, Mars is the most accessible planet beyond the Earth-Moon system.
No official position has yet been taken. This remains a project even if many people at NASA are working on it. They already found a solution to weight and room problems in conceiving an inflatable module station. This concept might even be adapted to the International Space Station (ISS). So a theoretical project may help the achievement of scheduled missions. Since the ISS is being assembled it should have been the contrary. Anyway, the scientists working on future missions to Mars also intend to use the ISS as a testbed.

The Americans also demonstrate a great interest for Mars because they claim that it looks very similar to Earth. They think that studying Mars may enable them to understand better the evolution of Earth in comparing the two planets. But at the same time there seem to be no apparent trace of water left on the surface of the Red Planet which is quite a crucial difference with Earth. So the similarity is not that striking and it does not seem to be a very good argument in favour of human missions either. Scientist still hope to find water underground.

The main difference between such a project and an expedition to the moon is the cost. The reason why this project would lead to great expenses is the length of the travel. The Americans could shoulder a mission on their own to the moon but they will need financial help to lead a human mission to Mars. Foreign countries already participate in robotic missions. Since American scientists want to use the ISS as a test for new technologies which would be used in future missions to Mars, they already have to convince the ISS partners.
So NASA seem to try to find reasons for a human mission, as the study of a meteorite or others which we have just mentioned in order to convince the opinion of the American public opinion and potential partners. They need financial help so they try to attract funds and the participation of industries and foreign countries.

At the same time NASA and its partners already mislead robotic missions like the Mars Polar Lander and the Mars Climate Orbiter so they have to improve their technologies and the share of the work between partners before thinking about safe human missions. They also definitely must improve the telecommunications and the navigation infrastructure which may prevent NASA and its partners from any other failure.

The success of Mars sample return missions already seems quite crucial. It even might lead to the discovery of living organisms on this planet and help selecting a landing ground for any other mission. It will also help to determine if there may be any danger for astronauts to actually go onto the surface of the Red Planet. Robotic missions did not find any indications preventing human missions. In every future robotic missions, scientists will test new technologies to be used in a human mission to Mars as the MIP (Mars In-situ Propellant) experience. As a matter of fact, if going to Mars does not really seem to be a problem, coming from the Planet may be more difficult. Anyway, having a "gas station" on Mars would significantly lower the cost of the entire mission.

Objectives

The previous robotic missions' aim was to determine if it would be possible to send humans to Mars. As a matter of fact, the Martian atmosphere or other elements on Mars could be dangerous for people.
Until now nothing seem to prevent missions sending a crew. If people were actually sent, their aim would then be to determine if human beings can inhabit the Red planet.

The main purpose of the science research is to use the resources of Mars to augment life-sustaining systems. The MIP experiment, previously mentioned, aiming at producing propellant in using elements contained in the Martian atmosphere, will land on Mars in '02 and might be the first experiment to demonstrate that the Martian resources can be used in future missions. If it proves successful, a bigger propellant production plant would be sent to Mars. As soon as it was full, men could be sent to Mars because they would have the means to come back. Propellant could be sent with the crew but it would increase the cost of the mission. Solar energy is also an important issue. It should be entirely exploited and the system

which would be used by the crew would also have to take the dust storms into account. So solar energy must be utilised and accumulated to prevent the crew from running out of it.

Scientists also mean to learn more about the solar system's origin and history. So, like the others Mars missions, the human missions will have an educational purpose.
The teams working on this project have and still try to reduce the cost of such a mission to a minimum. Even if NASA intends to cooperate with other countries who would participate in the project by providing finance, the less it would cost and the more it would appeal to the Americans and to the countries who would join it.

To succeed, scientist will first have to challenge any technical obstacle linked to sending humans instead of robots as they are actually doing. Robots would still play a quite important role in human missions though. The crew would use intelligent robots to practice in situ observation on a planet-scale. So the participation of humans would remain quite remote and they would work in the laboratory of the surface station. The aim would be to prevent the crew from taking the risk to go too far away from their station. They would go off if really needed, as when a robot would find something really interesting.
The mobile vehicles would also need to be miniaturised, gain in autonomy and have a self-repairing capacity. They would use in-situ resources like the sun, thanks to advanced solar cells technology.
The development of technologies linked to the missions to Mars is to be used for other projects. As a matter of fact, the team elaborated an inflatable station for human missions on Mars. This concept might be used for the ISS, as we already mentioned, to gain space and diminish the weight of hardware launched. So the research lead for the Mars missions also benefits other programs and education.
This new type of module might also be more resistant once on orbit than the hardware modules actually launched and so that it would be cheaper to have inflatable modules on the ISS. Manufacturing hardware modules costs less but since they do not last as long as inflatable modules there are less advantages. Moreover NASA manufactured a prototype which has already been tested and proved to be air-tight.

The project

In order to attract foreign countries, Nasa must elaborate a coherent and precise project.

As a matter of fact NASA worked a lot on its presentation. They insist on the safety, the time and the material needed for such a mission.

The crews would need a robust capacity on the surface of the planet to support them for 500 to 600 days. It would be easier to use the Earth-Mars launch opportunities occurring from 2007 through 2018.

The Americans aim at 3 human missions returning to the same site to be able to reuse some material remaining from previous missions which would simplify and lower the cost of the project.

The flight to Mars would last 4 to 6 months for a stay of approximately 600 days enabling the crew to explore quite carefully the surface of the Red Planet.

If the missions are sent between 2007 and 2009, the transit would last 180 days whereas between 2016 and 2018 the travel would be of only 130 days. The aim is naturally to shorten the time of transit, which would enable the crew to stay longer on the surface of Mars. So the best opportunities leave time for NASA and its potential partners to organise themselves.

As a matter of fact NASA aims at sending humans in 2013 for the first time.

Since the most expensive trip is the one of the crew, Nasa thought about sending cargoes before and after the crew on a lower cost and with a longer transit time. They would also use the same habitat during the transit and on the surface of the red planet to reduce the cost of the mission. The crew size would be 6 people.

Since the partners of the ISS are more likely to participate in this project, NASA was thinking about using it to demonstrate the Mars Habitat Prototype. Actually the situation might be reversed as we already mentioned it as the concept of the inflatable habitat originally adopted for Mars human missions might be used for the habitat of the ISS.

The Americans also insist on the fact that the resources of Mars can be used. In the '02 mission to Mars, they send an experiment intending to prove that propellant can be produced in taking elements out of the Martian atmosphere (MIP and further experiments).

As soon as they are on the surface, the crew would observe and analyse the surface and subsurface geology. This would not be a pure human mission. They would surely use robots to diminish their journeys out of the station. The robots might be used to collect samples which would be analysed afterwards. They may also use expendable aeroplanes to determine the most interesting places to be explored or to examine the Martian surface. So they would definitely be assisted by high-tech equipment.

The crew would also study precisely the composition and the structure of the atmosphere. Their main purpose will be to determine if humans might be able to inhabit Mars.

A life support system has already been elaborated and tested in the Johnson Space Center in Texas. It can provide high degree of water and air recycling required for exploration missions. This facility was tested on Earth only. But it has supported human crews for up to three months and tests in excess of one year will soon be performed.

Food production and solid waste recycling will also be investigated.

Some more samples collected during the human missions would be brought back to Earth for further analysis.

Now we can wonder why, instead of using the ISS as a test-bed, the Americans did not consider with more interest that they could use the moon. Of course there must be a question of cost. If the material to go to Mars is tested on the ISS, it implies the participation of the partners. Other countries might not have been interested in expensive tests on the moon. But it still would have been a great opportunity to get effective training and at the same time assure more safety in testing material and capabilities.

It seems that the Americans and the rest of the World lacked interest in the moon almost as soon as Neil Armstrong stepped on it. Japan is still leading missions to this Planet, though and might have been interested in such a project.

The importance of the robotic precursor missions has already been stressed previously. But as we also mentioned, the missions of last year were a complete failure. So at the moment it might seem difficult to attract foreign countries into this project since they may think that the safety of the crew could not be ensured. Last year they lost the orbiter, the lander and the microprobes which means they lost everything.

Nasa and its partner would also have to elaborate a quite autonomous system operation for the surface capability so that the crew would actually spend their time on experiences and exploration rather than on taking care of the good function of the station.
They also need to improve the Earth-based support to help the crew efficiently. Last year the earth-based control of the mission to Mars did not work well and this was partly because of the cooperation between England and the United-States because they do not use the same metrics/measurements. So cooperation can also generate problems or even silly mistakes. It seems hard to lose millions of dollars and an opportunity for very interesting analyses and experiments crucial for future human missions only because of the difference of standards between two countries.

Cooperation

Since the end of the cold war, the Americans and the Russians tend to work more and more together. The cold war had positive sides, though. Because of the race confronting the two countries, they both gained rapidly a lot of experience but different ones. So now they complement each other in certain domains and are on the same level in others.
They share a common interest for space anyway. NASA and RSA are the main partners of the ISS and they also may shoulder most of the human missions to Mars.

Anyway, the human exploration of Mars should be inherently an international undertaking.
Of course every country has different priorities and different budgets. But it still offers large ranges of opportunities and interests.
There seem to be three main types of countries likely to take part in this project.

Countries with limited resources will participate in a technical internship and an educational program. Cuba and Vietnam cooperated with Russia in this way/manner.

Countries with greater amounts of resources and having a technical base would be provided with technical information concerning limited areas. Their participation would then be in favour of a technical and industrial growth in their economies. Canada joined the ISS project to achieve this goal.

Countries with substantial resources, having a technical base and belonging to the World leadership and having broad technological skills, will promote aerospace industry like the contributors of the ISS program.

In one word, everybody's money is good even if some countries will just have a small amount of money to invest in Space projects. Each country would get information or help proportionate to the amount of money they would give. In a way, the richer countries would help the poorer ones to get modern technology. It also means that only the richer countries will directly participate in the project, which seems logical in a way. As a spokesman of NASA stated, "All participating countries should expect to gain in proportion to their investment in the enterprise". So only the top set would be able to show off with their participation in the mission and they will also be the only ones to take the decisions. So the less you invest, the less you decide what will be done with the money you would invest.

So then we can wonder if it would be really worth it for certain countries to participate in this international project. Even if the amount of money they would give may seem ridiculous compared to others, they may actually invest a great proportion of their State budget. The benefits they would get out of their participation would then not be proportionate to their sacrifice. If we take the example of a country giving one million dollars. This million may represent one percent of the general budget for the mission but it also may represent fifty percent of the State budget of this country. Another country may invest ten millions but this amount of money would represent five percent of its State budget.

So the gains small countries may get out of their participation will definitely not be proportionate to their efforts which seems quite unfair. At the same time many countries think that the most important point is to participate in this project because of the challenge it represents.

Another difficult problem would be the constitution of the crew. NASA thinks about sending six people but of which nationality? There would be at least one American and one Russian and then? It would become complicated to decide about the rest of the final team and they have surely not thought about it yet since sending humans to Mars is still a project.

If the United-States and NASA do not exclude any nation it might be because even small amounts of money are good to take and, once clustered, they may represent a much larger sum. It partly explains the relationships recently pledged with Romania and Marocco. In other cases, diplomatic purpose are also induced as with Russia and the countries of Eastern Europe. Nations working on the same projects are less likely to engage themselves in conflicts.
The basis for international cooperation were already laid with the ISS which will help a lot in any future project involving different countries. The best would be, of course, to create an International Program Office specialised in organising and ruling the international cooperation on each project.
As a matter of fact, there seem to be no race in Space projects anymore and NASA will lead less and less projects on its own but tend to encourage international participation in their missions.

The United-States also encourage the universities and industries in participating in Space projects. A lot of American universities lead research linked to particular missions or to NASA in a larger sense.
The universities participating belong to the same project called HEDS.
HEDS means "Human Exploration and Development of Space Enterprise".
The aim now is to attract foreign universities. The research would become more interesting if it were led by different countries.
The universities provide brains and free research. So HEDS already helps a lot in every mission and the aim is to have new members joining the group every year.
American industries already provide NASA with money and technology. The aim would be to attract also foreign industries which would really be interesting since they would have different technologies to offer.

So Space Agencies already work together as on certain missions to Mars and on the ISS.
But a full international cooperation would mean that industries and universities from around the World would work together on future Space projects.

The International Space Station

Historical Background: the phase 1 program

Introduction

The phase 1 program corresponds to the Shuttle-Mir missions. After a period of tension between the United-States and USSR, the two countries decide to work together on orbit. Before they were leading two distinctive and secret programs. They were competing with each other. But then, the world's experts in human space flights decided to work together and share their knowledge. So George Bush and Boris Yeltsin meet in June 1992 to sign an accord "for peaceful cooperation in space." Astronauts and cosmonauts started to train together.

In November 1993, Mr Goldin, NASA administrator, and Mr Koptev, RSA director, signed an agreement about the Phase 1 Program. Before the cooperation between the two countries in space matters consisted chiefly in exchanging scientific data. They had already worked together in 1975 on an Apollo-Soyuz Test Project, though, but they had stopped their efforts afterwards.

The RSA had actually already a great experience concerning long-duration orbital missions with Mir. The Americans would learn a lot during the Phase 1 program and start to work with RSA on the ISS project. As a matter of fact, the Phase 1 Program was the first step towards the ISS.

NASA and RSA also prepared themselves for the ISS in conducting precursor scientific research, learning how to work together and testing hardware and scientific equipment on orbit. They set the basis of international cooperation encouraging it in the future.

Cooperation between NASA and RSA.

The Space Shuttle and Mir were designed to operate independently in space. "Less than three years from the initial bilateral agreement, the Space Shuttle Atlantis and Mir rendezvoused on orbit". As a matter of fact, the space shuttle first docked with Mir in June 1995. But the first

Americano-Russian flight occurred in 1994 marking the beginning of the Phase 1 Program. The crew on board included Sergei Krikalev who was the first cosmonaut to fly on a American spacecraft.
Between 1994 and 1998, seven astronauts stayed on Mir and nine cosmonauts flew on the Space Shuttle.
Mir was Russia's seventh space station. Mir means peace in Russian and it became quite symbolic when the Americans joined the project. Before the world was split in two distinctive parts by the Cold War and now the two countries were finally working together, cooperating in Space.

Mir was mainly built and launched by the Russians. But the last two modules, "Spektr" and "Priroda" were partly financed and equipped with scientific instruments from the Unites-States as part of the phase 1 program. They also provided solar arrays to supply more power for experiments.
The 380 cubic meters of habitation space of Mir enabled up to three people to stay for extended period and up to six people to stay for several weeks.
The crew members travelled to and from the station via either the Space Shuttle or the "Soyuz" spacecraft.

The missions were controlled from two separate centres, one in Russia and one at the Johnson Space Centre in Houston, Texas. The astronauts trained in the United-States and in Russia (in the Star City) on three spacecrafts: the Shuttle, Mir and Soyuz. The control centres had to overcome time differences and the crews in the two training centres, language barriers. This was not easy in the least but both astronauts worked hard to be able to understand each other which was important on the ground during the training and became crucial during the flights. The advantage of having two different control centres in two different time areas was that they could relay each other and not operate simultaneously. In case of a problem two teams would try to sort the situation out which would give twice more chances to solve it.

The Spacelab and the Spacehab missions were also part of the phase 1 program. ESA already cooperated with NASA on the Spacelab project. So the main partners taking part in the elaboration of the ISS are the ones who already worked together on the phase 1 program.

So the phase 1 program seemed to be a unique opportunity for the American and the Russians to get used to work together and to learn from each other and from their common experience on Mir. For example they noticed that "Mir's surface was being contaminated by residue from its own attitude control propellant. As a result the propellant venting procedures of the ISS have been changed. The main aim of the two teams was to ensure and improve the security in Space for the astronauts and to prevent the station from being damaged. To react faster in case of an incident on the ISS, the station will be equipped with fly-by robotic cameras. The scientists also re-evaluated the ISS fire control options after an incident which occurred on Mir in 1997. The ISS will also have three entirely different ways to generate oxygen, a capability which already existed on Mir. So the Phase 1 program was a crucial step towards the ISS. Before building such a big station on orbit, the Russians and the Americans had to get a great experience. Now, even if some improvement may be necessary during the ISS missions, the astronauts and cosmonauts will feel secure when working on the ISS.

Changes also occurred in the training of the crew. The psychological side of the training tend to become more important. Long stays on orbit are not easy to cope with. The astronauts have to work together as a real team. On the ISS it becomes even more complicated than on Mir because more than two nations will be on board simultaneously. Different cultures and mentalities will be melt all the time. Astronauts and cosmonauts already train together in Houston Space Centre and in the Star City in Russia.

The Shuttle-Mir Program was a unique opportunity for the Russians and the Americans to live, work and conduct long-term research in space together. They meet problems which helped them in elaborating the ISS.

Phase 1 Program accomplishments

Russia and the United-States learnt how to work together. They completed each other by their experience of space. They also learnt that duplicating the means of communication, transports or even material on the station was a security. So they support the missions from both of their mission control centres. Astronauts go and train in the Star City in Russia and cosmonauts train in Johnson Space Center in Texas.

So Americans learnt how to operate Russian equipment and Russian how to use the American one. They also learnt each other's languages.

They conducted Space walks which will be very useful for the assembly of the ISS and later if they have to conduct repairs on the Station.
They created a joint Americano-Russian process to assess the safety of the missions and to certify the flights readiness.
They have different power generators but common safety procedures as in case of a fire or depressurisation.
They established that non-critical systems can be operated until they fail and that critical ones have to be duplicated.
They collected data on the effect of long duration exposure of men and hardware.
They "learned how to conduct long-term research and maintenance on an operational space station through flexible scheduling of crew time on orbit."
They elaborated a specific physical and psychological training for team work on long duration missions in space.
During the Phase 1 Program, Mir and the Space Shuttle docked nine times in orbit exchanging international crews and equipment and resupplying the Station.
Americans established working relationship with the Russians which has really not been easy because of their different cultures, language, way of working and mentality. American learnt a lot from this program. They had been the first to reach the moon but the Russians really were the experts in long-duration space flights. Up to now they have accumulated more hours in space than any other nations over more than 30 years. As a matter of fact, Mir was the eighth station that the Russian had built. It actually has been operating since 1986 without any loss of life in spite of the problems occurring during this period of time. So the Americans definitely learnt a lot from their experience with the Russians about long-duration missions in space. The record of long stay was held by Dr. Valeri Polyakov who stayed 438 days on Mir in 1995.
Now the aim with the ISS is to build a permanent station. Mir became obsolete and will not be operated anymore. NASA and its partners intend to keep the ISS operational and modernise it over the years.
Astronauts and cosmonauts conducted worked on many experience together. Their research focused on life science, microgravity and environment. It helped selecting research subjects and crucial issues to be studied on the ISS.

The American and the Russians improved the level of safety on Mir while it was in operation. They had already worked on the elaboration of the ISS but they modified it during the Phase 1 program. Corrosion damaged a lot the hardware of Mir. When the partners noticed this phenomenon, they decided to add a protective coating to the ISS. So they improved the ISS thanks to the experience they accumulated, the lessons learned, and the problems they meet on Mir.

Phase 1 Program flights.

The first module of the Mir Space Station was launched in 1986. Other modules would be added progressively over the years. Mir was then purely Russian and was the first permanent space station. The Russians operated the Station on their own until 1994 when the Americans joined the project. The first Russian space station, Salyut 1 had been launched in 1971.
The Americans had launched their first provisory/temporary space station, Skylab, in 1973. It stayed on orbit and operated for eight months. The Americans did not launch any permanent space station. They joined the Russian one, Mir.

STS 60, which occurred in February 1994, was the first Americano-Russian flight. As a matter of fact a cosmonaut, Sergei Krikalev, flew on the American Space Shuttle. He was the "mission specialist" on board for this mission. He had already accumulated experience through two long-duration stays aboard Mir.
Sergei Krikalev is now the flight engineer of the Expedition 1 crew. So cosmonauts and astronauts who already flew on Mir and trained together will work on the ISS. It seems quite important to send crews with experience and who really are used to work in an international team in the beginning. There should be no tension or misunderstanding between the members of the crew during the ISS Assembly. Sergei Krikalev has been training with the Americans astronauts for many years. He is actually living in the United-States at the moment and trains in JSC when he is not in Space. He will come back to Earth in February 2001 on board of the STS 102 flight.
Safety is definitely a crucial issue and the people who decide of the composition of the crew teams must be quite aware of it and select carefully the astronauts and cosmonauts they send on the missions to the ISS. Another cosmonaut, Vladimir Titov would join another American

crew on the next flight, STS 63 in February 1995. Houston and Kaliningrad Mission Control Centres worked together and conducted their first joint operations during this mission. Vladimir Titov would fly a second time on the Shuttle during STS-86 mission.

So from February 1994, cosmonauts would fly on STS American flights and astronauts would fly on Mir missions launched from Russia. As a matter of fact, Mir 18 crew included Norm Thagard, who was the first astronaut to fly on the Russian spacecraft Soyuz. This mission was launched in March 1995. The Spektr module, which was outfitted with American scientific equipment, was attached to Mir during this mission. This facility would be operated until 1997 when a Russian supply ship collided with it and put it out of order.

It was actually easier and nicer for the Russians to join American Missions than for astronauts to fly on missions launched from Russia.
Soyuz is a small spacecraft which is able to transport only a crew of three. The members of the crew must also fit into the spacecraft. Only small astronauts and cosmonauts can fly on it.
Soyuz is an old technology and will still be used for the ISS because it actually works quite well and its use is cheap.
The Shuttle is a larger spacecraft which transports crews without restrictions. Fat and very tall astronauts and cosmonauts are very welcome on board. It is a more expensive spacecraft though but it also enables the transport of hardware and equipment. The shuttle is a more modern technology which procures more comfort.

The American Shuttle docked with Mir in June 1995 for the first time, during the STS-71 mission. This was a very delicate mission. The Shuttle and Mir had not been designed to operate in an integrated fashion. The Shuttle accomplished missions on its own as part of the Phase 1 Program as well. The Russian spacecraft Soyuz was the only one which was conceived to dock with Mir since the start. They were conceived separately by two different countries who were working with their own methods and in very different ways. So the docking of the Russian space station with the American was very far from being simple. Scientists, engineers and technicians of both countries worked hard together to make it possible. They really did a TEAM effort.

This particular mission laid the foundation for the ISS assembly. So 1995 was actually a crucial year in the Phase 1 Program. It brought a lot of novelty on board of Mir Space Station.
In 1996, an American women, Shannon Lucid, would be welcomed aboard Mir. She stayed 188 days in space, a record which has not been challenged by any female astronaut yet. She was on board when the "Priroda" module was brought to Mir. As "Spektr", "Priroda" carried American hardware.
1996 also witnessed the first American space walk, another crucial event.
Everything evolved quite fast during the Phase 1 Program. As a matter of fact it started only four years before the Phase 2 program which means that astronauts and cosmonauts only had four years to learn how to work together, how to improve the future ISS and to lead crucial experiments which would give the guidelines of the research which would be lead on the ISS.
Americans and Russians achieved quite a lot during this small amount of time.
They also meet difficult problems and had to face hard situations because of incidents occurring on Mir or during the docking phases.
As a matter of fact the crew of the Mir 23 mission went through a flash fire and a collision which damaged so badly the Spektr module that it would be depressurised and sealed off and would not be used again.

The Phase 1 Program ended in June 1998 with STS-91 mission. The same year the Phase 2 Program started with the first sequence of the ISS assembly.
The Phase 1 Program improved the working relationships between the United-States and Russia. The Americans provided two modules, Spektr and Priroda, which were outfitted with quite a lot of scientific payload. This enabled cosmonauts and astronauts to do additional long-term experiments in microgravity in preparation for the ISS program.
The Phase 1 Program also made scientists and crews aware of the dangers ran during space flights and docking phases. They tried to reduce the risks associated with the assembling and operating of a space station on the ISS. The collision which occurred in 1997 may have ended in an even worse way.
Americans and Russians really enjoyed the advantages of cooperation. They gathered more means and were able to enlarge/extend the Mir Space Station. It also enabled astronauts to try Russian equipment and facilities and gave the cosmonauts the opportunity to try American spacesuits, to fly on the Shuttle and so on.

Cosmonauts appreciated the modernity of the American material. Astronauts noticed that the Russian equipment was cheaper and more reliable. They were using old technology but because they had been using them for a long time they new that they were working.
Americans were using new and expensive technology. What is new need to be tested so it is not hundred percent reliable. Just observing each other's material, Americans and Russians realised that they were not working in the same way and that they had very different mentalities.
On the ISS they tried to do complementary work to advance intercultural understandings. They analysed the advantages and inconveniences of both ways of working and applied it to the ISS.
So the ISS aims at embodying the best of both American and Russian methods and technologies. It will hopefully prevent them from doing big mistakes in the ISS conception and assembly. For example, the ISS will be equipped with three different computer systems for safety reasons. The reliability of the computers have already been challenged. In April, the first system broke down so the second system took the relay. The second system broke down. Of course the station could not be supplied with three powerful computer systems. So the third network should only be used in case of emergency and should not be relied on for a too extended period of time. So the ISS could not communicate directly with the Earth. By chance in this case, the Endeavour Shuttle was docked to the Station and could act as a go-between to connect the station and centre control on Earth. When the main computer system breaks down, the astronauts and cosmonauts are completely unable to test or experiment anything which partly explains why Canadarm2 could not be used at the time and why its tests were delayed.

The United-States and Russia are the leading partners since they are the only ones in the ISS team who accumulated experience on a common space Station: Mir. Some other countries participated in the Phase 1 Program. Astronauts from ESA and Canada joined the Americano-Russian team of STS-74. Europe and Canada are participating in the ISS. They were working for the first time altogether on Mir. This experience taught them how to operate as a multinational crew. They will work a lot more together on the ISS but it was a successful and encouraging first experience.

Jean-loup Chretien, a French astronaut, also flew on STS-86. ESA participated as a NASA partner in the Phase 1 Program in developing Spacelab, a "research laboratory for life and microgravity sciences and applications".

The United-States and Russia worked with Canada, France, Hungary, Japan and the United Kingdom throughout the Phase 1 Program. Their help was either financial or scientific. These international partners started to share equipment, data and knowledge. But the Phase 1 Program was mainly Americano-Russian. The ISS is the symbol of the evolution of international cooperation in space matters. The main partners will be permanently represented on board the ISS and will have their own modules. They will be slightly more independent of the Americans and Russians during the Phase 2 and Phase 3 programs.

The Phase 1 Program was very challenging. Americans and Russians worked successfully together for four years and both learned a lot from it. This Program can be viewed as a unique "rehearsal" for the ISS. The ISS will be much more complicated to operate because of its size and because there are more partners actively participating in this project.

The two countries also depend on each other for the Phase 2 Program since they both provide and launch hardware for the ISS. They have already been working successfully for two years on the ISS in spite of some delays.

The Phase 2 Program has to be completed and will be followed by Phase 3 Program, the final step.

Conclusion

The Phase-1 program was a crucial contribution to the ISS project. Many problems occurred on Mir from which both Russians and Americans learnt a lot and the experience gathered on the Russian station enabled the ISS partners to elaborate a safe and reliable station. The mistakes in the elaboration of Mir would not be reiterated on the ISS.

Russian and American specialists learnt how to work together. But the relationship between NASA and RSA have fundamentally changed between Mir and the ISS.

On Mir the Russians were the leaders. The Americans were "invited" on their station. On the ISS the situation seems nearly reversed since the Americans own over 70% of the station. So the "team" work on the ISS embodies a new challenge since the situation and the context have changed.

The Russians did not really realise that the Americans would be the leaders and take the main decisions. On the ISS, the Russians provide energy for themselves, they have their own solar arrays. They also have their own means of transport and of course their own laboratories and quarters on board. So they seem quite independent on the ISS and they could even not have any contact with the rest of the crew if they wanted to. To them it was evident that they would decide for themselves on the Station and they would not have to be under the American influence. The distension between the two countries and their different point of view was revealed through the "Tito's affair".

For the Americans, it seemed evident that since they owned most of the station and they provided transport for most of the partners even including Russians, they would be the leaders on board and take all the decisions. At least, they expected from the other partners that they would consult them before taking any crucial decision. The Russians decided that they would send a tourist to the ISS. NASA did not agree with this but RSA ignored their discontent. But even before, the relationship between started to degrade. Most of the actual delays imposed on the ISS assembly are due to the Russians. They send the Zvezda Service Module, which is a crucial part of the actual Station, with an important delay. They argued that they did not have enough money to finish it and were asking the Americans for an extra budget. After very long and harsh negotiations, the module was eventually sent last spring nearly a year late since it was initially planned to be sent in July 1999.

The Americans had always presented their cooperation with the Russians on the ISS as a political choice. They wanted to work with them in space, try to ease the relationships between the two countries and forget about the past distension climate of the Cold War. It did not start well and they are now in a delicate situation and they even spoke about splitting the actual station in a Russian station and an International Station. It was hopefully only a short crises and the two countries will certainly come to an adjustment of differences by mutual concession.

Anyway, the Americans will certainly remain the leaders on board and the Russians may have more independence than the other partners towards them.

The Americans own most of the station and they also have rights on the other modules since they provide transport energy for all the other partners. So it seems evident that they will always have an important influence on board.

Program organisation

Introduction

The ISS gathered 15 partner nations until Brazil joined the project. So now 16 countries are participating in the ISS.
The United-States, Europe, Canada, Japan, Russia and Brazil are working together on this project. The European States are represented through the European Space Agency (ESA). The members of ESA cooperating on the ISS are Belgium, Denmark, France, Germany, Great Britain, Italy, The Netherlands, Norway, Spain, Sweden, and Switzerland.
Italy participate in the ISS trough ESA and through its own space agency: ASI.
The United-States, Canada, Japan and Russia are represented through their Space Agencies which are respectively NASA, CSA, NASDA and RSA.
Brazil participates in the ISS trough its space agency INPE.
"The ISS partnership was cemented on January 29, 1998 when the governments that constitute the core of the partnership came together to sign the ISS Intergovernmental Agreements" and a "Memoranda of Understanding." The space agencies represented for the occasion were RSA, ESA, NASA, CSA and NASDA.

The United-States and NASA

NASA, which stands for National Aeronautics and Space Administration, was created in October 1, 1958. It succeeded to NACA, the National Advisory Committee for Aeronautics.
Up to the end of the Cold War, NASA worked quite independently from any other country on various projects concentrating on human space flights and the exploration of the solar system. They also lead scientific and technological research for aeronautics in general.
The first project was called "Mercury, an effort to learn if humans could survive in space" followed by "Gemini" and its two places spacecraft. The next step would be to determine if humans could fly to the moon before the Soviets would reach it with the "Apollo" project. NASA reached its goal with the Apollo 11 mission. Up to now, this event remains the most popular achievement of NASA and everybody knows of Neil Armstrong, the first man who stepped on the Moon. Nowadays, NASA works more and more with other countries and more

particularly with Russia and Europe. The ISS embodies this new trend for cooperation. NASA will build and deliver most of this station but also tried to attract as many countries as possible in this international project. Thanks to cooperation more means, money, effort and knowledge are gathered to elaborate the ISS. All the countries concentrate on the same project and it may decrease the tensions between the different partners and they will so learn how to work together. It was already a great challenge for the United-States to work with Russia. In spite of many problems and difficulties meet while these two very different countries started to work together, they know how to cope with this sort of situation and they are the main partners of the ISS. They understand each other, but now the problem is more the political instability of Russia.

NASA will co-ordinate the missions and the operations needed while building the ISS. Since they provide most of the station and the transport for the other partners, they also have more decision power.

The US laboratory module, Destiny, was launched in February 2001 on STS-98 ISS assembly mission. It was the first laboratory delivered on the ISS.

NASA also achieved a lot as far as satellites and communication are concerned. Landsat and Earth Observing System spacecrafts have "literally changed the way we see our home planet."

In the future, NASA will lead less and less projects on its own. Cooperation will certainly enable the realisation of more ambitious projects.

Russia and RSA

The current Russian Space Agency is quite recent. The dissolution of the Soviet Union marked the end of the former State Organisation and lead to the creation of a purely Russian Space Agency called RKA in Russian and RSA in English.

But RKA is really similar to the former Space Agency. It uses the same technologies and launch sites, works on the same programs and kept its 300 employees. Their cosmodromes are located in Plesetsk and Baikonur and they train their cosmonauts in the Star City and in the Gargarin Cosmonaut Training Center.

The RKA played a crucial role in the Phase 1 Program in being the main partner of the United-States and providing the Mir Station as a test-bed to elaborate the ISS.

In spite of political and financial difficulties, RKA goes on with the ISS delivering the module they provide for the Station with important delays. The ISS will be completed a year or two later than it was originally planned because the Russians do not stick to the planned launch schedules.

However, their participation in the ISS is quite crucial and they are the ones who have the more experience which they gathered on Mir. Their main task will consist in maintaining the station and delivering cargo to it.

The Soviets were the first ones to launch a satellite into orbit with the Sputnik 1 mission. They then ran a race to the moon with the United-States. Now the challenge for NASA and RKA is to cooperate on the same projects instead of competing. Both the United-States and Russia made the elaboration of the ISS possible. The other countries bring their own stone but their participation is not as crucial as the American and the Russian ones.

However, Russia still think about a Mir-2 Station and they timidly start to speak about this project. Because of the recent trip of the first tourist to the ISS, NASA was starting to think about being independent of the Russians concerning the ISS and they also even considered the possibility of getting rid of them.

Mir 1 was destroyed in March 2001. The Mir-2 project is not really new but up to now RSA lacked of finances to build a new station. Most of its budget is already dedicated to the ISS. But a new station could be financed by its visitors, tourists like Dennis Tito. If the distension between the United-States and Russia increase, and if more millionaires are interested in trips to space, Mir-2 may actually be build. Russia already threatened to separate their module Zvezda from the ISS if NASA would not come down and appease the atmosphere between the two countries.

Europe and ESA

Fifteen European countries participate in European Space project through their common space Agency: ESA, which was created in 1975.

ESA develops space projects focussing on Space Science, Telecommunications, Earth Observation, Manned Space and Microgravity and Launchers.

The fifteen partners do not work on all the projects but each country participate in one of them at least.

The Advantage of ESA is the partnership of several countries. They all gather their efforts, share their knowledge and their scientific and engineering skills. They confront their different technologies and complete each other's work. This gathered research explains why "Thanks to ESA and the efforts of scientists and engineers across the continent, Europe now leads the world in several areas of space science." ESA uses facilities spread all over Europe.

ESA works with the private sector in the area of telecommunications. So most of the funds needed for such projects come from companies and industries investing for themselves.

Earth observation is also one of the main concern of ESA. The evolution of the Earth environment is closely and permanently studied. For example, ESA launched capabilities to monitor atmospheric composition and chemistry.

ESA developed the Ariane launcher. "An ambitious space programme needs an independent launch system." This facility may play an important role in Mars Sample Return missions. Before, the European space agencies had to rely on the Americans or the Russian to provide them a launch facility to support their projects.

ESA is already the result of international cooperation inside Europe. But the European Space Agency also participate in international projects. They cooperate with Japan, Canada, Russia and the USA to complete the International Space Station. They will soon deliver a European Robotic Arm which will be attached to the Russian module. They will also provide an Automated Transfer Vehicle in 2003 which will carry cargo to the ISS "and finish as an incinerator". This unmanned, automatic spacecraft, will be launched on Ariane 5 and will bring up to nine tonnes of payload to the station.

The most important contribution of ESA to the ISS will be the "Colombus" module, the European laboratory. This module is planned to dock with the ISS in 2004. It includes a Biolab, Physiology Modules, a Fluid and a Material laboratories.

But ESA cooperates with different countries on other elements of the station as well. They develop a Crew Return Vehicle with NASA.

ESA also worked with the Russian Space Agency on a Data Management System (DMS-R) for the Russian Service Module and on the European Robotic Arm (ERA) which will be used for the ISS assembly and then by the Russians for the maintenance of their modules.

And finally, ESA worked with NASDA on a "cooler and freezer equipment for the Japanese Experiment Module.

ESA will participate in 20 flights of the 50 flights planned for the ISS Assembly.

Italy and ASI

ASI, the Italian Space Agency, was founded in 1988. This government agency participates in European and international projects through ESA. Every five years, ASI elaborates a National Space Plan (PSN) "to promote, support and control a coordinated program for the scientific, technological and commercial applications of space activities as well as to promote new technological capabilities in the Italian Aerospace Industries." The current PSN will end in 2002.

Italy spends over 600 million dollars a year on space projects. ASI works in correlation with industries, universities and other government organisms. "Investigation fields covered are: Universe Sciences, Earth Sciences, Life Sciences, Engineering Sciences."

Italy and ASI belong to ESA. They will also participate in the International Space Station independently, elaborating on their own the Multi-Purpose Logistics Module for the ISS.

This module called Raffaello is now docked to the ISS and an Italian astronaut was present on the ISS at this occasion. Raffaello also contained food, cloth and scientific equipment for the ISS inhabitants.

Japan and NASDA

NASDA, the National Space Development Agency of Japan, was created in 1969 and its headquarters are located in Tokyo.

NASDA is responsible for the development of satellites, launch vehicles. Japan will also have its own research facility on board of the ISS and they will provide other elements as a Remote Manipulator System, an Exposed Facility and an Experiment Logistics Module which will be attached to their laboratory.

Japan has been cooperating with the United-States for years on various projects. Japanese astronauts trained and flew with Americans. They also have overseas offices in Paris, Bonn and Bangkok. "NASDA puts emphasis on international cooperation, and currently most of the projects have been conducted through international cooperation." Japan is an industrialised

country and has the means and the technology to participate in international Space Project and is a very interesting partner. NASA hopes to work more with NASDA in the future.
Only four Space Administrations will have a research facility on board the ISS and NASDA is one of them. A Japanese astronaut already flew on a ISS assembly mission, STS-92 in October 2000. Kibo, the Japanese Experiment Module will be attached to the ISS around June 2003.
In spite of the resources of Japan, NASDA is in a difficult position. Its future depends on the success of its H-2A rocket, presented as a competitor for Ariane 5. NASDA hopes to launch it next summer. With this rocket, Japan intends to compete with the United-States and Europe as a commercial satellites launcher.
NASDA already faced two failures in a row including the loss of a satellite with the previous attempts at launching the H-2 rocket. Japan lost then their potential customers and the support of the public opinion. NASDA also elaborates a shuttle without crew.
NASDA underlines its lack of experience which explains its current situation. NASDA was created when the Americans had already landed on the moon. Another problem is the cost of its rockets. The American and the European rockets are far less expensive than the Japanese one.
To palliate these problems NASDA decided to turn to international cooperation. So thanks to the commercial difficulties of the Japanese, Europe and the United-States gained a collaborator instead of a competitor. But, of course, Japan refuses to cooperate with China and is reluctant to an alliance with Russia.
Japanese and Russians will work together on the ISS and their collaboration may lead to an understanding between the two countries.

Canada and CSA

CSA means Canadian Space Agency and is also know as ASC, Agence Spatiale Canadienne. CSA was created in March 1989 and employs 350 people permanently.
Canada will provide crucial equipment for the ISS as a Mobile Servicing System (MSS). MSS "consists of equipment and facilities located both on the Space Station and on the ground."
The elements which will be on the station include a Space Station Remote Manipulator System (SSRMS), a Mobile Remote Servicer Base System (MBS) and a Special Purpose

Dexterous Manipulator (SPDM). SSRMS is a sophisticated arm, MBS is the mobile platform which will support it and SPDM is a dual-armed robot that will work in conjunction with the rest of the equipment. These "arms and hands" will be used for the assembly and the maintenance of the ISS. It will enable the crew on board to remove or replace components on the Space Station. "CSA is also developing the Canadian Space Vision System (CSVS), which astronauts and cosmonauts will use to support (…) operations with large objects". So CSA will provide crucial and very useful equipment for the station and help diminishing the number of space walks to be accomplished by both astronauts and cosmonauts and the risks they run while doing so. So CSA contribute to the safety procedures on the Space Station.

CSA will not have any research facility or module of its own on the ISS but will participate in several missions through its astronauts. As a matter of fact, because they provide components for the station, CSA will gain "the right to use the station for scientific and technological research". As soon as CSA decided to participate in the ISS, they elaborated a "Microgravity Science Program" (MSP). So they already know what kind of experience they will do in the capacities which will be lent to them. So CSA participated only because the precisely knew that they could take advantage of their participation. So unlike other countries like Brazil, their aim is not only to start participating in the International Space Projects. Even if they already participated in previous missions, CSA has not the Space experience, which other Space Agencies have like ESA and more particularly CNES. Canada knows about the advantages of participating in Space Projects but they do not want to invest large sums of money in them yet. The Canadian Industry was really interested in the opportunities of research and experimentation represented by the ISS. Canada starts to really invest in Space. The Canadian astronauts do not only train with the Americans but also have facilities at their headquarters in Saint-Hubert, Quebec. Canadians will support the ISS operation from this facility where the people participating in this project will be trained. They will particularly learn how to use the equipment provided by CSA on the ISS. So astronauts from other countries will come and train in Canada as the Canadian astronauts train in the United-States and more particularly in Texas. Cooperating on such a project means a lot of exchanges between the different countries working on the same project. So CSA and NASA will have a common part in their training program in the Canadian and the American training facilities.

Canada signed the revised Inter-Governmental Agreement establishing the new partnership involving 15 nations in the ISS project in January 1998.

A Canadian astronaut will fly to the ISS every year and Canada will also participate in other flights delivering the elements they elaborated for the ISS.

When advertising for their project in Canada, CSA stated that "Canada's destiny is in space."(…) "In striving to meet the challenges of space, we learn how to solve problems on Earth". So to justify their participation in the ISS, Canada stresses that the research linked to Space projects may benefit people on Earth. So they lead research. If it can improve life on Earth, it is the justification of the work of CSA. If they do not find any application of what they elaborate to everyday life on Earth, then too bad. Research could be led on Earth to benefit the people on Earth. But here the research is to benefit the people in Space and if it eventually benefit people on Earth, they use this fact as a justification for the money they dedicate to Space projects. So they take the problem upside down. It still work on the common people who are persuaded that research in Space is vital for them. It is true that the research which has already been lead on orbit improved our knowledge and scientists made very interesting discoveries which were applied to medicine for example. But for the amount of money they spend on Space projects, they could have done a lot of research on Earth. Because this money is part of the State budget, CSA has to justify its use of it and as we already mentioned, it is always better to be supported by the public opinion.

What is true is that the ISS will enable the scientists to observe Earth permanently, better understand what happens on its surface and study the weather phenomena affecting it. Other satellites and projects are on orbit or will be launched in the future to complete the work effected on the ISS on that prospect.

CSA concludes that "Canada's contribution to the International Space Station Program ensures that we will be part of mankind's greatest adventure. Like the explorers of the past, we know not precisely where we shall land, but we voyage forth in the knowledge that great rewards await us." Reading that we guess that the Americans did not only train the Canadian astronauts but also the people leading the campaign for Space projects in Canada…

The Canadarm2 is now on the station. On the 22 of April the Canadian Chris Hadfield and the American Scott Parazynski, went on a space walk to connect the different elements of the arm. Unfortunately, a series of problems and breaking downs of the computer system of the station and the visit of the first tourist, Dennis Tito aboard the ISS, delayed the tests and the first attempts at using the arm. These problems with the computers also challenge the safety

on board. During this mission four countries, Canada, Italy, Russia and the United-States, were represented on the ISS.

Brazil and INPE

Brazil is not a very rich country. It is developing its Economy and while doing so tries to enter the international scene among the industrialised countries. It slowly starts to affirm itself and is now considered as a New Industrialised Country.

Brazil considered that its participation in International Space projects was crucial to its integration among the "Old" Industrialised Countries.

In 1961, COGNAE, meaning Organising Group for the National Commission on Space, was created. It later became known as CNAE and eventually as INPE which is the current Brazilian Space Administration. The INPE employs 1056 people.

INPE organises and supervises the space research development. Its directorate is settled on its main campus, "Sao Jose dos Campos-SP".

Brazil can still not dedicate an important budget on Space research and invest a lot in cooperation with different countries like the United-States, China, Argentina, and different European Countries belonging to ESA. The relationship with these countries are in charge of the Institutional Relations Coordination, (CRI).

The ISS appeared as a very appealing project to the Brazilians. They will provide a piece called the "Express Pallet for the ISS. Their contribution is quite important compared to their State and their Space budgets.

"INPE' s main goals lie in fostering scientific research and technological applications and in qualifying personnel in the fields of Space and Atmospheric Sciences and Applications, Space Engineering and Technology, as defined by the Ministry of Science and Technology (MCT)."

Conclusion

Even in the description of the space agencies, NASA already appears as a leader. It is the biggest and the most active of them, sending commercial and scientific missions in space. ESA is also important but also gathers several countries whereas NASA is the space agency

of the United-States only. RSA definitely lacks of money at the moment and NASDA has not developed its commercial activity yet to be able to compete with NASA.

The United-States already enjoy a great influence on the political scene and the international business market. This influence on Earth is to be projected in space. At the same time, the budget allocated to NASA only represents 1% of the federal budget. So in a way the United-States is the country that spends the lest money in space matters among all the ISS partners.

NASA still looks for partnerships and additional means to send more scientific missions. So they developed a lot international cooperation recently which enabled more countries to participate in space project. But in every international project they also have always been the leaders. The Phase-1 program was the only exception. But without this effort with looking for international partners, even if they did not have great means, and however they may help certainly encourage countries which would never have participated in the Station otherwise, like Brazil. It also encourage ASI to cooperate provide a module for the ISS on its own.

The positive point in having such a strong leadership, is that it simplifies the ISS assembly. The United-States will fly most of the modules and the crews to and back from the Station. Unfortunately the participation of the Russians still lead to at least a year delay in the Assembly. But if more countries had flown modules to the station, it may have been worse. The United-States really plays the role of the leader and the co-ordinator for the ISS assembly even if all the countries participate in it through its specialists sent to the Station when their modules are to be docked to it.

ISS Assembly, 1998-?, the Phase 2 and 3 Programs.

Introduction

The ISS Assembly started in November 1998 with the launch of the first ISS module, Zarya, which means "Dawn" when translated into English and which was launched by Russia from Baikonur, Kazakstan. The first American module, Unity was launched shortly after, in December and was attached to the Zarya module which was already on orbit.
The ISS was planned to be assembled in 45 flights over 5 years. As a matter of fact, the ISS partners intended to complete the assembly in July 2004 with the launch of the habitation module. Now looking at the assembly sequence the ISS is more likely to be finished in 2005 if not in 2006. The expedition 1 crew arrived eleven months late aboard the Station.
On another hand, these delays may enable NASA scientists to elaborate a new type of module and send a more elaborate and a bigger habitation capability called "transhab".
In spite of the delays, the ISS is already used by the specialists on board as a laboratory. Experience have been started and some have even already be sent back to Earth and once completed it will really be a great test-bed for scientific experiments. The most exciting part of it being how all the countries will cope and work together and to what results their team efforts will lead.

The Assembly

The problem of cooperation is that you depend on your partners. NASA respected its schedule but not RSA. The delay is due to the incapacity of Russia to deliver the service module, Zvezda, on time. Zvezda, which means "Star" in English, is an early living module which would enable the first crew to lead the first experiments on board of the ISS. The Assembly was supposed to last five years and will last at least six years which is quite a long time. So

the ISS partners had to start the scientific missions before the ISS would be completed. The first crew would operate its mission using the service module as a living and research capacity. So Russia did not only delayed the assembly but also the research program, and eleven months do count a lot and this delay cost a lot of money to every ISS partner, who lost nearly a year. This sequence was quite crucial since the ISS modules are not supposed to last more than 15 years in space which explains why the partners wanted to start to use it quite early. The first modules, Zarya and Unity, will need to be replaced in 2013.

The United-States participated financially in the elaboration of the service module. Russia could not finish and deliver Zvezda on time because of a lack of means. It is true that the economical context of Russia is not in favour of its space program. Most of scientists go on working even when they are not paid, but the motivation of the Russians is not enough.

When the scheduled date for the launch of the service module approached, the Russians stated that they needed more money to finish Zvezda. The negotiations between NASA and RSA lasted for a while. The service module would finally be launched with nearly a year of delay. NASA was ready to go on with its sequence schedule but they could not do it before Zvezda was launched. The shame was that the delay occurred on a crucial sequence which would allow the first crew to stay on the station and to start the research program.

Now the Expedition 1 crew is on board and completes its mission. They arrived aboard the ISS in November 2000. The launch of this mission was initially planned for January 2000.

The ISS partners hope that no other problems will interrupt the ISS assembly. Otherwise, the ISS would be operated only a very short time once completed on orbit before the first modules would be replaced. Now that a crew lives on board the station, the Phase 2 Program's aim is achieved. A crew of 3 members can already permanently inhabit the ISS. Now the goal is to enlarge it to allow up to seven people to stay on board. The Phase 2 Program will really end with the delivering of the American laboratory and of its equipment. As a matter of fact, the Phase 2 Program will end on STS-111 flight which should be launched in February 2002.

The NASA research module will actually be the first laboratory to be launched. This confirms the general feeling that the ISS is chiefly American. The achievement of the Phase 2 Program was planned for August 2000 with the delivery of the joint airlock and the high pressure gas assembly on the STS-104 mission. But the Phase 2 Program is more likely to be completed around March 2001 because of the RSA delays opening the way for the Phase 3 Program. The aim to be achieved through the Phase 3 Program is to complete the assembly of the ISS which

will enable up to seven people to live permanently on the station and to lead elaborated experiments in the six laboratories on board.

Up to now the ISS is a purely Americano-Russian station, so that it is easy to decide of the composition of the crews flying on both Americans and Russians missions. But when the other modules, like the ESA laboratory or the NASDA experiment module, will be launched and brought to orbit; the crews will really become international. It will then be more complicated to chose the members of the working-teams. Moreover, the Russians and the Americans are really used to work with each other. The other countries did not have much international team training in space although they worked with their partners in Johnson Space Center in Texas, and in the Star City in Russia. A Japanese astronaut already joined an ISS assembly flight on STS-92 in October 2000, though. Wakata was the first Japanese citizen to participate in the ISS construction.

There was a misunderstanding since the start between NASA and RSA anyway. Maybe because Soyuz has a restricted capacity and can only fly three crew members, The Russian decided that the Americans would fly the other partners on the Shuttle.

The United-States would like Russia to make an effort on this issue and provide transport to the some of the other partners' crew members. Nothing was negotiated yet. Up to now NASA concentrating on the delivery of the service module and did not have the time to consider the issue of transport with RSA. They will soon be confronted to the problem in spite of the delays so that they would better start to negotiate right now. Otherwise the Americans would have to fly all the partners crew members.

Before, during the Phase 1 Program, cosmonauts and astronauts were working together but they were on a Russian station. Even if the Russians realise that they participate in an international project, they show independence towards the other partners. The ISS is also so conceived. The Russians have their own power resources, their own means of transport and their own laboratory which they do not intend to share but with the Americans. It seems that there is a Russian station inside the ISS. Because the other partners have to share everything with the Americans, the rest of the ISS looks more like an international station. The Canadians and Brazilians do not possess their own module on the ISS so they will work on the American or on the other partners' laboratory.

The ESA module will be shared already by eleven European countries. The United-States will have access to the European and the Japanese modules giving them means of transport and power on board of the ISS in exchange. So the rest of the partners will more work as a team because they will share their capabilities while Russia will operate quite independently.
Among the European countries, Italy may have a special status since it will provide a module on its own. So they may get access to more of the ESA module or to part of the American research equipment/capability.

The ISS will remain mainly Americano-Russian until the Canadian-built remote manipulating system will be launched around April 2001. This is no "module" but since it was elaborated by the Canadians, the Americans will have to consider it and take a CSA astronaut on board of the Shuttle for the STS-100 mission. A Canadian-developed "hand" for the station mechanical arm will also be delivered in December 2003 on the STS-127 mission. So another CSA astronaut may fly on the American Shuttle again. Afterwards, Canadian crew members will join certain missions and participate in the research lead in the American research facilities.
The next foreign module to be launched will be the Japanese Experiment Module. Each time that an ISS partner module will be launched, the crew flying on the mission will include an astronaut from this country. NASDA already had one of his astronauts flying on the STS-92 flight and will certainly have another one on the mission delivering its module. Even if it was the first time that a Japanese citizen joined an American mission on the ISS everything went on without any problem inside the team so it was a positive experience. Part of the Japanese astronauts training occur in the United-States among American astronauts anyway.
NASDA first experiment module will be launched on the STS-123 mission around July 2003. Japanese astronauts will fly on the Shuttle for this missions and on the following one. As a matter of fact, the Kibo Japanese experiment module laboratory will be attached to the ISS through the STS-124 mission planned for August 2003. Actually even more than two flights will be needed to bring the Japanese equipment and module to the ISS since their facility will be completed through other missions like the STS-128 in February 2004, but NASDA will be able to use its laboratory as soon as the STS-124 mission would be completed. So, counting the actual delays, the Japanese intend to be on board of the ISS from July 2003. The Phase 3 Program would not be completed yet, though, which means that the ISS would allow only

three persons to stay on board. So to decide about the composition of the crew will become really complicated from that sequence of the ISS assembly.

As soon as an ISS partner's module will be on orbit, they will certainly want to use their facility and equipment as soon as possible. So they will aim at being permanently represented on board of the ISS and be flown by either the Americans or the Russians. Otherwise there would be no point for them in having a module on the ISS.

The ISS partners did not decide and planned the teams composition and on which flight they would be flown. NASA, RSA and the other partners really concentrate on the assembly forwarding the debate on this issue. As a matter of fact no decision concerning this subject has been taken yet. The delay caused by the Russians gave more time to the ISS partners anyway.

The next ISS partner module to be launched would be the Italian multi-purpose logistics module. So there will certainly be an Italian crew member on board of the STS-105 mission. Because the Italians provide their own module, they may be more represented on the ISS than any other European country. As a matter of fact, they will participate in the ISS project through ESA and through its own space agency, ASI. So they will certainly join more American missions than any other partner and they may even fly with the Russians.

The participation of the different ISS partners may evolve with the station anyway. When the old modules will have to be replaced they may decide not to replace theirs or to increase the volume of their research capabilities. We know how the ISS will look like until 2013 but its configuration may be changed afterwards.

The European module will be launched near the end of the ISS Assembly, probably in September 2004. So ESA is definitely put at a disadvantage compared to the other ISS partners. Russians and Americans will be able to start their research program first. The Japanese module will also be launched the previous year. So ESA is really the last space agency to have its module assembled to the ISS. ESA will be represented on the STS-134 flight which will deliver the European laboratory.

The Russians laboratories will be delivered afterwards. But the difference is that the Russians will already have some of their modules on orbit which will enable them to start their research program before the actual launch of their research facility.
So ESA may want to participate in the research lead by the Americans or Russians crew members while they would wait for their module to be launched. At the moment the very first scientific crew just arrived on board of the ISS (in November 2000) so they would join later missions. The delay caused by the Russians really affects all the ISS partners, forward their participation in the ISS project and the start of their research.

So during the ISS assembly, the United-States will provide transport for the other partners' astronauts and cosmonauts and will deliver their hardware and equipment. Russia will only provide transport for the American astronauts. So the United-States expect Russia to also provide transport to the other partners only after the assembly but they really want them to do so at that time.

The United-States are considered as the leaders on the ISS project. As a matter of fact they own most of it including their laboratory, most of the solar arrays, the service module, the habitation module and the crew return vehicle. So they own the most important parts and modules. The habitation module and the crew return vehicle will have to be shared by all the members of the crew all the time as well as the energy provided by the American solar arrays.
They are also more active than the Russians by the number of flights operated by the American Shuttles. As a matter of fact the Phase 2 Program includes nine Shuttle and three Russian flights. Twenty-three flights will be operated by the Americans, while the Russians will launch only five missions to the ISS.
So then it becomes logical that the first laboratory to be attached to the ISS is the American one.

One of the most important element of the station delivered by the Americans is the crew return vehicle. It is supposed to be used only in case of emergency, like a fire for example, to evacuate the ISS. The CRV will be launched on the STS-136 flight around December 2004. Until then only the Soyuz spacecraft was the only crew return capability aboard the ISS. And Soyuz can provide transport only for three people. So the delivering of the CRV is an

important step towards the Phase 3 Program achievement. It will assure the safety for seven people on the ISS in giving them the possibility to evacuate the station in case of a problem.
Of course NASA hopes that the crews will not need it. The CRV vehicle will need to be replaced every eight to ten years.

One of the Russian laboratories will be launched on the Soyuz rocket around October 2004. The Russians will suffer from their own delays. This laboratory was planned to be attached to the ISS in October 2003 in the first place. Their second laboratory would be launched a few months later in March 2005 on the last Russian mission of the Phase 3 Program. It will be the last Russian sequence of the ISS assembly. Instead of having one large experiment module Russia will have two research facilities of about the same size. Soyuz will be directly docked to these laboratories. So in case of emergency, the Russian cosmonauts would be the first ones to evacuate the station and they have their own crew return vehicle. Whereas the American CRV would be docked to the habitation module. So if the astronauts are working in the laboratories, they would need more time to evacuate the station. The safety of the Russian cosmonauts will be slightly better secured/assured than the one of the rest of the crew.
The Russians laboratories will be the last experiment modules to be attached to the station. Although the Russian research modules will arrive late on the ISS, cosmonauts will be able to start experiments before. As a matter of fact, the first crew on board, including one astronaut, William Shepherd, and two cosmonauts, Yuri Gidzenko and Sergei Krikalev, are already leading experiments in the service module. They are staying four months on the station. They flew to the station on board of the Russian spacecraft Soyuz and they will return on Earth on the American STS-102 shuttle mission which would also deliver the Expedition 2 crew in February 2001. The second team will still be purely Americano-Russian but will include two astronauts and only one cosmonaut this time.
The aim of the Expedition 1 crew is to "make the ISS more like home". Their mission is quite important since they will install an air conditioner, providing the crew with air and water, a carbon dioxide scrubber and an oxygen generator. So they will make the orbiting complex really habitable and healthy for them and the next crews.
Up to now the ISS missions went on perfectly well and the crews practising the assembly meet no problem.

Permanent human presence will now be assured aboard the ISS by three-person crews. So even if the ISS assembly has hardly started, a lot has already been achieved…a bit later than initially planned though…

During the Phase 1 Program, the Americans learned how to work with the Russians. At the time, Russia was not going through organisation, economy and war problems.
The political situation of Russia certainly increased the delays interrupting the ISS assembly. Russia went through elections, ministerial changes and a war in Tchetchenia since the beginning of the ISS assembly. All these problems will hopefully not generate more delays. Luckily, most of the ISS assembly flights are operated by the United-States and only a few are launched from Russia.

A home away from home: Transhab.

The last module which will be attached to the station will be an important one: the habitation capacity.
While working on the human missions to Mars, a NASA engineer team elaborated an inflatable station to gain space and weight aboard the spacecraft which would fly the crew and its equipment to the Red Planet. It then came up to their mind that this concept could be applied to the ISS habitation module for the same reasons: to increase the space aboard the ISS without overloading the Shuttle delivering the habitable facility. So they elaborated a prototype which they called "TRANSHAB".
There is a lot of waste in space. Some of it may inflict damages to the station. One of the advantages of Transhab is that it would be easy to repair and would not suffer too much from the damages provoked by the space debris impacts. This one of the reasons why hardware modules would have to be replaced every ten to fifteen years. Transhab would also not fear corrosion damages. As a matter of fact its walls would be made of twenty-four layers of soft material and would be over a foot thick. Transhab would also protect the crew from radiations better than a hardware module.
Transhab really has a lot of crucial advantages.

The crew on board would dispose of threw times the space they have now in the hardware module and double their storage volume although it would be smaller than its hardware brother when folded.

Up to now, no human mission to Mars was definitely planned. So the inflatable station was really only a project in the first place and no prototype of it had been made up. When NASA decided that this concept could be applied for the ISS, a small unit was elaborated and tested. Because it passed the first tests, they elaborated a prototype as large as the real Transhab would be. They tested it under water, in the Neutral Buoyancy Laboratory and in a giant vacuum chamber at Johnson Space Center. Transhab went through all the tests and passed them all. Its shell proved to be stronger than metal even if it is soft. Space debris would be broken up into particles while penetrating the two dozen of layers. They are very unlikely to reach and damage the last layer. But even if it were the case, they would provoke only a very small air leek which could be repaired quite easily.

So this concept could definitely be applied to the ISS. A NASA team also worked on how it would be organised inside. They would split it in three levels including a crew health care area, a galley and wardroom, stowage and the crew quarters. The crew would also be able to look outside the module through two windows.

Of course every ISS partner would enjoy the additional living and stowage space which would be available on Transhab. This inflatable module show a lot of advantages anyway. But the habitation module is in the charge of NASA and the American will take the final decision. Up to now they refused to swap the hardware module for the inflatable one. They agree on the fact that the concept is very interesting but it is also slightly more expensive. The team working on the Transhab project found private funds. A company is interested in sponsoring the project. NASA argues that if they drop their proposition at the last minute NASA would have no choice but to pay for the additional cost. And of course they do not want to do that.

So the Transhab team feels quite frustrated because they found a way to enlarge the living quarters for the crew, to increase the storage space on the ISS and the funds they need for the additional cost compared to the hardware project but NASA still refuse to adopt Transhab as the habitation module. They should try and convince the other partners who will share this module and they may participate financially in Transhab.

One of the advantages which should have convinced NASA is that if the elaboration of Transhab cost more than the one of a hardware module, it also would last longer once on orbit. The fact that hardware module must be replace every fifteen years is quite an inconvenient. So in the end, inflatable modules would be less expensive and could replace hardware modules in the future.
Transhab would definitely become a very interesting concept as far as interplanetary exploration is concerned. It was initially conceived for human missions to Mars but could also be used for missions to other planets or to a permanent station on the moon. Eventually, as other concepts originally conceived for space matters, it may find applications on Earth and commercial uses.
As a matter of fact, after achieving its goal of permanent human space habitation, NASA would aim at a permanent human Mars habitation.

The ISS operating.

Once the habitation module would be attached to the ISS on STS-141, whether it would be a hardware or an inflatable module, the ISS assembly will be completed. Thirty-seven American shuttle flights and nine Russian launches will be operated to achieve this goal. Phase 1, 2 and 3 Programs will then be completed. STS-141 flight should occur around the end of 2005 if no new delay is added to the actual one caused by the Russians.
It will then weigh five hundred tons, be the size of a football field, and have the habitable volume of two 747 jumbo jets. It will be five times bigger and its habitable space will be four times larger than the one of the previous space station Mir. A control system constituted of fifty computers will help operating this giant station.

The Americans and the Russians are still the main partner of the ISS as it was the case for Mir. But more countries and foreign space agencies are participating in the ISS and this time some of them will have their own laboratory on board which seems a crucial difference.
Of course if we look at who owns what, the general feeling is that the ISS is more an ASS (American Space Station). But at the same time, the ISS will include six laboratories belonging to four different space organisation: NASA, RSA, NASDA and ESA.

So the United-States, Russia, Japan and Europe will lead the research to be accomplished on board. A crew of seven people representing these countries on board will permanently live on the ISS.

The United-States, Russia, Japan, Canada, Brazil, Italy, France, Germany, Belgium, Denmark, Norway, Netherlands, Great Britain, Spain, Sweden and, Switzerland will cooperate to complete research on microgravity, earth, space and life science and engineering and technology. Their industries will also aim at developing space products.

During the ISS assembly, the flights to the station were operated by the Americans and the Russians. In the future, Japan and Europe will also launch spacecrafts to the ISS but mainly to resupply it with equipment. They may provide transport for crews but later on and it has not been planned yet. The Americans will shoulder at least five missions each year to the station.

Because the ISS Assembly is taking such a long time, at least seven years counting the delays, it will not operate for more than ten years once assembled. Parts of it and modules will certainly start to be replaced as soon as 2013. But the core of the station would remain the same. NASA would also have to keep the interest of its nation and other countries so that they would want to participate for at least fifteen more years. Once on orbit, the countries will certainly want to keep their facilities and go on with their research.

Conclusion

Since the start, NASA made a point in not allowing any delay during the assembly considering that the hardware would not last more than fifteen years in space. So in 2013, the first module launched for the assembly would have to be replaced. NASA and its partners are half way through the initial program and they needed twice more time than was first planned to complete the first steps of the assembly. Now they hope that the ISS would eventually be completed by 2006 and would then stay on orbit for seven years only before having to start replacing modules. But delays may be added to the actual ones before the end of the assembly and seven years already sounds very little time for a space station.

"Transhab" seems then a good alternative to this problem. This kind of reparable module is supposed to last longer than hardware modules once on orbit. The ISS partners would also gain a lot of space on board and maybe enlarge their laboratories. Unfortunately, this concept initially elaborated for missions to Mars was applied to the station quite late. The actual

delays will hopefully give more time to the NASA team working on it and to have their project accepted and adopted for the habitation module.
NASA and its partners are really looking forward to the day when the last module will be docked to the ISS. They would be able to use it at its full capacities and finally really work together. The international community also expects to benefit from the research that the specialists will undertake on board.
But how will the members of the crew on board cohabit and co-work? Will the ISS be used for other purposes than research? Would there be a commercial way to work it?

Future: after Phase 3 Program completed

Introduction

Nobody really knows when the ISS will be completed yet. NASA and its partners planned to use the ISS as a laboratory and enable universities on Earth to benefit from such a scientific platform. Each module will stay on orbit over a decade and they will be used as soon as docked.
Since the United-States will use the ESA and the NASDA laboratories, these space agencies will have to agree how and when they will use their experiment modules. The ISS partners planned to share the result of the research led in their respective modules. To what extent will they respect their "contract"? Only the future experience of the different specialists who will work on the station will tell us about it.
The ISS may also be used as a holiday destination. The Russians may not have been the first ones to think about using the station in such ends but they were the first who did it. Let see what will happen in the future.

How the ISS will be used.

Up to now the different Space Agencies were trying to attract industrial partners and to seduce the public opinion in their respective countries.

Anyway, it is very simple to plan and to decide from the ground what will be done on the ISS. Four laboratories are on the ISS and scientists are supposed to work together. As a matter of fact, some countries do not have their own laboratory on the ISS so they will work in other countries' laboratories. Only the United-States, Russia, Japan and Europe will have their own research module. Nobody really knows how it will work in Space.

The different countries may have different aims. They all agreed on a general research plan though.

They will focus their efforts and research on Microgravity, Life, Space and Earth Sciences, Space Product Development, and Engineering and Technology.

Just looking at these aims we notice that Space appears three times (microgravity, space science and space product development). So the research will definitely be more directed towards Space in general and everything which is linked to it.

Engineering and Technology appear last in the list. Industries are participating financially in the ISS and expect the research to profit them in return. Of course their financial participation may represent only a very small part of the general budget but it also represents a great effort from the industries compared to their means. If NASA and its partners want to encourage industries to participate in their projects, they will definitely have to respect their engagement towards them and part of their research must really be helpful to these industries. As a general trend, NASA and its partners promised that the result of their research in Space would benefit people on Earth. Let us wait and see…

So the different partners agreed in using the ISS " as a means to foster private-sector contribution to and utilisation of space, both developing products in orbit and using knowledge gained from the unique environment of space for applications on Earth."

Most of the research led in Space will be applicable only in Space because the environment on Earth is so different. The result of research already led in Space on previous space projects as Mir or Skylab may benefit people.

Scientists discovered that the insulin produced in Space or on orbit is purer than the one produced on Earth. But then they would have to dedicate a part of their laboratories to the production of insulin. Nothing of the sort has been planed yet though. NASA and its partners tend to focus their interest on new research rather than on already studied subjects. They will actually dedicate part of their research to HIV (AIDS' virus) and cancer.

The ISS will also be used as a testbed for human exploration of the solar system. It actually may be used right away for missions to Mars. Technologies useful to go to Mars are planned to be tested on the ISS. The ISS might also be an intermediary station. As a matter of fact, spacecrafts going to far away planets may first stop on the ISS. It will certainly be used as a testbed for other missions to other planets. NASA intend to focus its interest on EUROPA after sending human missions to Mars. They would have to convince their partners though.
All the countries working on the ISS may not be willing to participate in every other project.

As Mir will not be used anymore when the ISS assembly will be completed, the ISS will be then the only laboratory where fundamental physical, chemical and biological processes will be explored in the absence of gravity's effect. As a matter of fact some striking phenomenon have been observed in previous research on orbit. Cells, for example, when cultured on earth form a single layered tissue while it produces a three dimensional shape when cultured in space. So cells cultured in microgravity actually adopt structures which more closely resemble the natural state of the tissue in the human body. This type of observation may be very useful to medicine and particularly to doctors to enable them to improve their curation methods/techniques.
As Steve Olson stated, "biology is not just science of what we are and how we came to be, it is also the science of what we can become."

The ISS, because it will be on orbit 10 years around Earth, will enable scientists to observe Earth and space. So they will not only work in the different laboratories. So more people will be able to work at the same time on the station. Different satellites dedicated to specific tasks will be permanently observing specific areas or phenomenon happening on earth while it would be observed in its whole from the ISS.
Space around earth will be closely studied from the ISS to improve our knowledge about our close space environment. We may so detect some meteorites before they fall on Earth.

Before sending humans to Mars, our knowledge about the effect of microgravity on our body and its functions must be studied in details. Up to now, one of the arguments preventing any human mission to Mars is the fact that we are unable to guaranty the safety of the crew on

such a long journey. Intervention must be possible in case of health problems. The presence of a doctor in the crew would be useful only if he really knows how a human being body reacts in microgravity.
So the ISS will also be used as a means to study long-effects of weightlessness on the human body. This type of research would enable further exploration of space, Mars and eventually of other planets of the solar system.
This knowledge would also be applied to better the health and well-being of humans on earth. As a matter of fact, studying the effects of microgravity on our body is to study the effect of gravity on it as well in noticing the differences of its reactions and functions on earth and in space.

NASA and its partners also intend to elaborate "tomorrow's products" on the ISS. This part of the research to be led on the ISS is more linked to technology and would benefit the industries which are participating in the ISS. They would tend to use space environment to develop new processes and products to improve the life of the people on Earth. In some cases it also benefit the science and people. NASA and its industrial partners developed visualisation and telescience technologies which are now used in medical training for example. NASA and its partners also intend to train future ISS astronauts in a "virtual Station environment".

The ISS already led governmental cooperation. Once the assembly would be completed, scientists from around the world would work together. So it would then lead to a scientific cooperation.
Industries from every country participating in this project will also have to share the knowledge resulting from the research led to benefit them. So it will lead to an industrial cooperation.
On earth the trend is more to compete national and foreign industries. So the industries will definitely have to adopt a different mentality and change their working habits. This may be really interesting.
NASA and its partners intend to have people on earth participating in the research led on orbit. There would be a certain interactivity between earth and space. Universities from around the world would get directly the result of the experiment led on the ISS. Anybody on

Earth may even be able to learn about what is being done on the ISS through internet. Research on orbit and on earth is supposed to complete each other.
So universities from around the world would communicate and work together with the scientists on the ISS. So it would also lead to an academic cooperation.
An internet-based telemedicine testbed already links academic and clinical sites in the United-States and in Russia for clinical consultations and medical education.
NASA is encouraging inter-activity with people on earth through internet and university only with an educational purpose. Even educators in schools will be able to use it to show their pupils the importance of science in daily life. Pupils would be able communicate with the scientists and to "visit" the laboratories. The aim will be to interest the youngest pupils in science and technology so that they may choose to study these subjects later on the university.
They want to interest the people and next generation so that they would invest themselves in space projects.

Up to now countries have always been competing in every sector of activity. They compete to win scientific rewards, to invent the best technologies. They compete to be the first ones for everything and everywhere.
On the ISS this type of mentality should be excluded. It is built on the share of the knowledge, even if some countries have their own laboratory on orbit. It will not work in one day and it is still really theoretical.
The ISS is mainly American and Russian anyway. There even seem to be two different stations inside the ISS with very small modules from other countries.
NASA and RSA get their power from their own solar arrays so that they get their power in their own ways.
Russia does not share its power with any other country.
NASA share its power with Europe (ESA) and Japan (NASDA).
The positive side of having two different systems to get power is that if one system fails, the other may work so it is a kind of security. But will countries who are not able to share their power be able to share their knowledge and findings?
Every module has also its own way of working and its own specificity.

The electricity on the American module is of an American standard. The electricity on the ESA module correspond to European standards. And the standards on the Japanese module are also different. So if the scientists want to lend each other material they will also need transformers. So the different countries did not agree on a general standard and already express their difference in their equipment.
If we just read the general statements of NASA and its partners on cooperation we may think that they really intend to work together so that they equipped their modules in that sense but it is very far from the truth. You enter Russia when you enter the Russian module, Europe when penetrating the ESA module and so on. So scientists will certainly have difficulties to go to one module to the other and to work in different modules. Only the scientists will really feel at ease in their country's module. These differences may even lead to mistakes as it already did in the Mars missions because scientists would have to convert other's standards into theirs and vice-versa. NASA was speaking of "the advantages of equipment sharing" but sometimes it may become a burden.

Because the ISS is an international project the crew on board will also be international. Even if scientists are supposed to speak the same language and if they will all speak English, they may find it difficult to live together in the first place. On Mir different cultures were mixed and if they got used to each other, the astronauts and cosmonauts found it difficult in the beginning. Russians and Americans have very different cultures and they had been through the Cold War. The French joined as well and also went to the "star city" first to learn Russian and to adapt themselves to working with Russian people.
On Mir only few different cultures were mixed. On the ISS nearly each member of the crew will come from a different country. At JSC, Texas, astronauts from different countries already train together. This will already make things easier. But nothing has been decided about the crews to go on the ISS yet. The United-States, Japan and Russia will certainly be permanently represented on board. Europe will also be permanently represented but through different countries.
The crew already sent were either purely American, purely Russian or Americano-Russian. As both countries were used to work with each other on Mir there was no surprise or problem yet. Things may become more complicated when the other countries will have to intervene when their module will be launched.

The United-States and Russia will provide the transport for the rest of the crew. As the Americans has got a bigger spacecraft, the Russians already decided that NASA would provide the transport for the other countries. Soyuz would send mainly Russian or Americano-Russian crews to the ISS. The United-States would like Russia to also send foreign crew members. They have not negotiated on this issue yet even if the ISS is already being assembled. This means that they will have to take decisions very soon.
If the Russian were not changing of mind, the Americans would then have to provide the transport for themselves, Europe, Japan and other countries.

Orbit: over a decade.

The ISS will be on orbit for approximately a decade once its assembly will be completed. It will provide almost four times the enclosed volume of Mir and seven astronauts will inhabit it permanently. Six outfitted laboratories will be shared between the United-States, Russia, Japan and Europe.
The crew will lead experiment on combustion, fluids, materials, gravitational biology and ecology, earth system science, space science, protein crystal growth, cell culture, biomedical research, medical care in space, advanced human support and finally on commercial product development. This is a very long list and nobody knows how well it would work on the ISS laboratories. Since this is the first station of this type and this size, it can not work perfectly well from the start. Once assembled, the ISS is supposed to last ten years. So if some partners stop their participation in the project, some of the modules may not be replaced. This means that this long list must be completed in ten years. Because the ISS represents a unique opportunity for research and because it is a very expensive project, NASA and its partners want to make the best of it. This might be possible if they were really organised and if everything were working as they planned it would work. They do not even know how nor when the foreign astronauts would be sent so they really did not think about any sort of organisation plan applicable on board. Even if they had done so, what seems simple from the ground become more complicated since the astronauts actually are in space. But they are not organised in anyway so their project really sound very ambitious. They may not be able to lead all the research they would like even with help from the ground from universities for example. Every country also seem to forget that the crew will be constituted by astronauts

from different countries. Some of them make plans as if the seven members of the crew on board would be from their own country. The ISS is the first capability of this type to be put on orbit. As already mentioned it will be four times bigger than Mir. But it will also be shared by the countries participating in this project and it still is limited in time and space. After ten years the first modules launched will have to be replaced. There is more space on the ISS than on Mir but it will be shared by more people and by more countries.

If the technology of the inflatable module is adopted in the future, the replaced modules would supposedly last more than ten years and be more spacious and may allow more people to live on the ISS at the same time.

Because the countries invest a lot in this project they also want returns. They may not take profits out of their investment before many years though…Some of their aims seem reasonable and other less.

What is to be accomplished

Inputs

Even if the ISS assembly would not be completed before 2006, research will be started before with simple experiment. Up to now the crews were quite busy with the assembly but they can already do some research in the modules assembled. In 2003 most of the research projects will have been started and some may even be completed by then.

Now the aim is to assemble the Station, equip it with research instruments and facilities, and with power, data-handling as well as communications resources. This would enable the crew to lead research inside the ISS and to observe Earth and Space.

Students already sent experiment to the station as part of the "NASA Student Involvement Program". These first university experiments came back on the STS-102 mission in March.

Outputs

Once everything will be settled, the ISS will enable industries to improve their products or to conceive new ones.

Scientific research will enable publications and internet websites to spread discoveries and the results of the work of the scientists on the ISS around the world.

New knowledge will enable teachers to add new elements to their educational materials and programs.

Outcomes

The research lead on physics sponsored by industries will enable them to improve their industrial processes.

The results of the experiments lead by scientists on the ISS will increase fundamental knowledge.

The findings linked to the functions of our body will lead to better health measures for the members of the crew working on the ISS and for people on Earth.

Impacts

The ISS will be used as a testbed for other missions. It will then help developing human exploration of the solar system.

The problem of long duration flights are oxygen and food. "Space food" provided to astronauts during their flight is well-balanced. But the best for astronauts would be to grow plants which would provide oxygen or food. Such experience were already successful on Mir. At the Johnson Space Center in Texas, scientists are growing plants under drastic/extreme conditions tending to imitate the environment in space. Food research already elaborated products out of the plants which are more likely to be grown in space. This could already be applied to the ISS and be improved for long-duration human missions to Mars or to other planets of the solar system. Day-to-day "foodstuffs" would be grown on board in order to maximise resource efficiency and overall spacecraft mass.

NASA and its partners also intend to build "tomorrow" in elaborating new commercial products improving life on earth. They want to use the ISS to invent the technology of the future.

Aims of cooperation.

"Each cooperating government partner (…) is allocated a share of Station resources in accordance with its contribution to the program."

If we have a look at what belongs to each country on the ISS we notice that it is mainly an American Station. So the United-States are the one who really will take advantage of the station. Actually if we study the project in detail, we notice that the ISS is more an ASS (American Space Station) with Russia as a main partner. The other countries have a less important role on the station. Japan has a good capability on board but depend on the Americans for power and transport. The Russians have their own solar arrays providing them with power and they also have their own means of transport. So they really are independent. It nearly looks like they would have a "Mir" on board of the ISS…

Europe has its own module like Japan but it will be shared by several countries. As a matter of fact, 11 members of ESA take part in the ISS. It is a European module so every Space agency of ESA participating in the project will have a limited access to their research capacity since they have to share it. Without counting that only seven people are able to live on board at the same time. Italy may be privileged compared to other European countries since it is providing a module on its own (Multi-Purpose Logistics Module).

Brazil and Canada do not provide a lot to the ISS. Canada is participating financially in the project and will receive in return technical information which would be useful to its industries.

Brazil is just providing a small module but it already represents a great effort from this country compared to its Economy. Brazil really expects a lot from its participation. They want to have their place in the world-wide Economy market.

So the United-States supervises the ISS and owns most of it. Because they provide transport and power to Japan and Europe they will have the use of half of the European and Japanese pressurised laboratory space in return. So in a way the ISS embodies a sort of "American Imperialism" in space.

Companies from around the world are also participating in the ISS. They will provide their own proprietary hardware and pay their share of power, crew and launch costs. The crew on board may even use their facilities and hardware. So their contribution is quite important.

A company is actually ready to sponsor the Transhab inflatable module. NASA did not agree with swapping its hardware for this new module. They argue that the hardware is less expensive and is already ready. They do not want industries to sponsor it because if they were leaving the project, NASA would still have to pay for the extra cost.

If the company really engage itself, the crew would gain a lot of space and the module may last longer than a hardware module. So the ISS might be improved thanks to purely private fundings. Industry will participate more and more in space projects in the future. This kind of partnership seems as profitable for the space agencies as for the companies concerned. Moreover their research is more linked to products enjoyable by the people. So they seem more likely to keep common people on Earth excited with their projects. Whereas the space agencies may lead more research linked to space matters.

NASA even created Commercial Space Centres (CSC) to ease their relationships with industries and encourage commercial projects linked to space. Industries are also very likely to make profits out of their research because it will lead to the commercialisation of products afterwards.

So this type of cooperation is really linked to business. NASA actually hopes that "one day, popular interest and entrepreneurship will open the space frontier to tourism."

An investor is interested in building a hotel which would be on orbit around the moon and he already has one milliard of dollars to invest in this project. This sum of money is nothing compared to the budget needed to realise such a project but it is a start.

So they want space to be accessible to everybody and their main aim is to make money out of it since every project up to now was really expensive. So instead of "spending" money on space projects, Space Agencies and industries would prefer "investing" in them.

A new prospect: the ISS as a tourist station!

The media forgot about the world-wide problems and focussed their attention on a special event in April and Mai. The ISS has welcomed its first tourist on board.

The ISS assembly has not even been completed yet. So how may this exceptional trip be explained?

Since the ISS is not finished yet, the station receives new payload on board and new equipment which have to be tested. The moment seem really ill chosen to send a non specialist to the ISS. It may even appear dangerous. And is the point even for somebody to go to the Station if it is not completed? There is no living quarters on board , so no comfort. This would only delay the work of the astronauts and endanger their safety.

So of course the ISS partners did not agree with this purely Russian initiative. First of all, they realised that the station would loose of its credibility if used in this way. The ISS was presented as a scientific station to benefit the people on earth and not an individual in Space.
However, for twenty millions dollars, the Americans may have accepted the idea but the would have waited the end of the assembly to start taking "tourists" to the station.
Who could afford such a holiday? A Californian millionaire, Dennis Tito. So why did he fly with the Russians? Of course, because of the circumstances, the Americans refused having a tourist aboard the ISS. Dennis Tito may even not have asked them because he knew that they would refuse. Why did the Russians accept? Because they can not afford refusing twenty million dollars. The Russian Space Agency really needs money at the moment. The ISS partners did not want a tourist on board. But the Russians imposed it on them. And they could since Dennis Tito would be flown on Soyuz and would take the place of a Russian cosmonaut. The ISS partners were really annoyed by this additional delay. The ISS assembly will be completed a year late and now more than ever, they have no time to loose.
The Canadian arm had just been brought to the ISS and the astronauts were about to start to test it. But because of Dennis Tito's arrival, they had to differ the essays and wait for the millionaire's departure.

Dennis Tito's holidays also revealed the dissension between the United-States and Russia. Since the start, the ISS was an Americano-Russian project. The collaboration between the two countries already existed on the Russian space station Mir.
The Americans needed the Russian experience but also believed that cooperation in space would bring the two countries to a better understanding of one another and they aimed at easing the political relationships between the two countries.
In the Tito's case, the Russian took a decision in spite of the American disagreement on this specific subject. This schism occurs quite early in the ISS assembly and does not forebode anything good for the ISS in the future.

Dennis Tito, a sexagenarian, had a dream and a lot of money which enabled him realising his project. He had the best holidays ever which he himself qualified as a "trip to paradise". He is the very first tourist who went to the ISS. He spent eight days in space including six on the ISS. He left on the 28 of April and he came back safe and sounds, on the 6 of may, his

camera still in his hands. He even thinks about going back in three years from now. But he had to train for an extended period in the Star City before being allowed to fly on Soyuz to the ISS.

But will he be the last? Now the Russians showed that they were ready to satisfy the envies of people for any large amount of money. This may give ideas to many…And many already applied. The Russians intend to send other tourists in Space and why not on their own station. They start to speak about a Mir 2 station. They already negotiate with the next candidate for the ISS and Dennis Tito said that he would send four more to the Russians. The Russians had already sent "tourists" to space as Toyohiro Akimaya, a journalist, or Helen Sherman, a Mars employee but D. Tito was the first to be sent to the ISS.

RSA intends to finance part of its space projects like this. The Russians have suffered too long from a lack of money. Twenty million dollars represent 15% of the current annual budget of RSA. Because the Americans financed nearly 75% of the ISS and started the project, they intended to be the leaders on board. But the Russians wanted to remind them that they were their most important partner in this project and that they owned an important part of the station. Dennis Tito had to sign a document with the Americans entitling him to repay any damage he would occasion on board. As a matter of fact he hardly went to the American quarters. Daniel Goldin, also stated that the Russians would have to pay for any additional cost related to the flight of the "tourist". And the so-called "tourist" used to work for NASA as an engineer. NASA must be frustrated anyway. They always want to be the first ones in everything and also they lost twenty million dollars in a way. Even if NASA is not in the situation of RSA, they have always been interested in any additional funds to finance their space projects. And because the Russians imposed their decision on them, the Americans start to think that it was a mistake to collaborate with RSA and wonder if they could not part from them in the future.

Other projects had already been imagined in favour of tourism in space. As a matter of fact, an American millionaire had the project to build a "hotel around the moon". So Space tourism is an old concept but it had not been realised yet. Now the Dennis Tito experience started a new era and concept of tourism. The president of Kazakhstan, Noursoultan Nazarbaïev stated that " anybody could do the same " as Dennis Tito.

The ISS was never intended to be a holiday destination or a tourist station but a scientific station which explains the disapprobation of the ISS partners concerning Dennis Tito's trip.

The ISS assembly is not even completed yet and the station is already used for different purposes than it was originally conceived for. Was Dennis Tito the first and last tourist on board? Would the station also be used in this way in the future by other millionaires? Will the Americans agree with other tourist trips?

Conclusion

The ISS will be used as a giant space laboratory. All the countries present on board at the same time planned to work together. The Russians already showed a feeling of independence. They flew a tourist to the station without the agreement of the other partners and more particularly of the United-States.

The first tourist was not really "welcome on board" and the ISS partners did not agree with his flying to the station. The assembly has not been completed yet. But after, it may be a way to commercialise the station and to sponsor all the expenses linked to it and to the research led aboard the ISS.

So the Russians were the first "holiday on the ISS" provider but they will certainly not be the last one. The ISS partners may even find other ways to gain a lot of money by using the ISS.

The ISS is also supposed to be used as a test-bed and why not a go-between Mars and Earth. Missions to Mars may be first launched to the ISS which partly explains why NASA also try to excite the interest of the ISS partners in Mars missions. It actually worked quite well with France. In the future, NASA intends to have the ISS partners participate in all the space projects they will elaborate and launch. The ISS is hopefully only a start as far as international cooperation in space is concerned. NASA looks for the development of ESA and NASDA scientific missions. The aim of any space agency remaining to launch commercial missions like satellites. Considering that the Americans will be the leaders on board and that ESA and NASDA will be less represented on the Station there will not be any problem of influence. NASA organises everything and provide transport for them so they must cohabit and work together without any problem or distension. But with Russia it is already different. They proved to be unfaithful when considering how late they delivered certain modules. They showed their independence not considering the American opinion about "Tito's trip". Americans and Russians will hopefully make efforts in the future or the balance on the ISS will be challenged.

Conclusion

Cooperation has many advantages but is sometimes difficult. In the case of international cooperation several countries gather their efforts, their technology, their experience and their means. But they also bring together different cultures which sometimes generate a lack of comprehension between the partners working together.

In the missions to Mars, most of the time, the partners work independently. They elaborate their own scientific equipment and deliver it to the Americans. When NASA really worked with other countries, it sometimes failed because of misunderstandings initiated by a difference in their respective scientific language.

Even in the Mars Sample Return mission, France would work quite independently from the United-States. CNES and NASA will cooperate and work together only on very specific stages of the mission.

The United-States presented themselves as the leaders in the missions to Mars even more than for the ISS. They will be the ones who will get the samples from Mars and who will study them in their own laboratory. So if anything interesting is found in them the international community will again have the feeling that the mission was an American mission even if the French shoulder the half of the mission.

Missions to Mars cost a lot of money and this explains why NASA needs partners and encourage international cooperation. But if the partners invest a lot of money in the missions to Mars they will want to benefit from it. France want to have direct access to the Mars

samples which would be brought back to Earth but the Americans did not agree with the French point of view.
If human missions were launched to Mars, NASA would look for partners again to share the cost but the first flag to appear on the Martian surface would be an American one for sure!

On the ISS, the partners having their own laboratories belong to fundamentally different cultures and they all have their own way to work and live. They also have their own scientific language and specific equipment. They will all have already worked together on Earth but once confined in a limited space on the ISS it may be different.
Cooperation does not prevent the different partners from competing against each other for commercial purposes. ESA and NASA both launch commercial satellites and NASDA want to enter this market. So all the partners in space for scientific missions are money makers and adversaries on Earth as far as commercial activities are concerned.
The United-States had always presented its cooperation with Russia as a political choice. First of all this seems quite hypocritical. Without the Russians and their station Mir the Phase-1 Program would not have existed. RSA specialists helped a lot and gave important and useful advice when the ISS was elaborated. And now the Americans may regret their "political choice" considering the delays in the ISS assembly originated by the Russians.
Compared to the Cold War period, the relationships between the United-States and Russia improved a lot but there seem to be still an atmosphere of distension between the two countries. They quarrelled recently about the "Tito's affair". The Russians decided to send a tourist to the ISS without the consent of the Americans. RSA knew about the disagreement of NASA concerning this issue but they completely ignored it.
This bone of contention put a big mess in the relationships between the two countries but they will hopefully soon recover from this crises and come back to more reasonable decisions and compromises. Still it shows that the Americans and the Russians have very different mentalities and that there is still a distension climate between the two countries. Of course this tensed atmosphere is not to be compared with what happened during the Cold War.
The Russians also showed that they were not impressed by the Americans and they are not to take orders from them. They have their own means of transport, they will provide energy for themselves, they have their own laboratories on board. So they seem quite independent from NASA on the ISS and they want the United-States to keep it in their mind.

Since the start, the ISS was presented as a great international project but problems already disrupt and delay the ISS assembly. NASA stressed the fact that their cooperation with Russia cost them a lot but they accepted it for diplomatic purpose. The Russians delivered their second module with important delay and they already take decisions on their own without consulting the Americans.

The Americans were frustrated for two reasons when the Russians decided to send a tourist on the ISS. In their opinion it was really not the moment to send a tourist on the ISS in the middle of the ISS assembly and it would delay the tests of the Canadian Arm. The assembly already suffers from important delays and did not need an additional one.

On the other hand, the Russians argued that they had money problems and that the ticket of the tourist, worth twenty million dollars, would help them a lot. NASA also has budget problems. NASA gets a lot more money every year than RSA but its budget represents only 1% of the federal budget. So in a way, they lost twenty million dollar from an American citizen. Dennis Tito is from California. Once the ISS completed, NASA would be delighted to take tourists to the station for a short stay and for this price. The tourists would naturally choose the comfortable shuttle to the detriment of the Russians. Soyuz is a reliable but old technology. This explains why the Russians sent Dennis Tito now and why they did not wait until the end of the ISS assembly. The Russians are the only one who give the opportunity to rich common people to fly to the station but it may change in the future.

The United-States always presented the ISS as a great international project. But they also insisted on the fact that they owned over 70% of the station and that they would provide energy and transport to the other partners, ESA and NASDA. So they presented themselves as the leaders in this project and it was evident to them that they would take the main decisions on board and they would decide how each partner would use the ISS. They would not have imagined that a partner could impose its decisions on them.

The Americans really have a business like mentality and they make a point in gaining money out of everything. So they agree with the Russian idea but they disagree with the time and with the fact that they should be the ones to fly tourists to the ISS and even more if these tourists are American citizens. They seem frustrated because they lost an opportunity to make money.

The Russians already threatened to detach the Russian part of the station from the core of the ISS if other conflicts were opposing them to the United-States and NASA also expressed its

will to be completely independent from the Russians on the ISS. So let us hope that the "great international project" will not end in a flop. There would still be an ISS and a MIR-2 station but the project would then loose of its scientific and politic interest.

NASA also always stated that the research lead in the ISS laboratories would benefit people on Earth. People may not find it evident. The results of the research will benefit scientists and industries first. For example, scientists found out that the insulin produced in space was purer than the insulin produced on Earth. But NASA and its partners are very far from planning to produce insulin in massive quantities on the ISS and sending it back to Earth for the use of diabetics. Some of the research will also be dedicated to future space projects. Scientists intend to try and grow plants on the ISS and study the effect on human beings of long duration stays in space. Human exploration of space is still an issue and NASA intend to send astronauts to Mars and there will be other planets to explore afterwards like Europa. So the research lead on the ISS will also benefit people in space or astronauts to be sent to other planets in the future.

NASA made the international community very enthusiast about the ISS giving a general overview of the advantages of having a scientific station in space. But if individuals try to find out what will directly benefit them, they may be disappointed.

The ISS will benefit people on Earth in a large extent and over an important period of time. The next generation will start to notice the impact of the results and discoveries made by scientists in space on the life of people on Earth but no sooner. Nothing that was stated by NASA was wrong but they did not give any detail or precision. And if they had done so, the international community may have been a little less enthusiastic about the ISS. People usually lack of interest in projects which will not directly benefit them.

NASA propaganda for its space projects, including missions to Mars and the ISS, always attract the attention and interest of people on a world-wide scale. NASA also coped with attracting contractors and other foreign Space Agencies into their projects. They still try to encourage international cooperation even with New Industrialised Countries and countries formerly belonging to the East Block. Brazil participates in the ISS already. Romania and Marocco intend to participate in international Space projects in the future.

But even if NASA encourages international cooperation they always initiate the "international" space project and participate in them more than any of its partners so that they

also always impose themselves as "The Leader". Their position already generated problems with the Russians concerning the ISS. The ISS now embodies a greater challenge. If the ISS partners cope with working together on such a project they would then work more as a "team" in the future. The next challenge would be an international human mission to Mars. Some of the ISS partners have already worked together or are close from one another culturally speaking. But with others it may seem more difficult. The ISS partners already went through their first crises and the ISS assembly has not even been completed yet. Let see if the relationships between the ISS partners will encourage international space projects in the future or, on the contrary, stress their cultural differences.

SIGLES

-APEX : Athena Precursor EXperiment
-APXS : Alpha-Proton X-ray Spectrometer
-ASC : Agence Spatiale Canadienne
-ASI : Atmospheric Structure Instrument
-CSA : Canadian Space Agency
-DSN : Deep Space Network
-ESA : European Space Agency
-GRS : Gamma Ray Spectrometer
-HEND : High Energy Neutron Spectrometer
-IMU : Inertial Measurement Unit
-INPE :
-ISS : International Space Station
-JPL : Jet Propulsion Laboratory
-MARIE : Martian Radiation Environment Experiment
-MECA : Mars Environmental Comptability Assessment
-Mini-TES : Mini-Thermal Emission Spectrometer
-MIP : Mars In-situ Propellant production
-NASA :
-NASDA :

-RAC : Robotic Arm Camera

-RSA : Russian Space Agency

-TES : Thermal Emission Spectrometer

-THEMIS : Thermal Emission Imaging System

-US : United-States

-USSR :

-UV : Ultra-Violet

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