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## Paper Session I-B - Painting by Numbers a Statistical Analysis of Cape Canaveral Launches, the First 50 Years (1950-1999)

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# **Painting By Numbers A Statistical Analysis Of Cape Canaveral Launches The First 50 Years**

**By Cliff Lethbridge**

## **Introduction**

It seems sad to say, but no one knows exactly how many rockets and missiles have been launched from Cape Canaveral. The first Cape launch, that of a two-stage German V-2 rocket called Bumper #8, occurred on July 24, 1950. From that point on, launch activity at Cape Canaveral literally exploded. Because much of the launch activity was classified and took place at a rapid pace, no one organization or individual was able to accurately maintain a list of all the launches.

My own research on the subject began in 1994, shortly after I became a volunteer at the Air Force Space and Missile Museum on Cape Canaveral Air Station. I had been asked by Museum leadership to consider writing a book on the history of Cape Canaveral. This request coincided with the release of the first reliable, comprehensive Cape Canaveral launch chronologies by the 45th Space Wing History Office. Although the 45th Space Wing History Office chronologies are excellent, they did not contain all of the information I was looking for.

I subsequently spent the next several years reviewing Cape Canaveral launch chronologies published independently of the 45th Space Wing History Office. These were available from a number of sources, including books, publications, data bases and contractor reports. Without exception, none of the documents contained information that exactly matched the "official" Cape Canaveral launch chronologies published by the 45th Space Wing History Office.

The statistical results in this paper are based on a combination of several credible Cape Canaveral launch chronologies built around the 45th Space Wing History Office chronologies. It should be noted that the numbers I have included will not exactly match the 45th Space Wing History Office chronologies or any other. I have had to interpret information I have come across while weighing the reliability of each individual source. I believe that my numbers are very good, but the reader must bear in mind that no Cape Canaveral launch chronology is absolutely accurate.

## **Grand Totals And Terminology**

Not including weather rockets and sounding rockets which are not included in official launch chronologies, there have been 3,182 missile and rocket launches from Cape Canaveral from July 24, 1950 through December 19, 1999. This period encompasses the first 50 calendar years of launch activity at the Cape, or 1950 through 1999. The actual 50th anniversary of the first rocket launch from Cape Canaveral will not be celebrated until July 24, 2000. However, a statistical analysis of the first 50 calendar years is sufficient to discover the trends that have shaped the evolution of the Cape.

In order to make the raw numbers meaningful, the launches may be placed in two basic categories. These are "User" and "Type". "User" indicates the organization sponsoring or conducting the launch, and may be divided into Air Force, Army, Commercial, NASA and Navy, listed in alphabetical order. Note that the term "Commercial" is used to define a commercial corporation conducting its own launch after the creation of a virgin commercial launch industry at the Cape in 1988. Prior to 1988, NASA launched all commercial payloads. Commercial payloads launched by NASA would make NASA the "User", while payloads launched by a commercial corporation would make that corporation a "Commercial User".

"Type" indicates the type of mission being conducted, and may be divided into Weapons Testing, Suborbital Research, Military Space Payload, Civilian Space Payload and Commercial Space Payload. Weapons Testing includes weapons development and troop training, including missile launches from submarines. Suborbital Research includes scientific payloads not intended to orbit Earth, although these payloads may have reached space altitudes. Military Space Payload includes payloads launched into Earth-orbit to meet military objectives. Civilian Space Payload includes scientific payloads launched into Earth-orbit or Earth-escape trajectory, including all manned missions except those which were suborbital. Commercial Space Payload includes payloads placed into Earth-orbit for commercial purposes.

It is also useful to analyze what types of missiles and rockets were introduced at the Cape at any given time. Missiles and rockets may be divided into Research Rocket (R), Cruise Missile (C), Ballistic Missile (B) and Space Launch Vehicle (S). Repeating, official Cape Canaveral launch chronologies do not include the launches of weather rockets and sounding rockets, so these will not receive their own designation. Depending upon interpretation, some research rockets performing suborbital missions might be classified as sounding rockets, but these are typically not included in official launch chronologies unless the suborbital mission is tied directly to a weapons development program or is of historic significance. But the vast majority of sounding rocket launches have not been included in official launch chronologies.

Broken down by "User" and listed in order of frequency from greatest number to least number, a total of 1,230 (39%) Cape Canaveral launches were Air Force, a total of 1,136 (36%) were Navy, a total of 443 (14%) were NASA, a total of 298 (9%) were Army and a total of 75 (2%) were Commercial. Broken down by "Type" and listed in order of frequency from greatest number to least number, a total of 2,391 (75%) Cape Canaveral launches were Weapons Testing, a total of 359 (11%) were Civilian Space Payload, a total of 158 (5%) were Commercial Space Payload, a total of 150 (5%) were Military Space Payload and a total of 124 (4%) were Suborbital Research. In order to identify trends in the specific evolution of Cape Canaveral, these numbers will be further broken down by decade along with a list of vehicles introduced during each decade.

## **The 1950's**

### **The Era Of Winged Missiles, The Birth Of The ICBM And The Dawn Of The Space Age**

The 1950's witnessed the introduction of a number of missiles and rockets to the Cape Canaveral landscape. In chronological order, these included Bumper-Wac (R), Lark (C), Matador (C), Snark (C), Bomarc A (C), RV-A-10 (R), Redstone (B), X-17 (R), Navaho X-10 (C), Jupiter A (B), Jupiter C (R), Navaho XSM-64 (C), Vanguard (S), Thor (B), Jupiter (B), Bull Goose (C), Polaris FTV (R), Atlas A (B), Juno I (S), Thor-Able Zero (R), Bold Orion (B), Atlas B (B), Thor-Able I (S), ALBM-199C (B), Polaris A1 (B), Juno II (S), Atlas-Score (S), Atlas C (B), Thor-Able II (R), Titan I (B), Alpha Draco (R), Atlas D (B), Hound Dog (C), Bomarc B (C), Mace (C) and Atlas-Able (S).

This was primarily a decade of missile testing, which was the chief purpose for which the range at Cape Canaveral was established. There were a total of 789 launches from the Cape from 1950 through 1959. This represents 25% of all Cape launches. Classified by "User", a total of 647 (82%) Air Force, 77 (10%) Army, 51 (6%) Navy and 14 (2%) NASA launches were conducted during the decade. The Air Force dominated the range due to a large number of winged missile launches, reinforced by ballistic missile testing later in the decade. The Army also conducted significant ballistic missile testing throughout much of the decade, as did the Navy upon embarking on a sea-based ballistic missile program late in the decade. NASA launches were understandably low since the agency was not established until October, 1958.

The emphasis on missile testing is exemplified when the launch numbers are classified by "Type". During the decade, 678 (86%) of the launches were Missile Testing, 82 (10%) of the launches were Suborbital Research, 28 (3%) of the launches were Civilian Space Payload and 1 (1%) of the launches were Military Space Payload. Since the first U.S. satellite was not launched until January 31, 1958 it is quite understandable why space payloads fared very low in the overall launch percentages.

## **The 1960's**

### **Vigorous Weapons Testing, Astronauts Enter Space And Men Walk On The Moon**

The 1960's also saw a number of missiles and rockets added to the Cape Canaveral inventory. In chronological order, these included Pershing I (B), Atlas-Agena A (S), Thor-Able Star (S), Delta (S), Mercury-Atlas (S), Blue Scout Junior (R), Atlas E (B), Polaris A2 (B), Mercury-Redstone (R), Blue Scout I (S), Minuteman I (B), Blue Scout II (R), Atlas F (B), Atlas-Agena B (S), Saturn I Block I (R), Mercury-Scout (S), Titan II (B), Skybolt (B), Atlas-Centaur (S), Polaris A3 (B), Delta A (S), Delta B (S), Atlas-Agena D (S), Saturn I Block II (S), Gemini-Titan II (S), Atlas-Antares (R), Delta D (S), Titan III-A (S), Minuteman II (B), Delta C (S), Titan III-C (S), Delta E (S), Saturn IB (S), Delta G (S), Saturn V Apollo (S), Minuteman III (B), Poseidon (B), Delta M (S), Delta N (S) and Delta L (S).

The 1960's witnessed the glory days of the Cape, with a staggering 1,120 launches conducted from 1960 through 1969. This figure represents 35% of all Cape launches, and over twice the number of total launches for any decade since. Like the 1950's, the range was dominated by missile testing, although the Air Force began yielding its numerical lead to the Navy. Classified by "User", a total of 438 (39%) Air Force, 431 (39%) Navy, 179 (16%) NASA and 72 (6%) Army launches were conducted during the decade. The Air Force continued vigorous winged missile and ballistic missile testing, while Navy numbers skyrocketed as multiple submarine-based launches, as many as seven on any given day, became common. Although NASA numbers were not large, it was the NASA manned space flight programs that stimulated unprecedented public awareness and interest in Cape Canaveral. From the launch of the first U.S. astronaut on May 5, 1961 through the first manned lunar landing on July 20, 1969 literally all eyes were fixed on the Cape. The Army also kept a slow but persistent pace in ballistic missile testing.

Although weapons testing, by percentage, dipped slightly over the previous decade, weapons tests were carried out at an astonishing pace. A total of 885 (79%) of the 1960's launches were Weapons Testing, a total of 152 (14%) were Civilian Space Payload, a total of 35 (3%) were Suborbital Research, a total of 35 (3%) were Military Space Payload and a total of 13 (1%) were Commercial Space Payload. These figures represented the largest number of weapons tests and the largest number of civilian space payloads launched during any single decade in the history of Cape Canaveral. Although numbers of commercial space payloads were scant, the reality of the commercialization of space was achieved during this exciting decade.

## **The 1970's**

### **The Recession Hits Cape Canaveral Big Time**

As would be expected during a time of general recession and restructuring, just a few missiles and rockets were introduced at the Cape during the 1970's. In chronological order, these included Delta M6 (S), Delta 1000 Series (S), Pershing IA (B), Saturn V Skylab (S), Delta 2000 Series (S), Titan III-E Centaur (S), SRAM (C), Delta 3000 Series (S), Trident I (B) and Chevaline (B).

There were a total of 512 launches from Cape Canaveral from 1970 through 1979. This represents less than half the number of launches conducted during the previous decade, and 16% of total Cape launches. It is generally perceived that the post-Apollo era ushered in an overall decline in launch activity at the Cape, but that was just a part of the overall picture. Dramatic declines in the number of Air Force and Navy missile tests had the greatest effect on total launch figures. These factors, coupled with a time of economic recession, led to troubled times at Cape Canaveral, especially for Cape workers, who were laid off by the thousands during the decade.

For the first time, the Navy conducted more launches than the Air Force during any given decade, a trend which would continue in decades to come. Classified by "User", there were 296 (58%) Navy, 97 (19%) NASA, 63 (12%) Army and 56 (11%) Air Force launches during the 1970's. In a dramatic shift from previous decades, the Air Force had the lowest number of launches than any other user. This is primarily because Air Force missile testing concluded early in the decade and Air Force operations shifted to the relatively infrequent launching of military

satellites. The Navy dominated the range with the continued testing of submarine-launched missiles, conducting multiple launches on any given day.

Consistent with previous decades, missile testing dominated the range in the 1970's. Classified by "Type", 381 (74%) of launches during the decade were Missile Testing, 53 (10%) were Civilian Space Payload, 44 (9%) were Commercial Space Payload and 34 (7%) were Military Space Payload. Commercial payloads, which were launched by NASA at the time, saw a three-fold increase over the 1960's. By the close of the decade, the U.S. culture would come to rely heavily on the use of commercial communications satellites.

## **The 1980's**

### **The Space Shuttle Saves The Cape And A Commercial Launch Industry Is Born**

While the evolution of Cape Canaveral in the 1980's is best showcased by the birth of the Space Shuttle, some other missiles and rockets were introduced during the decade. In chronological order, vehicles introduced at the Cape during the 1980's included Space Shuttle Columbia (S), Penguin (C), Pershing II (B), Titan 34D (S), Space Shuttle Challenger (S), Space Shuttle Discovery (S), Space Shuttle Atlantis (S), Trident II (B), Loft I (R), Delta II 6000 Series (S), Titan IVA (S), Delta 4000 Series (S) and Commercial Titan III (S).

A total of 420 launches were conducted from Cape Canaveral from 1980 through 1989. This represents 13% of all Cape launches. Navy missile tests still dominated the range, but the introduction of the NASA Space Shuttle provided economic revitalization to the Cape. Although NASA launch numbers were at their lowest for any full decade since the creation of the space agency, the Space Shuttle program generated public awareness of Cape Canaveral not seen since the 1960's. A tragic loss would also pave the way for the most important development in the late-term evolution of the Cape.

Classified by "User", there were 235 (56%) Navy, 86 (20%) Army, 66 (16%) NASA, 30 (7%) Air Force and 3 (1%) Commercial launches during the 1980's. This marked the first decade since the 1950's that the Army conducted more launches than NASA, primarily due to vigorous Army testing and troop training of its Pershing II ballistic missile, with as many as six Pershing II missiles launched on any given day. In the wake of the Challenger tragedy, NASA decided to withdraw commercial payloads from future Space Shuttle manifests. Late in the decade, the first fully commercial launches from the Cape were conducted. As a result, expendable rocket families like Atlas, Delta and Titan were reborn after facing elimination by the Space Shuttle.

By percentage, missile tests kept pace with previous decades. Classified by "Type", 324 (77%) launches during the 1980's were Missile Testing, 39 (9%) were Civilian Space Payload, 29 (7%) were Commercial Space Payload, 27 (6%) were Military Space Payload and 1 (1%) was Suborbital Research.

## **The 1990's**

### **The Cape Becomes A True Spaceport**

Keeping up with previous decades, a number of missiles and rockets were introduced at the Cape in the 1990's, primarily those designed to meet the ever-changing demands of the international commercial launch services marketplace. In chronological order, vehicles introduced at Cape Canaveral in the 1990's included Delta II 7000 Series (S), Starbird (R), Atlas I-Centaur (S), Joust I (R), Red Tigress I (R), Atlas II-Centaur (S), Space Shuttle Endeavour (S), Atlas IIA-Centaur (S), Pegasus Standard (S), Red Tigress II (R), Atlas IIAS-Centaur (S), Titan IVB (S), Athena II (S), Delta III 8000 Series (S), Pegasus XL (S) and Athena I (S).

There were a total of 341 launches were conducted from the Cape from 1990 through 1999. This represents 11% of all Cape launches. Navy missile testing declined sharply over previous decades, accounting for the lowest number of total launches in any given decade in the history of Cape Canaveral. Classified by "User", 123 (36%) Navy, 87 (26%) NASA, 72 (21%) Commercial and 59 (17%) Air Force launches were conducted during the decade. This was the first decade in the history of Cape Canaveral that the Army did not conduct any launches.

Classified by "Type", 123 (36%) launches during the 1990's were Missile Testing, 87 (26%) were Civilian Space Payload, 72 (21%) were Commercial Space Payload, 53 (15%) were Military Space Payload and 6 (2%) were Suborbital Research. These numbers clearly indicate a transition of Cape Canaveral from a missile test range into a spaceport. This was the first decade in the history of Cape Canaveral that the total number of civilian, military and commercial space launches outnumbered the total number of missile tests.

## **Beyond 2000**

### **Cape Canaveral Faces An Uncertain Future**

No one can say exactly what the future will hold for Cape Canaveral, but it is almost certain that as long as rockets continue to be launched, they will be launched from the Cape. What exact form these launches take may be uncertain. Cape Canaveral is no longer primarily a missile test range. Civilian, commercial and military space launches have begun to outnumber missile tests, and this trend is almost certain to carry into the future. Missile tests have traditionally been responsible for keeping the range infrastructure at the Cape in smooth, consistent working order, as exemplified by the large number of missile test launches supported in the 1960's. As many as eight major vehicle launches have been conducted in a single day, a feat which would be impossible today due to incredibly complex range safety requirements that typically dictate at least 48 hours between each launch. With launch numbers consistently diminished, clearly the future will mandate a climate where launch quality replaces launch quantity.

As Cape Canaveral faces a transition into a predominately civilian and commercial spaceport, certain statistics are troubling. Just 75 Cape launches have been conducted by commercial users since the first one in 1988. This represents an average of seven launches by commercial users each year, far less than a forecast of several dozen commercial launches per year anticipated at the dawn of the commercial launch industry. At the close of the 1990's, the commercial launch industry remained dominated by the Boeing Delta rocket fleet and the Lockheed Martin Atlas rocket fleet. Despite multi-million dollar promotional efforts by organizations like the Spaceport Florida Authority, no new commercial companies have taken root on the Cape. The Spaceport Florida Authority itself has pledged to bring new, smaller classes of commercial rockets to the Cape to boost launch numbers and provide a platform for entrepreneurial interests. Efforts have thus far proven fruitless, with the Spaceport Florida Authority directly involved in just two launches, one Lockheed Martin Athena II and one Lockheed Martin Athena I, since the creation of the agency over a decade ago.

Some hope for the commercial launch industry may come in the form of the Evolved Expendable Launch Vehicle (EELV) program, funded by the Air Force. The program has resulted in the renovation of Launch Complex 37 for the Boeing EELV, called Delta IV, and the renovation of Launch Complex 41 for the Lockheed Martin EELV, called Atlas V. Both of these facilities will support unprecedented launch turnarounds, with perhaps one rocket launched from each facility every two weeks. Should the commercial market support these innovations, the Delta IV and Atlas V could do much in the years ahead to stimulate the Cape Canaveral commercial launch industry. Throughout the 1990's, NASA stimulated the civilian space payload launch rate by introducing a greater number of smaller, less expensive spacecraft. The future of NASA manned spaceflight will depend on the outlook for the International Space Station (ISS), the only scientific program intended to keep the Space Shuttle fleet flying. A combination of ISS development problems and Space Shuttle technical concerns have brought the Space Shuttle launch frequency to record lows at the close of the 1990's. However, should ISS be developed as advertised, the Space Shuttle program faces a healthy future. It is also likely that Cape Canaveral will host the next generation of manned spacecraft, sealing the fate of the Cape as a continuing platform for civilian, military and commercial space launches.

## Appendix One

### Most Cape Canaveral Launches By Year

1960 - 206  
1961 - 186  
1959 - 168  
1962 - 151  
1963 - 150  
1958 - 140  
1957 - 113  
1964 - 105  
1956 - 094  
1966 - 077  
1954 - 075  
1965 - 073  
1955 - 072  
1969 - 072  
1970 - 068  
1978 - 062  
1980 - 062  
1953 - 059  
1975 - 059  
1983 - 058  
1971 - 057  
1982 - 055  
1977 - 054  
1967 - 051  
1979 - 051  
1968 - 049  
1992 - 049  
1987 - 047  
1976 - 044  
1974 - 042  
1952 - 041  
1981 - 040  
1973 - 039  
1990 - 038  
1995 - 037  
1972 - 036  
1988 - 036  
1985 - 035  
1996 - 035  
1997 - 034  
1994 - 033  
1998 - 031  
1986 - 030  
1989 - 029  
1991 - 029  
1999 - 029  
1984 - 028  
1993 - 026  
1951 - 022  
1950 - 005

## **Appendix Two**

### **Most Annual Cape Canaveral Launches By Each "User"**

Air Force - 130 Launches in 1960  
Navy - 82 Launches in 1963  
NASA - 30 Launches in 1966  
Army - 26 Launches in 1961  
Commercial - 12 Launches in 1998

## **Appendix Three**

### **Most Annual Cape Canaveral Launches By Each "Type"**

Weapons Testing - 185 Launches in 1960  
Civilian Space Payload - 29 Launches in 1966  
Suborbital Research - 25 Launches in 1957  
Commercial Space Payload - 12 Launches in 1998  
Military Space Payload - 10 Launches in 1989

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