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Abstract

This paper discusses the industrial design influence on today's flight deck design process.

Today's pilots are highly trained and skilled individuals who have a tremendous amount of responsibility for their crew, passengers, and operation of the airplane. The pilots' work environment has become a consideration in today's commercial flight deck design because of the increased length of flights, increased number of duty cycles, and increasingly complex air traffic situations. These and other factors require that today's flight decks not only use advanced technology, but also create an "ideal" work space for the flight crew.

Industrial Design plays a significant role in creating this ideal environment for the pilot. The interior of the flight deck should increase comfort, bring order to a complicated and confined area, be aesthetically pleasing, and designed so that controls and instruments are placed at the optimal location for efficient operation.

Industrial Design focuses on the pilots' needs by taking into consideration design criteria such as human factors, aesthetics, and comfort. Overall, Industrial Design functions as an interface between the pilots and the design engineers by recommending materials, manufacturing techniques, colors, and shapes to incorporate the pilots' requirements and improve the overall design concept.

Introduction

Increased competition among world airplane manufacturers and longer flights have caused manufacturers to look more closely at developing better flight deck interiors. The Boeing 777 airplane is a vivid example of an aesthetically pleasing, functional and comfortable flight deck interior. Every component in the flight deck integrates well to make the interior look uniform. Close attention is paid to aesthetic detail, for example, as in the design of the glareshield. The glareshield flows continuously while contouring over the main instrument panel and fairing into the two side windows. (figure 1) It should be noted that the glareshield does not stop at the window frame; it continues into the windows, wrapping and molding them to blend into the upper linings, side walls, and side consoles.

Also worthy of mention are the smooth and soft curvatures of the overhead lining. Few seams are used in the overhead and the pockets for lighting have been designed to enhance the overhead without protruding from the surface.

The 777 flight deck is further enhanced by its nicely shaped forms and eye appealing convenience items such as the smooth and rounded

shaped rudder pedal housing. The housing is located underneath the main panel forward of the column and is made for the feet to rest on top of as well as to hide the rudder mechanisms.

The pilot area includes two functionally contoured cupholders per side, one forward and one aft of the pilot. One cupholder can be used for a can beverage and the other for a cup. The aft cupholder design provides an easier location for the flight attendant to set down beverages without disturbing the pilots.

Padding is carefully included in the interior where it is needed, especially around the knee areas of the aisle stand and on the bottom edge trim of the main panel. Padding has been designed into the interior for protection of the knees and for the feet to rest on while shielding the edges from scraping. Padding is also added around the edges of the overhead panels to help protect the head.

Stowage is in high demand in the flight deck especially for suit cases and manuals. The 777 flight deck includes more stowage areas than any other commercial airplane. The manual stowage areas are designed to be within reach of a pilot or an observer and allow stowage of U.S. and European standard paper sizes and notebooks. The suitcase stowage areas allow suitcases to be tucked out of the way of the pilots' and observers' path. There are currently two areas for suitcase stowage in the interior: one suitcase can be stowed in the closet on the left side and two more can be stowed in the designated suitcase compartment located next to the closet. All stowage compartments are integrated into the flight deck interior to enhance the overall look without cluttering the work space. (figure 2)

Another convenience item is the observers' console located between the observer seats. This console houses oxygen for the first observer and two molded cup holders. The upper forward surface of this console encases a sleek fold-out tray and writing table for the second observer. Manual stowage is provided at the bottom of this console. (figure 3)

The 777 flight deck interior has incorporated provisions for an Electronic Library System (ELS) located in the Captain's and First Officer's side consoles. The ELS displays created a starting point for location of the forward consoles. The location of the ELS displays involved extensive evaluation of the viewing angle, height and orientation, plus coordination with the pilots.

The 777 flight deck has incorporated simpler blended contours and softness resulting in an improved streamlined appearance. The industrial designer plays a key role in developing a better flight deck by getting involved in the early stages of design.

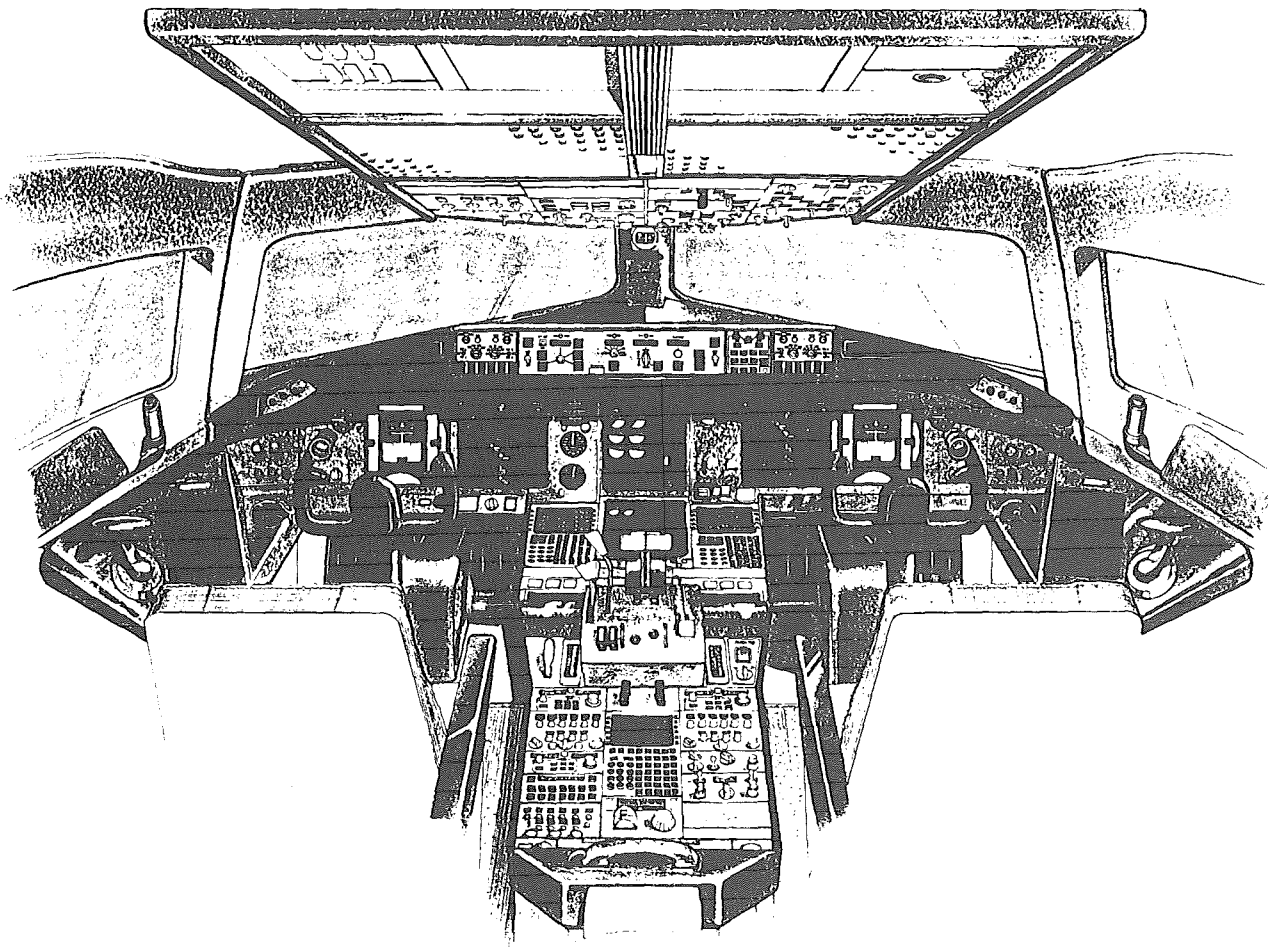


FIGURE 1. Rendering Of Glareshield Area

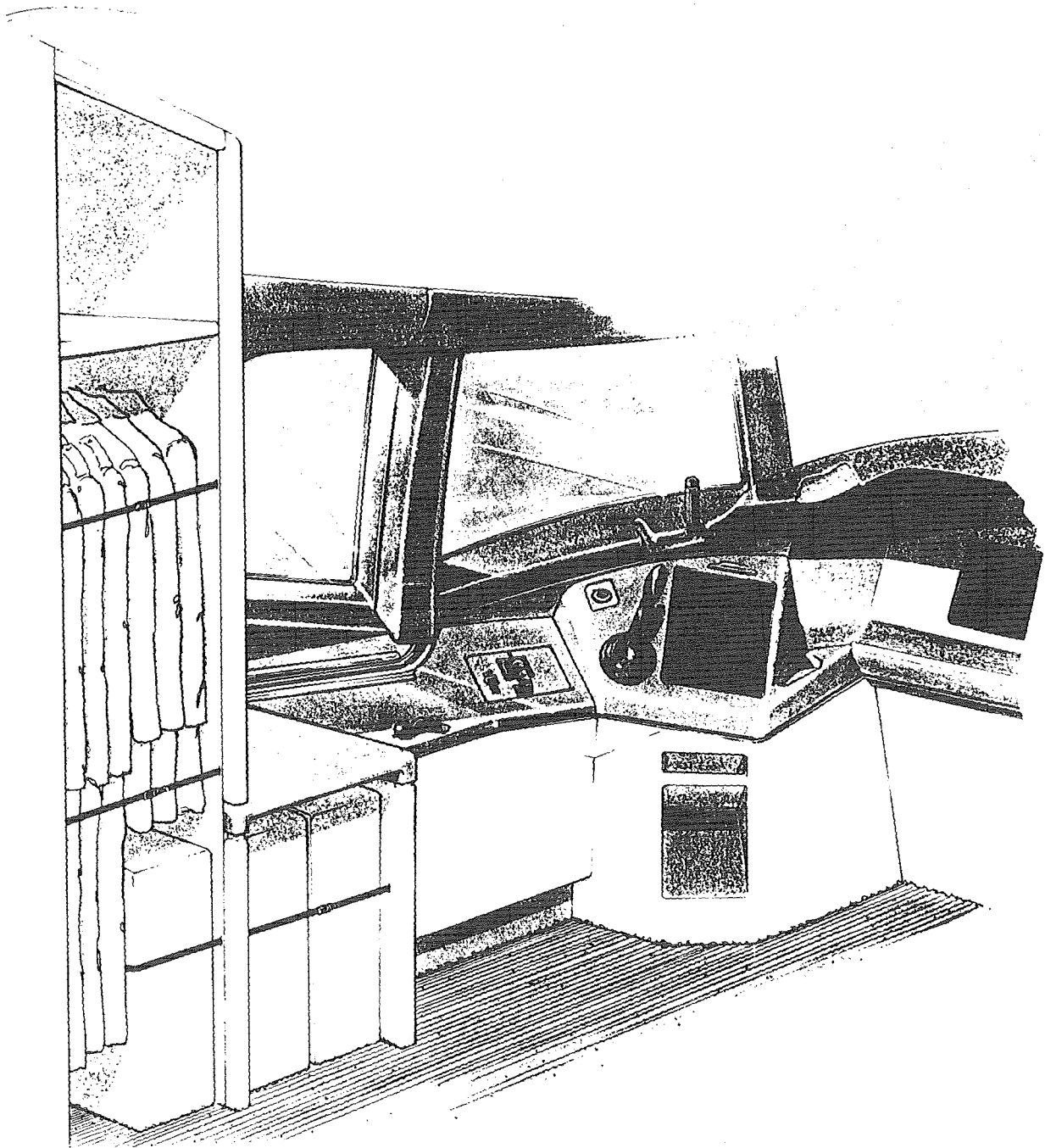


FIGURE 2. Rendering Of Coat And Suitcase Area

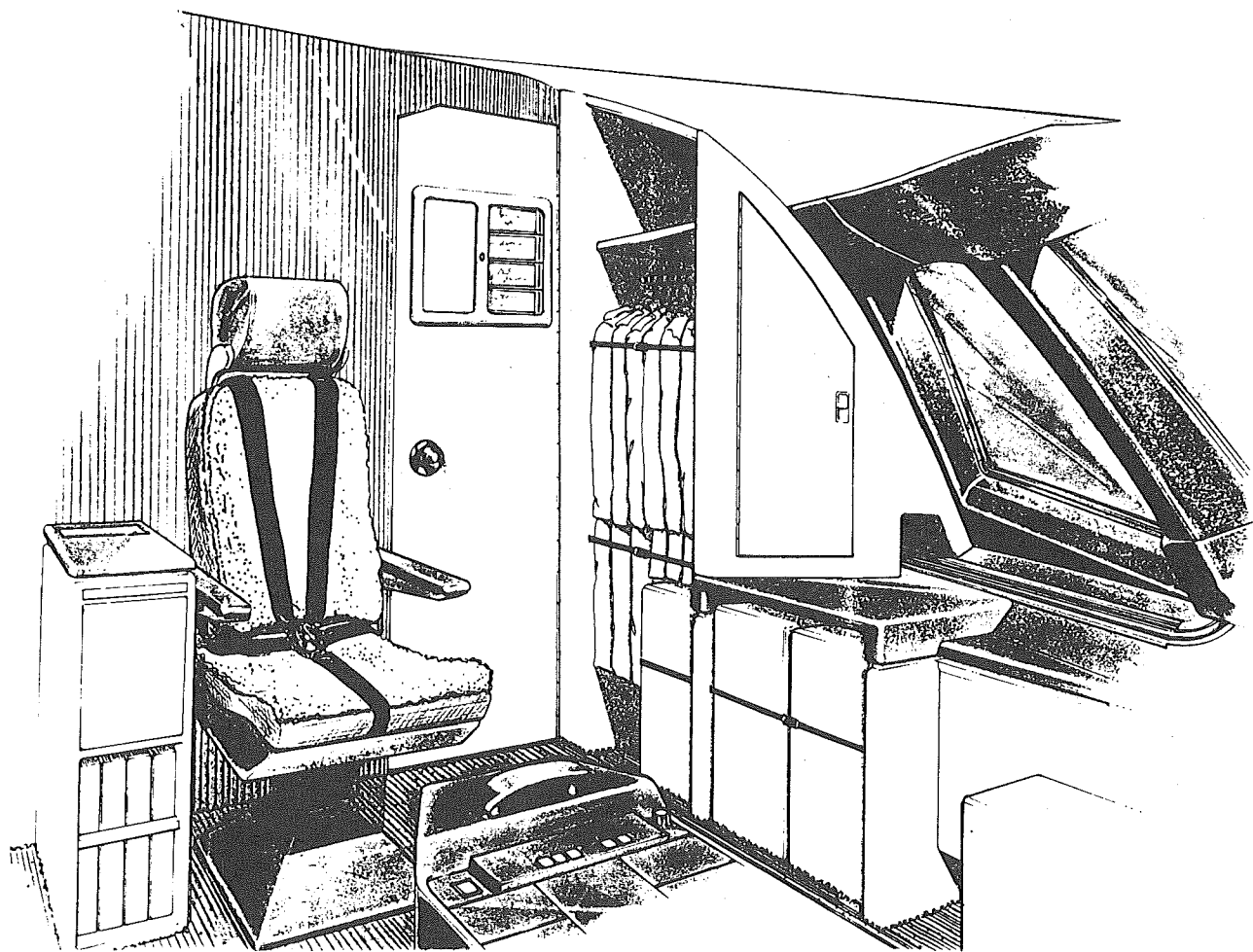


FIGURE 3. Rendering Of Observers' Console

To ensure a successful flight deck design, Industrial Design concentrates its efforts, particularly in the early stages of development, on communication, planning, comfort and visual effects. The industrial designers conceptualize flight deck layouts better than most engineers thus providing the overview/integrated perspective drawings required before the engineers develop the details. To ensure that the interior fulfills the pilots' needs, open communication, careful planning and phased development are required.

Communication

Good communication and "critical feedback" are important tools in dealing with the customer. To develop a modern flight deck, as on the 777, the industrial design team observed pilot flights to enhance their understanding of how pilots interface with the flight deck. The team also climbed onboard many different airplanes to disassemble/reassemble flight deck components and to study how the interiors are put together, different materials being used, and how comfort, convenience, and aesthetics can be improved. The team visit auto shows to view the latest styling and technology that are being used in today's vehicles. The most important lessons learned came from past designs and listening to the customer.

A valuable new communication tool is the Computer Aided Three-Dimensional Interactive Application (CATIA) system, a sophisticated computer-aided design package. CATIA is a great concept development and communication tool between Industrial Design and Engineering. Industrial Design uses CATIA to show ideas, how they think a product should look and function, and to provide the engineers a common base for feedback on structure and function of the design.

CATIA contains many programs to help design products with greater efficiency ranging from computing weight and stress to human factors and aesthetics. Reachability data for a 5'2" through 6'4" pilots can be obtained easily from the CATIA models. (figure 4) Human models can be used to rapidly check for interferences between the design and the pilot(s), i.e. various size body structures and movements. Another useful communication tool within CATIA is Kinematics, which enables movable features, such as a window frame, to be opened/closed and easily checked for interference with the interior linings. (figure 5)

CATIA also increases productivity by allowing multiple designers to simultaneously work on a design through different computer work stations. An industrial designer and an engineer can both be working on the same design but on separate computer terminals. CATIA allows the industrial designer to refine form while at the same time allowing the engineer to calculate stress loads of the same general design.

Flight Deck Development Process

Good organization and communication is essential when working with numerous design engineers. To define roles and responsibilities, a three-column list was developed: the design item,

the engineer, and the industrial designer. The industrial designers need to clearly identify who will be working on which design item and who needs to interface with each other so that the design will come together in a timely manner. Industrial design usually plays the role of a middle man or a liaison working with engineers and linking them to other designers. The optimum design is provided by a team effort, and has a uniform look instead of looking like a multitude of non-integrated separate designs.

Planning

The initial step in industrial design is product planning. A two phase plan was developed: concepts and detailed design. A schedule was then defined for each design phase. The schedule helps determine staffing and length of time needed to develop each concept/design.

Concepts

Data must be collected from lessons learned, past flight deck designs, customer inputs, and from detailed evaluations of other flight deck manufacturers. When enough information has been collected on a design project, concepts are then generated on paper usually in sketch form. Through the sketches, form and colors are developed, and different textures and materials are specified to achieve the overall look. It is important to keep in mind that the industrial designer must concentrate on function before form.

Sketches should always be signed and dated because they provide documentation of design development. In the future, they may have great importance for review and patent purposes, plus they provide an excellent way of tracking decision making.

The sketches were discussed with the design engineers. A few were then selected to be drawn in CATIA and mocked-up in foam core or other suitable material such as styrene. The CATIA renderings allowed the team to view each design in three dimensions and check for function, aesthetics, proper fit between components and measurements. The CATIA renderings provide technical information and are far more accurate than just an artist's conception. With CATIA's help, industrial designers can present a rendering that shows clearly how a design will actually fit and look in the flight deck area.

The sketches, CATIA renderings/drawings and prototype models were studied by engineers and members of the Design Build Team, (DBT) which consists of people from all affected technical and business disciplines. While the DBT studied the weight, material, and manufacturing requirements of each sketched concept, the shape was refined to fit and integrate better with the other interior components. Finished drawings or renderings were often necessary for management and customers to visualize and understand the proposed design.

The flight deck mock-up lets the industrial designers see how the design integrates with other components of the interior, and at the same time check for tolerances, interferences, and human

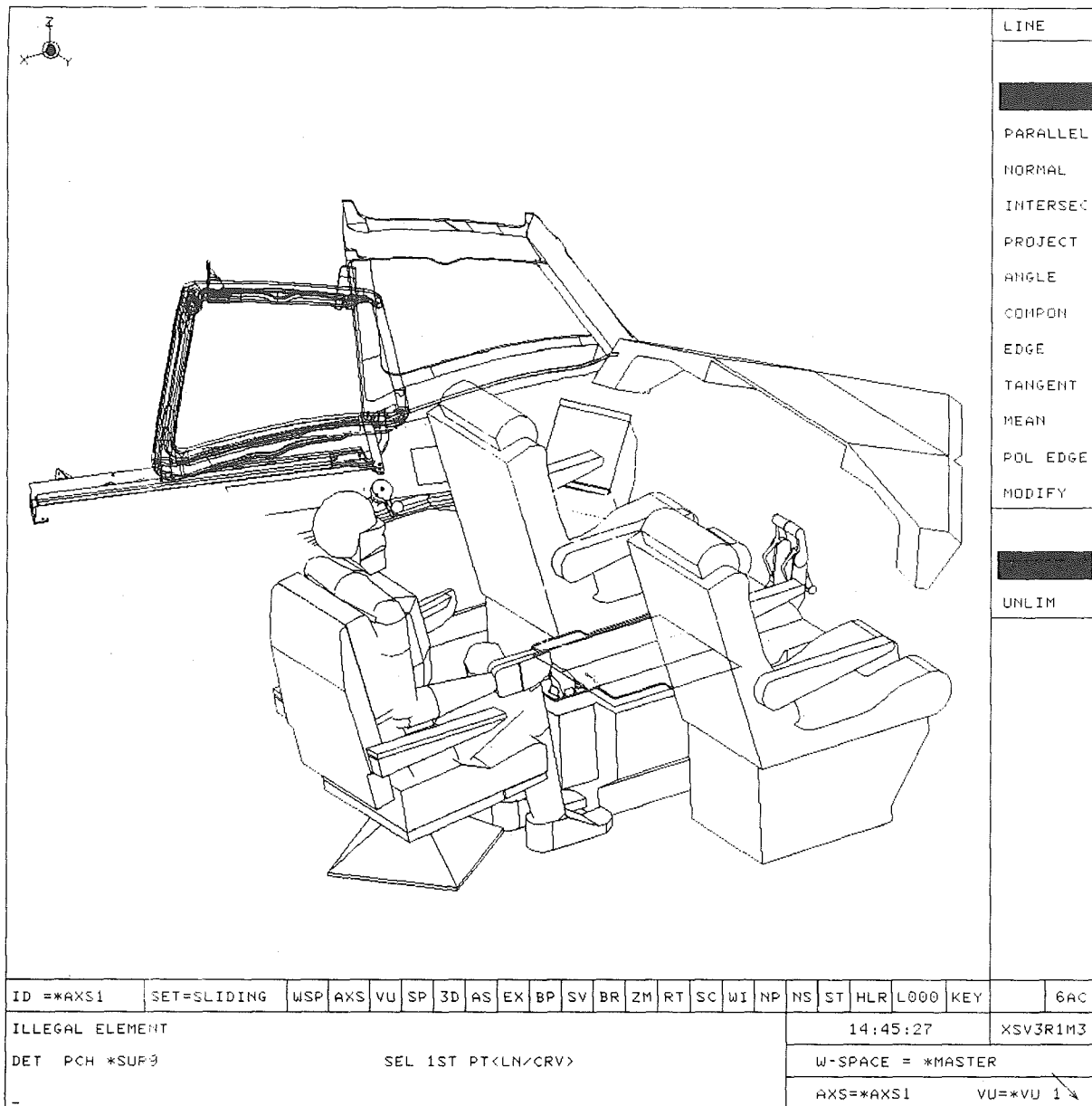


FIGURE 4. CATIA Picture Of Human Model

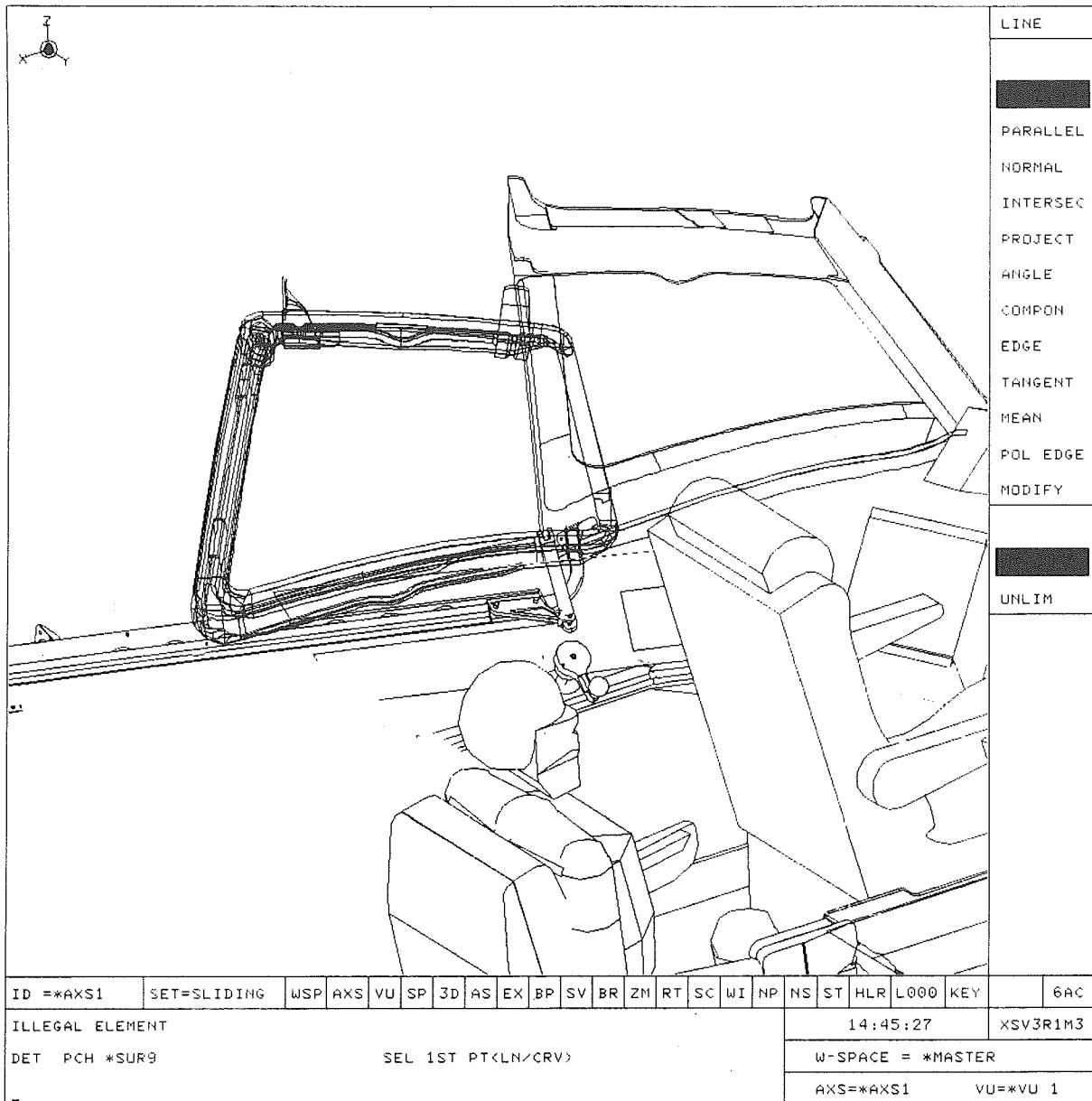


FIGURE 5. CATIA Picture Of Kinematics Being Used

interface. This phase is critical because it enables the industrial designers to communicate directly with the customer. Is it pleasing to look at? Do they feel comfortable? Does it meet their requirements? For example, is the amount of stowage area sufficient and is the closet wide enough for six coats? (figure 6)

Detailed Design

In the last design phase, detailed design, more attention is paid to manufacturing the product and issues such as cost effectiveness, ease of manufacturing, color, and form refinement.

Comfort

The industrial designer's goal is to design the interior so that it is visually pleasing to the eye, inviting and comfortable for the pilot to want to sit down and fly. These standard goals are a measurement of quality and consumer awareness. Comfort is a part of quality and consumer awareness and cannot be compromised in the flight deck; it is a critical item for the efficient operation of a pilot. Stress can limit a pilot's physical and mental capabilities.

Industrial design recognizes pilot seating as a major comfort and stress design item that needs attention. A good seat design will prevent harmful stress, discomfort and fatigue on a pilot.

In researching seat comfort, sheepskin and lumbar support adjustments were found to be the most beneficial for the pilot. The 777 pilot seat is designed with sheepskin on the seat and back areas and was found to provide additional cushioning where it is needed, especially around the thigh and back areas. Sheepskin is known to help absorb perspiration, relieve pressure points on the body, and improve air circulation around the seat and back areas, all contribute to enhance comfort. Air travels laterally in sheepskin, therefore maintaining a moderate body temperature all year around, keeping the pilot warm in the winter and cool in the summer. The lumbar adjustment added to the seat was found to increase lower-back comfort of the pilots.

Visual Effects

Out of the five senses (sight, hearing, touch, smell and taste), sight is the most important sensor for an industrial designer. Sight informs us of the world in color and form. Industrial design finds soft curvatures most appealing to look at as well as to touch whereas boxy, angular forms are found less inviting and desirable.

A color study conducted by Boeing's human factors specialists determined that warm colors relaxed and stimulated the mind for better concentration, alertness and mental activities. In an environment that demands alertness such as the flight deck, industrial design has adopted the warm colors. Color is also one of the best economical and practical ways to accomplish a change to an interior without adding significantly to design or manufacturing cost.

Dark brown, medium brown, and beige colors

were chosen for the 777 flight deck interior primarily for their warm tones. The dark browns are applied to areas that must be dark with a minimum amount of reflection such as the glare-shield and around the front windows. Medium brown was chosen for all control and maintenance panels that needed to be easily seen. Beige is used on the side wall panels, ceiling and wherever light is desired. All the color applications also took into account the "wearability" factor. For example, the coffee cup and feet placement areas are medium brown to hide coffee stains and dirt.

Attention to light, reflectance and color hue are extremely important to create a long-term comfortable and aesthetically pleasing environment. Thus floor lighting was added.

The 777 flight deck interior was carefully designed for uniformity and to ensure that each feature complimented all others. A clean appearance is provided by minimizing exposed fasteners and integrating all designs to look uniform throughout the entire cab. Joints were designed to overlap and hidden. The 777 flight deck was designed so that all parts fit better and compliment each other while enhancing the aesthetics. (figure 7)

Conclusion

With the help of Industrial Design, the new Boeing 777 flight deck will be an "ideal" work environment. The interior will be comfortable, aesthetically pleasing, bring order to a complicated and confined area, designed so that controls and instruments are placed at the optimal location for efficient operation, and be human oriented.

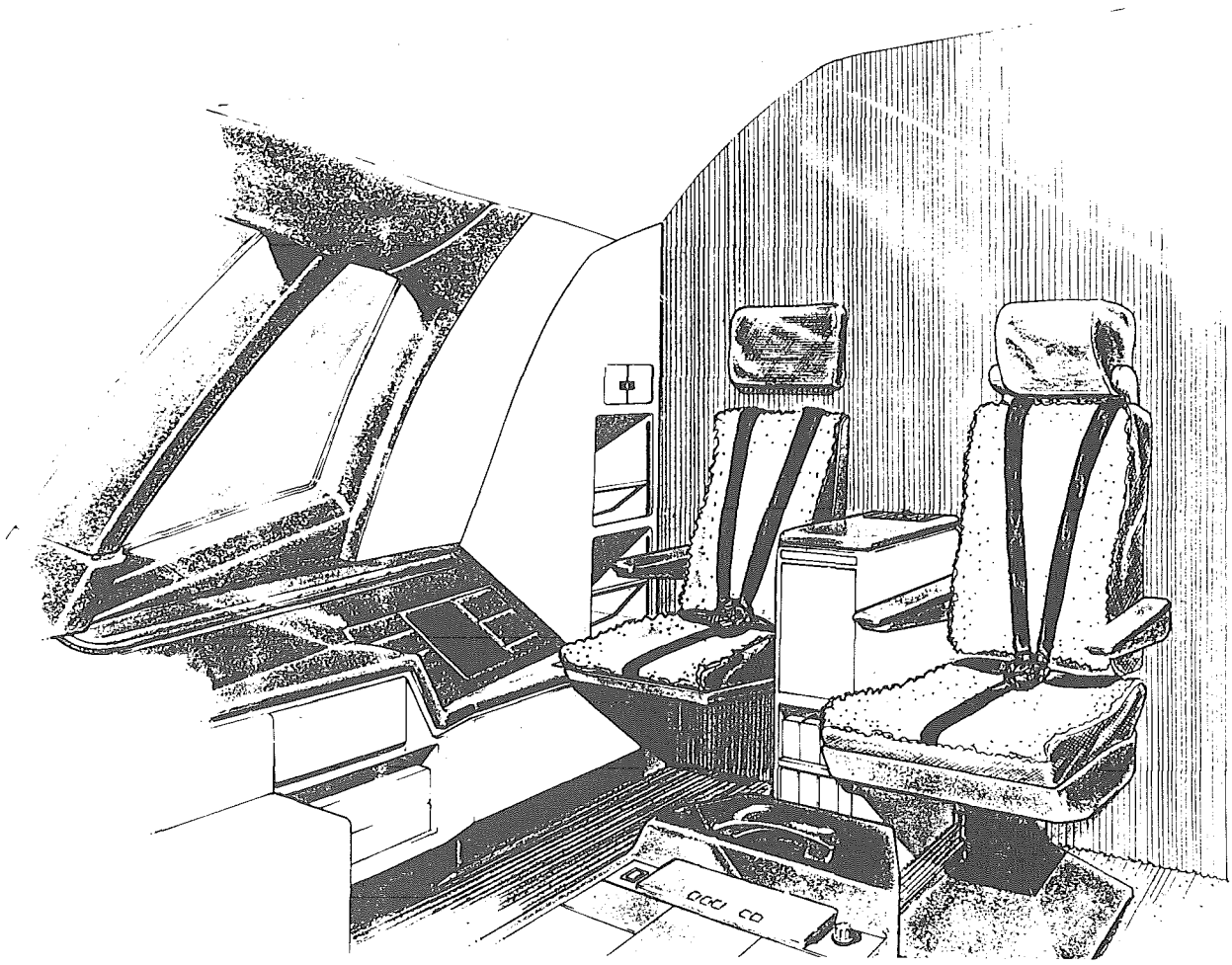


FIGURE 6. Rendering Of Observers' Area



FIGURE 7. Photo Of The Overall 777 Interior