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The World of Space and Science ? The evolution of space stations ? Part 1

By Jim Middleton

This is the second of a series of articles covering space and science.

I decided to divide the subject of space stations into three articles; this article will cover the history and construction of space stations; the next article will address Canadian participation and a third article on the uses and perceived benefits.

Space stations have been the subject of science fiction over many decades ??from 2001, A Space Odyssey through Star Wars Death Stars and the various incarnations of Star Trek, to name a very few. These space stations generally involved the creation of artificial gravity by rotating some or all portions of the space stations and were used as transfer points from some planet and out into the galaxy and beyond. Generally they were immense structures floating in space which, in reality, would have required lifetimes to construct.

In real life, both the USSR and the USA viewed space stations as military assets to be used for observation and, potentially, space warfare. The U.S. defence department developed a program in the 1960s called the Manned Orbiting Lab (MOL) for the specific purpose of spying (with its own military astronauts separate from NASA). The program was cancelled in 1969 due to the usual exorbitant cost and schedule overruns and the fact that unmanned spy satellites could do the job at a fraction of the cost.

Russia decided to make space stations a strategic priority of their space program after their attempt to send a manned mission to the Moon ended in failure. Everything that could go wrong did go wrong, blamed ultimately on Russian bureaucracy, underfunding and incompetence.

The first launch of a Russian space station, called Salut-1, occurred in 1971. There were seven Salut space stations launched over the next 11 years. Each space station was launched on a single rocket and each weighed in the order of 20,000 kilograms. They tended to remain in orbit from months to several years and were used for both clandestine spy missions and civilian programs investigating the physiological effects of microgravity on the human body and mind. The final Russian space station, called MIR, was launched in 1986, requiring six rocket flights to complete the assembly. MIR was continually manned until 2001 and is generally regarded as a major success. Note that several visits to MIR were made by the space shuttle starting in 1994. NASA provided eight astronauts to the MIR program commencing in 1994 through 2000, the last manned mission to MIR. As planned, MIR deorbited in a fiery re-entry into the Pacific Ocean March 23, 2001.

So, what about the U.S.? NASA (as opposed to the military) started considering a more permanent presence in Earth orbit while the first attempt to launch a human into space was under way. Space Station considerations were put on hold when President Kennedy announced the plan to put a man on the Moon and return him safely to Earth by 1969. Space stations were revisited in earnest in the late 1960s as a follow-on to the Apollo program.

Initially it was decided to use an empty third stage of the Saturn V Moon rocket as an orbiting laboratory and outfit it with a variety of experiments. It would be ?manned? for three-month periods. Skylab was launched in 1973 and weighed in the order of 68,000 kg. Three manned missions were conducted between 1973 and 1974, performing a variety of experiments including Earth and astronomical observations. Skylab fell out of orbit in a fiery uncontrolled descent in 1979.

With the shuttle program under way in the 1970s, the U.S. started to address the next major space goals. Various NASA Centers proposed a variety of potential missions which, not surprisingly, had their specific Center as the lead. The main battle ensued between the Marshall Space Center in Alabama and the Johnson Space Center in Texas; Marshall proposing large, high powered, unmanned platforms carrying a variety of instruments and experiments and Johnson proposing, unsurprisingly, a manned ?space station.? The battle raged until Washington stepped in and established a Concept Development Group (CDG) to identify basic requirements and benefits before running off and designing something that might be totally useless and hence cancelled later as so many programs had been in the past.

NASA led the CDG with Canada (myself leading a team from Spar Aerospace under contract to the National Research Council), the European Space Agency (ESA) and Japanese Space Agency participating in the group. The CDG ran from 1983 through 1984 and published a set of recommendations and requirements for manned and unmanned platforms which would be in Low Earth Orbit. The manned platform orbiting in equatorial orbit and a series of unmanned platforms in polar orbit (90 degrees to the equator). The space station would be for purely civilian purposes with absolutely no military involvement (enshrined in law).

The program, called Space Station Freedom, was authorized by President Reagan in 1985 and international government agreements were put in place with Canada, Japan and Europe (led by Germany and France). The intent was to have the space station in orbit by 1992 to coincide with the 500th anniversary of the discovery of America by Columbus. The cost was estimated at $14 billion. Keep in mind 1992 and $14 billion was the ?original? plan.

I won't bore you with the inevitable: The cost went up and schedule slipped out; both big time! Major portions of the program were cancelled or significantly scaled back. Finally, in 1992, with the election of President Clinton and a new U.S. Congress, pressure was on to cancel the entire program. It got through a Congress vote by the skin of its teeth in 1992.

With the dissolution of the USSR and the putative end of the cold war, the U.S. and Russia began talking about cooperation in various activities, including space. As noted above, the U.S. commenced visits to the Russian space station MIR and provided astronauts to MIR over the course of five or so years. Discussions got under way between the U.S. and the other international partners and Russia on a new program, to be called the International Space Station, or ISS for short, on what each partner would provide to the revised station.

Russia would provide a set of modules which would include control and initial life support capabilities as well as living quarters. The U.S. would provide U.S. control and habitation modules as well as power and thermal control and the overall structure. Europe and Japan would provide Experiment modules. Canada would provide robotics to help build and maintain the space station. The agreement between all the parties was signed in 1998 and the first launch (first Russian element) occurred in November 1998. Forty flights between Russia and the U.S. were required to assemble the ISS, culminating in the final shuttle flight in February 2011 ? more than 13 years to build the ISS.

Pertinent facts about the International Space Station: Cost greater than $100 billion (some estimate it to be around $150 billion U.S. to date). Weight: 925,000 pounds. Size: about the length and width of a football field. Living space: about the size of a small house. Continuous human occupation since November 2000. Crew size: typically six, sometimes down to three for short periods. Altitude: 410 kilometres. Orbit inclination: 51.6 degrees (angle from the equator). Velocity: 7.2 kilometres per second.

There are many websites and applications which will let you know when the space station is passing over your particular location. Here is one: http://spotthestation.nasa.gov/. The ISS is the third brightest object in the night sky (after the Moon and Venus) and moves fairly rapidly. You can ?see it? in some detail with 20X binoculars but it is sometimes difficult to track as it moves quickly across the field of view.

Agreements are in place to continue to operate the ISS up until at least 2024. When the decision is finally made to bring the ISS down, it will be a spectacular fiery re-entry and crash into the Pacific Ocean. Plans for a follow-on space station are in the formative stages. It will not be in low Earth orbit like the ISS. It may be located on the Moon surface but the best guess is that it will be located at what is called a libration point ??a stable point in space where the Earth, Sun and Moon's gravity is cancelled out. I will discuss this further in a future article on Mars exploration.

My next article will cover the Canadian involvement in the space station program with all the excitement of the ?Perils of Pauline!? Stay tuned!

Jim Middleton is a ?semi-retired? aerospace engineer with over 50 years of experience in the U.S. and Canadian space programs. He has worked on the Space Shuttle and Space Station programs for over 25 years. He is currently involved in the operations of Canadensys Aerospace Corporation, a space company in Bolton.