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# **ENGINEERING HISTORY PAPER #41**

# "1957, 1958 and 1959: Watershed Years for Engineering"

by Andrew H. Wilson

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# Abstract

The watershed, obviously, is 'space' - beginning with the Russian and American adventures into it in 1957 and 1958 and the beginning of the Canadian one in 1959 that culminated in the launching of the *Alouette I* satellite three years later.

These years were a dozen after the end of World War II and a dozen before the political, social and economic upheavals of the early 1970s changed much about the world and its ways. They were also the years after which a number of significant engineering achievements were realized, and the years before others were initiated.

This paper suggests a pivotal role for 1957-8-9 in the history of engineering. It also serves to 'situate' engineering achievements, and potential achievements, during these 26 years. We tend to forget, in 2009, just how long ago some of them happened. It also suggests that the world, through engineering, could be changing significantly every dozen years or so.

## **About this Series**

Principally, the Cedargrove Series is intended to preserve some of the research, writings and oral presentations that the author has completed over the past half-century or so but has not yet published. It is, therefore, a modern-day variant of the privately-published books and pamphlets written by his forebears, such as his paternal grandfather and grandmother, and his grandfather's brother John.

## About the Author

He is a graduate in mechanical engineering and the liberal arts and has held technical, administrative, research and management positions in industry in the United Kingdom and in the public service of Canada, from which he retired over 20 years ago.

He became actively interested in the history of engineering on his appointment to chair the first history committee of the Canadian Society for Mechanical Engineering in 1975, has served both CSME and the Engineering Institute of Canada in this capacity for varying periods of time until 2003. He has researched, written and edited historical material for EIC and CSME, and is a past president of both.

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#### Introduction

This paper is different. It is a journalistic piece rather than an essay, discourse or memoir although, as the latter, it is focussed on the time between my arrival in Toronto in 1957 in single blessedness, as it has been called, and my marriage in Cobden, also in Ontario, in 1959. It has nothing to do with causes and effects, arguments and correlations - just with things that happened. It has economic, political, social and scientific elements as well as engineering ones. So perhaps it is really a sort of loose discussion that revolves around a 'focal period' that lasted for three years.

Why these three? In part, because they will always be associated with the beginning of the so-called 'space race' between Russia and the United States, and because in 1959 Canada took steps to become the 'third nation in space' when it set up a team to begin the design and construction of an earth satellite to gather scientific research data that would be launched three years later.

In part, because engineering dominated the space race. While the conquest of space required scientific research and the services of scientists to succeed, the 'mechanics' of getting there were based on engineering and the work of engineers. Too often, *science* has been given the credit.

In part, because these years separated the time of a World War by a dozen years from a world that began to 'work' quite differently a dozen years later, in the early 1970s, when there was a local war in Vietnam, so-called 'oil shocks' and 'stagflation' and young men in Europe and North America began to wear their hair long and their suit coats and jackets had wide lapels and loud checks.

In part, because 1959 was the last year of a decade and the year that was a half-century before the time of writing - a nice round number for looking backwards.

This paper had several roots. One was based on the flights in 1957 and 1958 of the first Russian and American spacecraft in earth orbit and the beginning of work in 1959 on Canada's first orbiting research satellite, the *Alouette*, with whose scientific data output (and that of its successors) sister Margaret was associated during its productive lifetime in space. A second was an article that appeared in the *Globe and Mail* that reminded me that the St. Lawrence Seaway - a massive Canadian/U.S. engineering project - was officially opened in 1959. The third was the fact that another massive Canadian engineering project, the Avro *Arrow* military plane, was cancelled in February of that same year. And hovering in the background was my wish to have a timeline that would show when many of the industrial/commercial achievements of the post-World War II era involving engineering first appeared. From these, it was an easy step to decide there had indeed been a watershed!

My next thought was to offer the paper for presentation at the biennial conference of the Canadian Science and Technology Historical Association in September 2009. The offer was indeed made, but was not accepted. So the idea 'went away' for some months while the papers that *were* accepted were prepared and delivered. However, as the end of 2009 approached, the paper was revived, the research completed and the writing begun.

Technically, according to various dictionaries, a 'watershed' is a line of separation between waters flowing to different rivers, basins or seas, or a ridge that divides two areas drained by different river systems. It might also be considered, in historical terms, as part of a continuum that includes a particular event - such as a revolution, the end of a particular sovereign's reign, or someone's 50<sup>th</sup> or 80<sup>th</sup> birthday. It may also be thought of as a turning point, or a hiatus, in the course of events which - in the context of this present paper - would be sometime between the years of adjustment following World War II and the events that led up to the political, economic and social problems of the 1970s, when the world began moving in some very different directions. Or it may be something that attracted wide media and public attention that did not disappear from sight the next day or so but remained a topic of discussion for some considerable time after it happened.

So, let us take four bites at this particular cherry....a look at the years from 1945 to 1956, from 1957 to 1959, from 1960 to 1971, and then very briefly discuss the watershed.

## 1945 to 1956

1945: In a number of ways, this year was itself a watershed year for engineering. World War II ended in Europe and Asia. One of the factors expediting the war's end was the dropping during the summer of an entirely new weapon - the so-called 'atomic' bomb - on Japan. Although scientists and engineers had been investigating the atom and its nucleus many years earlier, the nuclear age 'proper' began with these events.

By year's end, two of the three principal participants at the earlier Yalta Conference were no longer in power: Roosevelt was dead; Churchill lost a General Election; Stalin alone survived. During the year, along with the aftermath of that Conference and dealing with defeated Germany and Japan, a number of the allied countries had also turned their attention and energies seriously to peaceful activities, including the generation of usable electrical power from the atom. The ZEEP nuclear reactor, the first to operate outside the United States, went critical at the new laboratories at Chalk River, Ontario, in September. As well, the last of the V-2 rockets had fallen on Britain and many of the warlike technical initiatives in progress at mid-year were terminated in the months that followed. As it happened, the engineering of more and different kinds of rockets was simply shelved until new opportunities to use them were devised - in the United States and Russia, rather than in Germany. Meanwhile, the man behind the V-2, engineer Wernher von Braun, and some of his rocket specialists were 'transferred' to the United States, where - over the years - they made significant contributions to the U.S. rocketry and space programs.

1946: North America, relatively untouched by the conflict, recovered quickly in the years that followed. Most of Europe and much of Asia were not so fortunate. While control of Germany was split between the Allied Powers, power in Japan was transferred from the Emperor to an elected assembly. There was still fighting in China between the Nationalists and the Communists. A number of states involved in World War II became independent. The war crimes trials of the Nazi leadership began at Nuremberg.

On the economic front, the International Bank of Reconstruction and Development - the United Nations' World Bank - was founded. Canada's war debt stood at \$13 billion. Its population was in the neighbourhood of 12.5 million. Early in the year, the United Nations held its first General Assembly in London, but New York was declared its permanent headquarters. Relations between the victorious eastern and the western allies deteriorated and, as a harbinger of things to come, Churchill made his famous 'Iron Curtain' speech at Fulton, Missouri.

The first electronic computer (ENIAC) was built in the United States, and the xerography process was invented there by Chester Carlson. Further U.S. atomic bomb tests were made at Bikini Atoll in the Pacific.

1947: During this year, an economic recovery plan for Europe was proposed and was named after George Marshall, the U.S. Secretary of State. India became independent and was partitioned into India and Pakistan. Burma also became an independent republic. The Cominform was established at a conference in Warsaw. Britain's Princess Elizabeth married Prince Philip of Greece. Over a million war veterans were enrolled in U.S. colleges under the G.I. Bill of Rights. The Dead Sea Scrolls were discovered. In Canada, W.L. Mackenzie King completed 20 years as prime minister - a Commonwealth record. He was succeeded by Louis St. Laurent the following year. Henry Ford died. Jackie Robinson was the first African-American to sign a contract with a major league baseball club.

This year also brought the first flight of an American aircraft at supersonic speed, the start-up of the first British nuclear reactor, and the sale of the first microwave cooker and tubeless tire in the United States. John Cobb set a world ground-speed record just shy of 400 miles per hour. In Canada, the NRX reactor went critical at Chalk River.

1948: Bread rationing ended in the United Kingdom. London hosted the first postwar Olympic Games. Mahatma Gandhi was assassinated in India. Chiang Kai-shek became president of China. The Jewish State became a reality in the Middle East. Russia stopped road and rail traffic between Berlin and the West and the Berlin Airlift began. It lasted well into 1949 and involved over a quarter-million flights.

Idlewild (later Kennedy) Airport on Long Island, New York, was opened by President Truman, setting the stage for the development of regular trans-Atlantic passenger flights. It was also the year of the discovery in the Bell Laboratories of the transistor and the beginning of the trend towards the miniaturization of some electrical equipment. The long-playing record was invented by Peter Goldmark of RCA, and Edwin Land invented what became the polaroid camera. Aircraft pioneer Orville Wright died.

1949: The communist-based regime of Mao Tse-tung took power in China and Chiang Kai-shek took

his nationalist forces to Formosa (later Taiwan). The North Atlantic Treaty was signed in Washington. The Council of Europe was established at Strasbourg. Germany was divided into the Federal and Democratic Republics. Holland granted sovereignty to Indonesia, France to Vietnam. The pound sterling was significantly devalued, and clothes rationing ended in Britain.

The U.S.S.R. tested its first nuclear weapon. Cortisone was discovered. The Comet airplane flew.

1950: In the first year of the decade, China and Russia signed a 30-year pact, and Chinese forces occupied Tibet. In the United States, Alger Hiss was sentenced for perjury, and Senator McCarthy began his anti-communist, 'witch-hunting' investigations. Klaus Fuchs was found guilty of betraying British atomic secrets to Russia. In June, the Korean War began and United Nations forces became involved. The world population reached an estimated 2.3 billion, of whom 480 million were estimated to be undernourished children. London remained the largest city, followed by New York, Tokyo and Moscow. Montréal remained Canada's largest.

President Truman agreed to the development of the hydrogen bomb. The first Canadian-designed and -built jet fighter aircraft, the CF-100, first flew in January, powered by Rolls Royce *Avon* engines (later to be fitted with Canadian-designed *Orenda* engines).

1951: The number of TV sets in use in the United States rose from 1.5 in 1950 to 15 million in 1951 - the year colour was introduced. In Britain, the Conservative Party under Churchill regained power. Juan Peron became president of Argentina.

A heart-lung machine for use in heart operations was devised in the U.S. Three-dimensional motion pictures were exhibited for the first time. Power steering, introduced by Chrysler, became a feature of automobile design. UNIVAC I became the first electronic computer to be commercially available and the first to store data on magnetic tape. On his way home by ship from Europe, Canadian George Klein - a National Research Council of Canada engineer and a 'roll-your-own' cigarette smoker - conceived the idea that led to the development, design and construction in Canada of STEM (storable, tubular, extendible member) antennas, used first on Canadian and later on American spacecraft.

1952: In Britain, Princess Elizabeth became Queen, succeeding her late father, King George VI. Dwight D. Eisenhower was elected president of the United States and the UNIVAC computer was used for the first time to predict the results of the election. A state of emergency was declared in Kenya, following the Mau Mau disorders. General Naguib seized power in Egypt.

The first U.S. hydrogen bomb was exploded at Eniwetok Atoll in the Pacific. Britain completed its first atomic bomb tests in Australia. The first breeder reactor was built in the United States. The first commercial product to use transistors - a hearing aid - was put on the market. A pocket-sized

transistor radio was also marketed, by Sony. Wernher von Braun first published his concept of a manned space station.

1953: The year Queen Elizabeth II was crowned - not long after the death of her grandmother, Queen Mary, and just after Hillary and Tenzing became the first to climb Mount Everest. In Russia, Stalin died and was succeeded by G. M. Malenkov, and Nikita Kruschev became first secretary of the Central Committee of the Communist Party. An armistice was signed in Korea. The U.S.S.R. exploded a hydrogen bomb. A rocket-powered U.S. plane was flown at more than 1600 mph. The smoking of cigarettes was identified as a leading cause of lung cancer. Radial-ply tires were introduced in Europe. C.H. Townes developed the maser, the precursor of the laser. Franklin and Wilkins in Britain performed the x-ray studies of DNA that enabled Crick and Watson, later, to determine its structure.

1954: The U.S. Supreme Court ruled that segregation by colour in public schools was a violation of the 14<sup>th</sup> Amendment. Colonel Nasser seized power in Egypt. The South East Asia Treaty Organization was established. France exited Indochina. Vietnam was divided into two republics. Roger Bannister ran the first under-four-minute mile.

Canada and the U.S. agreed to build a line of radar warning stations across Canada's north, which became known as the DEW line. The Americans tested a hydrogen bomb at Bikini Atoll, and commissioned the nuclear submarine *Nautilus*. CERN, the European Centre for Nuclear Research, was established at Geneva. The Soviet Union built its first small nuclear reactor for peacetime purposes. The photovoltaic cell was developed at the Bell telephone Laboratories in the United States. The Independent Television Network was established in Britain and the Eurovision Network on the Continent. Twenty-nine million homes in the United States had TV. Atomic 'pile' pioneer Enrico Fermi died, as did Auguste Lumiere, the French co-inventor of the cinematograph, and Alan Turing, the British computer pioneer. The 'father' of the atomic bomb, J. Robert Oppenheimer, was dismissed from U.S. government service.

1955: In Russia, Malenkov resigned and was succeeded by Bulganin. In Britain, Churchill resigned and Atlee retired and were succeeded by Eden and Gaitskell. The United States opened an Air Force Academy, similar to West Point and Annapolis.. The Warsaw Pact linked the countries of Eastern Europe with Russia against the West. The U.S. GNP reached \$400 billion.

The United States and Russia both announced their intention to launch earth satellites during the International Geophysical Year of 1957-58. Domestic freezers for preserving food went on sale in America. Velcro was patented. Christopher Cockerell built the first practical hovercraft. The first optical fibres were developed. Einstein died.

1956: The U.S. and Britain informed Egypt they would not participate in the financing of the Aswan

High Dam. Nasser seized the Suez Canal. The short-lived Suez War followed, involving Anglo-French forces and Egypt. A United Nations fleet cleared the debris from the Canal. Lester B. Pearson, the Canadian Minister for External Affairs, was awarded the Nobel Peace Prize for his part in the ending of the War. Soviet troops marched into Hungary, in spite of censure by the U.N. General Assembly. Eisenhower was re-elected president of the United States. Fidel Castro began his insurgency against Batista in Cuba.

The neutrino and the antiproton were discovered, and the ion microscope was developed. Trans-Atlantic telephone cable service began. The Sabin oral vaccine against polio was developed. Birth control pills were first used in a large-scale test in Puerto Rico. Shockley, Bardeen and Brattain received the Nobel Prize for Physics for their semiconductor studies and the invention of the transistor. The first commercial watch to run on electric batteries was produced in France. The computer programming language, FORTRAN, was invented, as was the AI computer language, LISP. The first large scale nuclear power plant was opened at Calder Hall in England.

#### 1957-1959

Politically and economically, if not also socially, these three years were relatively quiet. In 1957, the Common Market was established in Europe by the Treaty of Rome. The Suez Canal was reopened after the brief war involving Britain, France and Egypt. Eden was replaced as British prime minister by Macmillan. General Franco announced that the Spanish monarchy would be restored after his death. President Eisenhower sent troops to Little Rock, Arkansas, to forestall race-related violence. Queen Elizabeth visited Canada. There were 71 cities throughout the world with 1 million inhabitants or more, in comparison with 1914, when there were only 16.

In 1958, Khrushchev succeeded Bulganin as chairman of the U.S.S.R.'s Council of Ministers, and General de Gaulle was elected president of France. Alaska became the 49<sup>th</sup> American state. Britain established life peerages. J.K. Galbraith published *The Affluent Society*. The *Beatnik* movement spread across Europe and the United States.

In 1959, Britain finally shook off the restrictive aftermath of World War II. There were uprisings against the Russians in Hungary and Czechoslovakia. Fidel Castro became the Communist premier of Cuba, and de Gaulle was proclaimed president of the Fifth Republic in France. Hawaii became the 50<sup>th</sup> U.S. state. The European Free Trade Association ratified its founding treaty. Canada recovered from the economic downturn of the two previous years, although the Canadian dollar began its slide from parity (or better) with the U.S. one, and there was concern about the amount of foreign capital entering the country. Governor General Vincent Massey, the first Canadian to hold the office, retired and was replaced by the second, Georges Vanier. European small cars were still taking a relatively large share of the Canadian market.

Back to1957 - to engineering and science. The International Geophysical Year was proclaimed by 67 countries world-wide. On the nuclear front, the International Atomic Energy Agency was established in Vienna. Britain exploded a thermonuclear device in the central Pacific. The NRU

reactor went critical at the Chalk River Nuclear Laboratories. The Mackinac Straits Bridge, the longest suspension bridge in the world at the time, was opened. Sabin developed the polio vaccine that bears his name. Lord Cherwell, Churchill's science adviser during World War II, died.

In 1958, the U.S. submarine *Nautilus* passed under the icecap at the North Pole. The U.S. opened its first experimental nuclear reactor for the generation of electric power at Shippingport, Pennsylvania. Stereophonic recordings came into use. Bifocal lenses for eyeglasses were introduced. Dr. Ian Donald used ultrasound to examine unborn children. TV covered a British general election for the first time, and the first section of the M1 motorway was opened. Prime Minister Diefenbaker announced that he proposed to have a decentralized federal system of emergency shelters constructed so that governments in Canada could continue to operate in the event of a nuclear bomb attack.

In 1959, in Canada, the development of the Avro Arrow military aircraft was abandoned, decimating the country's engineering efforts in that field and encouraging Canadians to go south to take advantage of new opportunities in the aircraft and space fields. But, later in the year, Canada and the United States opened the St. Lawrence Seaway to marine traffic - an engineering achievement of considerable significance, which also led to the building of very large 'laker' ships. As well, the first trans-Canada oil pipeline from Alberta to Ontario was completed, and the South Saskatchewan Dam project was begun, providing water for both irrigation and power generation. The Second Narrows Bridge across Burrard Inlet at Vancouver was opened. It was 4200 feet long. 1959 was also the first 'real' year for 'Skidoos' - the Canadian-built personal snow vehicles. It was also a 'nuclear' year. The Canadian Candu horizontal fuel-rod design for nuclear power reactors was established, and the first reactor to be built at a Canadian university was started up at McMaster. The first nuclearpowered surface ship, the Russian icebreaker Lenin, performed successfully. The first American nuclear-powered merchant ship, the Savannah, was launched and the first U.S. nuclear-missilefiring submarine was commissioned. In Britain, the keel of the first nuclear submarine was laid. The first commercial Xerox copiers were put on the market, and De Beers, in South Africa, manufactured the first artificial diamonds. In Africa, the Kariba Dam on the Zambesi was under construction. Bell Labs in the United States developed the first push-button phone, but manufacture of the unsuccessful Ford Edsel automobile was discontinued. A mask was worn for the first time by a National Hockey League goaltender. Frank Lloyd Wright died. Scots-born C.T.R. Wilson - who shared the Nobel Prize for Physics in 1927 - also died, at the age of ninety. In his youth, Wilson had thought seriously of becoming an engineer. As he saw it, engineers were involved in solving interesting problems. In the Nobel context, he was honoured for the invention of the cloud chamber, which may also be considered an engineering achievement. In his last years, on a chair by his bedside, were the books he was reading. On top of the pile was a notebook....and a slide rule.

The real 'noise' - in 1957 - came from space and, in particular, from the successful launching flight, in October, of the first artificial earth satellite, the U.S.S.R.'s *Sputnik I*. It was unmanned. The second satellite, *Sputnik II*, launched before year-end, carried a dog as its passenger. With these flights, U.S. authorities began immediately to utilize more fully the experience of von Braun and his

colleagues to create orbital launch vehicles for their own satellites. The work of von Braun's Russian counterpart, Sergei Korolev, was unhampered by the relative lack of interest expressed before 1957 by U.S. space flight administrators and was used to the full in the *Sputnik* program.

In 1958, the Russia launched *Sputnik III*, which weighed 3000 lbs. The U.S., by now in full competition, launched *Explorer 1*, from Cape Canaveral. It weighed only 31 lbs. A rocket developed by von Braun's group took it into space. The United States also established the National Aeronautics and Space Administration - NASA - to lead and administer the exploration of space. The first seven of its astronauts were selected. Meanwhile, space probes revealed the existence of the Van Allen radiation belts round the earth, which might imperil travel outside the earth's atmosphere unless protective shielding was used.

Early in 1959, Russia launched the lunar probe *Lunik I* aimed at the moon. It missed its target and went into orbit round the sun. The U.S. probe *Pioneer 4* took a similar path, intentionally. Later in the year, *Lunik II* crash-landed on the moon, and *Lunik III* flew past the moon, but was able to send back photographs of its far side. The U.S. and Canada began a long-distance radio research program based on ionospheric 'topside-sounder' satellites. This led to the design, development and construction of Canadian-built earth satellites which carried experimental instrumentation and which flew in space in the 1960s and 1970s. As a result, Canada became the third country to have an earth satellite orbiting in space.

#### 1960-1971

1960: The world's population was around 2.9 billion. That of the United States was just under 180 million, an increase of 28 million over 1950. Canada's population was almost 18 million, an increase of 4 million since 1951. Russia's was 209 million, Britain's 52 million, France's 45 million and Australia's 15 million. There were an estimated 85 million TV sets in use in the United States, 10.5 million in Britain and over 1.5 million in both Germany and France. The specially designed city of Brasilia replaced Rio de Janeiro as the capital of Brazil, the most populous country in South America, with 93 million people. Brezhnev became president of the U.S.S.R. and, late in the year, Kennedy was elected to replace Eisenhower as president of the United States. However, tensions were rising between the two major powers. The U.S. admitted, for example, that it had carried out aerial reconnaissance flights over Russia after a U-2 plane, piloted by Gary Powers, was shot down.

In space, the U.S. launched a radio-reflector satellite. The first weather satellite, *Tiros 1*, was launched by the Americans to transmit information on cloud coverage around the world. *Echo*, the first passive communications satellite, was launched. NASA opened the new Marshall Space Flight Center at Redstone Arsenal in Huntsville, Alabama. The rocket team led by Wernher von Braun was transferred from the Arsenal to NASA. The first major program at the Center was the development of the *Saturn* rockets to carry payloads beyond earth orbit, leading to the *Apollo* space flight program.

The first laser device using a ruby cylinder was developed in the United States. The U.S. submarine

*Triton* completed the first circumnavigation of the globe under water. The French bathynaut Jacques Piccard, accompanied by a U.S. naval officer, dived in the bathyscaphe *Trieste* to the record depth of 35,800 feet in the Pacific near the island of Guam. A U.S. experimental, rocket-powered airplane travelled at nearly 2200 miles per hour. Donald Glaser was awarded the Nobel Prize for developing the bubble chamber for subatomic studies. Astroturf was used for the first time, at the Astrodome in Houston, Texas. Smoking was identified as a major cause of death by the American Heart Association. The first oral contraceptive was approved for general use.

1961: In January, John F. Kennedy became the youngest president of the United States. U.S.-trained and supplied Cuban exiles unsuccessfully invaded Cuba at the Bay of Pigs. Kennedy and Krushchev met in Vienna. The Berlin Wall was constructed. U.N. Secretary-General Dag Hammerskjöld was awarded the Nobel Peace Prize, but was killed in an air crash.

A Soviet cosmonaut, Yuri Gargarin, became the first human to orbit the earth in a satellite, in April, aboard *Vostok I*. Alan Shepard became the first American astronaut in space when he completed a short sub-orbital flight aboard the Mercury capsule, *Freedom 7*, in May. This was followed by another sub-orbital flight in July by Virgil Grissom, aboard *Liberty Bell 7*. However, in May, President Kennedy told Congress he believed the United States "should commit itself to achieving, before the decade is out, the landing of a man on the moon and returning him safely to earth." In August, Soviet cosmonaut Titov orbited the earth 17 times. The Soviet Union also sent a probe to Venus, but contact with it was lost.

The Trans-Siberian Railway was electrified from Moscow to Irkutsk, but the *Orient Express* made its last journey between Paris and Bucharest. The 'Diefenbunker' - the uniquely engineered centrepiece of John Diefenbaker's government emergency shelter system against nuclear attack - was opened at Carp, Ontario. Lee De Forest, the inventor of the vacuum tube, died.

1962: The political news for this year was dominated by the Cuban Missile Crisis between the United States and the Russia in late October. Earlier, in March, President Kennedy proposed the creation of an Office of Science and Technology within the executive branch of the government - yet another sign that the United States was concerned about its world standing in these two areas of endeavour.

Travel in space dominated engineering. U.S. Mercury astronauts Glenn, Carpenter and Schirra orbited separately. *Mariner 2* was launched by the U.S. to probe Venus and became the first manmade object to travel to another planet. The first active communications satellite, *Telestar*, was launched from Cape Canaveral. The Soviet Union launched the first probe to the planet Mars, but contact with it was lost. Canada's *Alouette I* satellite was launched from California and, for many years, sent data back to earth.. The first British satellite, *Ariel I*, was launched from Cape Canaveral.

The U.S. was reported to have 200 nuclear reactors in operation and Britain and the U.S.S.R, had 39 each. The nuclear ship *Savannah* underwent sea trials. Lasers were used in eye surgery for the

first time. Rachel Carson published her book, *Silent Spring*. The first demonstration nuclear reactor designed to generate power for grid use in Canada went into service at Rolphton, Ontario.

1963: This year was one of the most news-worthy, dominated by the assassination of President Kennedy in Dallas in November. Lyndon B. Johnson became president. There were civil rights demonstrations at Birmingham, Alabama, that led to the arrest of Martin Luther King Jr., and 200,000 marchers descended on Washington, D.C.. British prime minister Macmillan resigned, following the Profumo scandal, and was succeeded by Sir Alec Douglas-Home. British journalist H.A.R. Philby was granted asylum in the U.S.S.R.. Lester B. Pearson and the Liberals defeated John G. Diefenbaker and the Conservatives in the Canadian general election and formed a minority government.

Russia's Valentina Tereshkova flew in space for three days (48 orbits) and became the first female cosmonaut. U.S. astronaut Gordon Cooper completed 22 orbits in the Mercury capsule, *Faith* 7. For the first time, American and Russian spacecraft with people on board (Cooper, Nikolayev (*Vostok III*) and Popovich (*Vostok IV*)) were in orbit simultaneously. *Syncom 2* became the first artificial satellite to go into geosynchronous orbit.

American surgeon, Dr. Michael De Bakey, used an artificial heart during surgery for the first time. American Arnold Palmer was the top money winner in professional golf, with \$128,230. Canada opened a second nuclear research laboratory, at Whiteshell, Manitoba.

1964: Queen Elizabeth visited Canada. In Egypt, the Aswan High Dam was completed across the River Nile. The passage of the *Gulf of Tonkin Resolution* by the U.S. Congress was seen as the start of the war between the United States and North Vietnam. Russia and the United States dominated the Olympic Games in Tokyo.

The International Year of the Quiet Sun began on 1 January 1964 (and ended on 31 December 1965). The spaceprobe *Ranger* 7 was launched from Cape Kennedy (formerly Canaveral) to explore the moon's surface and relay close-up photographs to earth.

Townes, Basov and Prokhorov shared the Nobel Prize for Physics for their work on the development of masers and lasers. The International Rice Research Institute began the 'green revolution' with new, high-yielding, strains of rice. The construction of containerships began, bringing significant changes to world-wide shipping. Britain granted the first licenses for the drilling of oil in the North Sea. The Verrazano-Narrows Bridge, then the longest suspension bridge in the world, was opened to traffic in New York.

1965: The 750<sup>th</sup> anniversary of the signing of the Magna Carta and the 700<sup>th</sup> anniversary of the British Parliament were commemorated. Winston Churchill died, having celebrated his 90<sup>th</sup> birthday the previous year. The Medicare Bill became law in the United States. There were demonstrations

against the Vietnam War and serious race riots in the Watts district of Los Angeles. General de Gaulle was elected to a second seven-year term as president of France. Over 710,000 degrees were conferred by academic institutions in the United States - 551,000 at the bachelor level, 140,000 at the master's and the remaining 18,000 or so were doctorates. A blackout - due to a chain reaction from a faulty relay originating in Ontario - covered much of entire northeastern U.S. and southern Canada and affected 30 million people

The first French satellite was launched. Both American (White) and Soviet (Leonov) astronauts left their capsules and 'walked' in space for several minutes. A Cooper/Conrad *Gemini* space flight was designed to test the feasibility of a lunar mission, and the later Borman/Lovell and Schirra/Stafford ones provided the first rendezvous in space. The U.S. spaceprobe *Mariner 4* passed within 12,000 km of Mars. The Russian spaceprobe *Zond III* photographed areas on the on the opposite side of the moon that had not been photographed earlier by *Lunik III*. Canada's second earth satellite, the *Alouette II*, was launched, again to carry out data collection to support long-distance radio transmission.

Kemeny and Kurtz developed *Basic*, a computer language for beginners, and it became the main programming language used by owners of personal computers.

1966: Mrs. Indira Gandhi became prime minister of India, and B.J. Vorster of South Africa. Kwame Nkrumah was removed as prime minister of Ghana by military coup. Former Nazi ministers, Speer and von Schirach, were released from prison. Roman Catholic bishops ruled that Catholics need no longer abstain from eating meat on Fridays, except during Lent. Alfred Hitchcock directed his 50<sup>th</sup> film, *The Torn Curtain*.

The Soviet spacecraft *Luna IX* made a soft landing on the moon, *Luna X* became the first to orbit the moon, and the spaceprobe *Venera III* became the first man-made object to land on another planet when it reached Venus. U.S. spacecraft *Surveyor 1* also landed on the moon and transmitted back several thousand TV images of the terrain. U.S. astronaut Aldrin made a two-hour spacewalk from the *Gemini 12* spacecraft. The spacecraft *Lunar Orbiter I* photographed the moon's surface. Astronauts Armstrong and Scott accomplished the first splashdown in the Pacific Ocean. The U.S. launched *ESSA 1*, the first weather satellite capable of viewing the entire earth.

Martin Rees discovered quasars. The first of Canada's *CANDU* nuclear power reactors went into service at Douglas Point, Ontario.

1967: Canada celebrated its 100<sup>th</sup> birthday and, among many associated events, hosted a world exhibition - *EXPO 67* - in Montréal. The Queen and Prince Philip visited. French president de Gaulle made his '*Québec libre*' speech in Montréal. Martin Luther King led a protest march against the Vietnam War in New York. Paul Whiteman, the U.S. 'King of Jazz,' died. Israel and Arab nations fought the Six-Day War.

Soviet cosmonaut V.M. Komarov was killed during the emergency re-entry of his space capsule *Soyuz I.* U.S. manned space flights were postponed after the deaths of three astronauts in an *Apollo* spacecraft on the launching pad. The third U.S. *Lunar Orbiter* searched for possible landing sites for the *Apollo* astronauts who were later to land on the moon. The U.S. spaceprobe *Surveyor 3* softlanded on the moon to send photographs of its surface to guide these same astronauts. *Lunar Orbiter 4* and *Surveyor 5* and *6* were also sent to the moon to send back information for those that were to follow. The Soviet spaceprobe *Venera IV* was sent to Venus, but ceased functioning shortly after arriving. The U.S. probe *Mariner 4* flew within 4000 km of Venus to find out why *Venera* failed. SPAR Aerospace Ltd. was formed in Canada from the Special Products and Applied Research Division of de Havilland Aircraft Ltd. to further exploit the development, manufacture and marketing of STEM antennae and other products for space applications.

France launched its first nuclear submarine, *La Rédoubtable*. The United States had 74 nuclearpowered submarines in commission. Sir John Cockroft, who was associated with nuclear energy research programs in Canada and Britain, and J. Robert Oppenheimer, the 'man who built the bomb,' died. China exploded its first hydrogen bomb. South African Dr. Christian Barnard performed the world's first human heart transplant. A Cleveland, Ohio, surgeon developed the coronary bypass operation. Mamography was introduced to detect breast cancer. Overseas direct dialing began between New York and London and Paris. R.M. Dolby developed his method for improving the fidelity of sound in recordings. Keyboards were put to use to provide data for computers.

1968: Pierre E. Trudeau replaced Lester B. Pearson as prime minister of Canada. In the U.S., incumbent Lyndon B. Johnson announced he would not run in the fall's presidential election. Robert F. Kennedy did run, but was assassinated in Los Angeles just prior to the Democratic Convention. Republican Richard M. Nixon was elected president in November by a narrow margin over Hubert H. Humphrey. The winner of the 1964 Nobel Peace Prize, civil rights leader Martin Luther King Jr., was also assassinated - in Memphis, Tennessee. Czechoslovakia was invaded by Russian and Warsaw Pact troops while attempting to resist pressure to cancel reforms recently instituted. A two-state federation was established.

Soviet spacecraft Zond V became the first man-made object to travel round the moon and return to earth. The U.S. spacecraft Surveyor 7 landed successfully and undamaged on the moon. The Apollo 8 manned spacecraft orbited the moon and returned to splash-down in the Pacific. The United States launched Intelsat 3A, the first of a series of communications satellites.

The U.S. Government moved the people of Bikini Island back to the atoll, believing that the contamination from the 1956 hydrogen bomb test had reached low enough levels. Regular hovercraft service began across the English Channel. The first petroleum-carrying supertankers went into service. The luxury liner *Queen Elizabeth II* went into service, as did the deep-sea drilling ship *Glomar Challenger*. The first supersonic airliner, the Russian *Tupolev TU-144*, made demonstration flights. American architect/engineer R. Buckminster Fuller was awarded the Gold Medal of the Royal Institute of British Architects. Fuller designed the U.S. pavilion for *EXPO 67*.

1969: Student disorders in Europe and anti-Vietnam demonstrations in the United States were common during the year. Violent fighting also broke out between the two religious groups in Northern Ireland. Yasir Arafat was elected to lead the Palestine Liberation Organization. De Gaulle resigned as president of France and Georges Pompidou was elected to succeed him. Prince Charles was invested as Prince of Wales by Queen Elizabeth at Caernarvon Castle.. Film star Judy Garland died. Agatha Christie's play *The Mousetrap* had its 7000<sup>th</sup> performance in London. The *Saturday Evening Post*, founded in 1821, suspended regular publication. The strongest hurricane to strike the U.S. coast since 1935, *Camille*, devastated the Mississippi Gulf coast. Dwight D. Eisenhower - wartime U.S. general and peacetime president, died, as did Joseph P. Kennedy, father of John and Robert.

U.S. astronauts on board *Apollo 11* and *Apollo 12* spacecraft landed on the moon's surface in July and November and returned safely to earth, fulfilling the promise made by the late President John F. Kennedy. Two *Mariner* spaceprobes sent back pictures of the surface of Mars. Two Soviet spacecraft, *Soyuz IV* and *V*, docked in space and transferred crew members. Canada's third radio research satellite, *ISIS-I*, was launched.

The Anglo-French supersonic aircraft, the *Concorde*, made its first test flights. Dr. Barnard's third heart transplant recipient, Philip Blaiberg, died, having lived 19 months after the operation. Bubble memory devices were created for use in computers, to 'remember' even when the machines were turned off. The scanning electron microscope reached practical use after more than 15 years of development. The first steps were taken to ban the use of the insecticide *DDT*.

1970: A General Election was held in Britain and, as a result, Edward Heath and the Conservative Party replaced Harold Wilson and Labour in power. Student protests continued in the United States against the Vietnam War, although the U.S. troop strength there was reduced. Marxist Salvador Allende was elected president of Chile. Soviet novelist Alexander Solzhenitsyn was awarded the Nobel Prize for Literature. C.P. Snow published the last volume of his *Strangers and Brothers* series. *EXPO 70* opened in Osaka, Japan. TV sets in use throughout the world were estimated at 231 million.

The U.S. spacecraft *Apollo 13* was launched at Cape Kennedy, intended for another moon landing, but the mission was aborted due to equipment failure. The craft and crew were able to return safely to earth. An unmanned Soviet spacecraft, *Luna XVI*, landed on the moon and returned to earth with rock samples. *Luna XVII* also landed and left an eight-wheeled self-propelled vehicle. Russia's *Venera VII* unmanned spacecraft landed on Venus. The first Chinese and Japanese earth satellites were launched.

In France and the U.K., nuclear-powered heart pacemakers were successfully implanted into three patients. Carbon dioxide lasers were introduced for industrial cutting and welding, and the floppy disc for storing computer data.

1971: The world's population had grown to an estimated 3.8 billion, that of the United States was 207 million, China 827 million, the Russia 242 million, India 439 million, and the United Kingdom 55 million. Canada's was just short of 22 million. The war in Vietnam reached its height but remained in stalemate while, in the United States, hundreds of thousands demonstrated against it. Violence worsened in Northern Ireland with the introduction of preventive detention and internment without trial. President Nixon ordered a 90-day wage freeze in the United States to combat rising domestic inflation and balance of payments difficulties. Kurt Waldheim of Austria was appointed U.N. secretary general. The U.S. dollar was devalued. A postal strike lasted 47 days in the U.K. Canada and the Peoples' Republic of China established diplomatic exchanges. Louis Armstrong died. Cigarette advertisements were banned from U.S. TV.

The U.S. *Apollo 14* space mission collected rocks from the moon in early February 1971. During the *Apollo 15* lunar mission, Scott and Irwin drove the lunar rover on the moon's surface. The U.S. spacecraft *Mariner 9* orbited around Mars. It sent back several thousand photographs to earth. Two weeks later, the Soviet spacecraft *Mars II* went into orbit round the planet. *Mars III* soft-landed on the planet in December 1971. Its short TV broadcast was, unfortunately, unreadable. Three crew members of the Soviet spacecraft *Soyuz X* docked with *Salyut I*, the first space station. Three Russian cosmonauts died when *Soyuz XI* developed an air leak on re-entry. Canada's fourth radio research satellite - *ISIS-II* - was launched

Gerhard Herzberg, a leading physicist at the National Research Council of Canada, was awarded the Nobel Prize for Chemistry for his work on the spectroscopy of gases. England's Dennis Gabor was awarded the Nobel prize for Physics for his invention of holography. Raymond V. Damadian applied for a patent on magnetic resonance imaging as a cancer detector. Direct dialling began between parts of the United States and Europe on a regular basis. The first microprocessor, or chip, was introduced by Intel in the United States. Texas Instruments introduced the first pocket calculator. It weighed over 2 lbs., and cost \$150. Nicholas Wirth developed *Pascal* - a language used in home computers. A 372,400-ton tanker, the largest vessel then built, was launched in Japan. The U.S. Congress voted to end funding for a supersonic transport aircraft. Canada's largest nuclear reactor power station went into service at Pickering, Ontario.

#### Discussion

Three quick points: first, the emphasis in this paper has been on engineering, but science and research have not been forgotten; second, the contents have been selective, not definitive, and undoubtedly many more items could have been added; third, to 'leaven' the mix, so to speak, selected political, economic and social events and statistics have been included, but not much has been noted about individual people.

For readers to argue that the 'watershed' thesis has been 'engineered' rather than proven, should be allowed. But, frankly, putting spacecraft into earth orbit with and without people on board, and bringing the people back again safely, beginning in 1957, 1958 and 1959, was a sufficiently large 'blip' in the continuity of the history of engineering that it should be possible to consider the proving

to be obvious - and activity in this field continued unabated in certain countries throughout the remainder of the period covered by the paper.

The same might also be said for the detonation of the atomic bombs in 1945. There was significant novelty in the type of explosive, and a considerably bigger bang. And by switching from bombs to the generation of electricity at the end of the war created a new sub-industry within power generation.

Indeed, it might be argued on the basis of some of the evidence mentioned in the paper that quite a few years, over a long time, have generated engineering watershed events, although almost all would be more evolutionary than revolutionary. James Watt's separate condenser, for example, in 1765. And in Canada's case, the year 1959 was also notable for the cancellation of the *Arrow* project and for the opening of the St. Lawrence Seaway.

Also, hopefully, I have captured the beginnings of some of the revolutionary and evolutionary innovations that owe much to engineering - and perhaps also to science - between 1945 and 1971. One of the penalties of growing old is that one forgets how long ago some of these things happened!

Lastly, based on the (admittedly sketchy) information given above - and extended on both sides of it - it would appear that every dozen years or so there is an engineering achievement that has a very significant influence on politics, economics and society world-wide. At the turn of the 20<sup>th</sup> century there was the automobile and the truck; in the years after World War I there was the commercial aeroplane; in the forties there was the atomic bomb, followed by the atom as a source of power; in the late fifties there was the beginning of space exploration; in the seventies there was the microchip and the personal computer.....

To sum up: yes, Virginia, there was a watershed......

## **Principal Sources**

Bernard Grun, The Timetables of History, Simon and Schuster, New York, 1982

Alexander Hellemans and Bryan Bunch, *The Timetables of Science*, Simon and Schuster, New York, 1991

*Encyclopaedia Britannica Book of the Year*, 1960 thru 1972, Encyclopaedia Britannica Inc. Toronto and Chicago (Canadian editions)

http://www.sciencetech.technomuses.ca/english/schoolzone/Info\_Space.cfm

http://www.ewh.ieee.org/reg/7/millennium/alouette/alouette\_franklin.html

http://en.wikipedia.org/wiki/Alouette\_1



The Alouette 1 satellite.