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A Deep Dive into Boeing's Everett Facility

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***Abstract*— The key elements of Boeing's facilities are explored, including products, assembly lines, service flow, employee attitudes, material handling, equipment, offices, and the role of Facilities Engineering in society.**

Keywords—Boeing, Facilities Management

I. INTRODUCTION

The goal of facilities engineering is to ensure that facility utility processes are routinely maintained while considering safety, cost, and time, to keep them as efficient and effective as possible. Facilities engineering encompasses many key components, such as understanding manufacturing facility designs, sources of information, material handling, Lean thinking and manufacturing, manufacturing goals, facilities design projects, and computers and simulations [1].

These concepts allow a facilities engineer to understand design processes, perform time studies, flow analysis techniques, activity relationship analysis, understand ergonomics, auxiliary services, employee services, material handling equipment, office and facilities layouts, and area allocation. This term paper will focus on Boeing's Everett Factory located in Everett, Washington. This Boeing-operated facility is an aircraft assembly plant that includes the world's largest building by volume, with over 472 million cubic feet. This complex sits on 1,000 acres and straddles both sides of State Route 526. The Everett site employs 30,000 workers spread across three shifts. The main assembly building covers nearly 100 acres and is split into 6 main production lines. The production lines move at 1.5 inches per minute and are guided by 26 overhead cranes suspended along roof trusses that move along 31 miles of track.

The facility also contains a network of tunnels spanning over 2 miles beneath the facility's floor for utilities and workers. The finished product is towed from the assembly facility to flight line facilities at night to avoid disrupting traffic. Since its opening in 1943, the Everett facility has made changes to its main assembly facility, such as relocating engineering teams closer to the production lines. As well as creating new office modules within existing hangar space to reduce communication delays and streamline the flow [2].

II. PRODUCTS AND ASSEMBLY LINE

Boeing is best known over the last 50 years for manufacturing and assembling large commercial aircraft, such as the Boeing 767, 777, and 737 MAX. Because of the product's size, variety, and safety requirements, Boeing has needed to implement moving assembly lines, reconfigurable layouts, and inspection zones. When the Everett facility first opened, it supported a fixed-position flow layout due to the large size of the airliners and their components. In 2006, the Everett facility began efforts to establish a moving production line specifically for their 777 aircraft [3].

This line was implemented using tugs to pull the aircraft through the final assembly line. Boeing implemented this change because its Lean Manufacturing efforts at the Everett facility found that a moving line could significantly reduce waste while improving production and quality. The director of manufacturing for the 777 airliner at the time stated, "In addition to productivity and quality improvements, the new production system enables greater involvement and support of the people who build the airplanes". Boeing produces different models, such as the 787, 777X, and 737 MAX, that vary in size, interior, capacity, and purpose. Because of this, the Everett facility needs to be adaptable to make changes in parts manufactured, assembled, and tooling needed to work with different materials. For example, the 787 line was converted into the 777X Airline over the course of 2014-2018. The 777X Airline utilized carbon-fiber composites for the center of its wings.

Because of the new product, the Everett facility needed to make many accommodations to support the new airline, add a new building to the campus so Boeing could manufacture its model-specific composite wings on site, and then implement them onto the final assembly line. Boeing has many quality assurance standards and procedures throughout the corporation to ensure compliance with Federal Aviation Administration (FAA) requirements. The Everett facility's Quality Management System (QMS) implements quality zones that inspect wiring connections, hole dimensions and locations, fastener torque, and parts requirements to meet Boeing's standards [3][4].

For example, to inspect the gaps between panels, mechanics use a thin electronic ribbon to measure the distance between the panels of 120 bolts. The tool connects to a computer that then records the data. A precise shim is used to fill each gap based on the data values obtained by the tool. Previously, mechanics would use physical gauges of various sizes and record the closest fit. This quality tool improves the accuracy of this inspection and reduces the time required to perform the check. Despite the facility's size and the products, the Everett facility still incorporates Lean manufacturing through moving assembly lines and line

configurations, and Quality Assurance (QA) using quality tools [5].

III. Service Flow

Every facility has receiving, service (fabrication, manufacturing, assembly), and shipping departments. The Everett facility is responsible for receiving components and components from suppliers and vendors. Once airplane model components are received, material handlers ensure that each assembly line receives the correct components at the correct workstation. Mechanics then use tools and equipment to assemble the components onto the aircraft. Once the airline model is assembled and all QA inspections are complete, the product is shipped to the customer [6].

The Everett facility directly receives components from suppliers via a just-in-time (JIT) system. Materials are transported by truck and train, then moved throughout the facility using custom transportation carts. The carts are delivered directly to the installation points, such as the wing assembly area, reducing the need for mechanics to travel and saving time. These carts facilitate the flow of services and products between departments. The Everett facility implements a “nose-to-tail” method where large subassemblies are manufactured and assembled, then transported and assembled onto the main assembly line. For example, Spirit Aerosystems in Wichita, Kansas, is a key Boeing supplier, manufacturing the fuselages for the Boeing 737 MAX jets [7]. By having the fuselage assembly work done by the supplier. The Everett facility must only install the fuselage onto the airliner, and then all the interior components. This improves the assembly flow for the 737 MAX assembly line and other models with various other large subassemblies. After quality inspections and rigorous testing, the airline is then ready to be shipped to the customer.

Before 2012, the shipping process involved towing finished aircraft to a “flight line,” then towing them across the Boeing freeway at night to minimize traffic disturbance. In 2013, the Everett facility constructed the Everett Delivery Center (EDC) [8]. This center improves customer service by allowing customers to more easily pick up the aircraft directly from the facility. The facility can also conduct ceremonies if the customer wishes, without disturbing other processes. By utilizing auxiliary services, Lean thinking, and workflow analysis. The Everett facility can conduct efficient assembly processes and make informed decisions through material handling equipment, supplier relations, and process improvements, thereby sustaining good product and material flow throughout the facility [8][9].

IV. Employee Friendliness

Boeing offers many employee services to their workers, including healthcare and insurance benefits, financial services, and career benefits. These services provide physical and educational assistance to employees. Boeing provides comprehensive health and insurance benefits to protect employees and their families from high healthcare costs. Employees at the Everett facility can receive cost coverage for medical expenses, prescription drugs, dental, vision, disability, and more [10].

Keeping employees and their families healthy fosters a loyal, compassionate relationship between employees and the company. Employees will be less likely to leave the organization if they feel valued and receive benefits beyond a paycheck. The company also offers financial services. These services include personalized investment advice, retirement check-up, budgeting, professional management, annuities, and student debt management. This service benefits both new and retired employees by helping them navigate budgeting and debt management, thereby lowering turnover and reducing training costs [11].

Boeing also offers tuition assistance through their Learning Together Program (LTP) to help employees to learn and improve their skills through higher education [12]. The company will pay tuition expenses toward individual courses, certificate programs, and degrees. Boeing will also provide up to $25,000 per year for graduate degrees related to science, technology, engineering, and mathematics. This provides employees with opportunities to advance their careers within the company and strengthen it, as they learn and develop new skills that will be valuable to the company. The services the Everett employees receive demonstrate that the organization provides real care for its employees, building positive relationships and fostering their development in both education and life [13].

V. Material Handling Methods and Equipment

The Everett facility uses a variety of material-handling equipment and methods. Equipment such as carts, forklifts, scissor lifts, cranes, and material lifts is all used. Methods involve Lean practices such as 5S, Kanban, and Kaizen to improve efficiency and reduce costs. The Everett facility produces the 777X wing, which is primarily made of composite materials for the next generation of Boeing aircraft. Large aircraft bays with two floors are used to manufacture and assemble the composite wings.

To improve the efficiency of moving food and other cargo between the first and second floors, Thyssen Krupp Elevators designed and installed a custom material lift. The Matot Model 840 Material Lift is forty-eight inches wide, 72 inches deep, 72 inches tall, and has a 1200 lb. capacity. This lift saves time and energy by allowing material handlers to easily transport pallets, carts, and boxes between the two floors in just 20 seconds [14].

The Everett facility established a Lean Office to analyze current practices and identify potential Lean opportunities across the facility and its manufacturing processes. The 777 assembly line established its own Critical Process Reengineering (CPR) group, focused on implementing Lean improvements to the 777 aircraft line. The CRP created a “Link the Flow” workshop to analyze the shipping for 777 floor grid components. Previously, Boeing would ship the floor

grid by truck from Tulsa to Kansas City, then transport it to Seattle by rail. From Seattle, the floor grid would then be transported by truck to the receiving and inspection teams at the Everett facility.

The workshop's new delivery method now has trucks transporting floor grids from Wichita to Tulsa, along with other floor beams, and delivering the complete set to the Everett facility for use. By implementing the new delivery system, Boeing was able to $7,900 per shipset or $396,000 in annual transportation costs. Reduce floor grid inventory by 25% with each shipping set using 50% less transportation. The Everett facility uses large cranes to move 767 and 747 wing assemblies. Previous wing operations had up to three sets of 767 and 747 wings in work using the cranes at a time. Lean efforts reconfigured these sealing operations into two moving lines, for 767 and 747 wings. This reduces the wing seal process down to four wings receiving work at a time. Making these changes reduced the number of flow days from 13 to 6 for the 747 and from 12 to 6 for the 767. Reducing the required crane moves from 7 to 5 to reduce costs. Lastly, reducing chemical spread from throughout the facility with fewer wings in operation. By effectively utilizing the equipment with lean practices. The Everett facility can cut costs and inventory, and reduce overall waste.

VI. Office Provisions

The Everett offices are located between manufacturing lines to easily oversee final assembly processes while managing logistics and processes for producing aircraft. While there's no public information on the Everett facility's office layout, the textbook states that most office layouts are designed to support the flow of paper, information, and people. The Everett offices support operations related to manufacturing, engineering, shipping, receiving, product development, aviation safety and security, and quality control. Much like the office provisions, there is no publicly available information on the time studies performed by the Everett facility. The textbook states that time studies are used from cost and budget allocation and control, production and planning, inventory management, performance and efficiency evaluations, and alternative methods of operation. As discussed earlier, Everett made significant changes to some of the shipping and crane operations. The changes were likely backed by numerous time studies and flow analyses [15].

VII. Facilities Engineering Successes

The Everett facility does an excellent job of thinking Lean, especially when it comes to process improvement. The 747 horizontal stabilizer project shows that the Everett facility is embracing Lean across all its manufacturing operations. Currently, the 747 horizontal stabilizers undergo a lengthy process, including being transferred to an environmentally controlled building ½ mile away for sealing, painting, and seal testing. The horizontal stabilizer is then returned to the main line for anti-corrosion treatment and final assembly. The Wing Responsibility Center (WRC) introduced the project to use small booths and other technologies to replace large-scale chemical and painting processes. The project was also to integrate these processes into a continuous manufacturing cell-based production flow. Implementing these changes would have resulted in a reduction from 16 to 4 flow days, from 31 to 8 crane moves, from 29,600 to 14,800 square feet in space requirements, and significant energy savings.

Despite all the benefits, the project was canceled due to the cost of moving everything onto the main line. Even though the project fell through, the example still shows how the Everett facility is always trying to make Lean improvements. The Everett facility utilizes many chemicals throughout the manufacturing process. Mechanics would have to travel to multiple chemical disbursement centers, known as "cribs," to pick up and return the chemicals required for the workstation, often including paints, sealants, solvents, and more. Reducing mechanical travel distance, time, distribution of hazardous materials, and controlling the supply use. Boeing's Safety, Health, and Environmental Affairs organization (SHEA), developed the "Point of Use" system for chemical materials. The new stations act as self-help areas that allow mechanics to pick up materials and return the waste at the point of use on the line. With over 120 different point-of-use chemical stations implemented, chemical use per airplane decreased by 11.6%, the amount of chemicals on the shop floor decreased by 23%, and C mechanic travel decreased by 56%. These examples reflect good facilities engineering principles, as they revolve around Lean thinking and manufacturing, resulting in process improvements and the elimination of excess costs and waste.

VIII. Areas for Improvement

While the Everett facility does many things right regarding process improvements and layout designs, there's room for improvement in quality assurance, safety awareness, and union relations. A signal incident puts all three issues on display. On January 5th, 2024, a door plug panel blew out midair on a Boeing 737 Max aircraft. The event garnered lots of media attention and the National Transportation Safety Board launched an investigation into the incident. The investigation found that four key bolts were missing from the assembly when the airline left the Everett facility. The FAA audit found problems in Boeing's manufacturing process control, parts handling and storage, and product control. As a result, Boeing had 90 days to develop a plan and address quality control issues. This event caused significant problems for the company's image and exposed a serious issue with QA at the Everett facility [16].

Following the scrutiny of the aftermath of the door panel incident. Major safety concerns were raised at the Everett facility regarding employees' inability to demonstrate safety culture efforts or the purpose of procedures. With reports of use of the internal

whistleblower portal being up 500% compared to the previous year [17]. Reports from one anonymous mechanic state that Everett management is in “panic mode” as they learn that fewer mechanics know what they should be doing than those who don’t. This report shows severe deficiencies in critical safety awareness among managers, inadequate training for mechanics, and other safety violations. The lack of communication with union members raised safety concerns, contributing to a strike by 33,000 mechanics in September 2024 [18]. While more complex issues were the root cause of the strike, they were definitely considered by employees. This strike lasted from September to November of 2024, during which the Everett facility produced no products. In attempting to resolve the strike, the corporation would go around the union leaders with public offers, making agreement on a resolution more challenging. Eventually, a resolution was reached; however, it may have been found sooner had the corporation had better communication and relations with union leaders. I think that in Everett's effort to think Lean, they cut too far back, which caused quality assurance weaknesses that led to the door panel incident. That incident led to internal audits and investigations, which revealed gaping training issues and safety concerns that hindered having positive relationships with employees.

IX. Facilities Engineering in Society

Facilities engineering plays an important role in modern industry, as organizations must operate with ever-increasing efficiency and leverage technological tools. Global competition pushes companies to continuously optimize, and facility engineers must ensure that buildings, production environments, and support systems run reliably and cost-effectively. Sustainability has also become a major factor, as corporations are under pressure to reduce energy use and lower emissions.

Facilities engineers design and manage systems that reduce resource consumption and meet environmental regulations. With advances in automation and smart facilities, facility engineers must ensure that the infrastructure supports these technologies. Facilities engineering has evolved from routine maintenance to a strategic function that enables corporations to compete and innovate across modern industries. In the early days, manual shops relied on craftsmanship and used simple tools. The Industrial Revolution saw the rise of factories and introduced new challenges that required more systematic planning and engineering oversight. Lean manufacturing principles later emphasized efficiency, waste reduction, and streamlined workflows. The current era of Industry 4.0 has expanded further into integrating smart systems, automation, IoT connectivity, and data-driven decision-making.

X. Conclusion

The goal of facilities engineering is to ensure that facility utility processes are routinely maintained while considering safety, cost, and time, to keep them as efficient and effective as possible. Boeing's Everett facility faces many challenges with the size and scope of its products. While they are not perfect, the Everett team does a great job practicing Lean by continually seeking to improve efficiency and reduce costs. However, they also demonstrate the consequences of taking it too far, and that could impact quality. The Everett facility provides a great look into solving complex problems through tracking material flow, quality control, and continuous improvement.

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