

# Unveiling the Architecture and Design of the John F. Kennedy Space Centre - A Comprehensive Case Study

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## ABSTRACT

The John F. Kennedy Space Centre (KSC) is a world-renowned spaceport with a history of space exploration and development programs. The architecture and design of this facility have contributed significantly to the successful launch of numerous space missions. This research paper is a comprehensive case study of the architecture and design of the KSC, based solely on online research and resources. The KSC is situated on an area of 144,000 acres in Florida and comprises more than 700 facilities. The facility houses multiple space development programs, including the International Space Station, Orion spacecraft, and numerous launch vehicles. The architecture of the KSC reflects the functional requirements of these programs, with an emphasis on safety, efficiency, and sustainability. The research paper examines the history and evolution of the KSC's architecture. The paper also discusses the design of the Vehicle Assembly Building (VAB), which is one of the largest structures in the world and was designed to assemble the Saturn V rocket. In addition, the paper explores the various challenges faced by the KSC's architecture and design team, including hurricane protection, environmental sustainability, and technological advancements. Overall, the paper provides a comprehensive overview of the architecture and design of the KSC, highlighting its significance in the history of space exploration and development. The case study offers valuable insights for architects and designers working in the field of space technology and presents a compelling example of the importance of functional design in complex engineering projects.

**Keywords:** Architecture, Design, John F. Kennedy Space Centre.

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## INTRODUCTION

The Kennedy Space Center is a well-known establishment, famous for its role in space exploration. Located in Merritt Island, Florida, the center is owned by NASA and was established on July 1, 1962. It serves as a space center and a visitor's complex, and boasts 700 facilities covering an area of 144,000 acres (580km<sup>2</sup>). Designed by Charles Luckman in the International Style of architecture, the center is managed by Janet E. Petro, its director, and has a staff of 10,479 as of 2020. The center was formerly known as the Launch Operation Centre [1]. The Kennedy Space Center has played a significant role in space exploration, including the launch of the first US manned space flight and the first moon landing. The center is home to a range of space-related activities, including rocket launches, research, and training for astronauts. Visitors can also enjoy exhibits, tours, and interactive experiences at the visitor's complex, which includes a range of displays, artifacts, and hands-on activities. Overall, the Kennedy Space Center remains an important center for space exploration, research, and education, and a must-visit destination for anyone interested in the history and future of space travel. [2] The Kennedy Space Center offers various programs that encompass human and robotic spaceflight, civil and national security space, spaceports, and the commercial space industry. These programs also include the NASA Astronaut Corps and the NASA U.S. Space Force. Space launch vehicles are also an important part of these programs [3-5].

### Topography

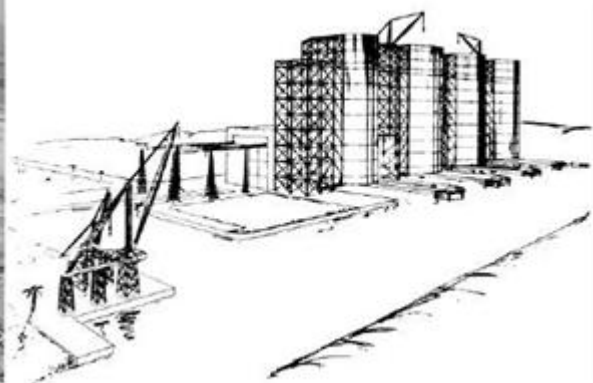
Located on Merritt Island, Florida, the centre is north-northwest of Cape Canaveral on the Atlantic Ocean, midway between Miami and Jacksonville on Florida's Space Coast, due east of Orlando. It is 34 miles (55 km) long and roughly six miles (9.7 km) wide, covering 219 square miles (570 km<sup>2</sup>). The southern area of Merritt Island is heavily residential, with centralized light commercial and light industrial areas. According to the United States Census Bureau, the (census-designated place) CDP has a total area of 122.2 km<sup>2</sup> (47.2 sq. mi), of which 45.4 km<sup>2</sup> (17.5 sq. mi) is land and 76.8 km<sup>2</sup> (29.7 sq. mi), or 62.88%, is water.

## FORMATION AND CONSTRUCTION

NASA began land acquisition in 1962, the area of 131 square mile (340 Km<sup>2</sup>) purchased and negotiated with the State of Florida for additional 87 square miles (230 Km<sup>2</sup>). The property costs \$72,171,487 at that time. [6] The construction began in November 1962. The major buildings in KSC's industrial area were designed by Charles Luckman. [7] Designers quickly began developing plans for Launch Complex 39 facilities which include the Launch Control Centre, Pads A & B as well as the huge hangar we know as the Vertical Assembly building now Vehicle Assembly Building (VAB). The NASA KSC Headquarters building, located in the industrial area, was formally opened on May 26, 1965. Headquarters is the administrative centre for all spaceport activities, including the centre director's office. In February 1964, construction on the Central Instrumentation Facility (CIF) began. The CIF is the core of instrumentation and data processing operations at KSC, which includes offices, laboratories and test stations. Formerly known as the Manned Spacecraft Operations Building, the Operations and Checkout Building (O&C) was opened during the fall of 1964. [8-10]



The early construction of Launch Pad 39A



Drawing of possible assembly buildings for C-5

On November 29, 1963 the facility was given its current name after Former President John F. Kennedy who assassinated in 1963 a week after his last site visit to the under-construction facility [11].

### Zoning and Land Use

Kennedy shares a boundary with the Merritt Island National Wildlife Refuge on Florida's east coast, where nature and technology co-exist. The refuge includes about 140,000 acres on land and water and provides a wide variety of habitats, including coastal dunes, saltwater estuaries and marshes, freshwater impoundments, scrub, pine flat woods, and hardwood hammocks that provide habitat for more than 1,500 species of plants and animals. [12] Kennedy Space Centre offers 6,000 acres of land for facilities and roads, and has 7.8 million square feet of building area, and 564 miles of roads, including 184 miles of paved and 380 miles of unpaved roads. The combined spaceport of Kennedy and Cape Canaveral Air Force Station (CCAFS) has served as the departure gate for every American human space mission and for hundreds of rocket launches carrying advanced research and interplanetary spacecraft. From the early days of Project Mercury to the space shuttle and International Space Station, from the Hubble Space Telescope to the Mars exploration rovers, Kennedy enjoys a rich heritage in its vital role as NASA's processing and launch centre [13-14].

### Central Campus and Industrial Area:

Central Campus includes non-hazardous NASA development in support of NASA programs and as part of the recapitalization process. Facilities to be relocated to Central Campus through recapitalization efforts can include Administration, Research and Development, and non-hazardous Support Services functions. Additional land is provided for expanded research and development and assembly, testing and processing needs. Expanded areas for alternative energy production are provided along with an additional seaport for water borne transportation connectivity [15-16].

### Launch Complex 39 (LC-39) Area:

Launch Complex 39 (LC-39) is a rocket launch site at the John F. Kennedy Space Centre on Merritt Island in Florida, USA. The site and its collection of facilities were originally built for the Apollo program, and later modified for the Space Shuttle program, before undergoing modifications to support launches of the Space X Falcon 9 and Falcon Heavy, and NASA's Space Launch System. Launch Complex 39 is composed of three launch pads-39A, 39B and 39C, a Vehicle Assembly Building (VAB), a Crawler way used by crawler-transporters to carry Mobile Launcher Platforms between the VAB and the pads, Orbiter Processing Facility buildings, a Launch Control Centre which contains the

firing rooms, a news facility famous for the iconic countdown clock seen in television coverage and photos, and various logistical and operational support buildings. Additional land area is designated as Assembly, Testing and Processing areas to provide support for anticipated increased future launch activity, Construction of sea walls will mitigate a potential rise in sea level [17-18].

#### **Shuttle Landing Facility (SLF):**

The facility includes a 150 x 168-meter (490x550ft) parking apron and a 3.2 km (2 mile) tow-way connecting it with the Orbiter Processing Facility. Located adjacent to the parking apron is a Landing Aids Control Building (LACB) which supports landing operations and houses operations personnel. Located at the northeast corner of the parking apron is the Mate/Demate device (MDD) used to raise and lower the orbiter from its 747-carrier aircraft during ferry operations. The open-truss steel structure is equipped with hoists, adapters and movable platforms for access to certain orbiter components and equipment. It also is equipped with lightning protection devices. The MDD is 45.7 meters (150ft) long, 28.3 meters (93ft) wide and 32 meters (105ft) high [19].

The Shuttle Landing Facility is equipped with a number of navigation and landing aids to assist Shuttle pilots in landing. There are four sophisticated Microwave Scanning Beam Landing System (MSBLS) ground stations - two located at each end of the runway - that provide elevation and directional/distance measurement for landing approaches from the northwest (runway 15) or southeast (runway 33). Equipment onboard the orbiter receives the data from the MSBLS stations and automatically makes any needed adjustments to the glide slope. A specially constructed earthen mound just east of the Convoy Staging Area contains bleachers, press facilities and a Public Affairs control room to support invited guests and press coverage during orbiter landings at the Kennedy Space Center [20]. The Center Planning and Development Directorate (CPDD) provides strategic leadership and management integration of centre planning activities and partnership development initiatives to enable Kennedy as a multiuser spaceport supporting both government and commercial launch providers and their customers. Serving as Kennedy's "front door" to industry and other government organizations, the CPDD develops strategic and business partnerships that advance NASA's and Kennedy's goals. CPDD also is responsible for centre land use planning and execution, development of spaceport infrastructure and business strategies, and the preparation and coordination of a Kennedy Space Center Master Plan with NASA organizations and external stakeholders [21-24].

### **ARCHITECTURAL CHALLENGES & DESIGN**

Kinetic architecture is a concept through which buildings are designed to allow parts of the structure to move, without reducing overall structural integrity. Thus, kinetic architecture allows for a completely relocatable, moveable system, including egress. The biggest challenge may have been the addressing multiple moving parts that make up a platform bigger than a basketball court, weighing more than 30,000 pounds. The flexibility of the platforms requires the flexibility of the systems (electricity, fire protection, hydraulics, lighting, pneumatics, water, etc.) to be used by the platforms [25-28].

#### **Life Safety paths –**

- 2HR access ways –moveable corridors, inspired by airport jet-way
- Open ramps; ramps, gangways

Depending upon where platforms are located, persons will be able to access platforms from level elevator landings. Challenges in design of multiple moving parts –translating a platform bigger than a basketball court, weighing more than 30,000 lbs [29].

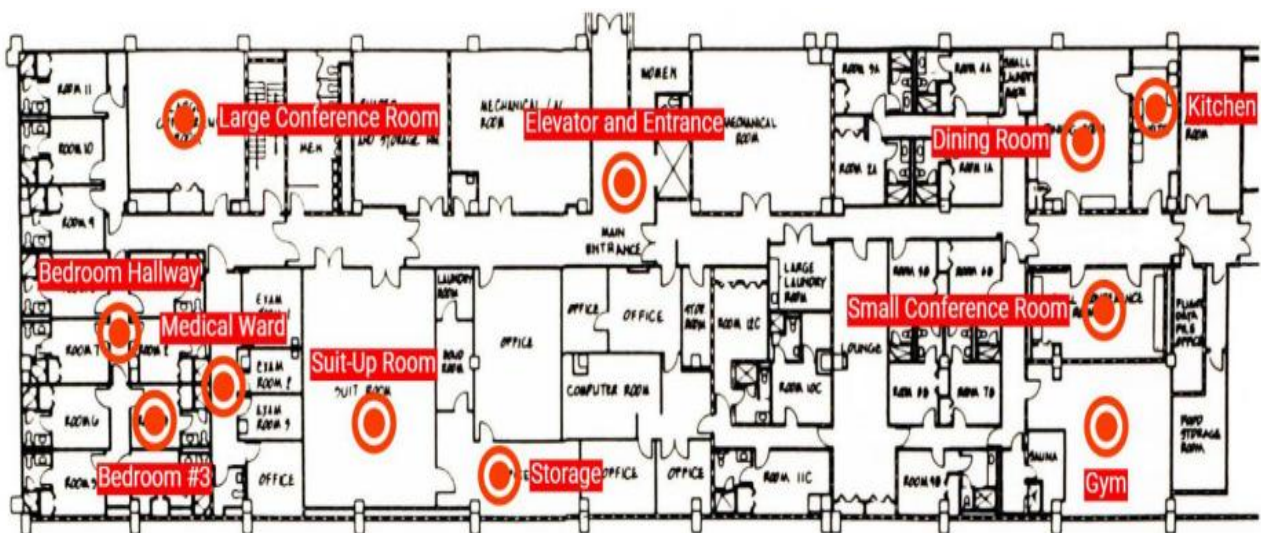
#### **Operation and Checkout Building (O&C)**

The Neil Armstrong Operations and Checkout Building (previously known as the Manned Spacecraft Operations Building) is a historic site on Merritt Island, Florida, United States. The five-storey structure is in the Industrial Area of NASA's Kennedy Space Center. Its facilities include the crew quarters for astronauts prior to their flights. On January 21, 2000, it was added to the U.S. National Register of Historic Places. [30] The Operations and Checkout Building is a five-storey structure containing 600,000ft<sup>2</sup> of offices, laboratories, astronaut crew quarters and spacecraft assembly areas [31].





The NASA building where Neil Armstrong stayed and his lunar landing spacecraft was readied before launching to the moon 45 years ago this month is being renamed for the late astronaut. In April 1981, there were just 14 bedrooms for crew members. Bathrooms were shared by 2 or 3 astronauts. When crews grew to 6-7 members, and women astronauts began to fly on board, 9 additional bedrooms were created along with a bathroom for each bedroom- for a total of 24 of each. Every attempt has been made to make the “college dorm-like” rooms as accommodating as possible. To provide a home away from home atmosphere and a chance for the astronauts to relax immediately before a launch. The newest improvements in the 24,000 sq. ft. sized Crew Quarters began last year, and include: new carpeting, freshly painted walls, ceiling tiles along with new appliances and an audio/visual teleconference system [32].



The Suit Room, where astronauts are helped into their pressure suits before leaving for their mission, has been upgraded with new recliners and three Containment Rooms- one each for Orion, Boeing and SpaceX. Construction upgrades include new high and low bays and basement refurbishment with [33]:

- Separate facility power feed, and chilled and hot water new ceiling lighting, flooring and wall surfaces
- New heat, ventilation, air conditioning and ducts new fire protection, roofing, freight lifts and crane new airlock and vehicle refurbishment area
- New proof press and test cell for vehicle testing
- New vehicle servicing utility suites, and test control room and system Refurbished vertical doors
- Preliminary work on a visitor viewing.



## CONCLUSION

The NASA Kennedy Space Center is a sprawling complex located in Merritt Island, Florida, United States. It covers an area of about 219 square miles and is a historic site for the country's space exploration program. The architecture of the Kennedy Space Center is unique and designed to meet the specific needs of space travel. The buildings at the centre range from launch pads to assembly buildings, from laboratories to administrative offices. One of the most prominent structures is the Vehicle Assembly Building (VAB), which was constructed in the 1960s and remains one of the largest buildings in the world. The VAB was designed to house the Saturn V rocket and Apollo spacecraft during assembly and testing. The building stands 525 feet tall, with a length of 716 feet and a width of 518 feet. It has a floor area of 129,428 square meters and is capable of accommodating four full-sized Saturn V rockets simultaneously. Another iconic building is the Launch Control Center (LCC), which is located on the northern edge of the VAB. The LCC serves as the primary control centre for all space missions from the Kennedy Space Center. It was built in the 1960s and contains four floors of control rooms and offices.

The LCC has an advanced communication and monitoring system that allows it to track all spacecraft launched from the centre. The Kennedy Space Center Visitor Complex is another significant architectural feature. The complex has an array of exhibits and displays related to space travel and the history of NASA. The exhibits feature artifacts from the Mercury, Gemini, and Apollo programs, as well as the Space Shuttle era. The facility has the capability to adjust and accommodate to the changing demands of launch vehicles and spacecraft. It also has adaptable interfaces to meet the specific needs of diverse customers. In addition, the Range has enhanced capacity and flexibility, and its infrastructure has been updated to better support operations. FLS must promote the commercial use of unique KSC/CCAFS infrastructure providing facilities that would be cost prohibitive for many companies to build unilaterally, while offering KSC the opportunity to cost share the operations and maintenance. The FLS will team with the US Air Force, Space Florida, Commercial, and International Partners to optimize resources and successfully and safely execute the mission. Kennedy Space Center has been actively involved in defining the architecture to satisfy the vision set by the US government leadership. Extensive cost benefit analysis has been conducted to optimize the FLS architecture to meet SLS, MPCV, and multiple government and commercial users. Kennedy Space Center is proud to extend the 30-year successes of the Space Shuttle program to the next generation of explorers through the FLS. The Environmental & Remediation Technologies proposed investments to promote clean launch operations and to ensure proper

environmental assessment/compliance was conducted to support the multiple users to be accommodated under the FLS. Three major sewage treatment facilities at KSC process most of the sewage flow, treating an average of 0.16 mgd which accounts for 80% of the total sewage treated. These plants use the activated sludge process to produce secondary quality effluents and serve various areas, including the Industrial Area, the Vehicle Assembly Building, and the Visitors' Information Center. Overall, the architecture of NASA's Kennedy Space Center is not only functional but also a symbol of human ingenuity and innovation. It has played a critical role in the success of the US space program and continues to be a source of inspiration for generations to come.

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