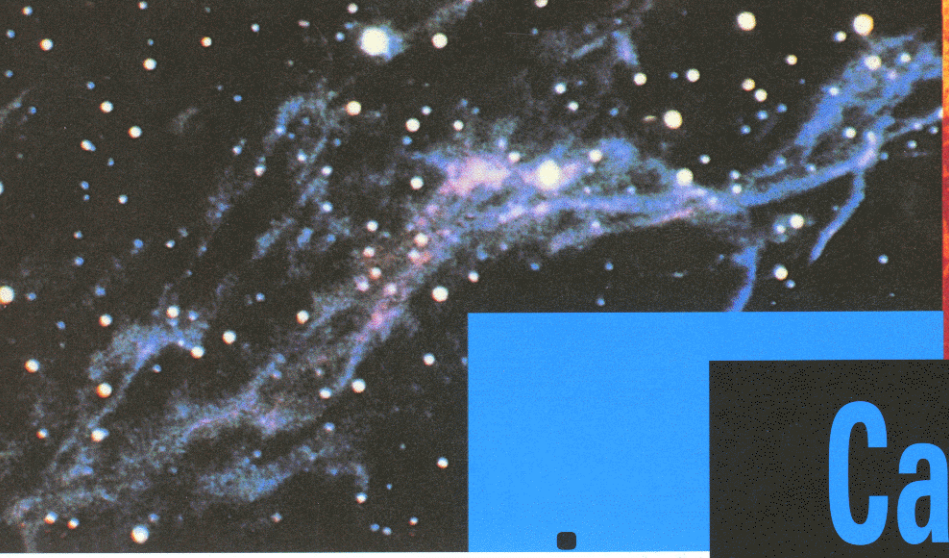
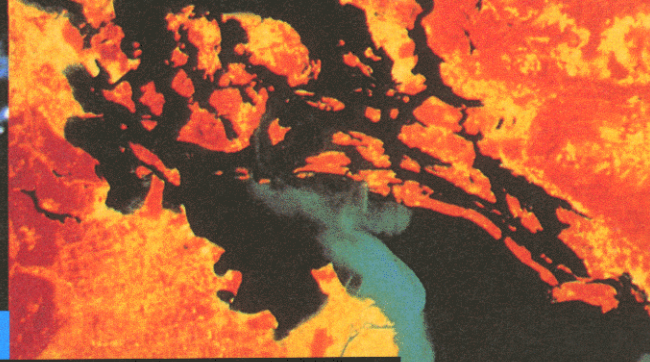




Careers in space...

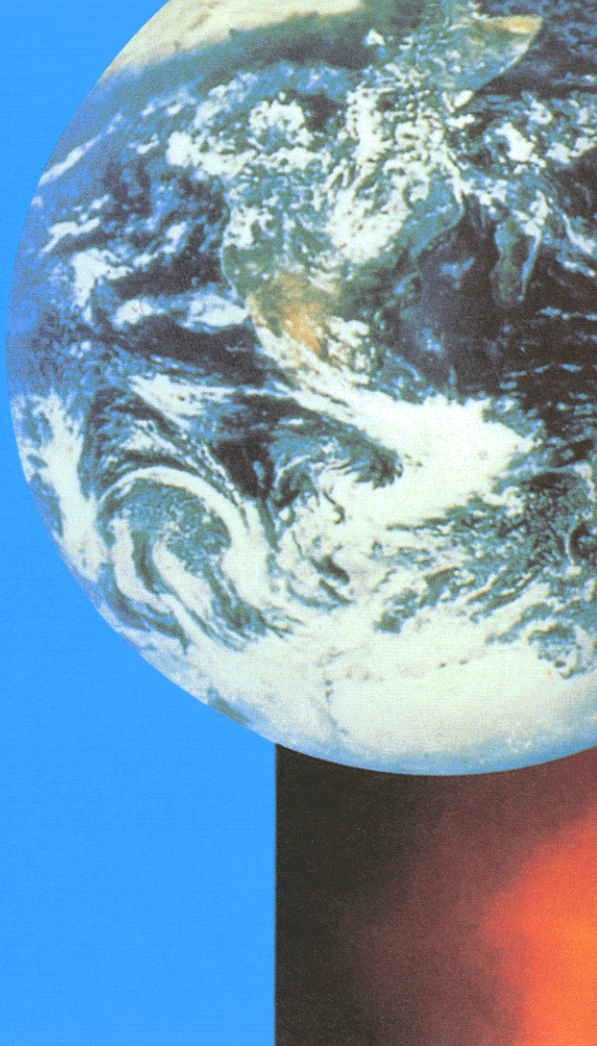
the leading edge!

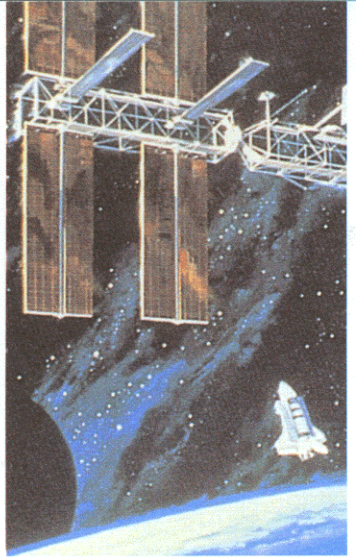
Canadian Space Agency | Agence spatiale canadienne

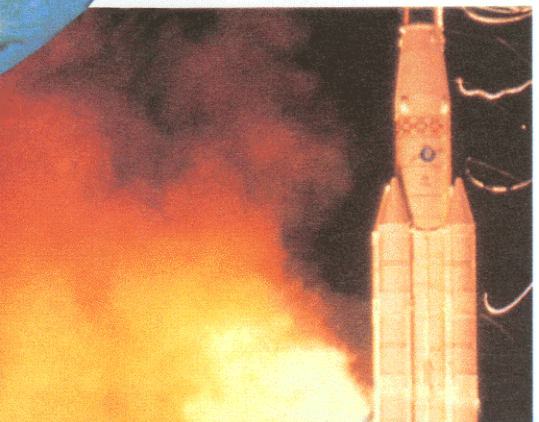
The 21st Century will be a time of great excitement in space exploration and research. It will be a time of discovery, international cooperation, robotic planetary probes, and outposts in space. You could be a part of all this.

Space is no longer a new frontier: it's a vital part of our world. Where will space lead you?

The sky is no longer the limit, let your imagination take flight.



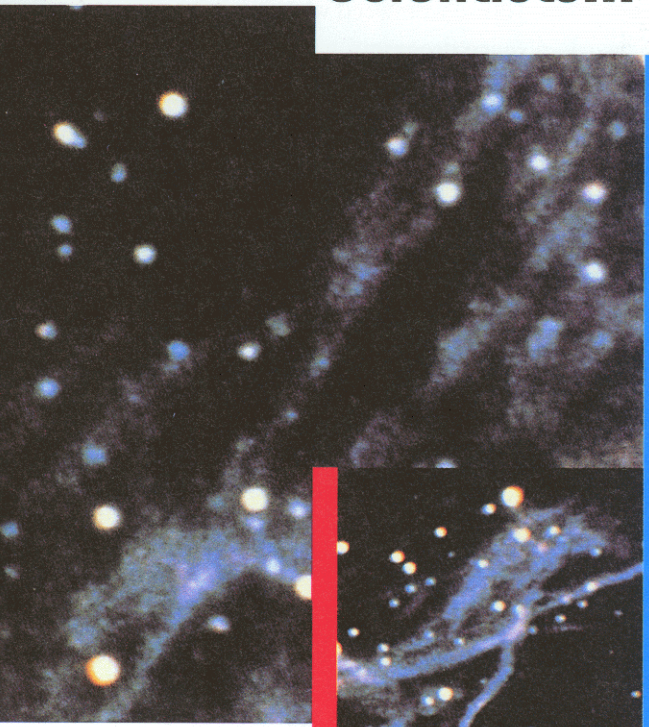




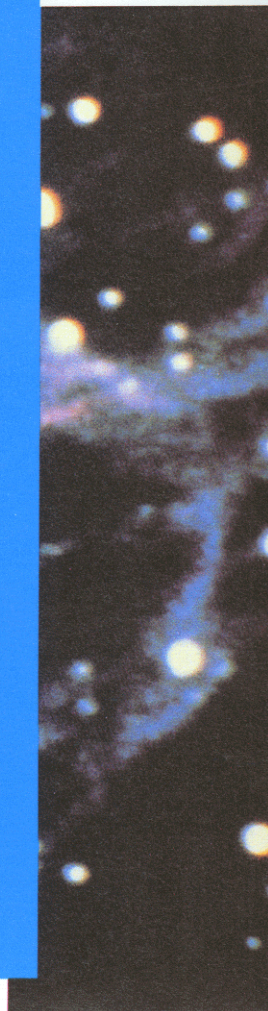
Perhaps you've wondered what kind of people work in space programs, what kind of work they do. Do you want to become a space scientist, a technologist, a technician, or an engineer? Do you want to be an astronaut, a space biologist, or a space physician? Do you want to build spacecraft, make them fly? Space fascinates you and you would like to be part of the great space adventure? If this describes you, read on: there are numerous career options in the space field.

Here are a few examples:

Scientists...



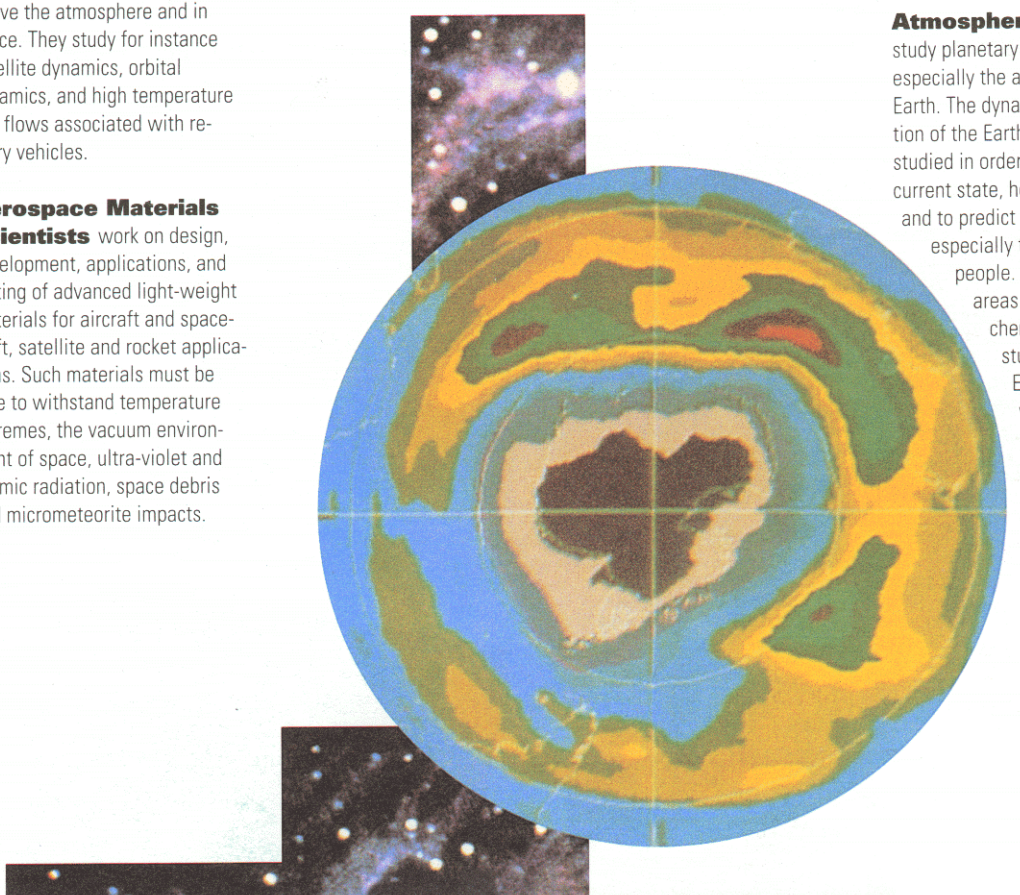
...are interested in expanding knowledge. They try to explain how and why things happen. They study and conduct research on various phenomena and develop theories based on scientific observation. Space Scientists work in many different fields. They can be Physicists, Astrophysicists, Geologists, Biologists, Meteorologists, Chemists, Physicians, Space Psychologists, Life and Materials Scientists, to name only a few of the scientific professions in the space field.



Astronomers and **Astrophysicists** study the planets, stars, and galaxies beyond Earth. They conduct astronomical research by planning experiments and observations with telescopes located both on Earth and in orbit. They design and build instruments, collect and analyze data using high-speed computers to handle the vast numbers of images of space. Through the progress of the space age, astronomers can now observe objects emitting radiation from the highest energies (X- and Gamma-rays) in regions of the universe where stars are being formed and violent events taking place, to the weakest energies (sub-millimetre and radio waves) from old stars and cooler planets. Current astronomy research includes observing the birth and death of stars, looking back through time and space to the beginning of the universe, supernovae, "black holes" and "dark matter", pulsars, gamma-ray bursts, and SETI - the search for extraterrestrial intelligence.

Aerophysicists study the applications of the fundamental laws of physics to problems related to flight, both in and above the atmosphere and in space. They study for instance satellite dynamics, orbital dynamics, and high temperature gas flows associated with re-entry vehicles.

Aerospace Materials Scientists work on design, development, applications, and testing of advanced light-weight materials for aircraft and spacecraft, satellite and rocket applications. Such materials must be able to withstand temperature extremes, the vacuum environment of space, ultra-violet and cosmic radiation, space debris and micrometeorite impacts.

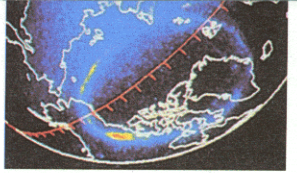


Atmospheric Chemists study planetary atmospheres, especially the atmosphere of Earth. The dynamics and composition of the Earth's atmosphere is studied in order to understand its current state, how it functions, and to predict future changes, especially those caused by people. Two important areas atmospheric chemists are currently studying are the Earth's ozone layer, which protects us from the sun's radiation, and global warming - a gradual rise in the temperature of the Earth.

Mathematicians solve problems related to space science and engineering using all available tools, including algebra, geometry, number theory, and logic. The theories and techniques developed by mathematicians are used to solve, simplify and speed up the complex calculations for designing spacecraft and spacecraft systems, understanding data from experiments, and generating theoretical models of space phenomena. Examples include calculating planetary or spacecraft orbits, determining planetary rotation, the study of cometary trajectories, theoretical modelling of fluid, plasma and atmospheric phenomena. In almost all branches of space activities, computers using advanced mathematical techniques are used.

Physicists are essential to the space program, determining what "space" is actually made of, and designing space probe experiments. From these observations, theories and further experiments are generated to more fully explain and describe the working of outer space. High energy physics, particle physics, fluid physics, plasma physics and optics are examples of the subdisciplines incorporated into the space program. Studies include planetary atmospheres and magnetospheres, solar processes, interplanetary material and the physics of materials under weightless conditions. Physicists perform both remote sensing and observations from spacecraft containing sophisticated instruments.

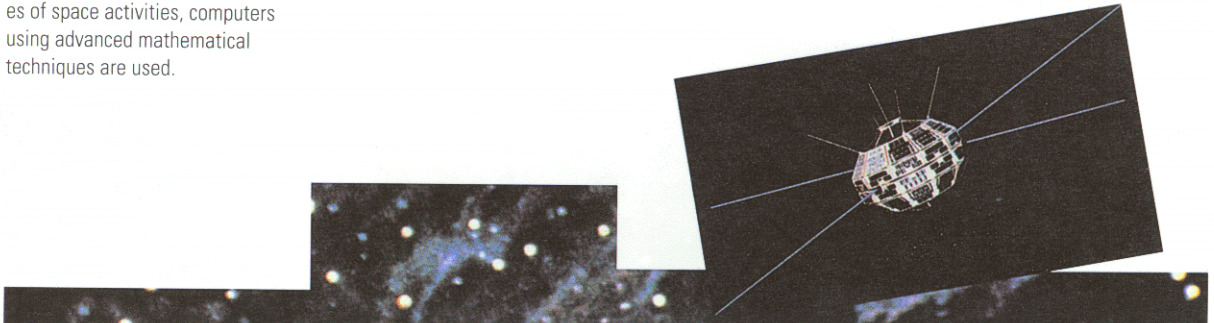
Biologists study living organisms such as plants, insects and animals. They study how plants and animals behave, grow and reproduce, be it in space or on Earth, and compare results. In the space field, they conduct research and design experiments that, when performed in microgravity aboard the space shuttle, on space stations, or on satellites, can enhance our understanding of how the human body works. For instance, studies of cellular biology in space could lead to a better understanding of the human immune system, improved treatment of diseases like cancer, and the effects of weightlessness on vision and movement.

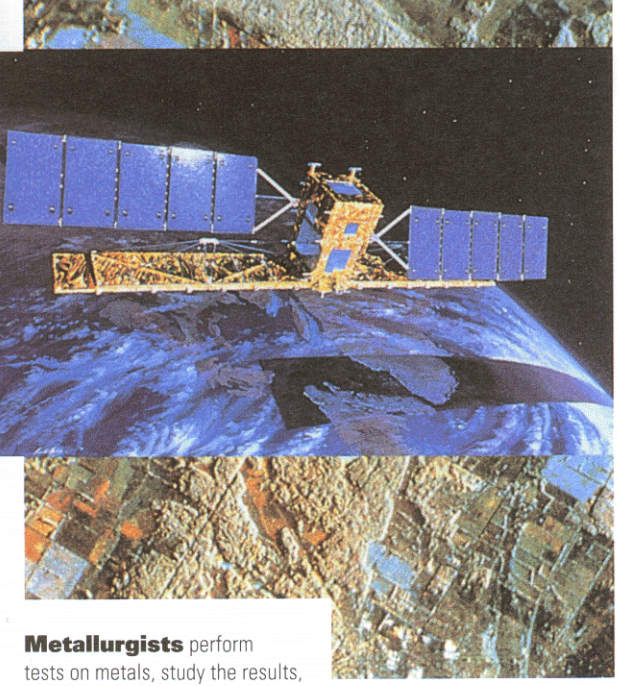


Chemists analyze data from space probes exploring distant planets. They research the composition of planets and asteroids for elements useful to human explorers, such as water, chemicals and minerals which may be used by future expeditions and colonies.

Physicians, are responsible for the health care and physical well-being of astronauts. They help plan pre-flight training programs, oversee the testing and development of special flight equipment, and monitor the health of astronauts in orbit. Physicians also assess the results of experiments conducted on astronauts during spaceflight with examinations prior to launch and after landing.

Space Psychologists research human behaviour in space and how humans adapt to this new environment. Space psychologists study how humans react mentally to weightlessness, to long-duration flights, to high-stress and confined conditions of spaceflight.





Metallurgists perform tests on metals, study the results, and work with scientists to produce higher-quality metals. For instance, they conduct research to develop new and stronger alloys - combination of metals - able to withstand the extreme temperature changes of space, and bombardment by small meteorites and space debris. They also test spacecraft materials and large rockets used to launch satellites, shuttles or space stations.

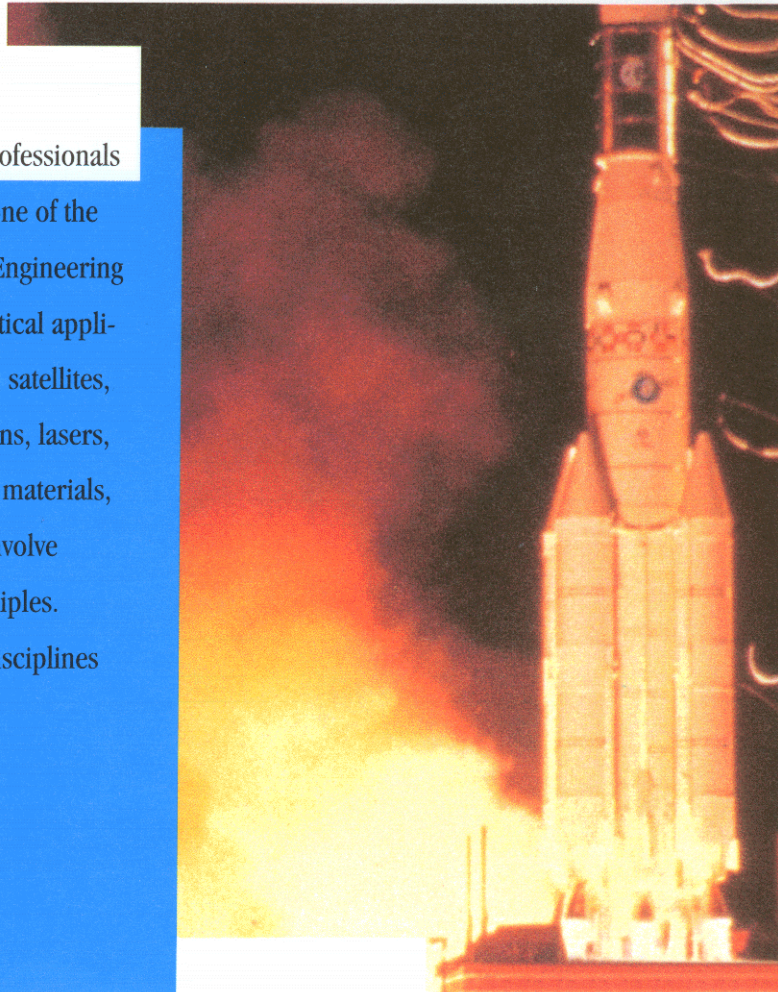
Meteorologists study the weather in order to forecast changes. They gather information from special instruments on board orbiting satellites high above the Earth. Information on clouds, radiation, winds, hurricanes, dust, and precipitation are studied from the satellites, and also from ground-based and airborne observations for comparison. Climatology, a branch of meteorology, is the study of climates, and climate changes.

Geologists study the Earth, how it was formed, what it is made of and how it is slowly changing. In space research, geologists analyze information and images of the Earth gathered by satellites to understand the evolution of our planet. They often use remote sensing images - images taken from space - to follow the movement of continents and glaciers.
One of the astronauts who landed on the Moon was a geologist and geology will continue to play an important role in future missions to other planets.

Oceanographers gather information and perform experiments on sea water, plants and animal life on the ocean floor. Some of their research is on the motion of waves, currents and tides as seen, for example, from orbiting Earth observation satellites.

Engineers...

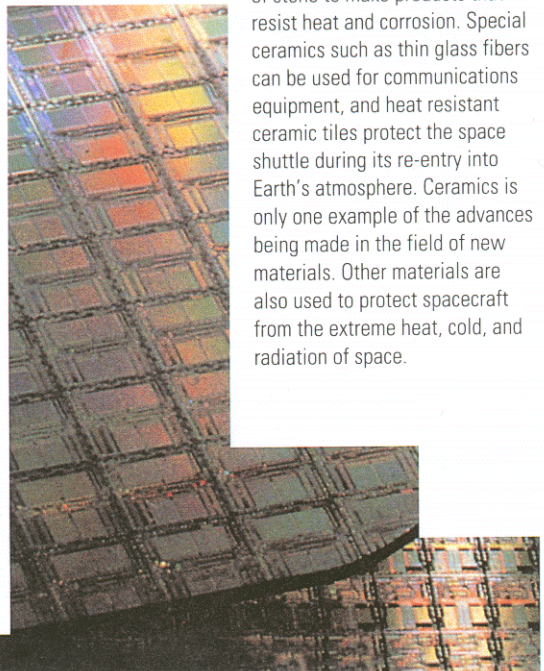
...account for a large number of professionals employed in the space sector. It is one of the key professions of the space team. Engineering involves the science of making practical application of pure sciences. Computers, satellites, aircraft, space vehicles, space stations, lasers, artificial intelligence, and advanced materials, to name only a few achievements, involve the application of engineering principles. Here are some of the engineering disciplines which are key to the space field.



Aerospace (aeronautical) Engineers design and develop aerospace vehicles such as aircraft, rockets, satellites and spacecraft, and supervise their manufacturing, integration, testing, modification, maintenance and repair. Aerospace/ Aeronautical engineers also design aircraft/spacecraft structures, engines and propulsion systems, using the principles of aerodynamics and mechanics.

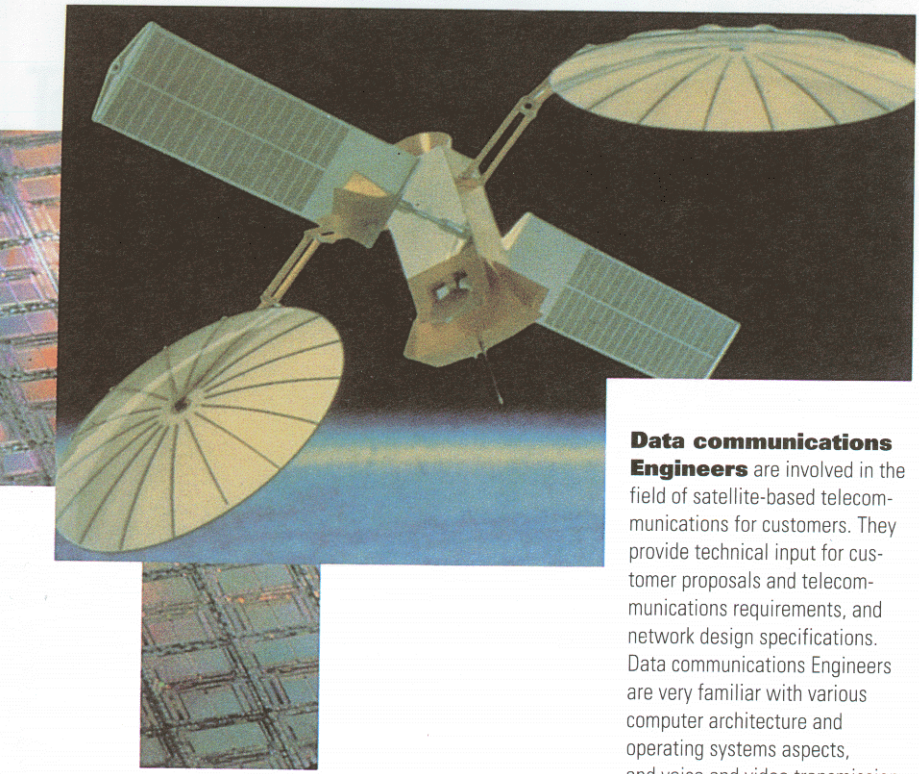
Avionics/ Instrumentation Engineers specialize in the design, development, manufacturing, testing and installation of aviation electronics, instrumentation, sensors and flight control computer systems for spacecraft.

Spacecraft Engineers design, develop, manufacture, and flight test all systems for spacecraft including satellites, rockets, and re-usable orbiting vehicles like the space shuttle. Such systems would include the basic design of the spacecraft structure, telemetry and communications, instrumentation, sensors, orbital parameters, attitude and control systems, selection of spacecraft materials, power supplies, and life support systems.



Materials Engineers are involved in the development and application of advanced materials. One example of such a material is ceramics. Ceramics Engineers use the minerals found in clay, sand, and some kinds of stone to make products that resist heat and corrosion. Special ceramics such as thin glass fibers can be used for communications equipment, and heat resistant ceramic tiles protect the space shuttle during its re-entry into Earth's atmosphere. Ceramics is only one example of the advances being made in the field of new materials. Other materials are also used to protect spacecraft from the extreme heat, cold, and radiation of space.

Computer Engineers design computer hardware, software programs, and systems to connect networks of computers so they can "talk" to each other. Computer engineers may be **programmers** who write and code the instructions that control the operation of a computer; or they may be system designers who develop the integrated computer systems that control spacecraft operations. For example, they prepare the instructions that control Earth-orbiting satellites, space-borne scientific instruments or space probes during flight.



Data communications Engineers are involved in the field of satellite-based telecommunications for customers. They provide technical input for customer proposals and telecommunications requirements, and network design specifications. Data communications Engineers are very familiar with various computer architecture and operating systems aspects, and voice and video transmission components relating to satellite telecommunications.

Data communications Implementation Engineers are involved in setting up new voice/data systems such as those used by telecommunications satellites. They purchase hardware and software for projects, review design details and testing of equipment.

Telecommunications Maintenance Engineers handle co-ordination of telecommunications traffic and the transfer of that traffic (communications: i.e. TV cable programs, newspaper transmissions, long-distance communications) between satellites, Earth stations and ground-based networks.

Technology Development Engineers in satellite communications evaluate and specify new technologies which help develop new satellite-based or integrated terrestrial/satellite services.

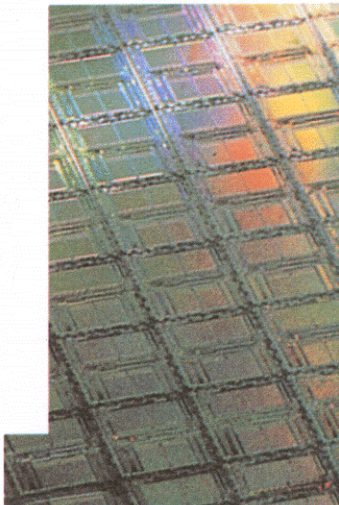
Telecommunications Scientific Programmers are involved in the design, development and implementation of flight dynamics system software, and satellite station-keeping functions and programs.

Robotics Engineers design and build robots and robotic systems to do tasks in environments which are unsafe for humans. These robotic systems can be used in the vacuum of space, in nuclear power plants or chemically-hazardous environments. Robotic arms like the Canadarm, or Canada's Mobile Servicing System for international space station, can do tasks in space, controlled by astronauts inside a space shuttle or space station.

Electronics/Electrical Engineers plan and develop aerospace electronic control equipment for spacecraft and rocket vehicles and telecommunications radio equipment to communicate with spacecraft or with astronauts. They design and test satellite antennas, power systems, and components, radio transmitters and receivers to name a few.

Mechanical Engineers are designers, builders and testers. In the space industry, they design spacecraft and help in the maintenance and testing of satellites, space hardware and related equipment and systems.

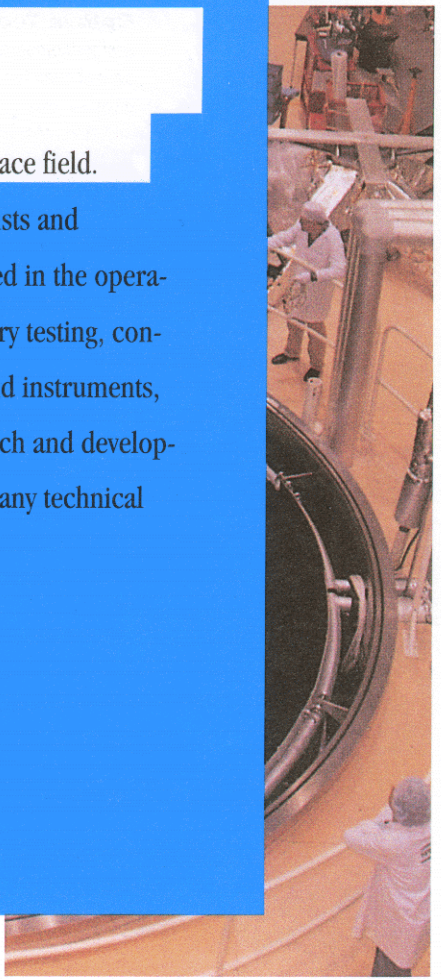
Antenna Engineers ensure that the special antennas on some Earth observation and communications satellites operate well in space. Signals from these antennas may provide pictures and information about Earth, or provide clear communications around the world.



Technologists and Technicians...

...are also important in the space field.

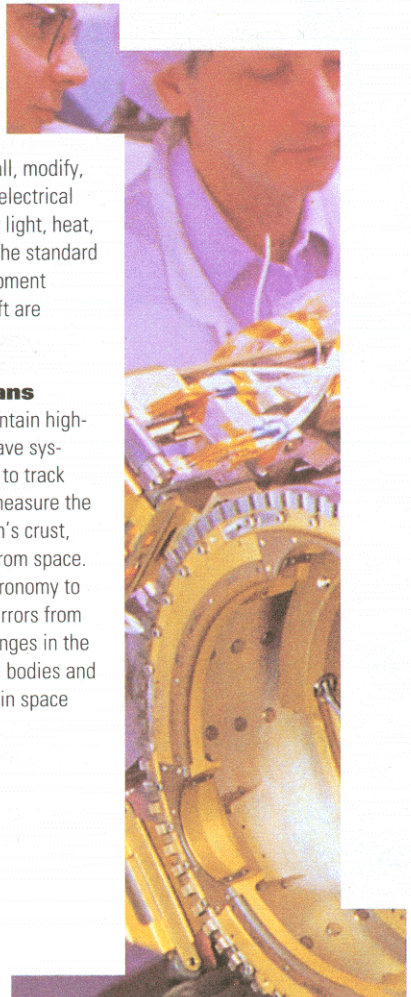
They work closely with scientists and engineers. Their skills are used in the operation of wind tunnels, laboratory testing, construction of test equipment and instruments, model building, and in research and development. Here are a few of the many technical careers in the space sector.



Computer-Aided Design Operators use computer systems which combine an engineer's drafting table with computer technology. Designs of spacecraft components are created and modelled on the computer. These designs are used to drive automated machinery which then construct a spacecraft component.

Communications Technologists operate radio and other special equipment used to test satellite antennas. They work in laboratories where satellites are tested before launch. Communications Technologists can be **Radio Frequency**, **Electromagnetic** and **Microwave Technologists**, to name only a few specialties.

Draftspersons make detailed drawings, plans, and blueprints for the construction of machines and parts such as spacecraft, satellite components, landing gear of space vehicles like the lunar module, or space probes.



Electricians install, modify, and repair wiring and electrical equipment that supply light, heat, cooling, and oxygen. The standard requirements for equipment onboard any spacecraft are extremely high.

Laser Technicians operate, test, and maintain high-precision laser lightwave systems. Lasers are used to track satellites in orbit, to measure the movement of the Earth's crust, and continental drift from space. Lasers are used in astronomy to adjust space-borne mirrors from Earth, to measure changes in the movement of celestial bodies and to measure distances in space travel.

Optical Technicians assist engineers in manufacturing optical components such as lenses for cameras, telescopes, and spacecraft windows. They help design special camera lenses, for example, used in space photography, in Earth observation satellites, and on space-borne instruments such as the Hubble Space Telescope.

Quality Assurance Technologists examine hardware, using specialized equipment. They may check the landing gear of a space vehicle designed to land on other planets or ensure that an essential component of a satellite was manufactured according to specifications.

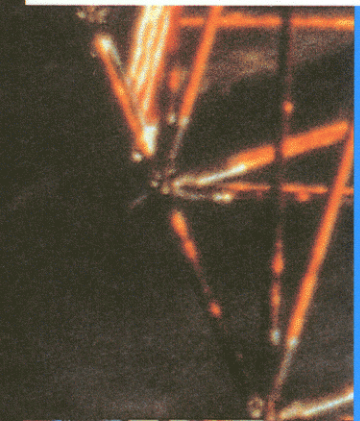
Radar Technicians operate, test, and maintain radar equipment on some remote sensing satellites and work in image processing companies that transform radar images into visual pictures.

Robotic Technicians help engineers build and operate robots. They may work with robotic engineers on robotic manipulators for spacecraft such as the space shuttle or the space station.

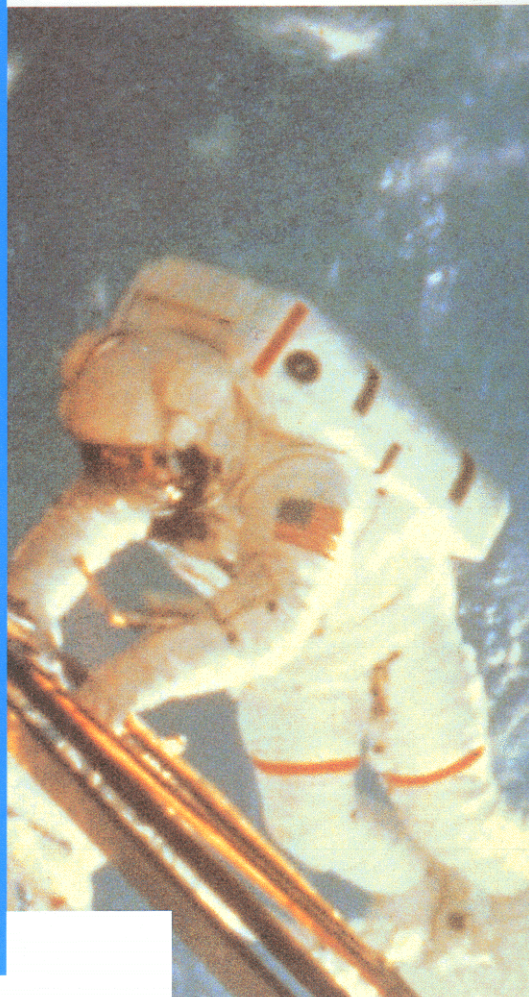
Satellite Control Technologists use Earth-based master control centres to monitor satellite operations; monitoring, recording, and analyzing data from satellites, and responding to satellite spacecraft anomalies. Satellite control technologists are involved with the execution of all satellite command functions, including manoeuvering, power systems management, and other tests in support of flight dynamics and satellite engineering.

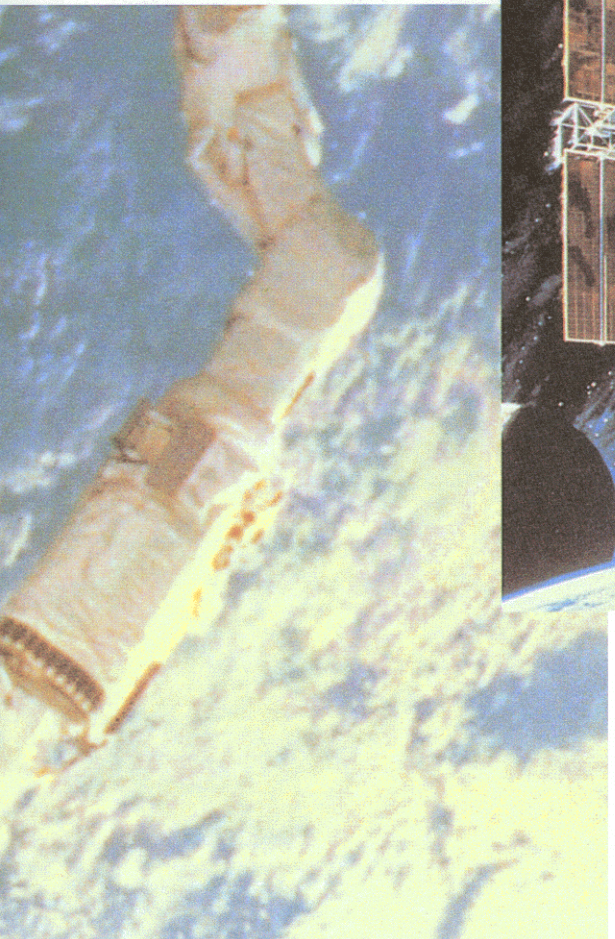
Satellite Technologists maintain and set up ground receiving stations for satellites and handle customer services involving corrective and preventive maintenance on a range of ground-based communications equipment.

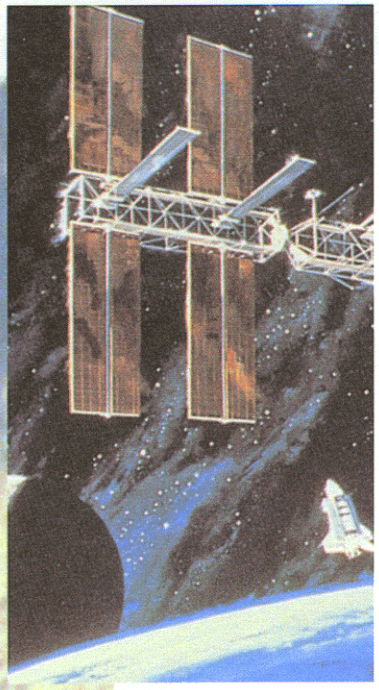
Astronauts...



...although they are the most visible professionals in the space field, astronauts represent a small segment of the space team. They carry out science and technical missions onboard the shuttle. Their work is essential to the advancement of research, namely in the field of human adaptation to the microgravity environment.







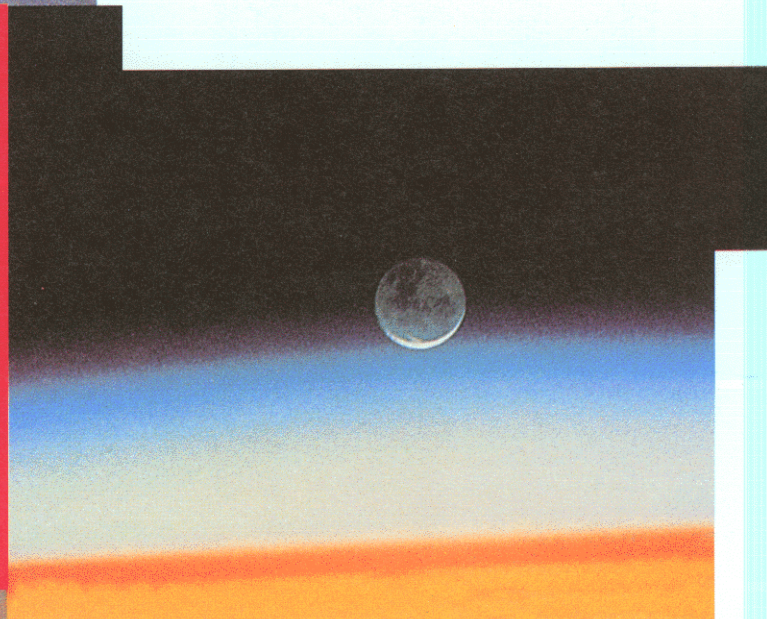
Astronauts have a scientific and academic background: in medicine, physics, or engineering. Some have military training, some have aviation flight experience, and all work very hard and are among the best in their chosen fields. Once selected for the Astronaut Program, they undergo continuous and rigorous training in preparation for a mission onboard the space shuttle.

Canadian astronauts are **Mission Specialists** or **Payload Specialists**. In addition to their own scientific research projects, astronauts work closely with scientists in the development of experiments to determine the effects of weightlessness on humans, animals, plants, and minerals. They conduct these experiments onboard aircraft that simulate microgravity. When these experiments are "space-qualified" or ready to be flown in space, the astronauts become crew members and operate missions onboard the space shuttle. Canadian astronauts can be Payload Specialists conducting experiments on board a spacecraft. They can also be Mission Specialists whose primary task is to operate spacecraft systems like the Canadarm.

Realizing your dreams

Space is not just about space voyages. It is also about understanding and improving the quality of life on Earth. More and more, science and technology are becoming essential to our everyday lives. Now and in the future, many professions need men and women who can apply their knowledge and expertise to a wide range of applications in science and technology.

Once you have decided that you're interested in a space career, you'll need to find out what skills and specific experience you may require. There are numerous choices that you can make that could lead to exciting careers in the space sector.



Be prepared to study:

Most space-related positions require excellence in science and mathematics and a college or university degree.

Talk with your teachers about your interest in a space-related career.

Read books and magazines about what has been, is, and will be accomplished in space.

Watch space science shows on television. Visit space exhibits at museums.

Consult with your career counsellors for the names of professional associations you can write to for information on space careers.

Read science fiction and let your imagination take you through time and space. You'll discover that what was science fiction yesterday has become science "reality" today.

Your future begins now. Work hard and hold on to your dreams. One day, you may become part of tomorrow's space reality.

For more information on the Canadian Space Program, please contact:

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