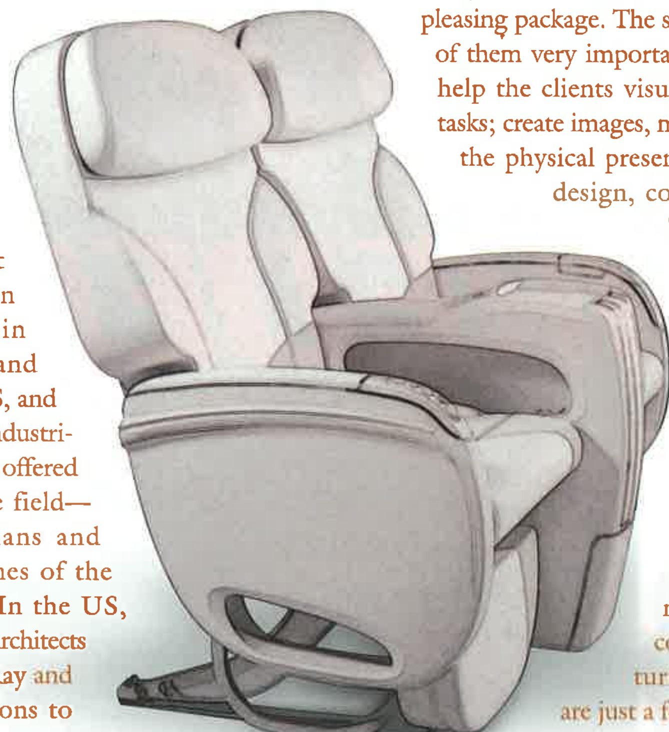
INDUSTRIAL DESIGN FOR AVIATION & IFE

design

By Wallace A. Peltola

The word "design" is derived from the Latin designare "to mark out" and is the process of developing plans or schemes of action. That very broad definition could include a president's plans for his company's success, a graphic designer's layout of a page, a fashion designer's sketch of a dress, an architect's design of a building, or one of the most sophisticated design sub-cultures, the field of industrial design. Design is a field that began to come into its own in the 1930s, originating in Germany and Switzerland and expanding into the UK, the US, and later, throughout most of the industrialized world. Each country has offered its own unique aspect to the field—from the flair of the Italians and French to the clean pure lines of the Scandinavians and Asians. In the US, Raymond Lowey and designer/architects like Frank Lloyd Wright, and Ray and Charles Ames are familiar icons to industrial design.



Industrial design is normally associated with designing products produced by large-scale industry for mass distribution and specialized usage. Compared to engineering design, it usually (but not always) involves a product related to the human form. Industrial designers organize the physical elements of a product into a user-friendly, functional format and encase them in a visually pleasing package. The seven senses are put into play, all of them very important to a successful design. They help the clients visualize their goals; evaluate the tasks; create images, models, and mockups to evaluate the physical presence; and specify the enclosure design, colors, materials, and textures. The goal of industrial design is customer satisfaction for both the client and end user.

Industrial design's basic precepts of form and functionality remain constant, but there are many other factors that affect the disciplines of today's industrial designers. Factors such as the constant emergence of new materials, changing fashion and color trends, and new manufacturing techniques and processes are just a few. There's no one product that can fulfill the needs of all users, but taking the needs of potential users into consideration in the initial design process results in a product that can be used by the broadest spectrum of users.

OXO's Ergonomic Ice Cream Scoop
Photo courtesy OXO International

ERGONOMICS

The relatively recent emerging science of ergonomics plays an extremely important role in industrial design. "The approach of human factors in design and engineering—ergonomics—is the systematic application of relevant information about human characteristics and behavior to the design of both the things people use and the methods for their use, and to the design of the environment in which people work and live." (Ernest McCormick, 3rd Ed, 1970.)

Ergonomics dictates that the interface between the user and the product is paramount. Is it intuitive? Can the user read the controls? Is it comfortable? Is it balanced properly? Does it efficiently accomplish the task required? Also important is understanding the task the product must accomplish.

A simple example of ergonomic design applied to a product can be found in a pair of scissors. Many early scissors consisted of two intersected blades with rounded, symmetrical loops for thumb and forefinger. The centuries-old design of a workman's tin snips is another example. More sophisticated designs involve ergonomically shaped handles that are molded to comfortably fit the human thumb and finger. The internationally recognized firm, OXO, has garnered a long list of industrial design and consumer awards for its wide range of kitchen, garden, and hardware tools. The tools feature large handles of a soft material easily gripped when hands are wet or strength is compromised. They're designed to be gripped in different places, to accommodate a wide variety of hand sizes, and to be aesthetically pleasing to the eye. They represent simple, good ergonomic design.

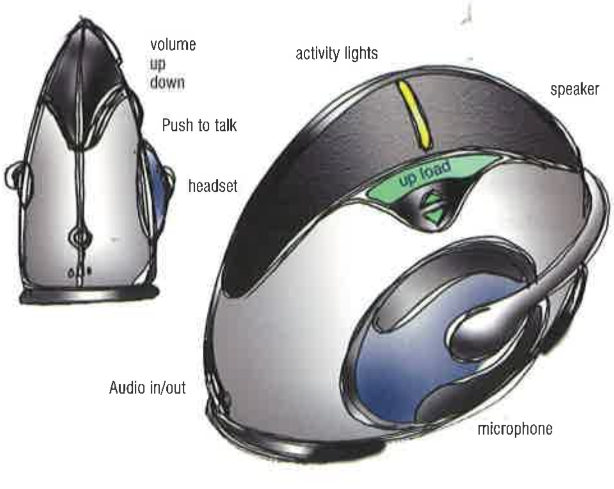
KEY FACTORS OF ERGONOMICS ARE:

ANTHROPOMETRY (Human Dimensions)
- Variation of population
- Size, weight
- Reach, physical space
- Standing and seating heights
- Sight lines

PHYSIOLOGY (Human Performance)
- Touch, feel
- Hearing, smell, vision
- Endurance, strength, and reaction

PSYCHOLOGY (Human Behavior)
- Cultural: Expectations, customs, and language
- Cognitive: Perception, interpretation, and knowledge
- Behavioral: Emotion, stress, and habits

ENVIRONMENTAL
- Lighting, color, and texture
- Space, shape, and size
- Temperature, vibration, and noise



Concept design for headset music upload and stowage device

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AVIATION & IFE DESIGN

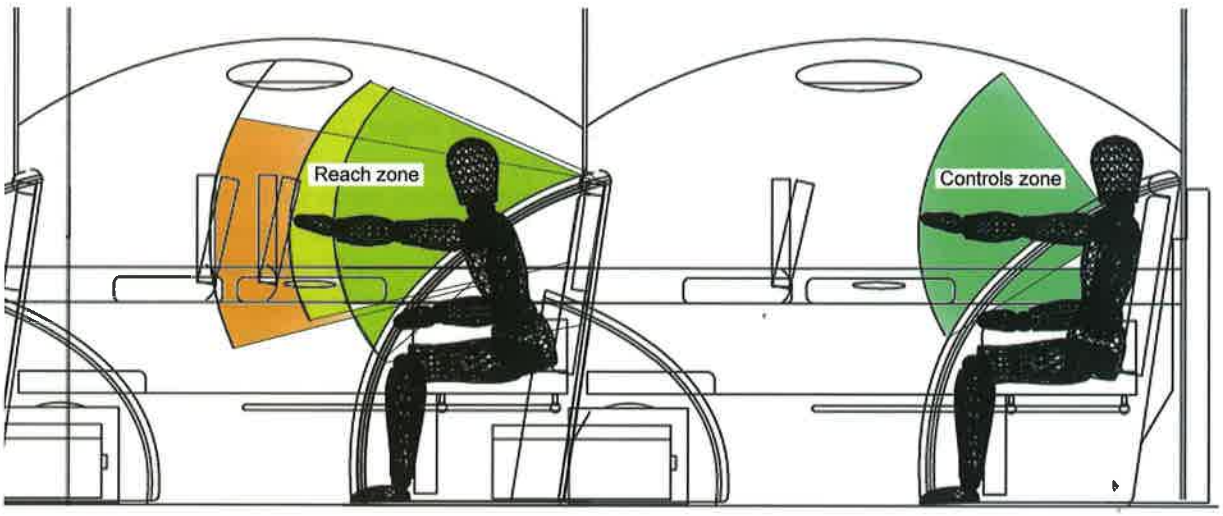
When something has to fly, it takes on a whole new set of rules, regulations, and restrictions. Add to that the aircraft environment and low production volumes, and a real design challenge exists. Traditional use of materials doesn't apply. The product must be lightweight, durable, fire retardant, and must pass severe load and CG requirements. A goal of aviation engineering designers is to maximize Mean Time Between Failures (MTBFs) and aviation industrial designers share that same goal. Space constrictions, hundreds of occupants as opposed to several, specialized accommodation to the aircraft environment, and a host of other variances apply. In many ways, designing for aviation and IFE is the most challenging and rewarding of all the industrial design areas. A thorough understanding of this environment is necessary to create a successful aviation product. Good aviation design must also take into account:

- Human factors
- Functionality
- Aesthetics
- Longevity
- Safety
- Durability
- Manufacturing
- Installation
- Ease of Maintenance

Those human factors and ergonomics are very important to the commercial aircraft industry because air travel is extremely people oriented. The aircraft and its amenities must be efficient and useful to passengers in different age, size, culture, sex, and ability categories. Also to be considered is locality, climate, and duration of flight.

The aircraft and IFE design environment is also influenced by socioeconomic trends. One example is the aging world population. Considerations must to be taken to accommodate this aging class when a Passenger Control Unit (PCU) or a hand-held IFE/telephony device is designed. Passengers who do not understand controllers or navigation systems are hesitant to ask for help and will do without.

Savvy travelers, however, are asking for real-time communications with speeds they are used to at their home or office. Wireless remote and satellite-based entertainment look like the next big step. Reduction of wiring and onboard components can add convenience and reduce fuel cost, while real-time information can also aid in medical emergencies.



Passenger sight and reach study for video LCD and seat controls (Phase I)

We have instinctively injected ergonomics into design, but today's design requires more in-depth research into passenger preferences, the environment, and task criteria. The result of these studies will guide the design of the product.

As mentioned, intuitiveness, touch, feel, and function are some of the basic rules. Ergonomics is evolving as we learn more about human interaction with products. How much force does it take to stow a video unit or deploy a food tray? On our firm's most recently introduced project (ANA First Class), the 15-inch video monitor was positioned at the precise viewing angle and all the controls located on one master panel. To minimize confusion, the graphics were subdivided, and only primary and emergency functions were made visible. The food tray floats effortlessly to the exact dining height from a stowed position in front of the passenger.

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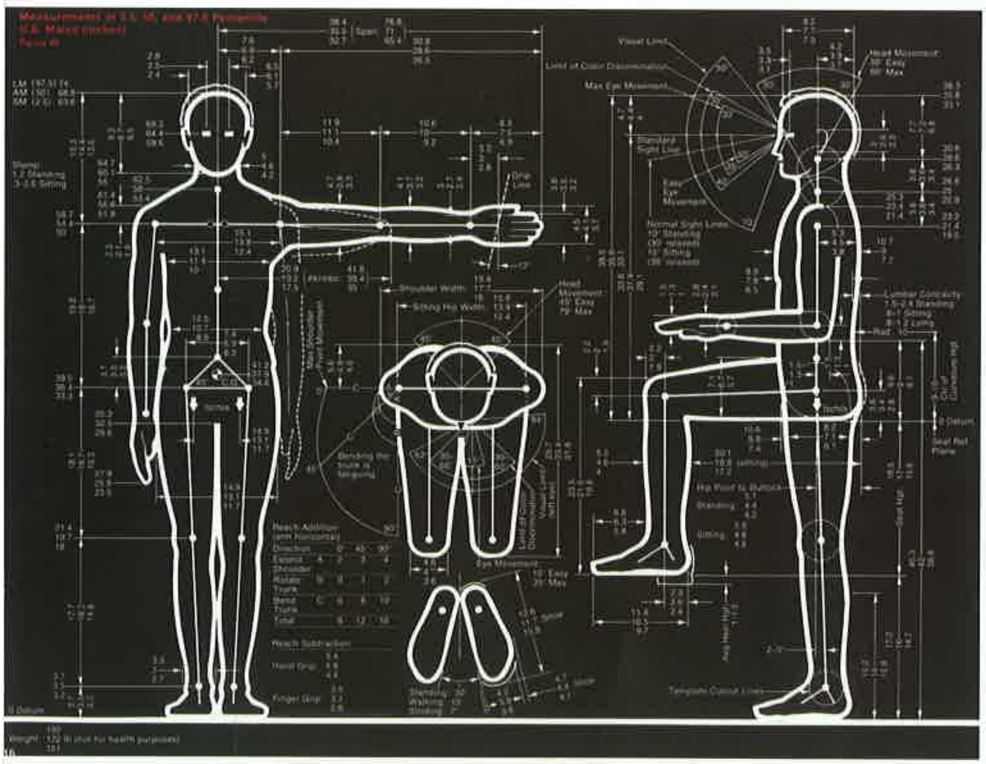
Functional prototype for the United Airlines/GEC Marconi LCD video monitor console and handset stowage

When we enter into the design phases of these projects, we use ergonomic guidelines like average skeletal size, body mass, comfort zones, etc. What are sources for these guidelines? For anthropometrics criteria we use publications like the Henry Dreyfuss human scale, Association for Advanced Medical Instrumentation (AAMI) manuals, office equipment standards, etc.



Typical Henry Dryfuss Human Scale layout (used for diminishing references)

There are also many associations like the Society for the Advancement of Travel for the Handicapped (SATH) and Simmons Market Research Bureau (SMRB) that serve as good sources for ergonomic guidance. Computer programs, such as Manikin, allow us to place the human body scaleinto preliminary CAD (Computer Aided Design) drawings for reach, site, and fit evaluation. New test equipment is available for body pressure and impact evaluation. Focus study groups help provide real-world input.

THE INDUSTRIAL DESIGN PROCESS

Design consultants work with a variety of clients and projects. Knowing all about everything is impossible, so there's a need to listen closely to those clients. They know the product best. The designer's goal is to understand the client's expectations, complement their internal capabilities, and apply the phases that are needed. A typical program can involve the following phases:

- R&D, market trends, and positioning
- Human factors investigation and task analysis
- Ideation/conceptual sketches, and preliminary layouts
- Ergonomics integration, design refinements, and color and materials
- Models and mockups
- Final design, specifications, and functional prototypes
- Vendor coordination and tooling follow-up

NEW TOOLS

CAD and CAM (Computer-Aided Design) have been of great assistance to industrial designers. Those high-tech tools are used to the maximum. Computers and their specialized software enhance our ideation sketches, build physical and virtual mockups, create photo-realistic images and walk-throughs, transfer data, and communicate efficiently with clients.

"Time to market" has inspired rapid prototyping systems such as stereolithography. This "Beam me up, Scotty" process is amazing. Briefly, 3D data is downloaded into a computer laser device. The data is sliced into fine layers. Each layer is solidified by the laser in a vat of liquid plastic one by one on top of each other until the object is created. After detailing, they can be used for appearance, fit and function evaluations (See sidebar article). Digital technology and many of the advances associated with it have presented industrial designers with a whole new bag of tools with which to tackle many problems. But, they are just tools. They enable the designer to more easily create the end product or service. The real tool is the human brain and its ability to imagine, conceptualize, and create. Creativity, coupled with knowledge and experience, isn't something that will be replaced by tools.

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STEREOLITHOGRAPHY

The fastest route from concept to reality is with solid imaging technology. Stereolithography allows almost any 3-D shape to be created that can be designed into a CAD program. Basic solid objects and objects with intricate cavities can be formed with the process. The only caveat is the need for structural integrity during the building process. Following that, the finished object can be drilled, painted, and in many cases, used immediately as a prototype or working item. The sophisticated system has many applications for designers, engineers, industry, and medicine.

What the designer can envision, stereolithography can reproduce in full dimension.

The stereolithography equipment consists of four major parts: a large tank filled with several gallons of a clear, plastic, photopolymer liquid; a perforated platform immersed in the tank that moves up and down as the layering process proceeds; an automated ultraviolet laser; and a CAD/CAM computer that drives the laser and the platform.

The liquid is sensitive to ultraviolet light, and when the laser touches the photopolymer, the polymer hardens. It's possible, by standing next to the apparatus, to actually see the forming object as the laser builds each layer.

The basic 3-D printing process goes like this:

- **A 3-D model of the object is designed in a CAD program.**
- **Specialized software horizontally "slices" the CAD model into thin layers.**
- **The printer's laser "paints" one of the layers, exposing the liquid plastic and hardening it.**
- **The platform lowers into the tank a fraction of a millimeter and the laser paints the next layer.**

Even large objects can be formed. A fully-formed wheel is pictured.

This is not a particularly quick process. Depending on the size and number of objects being created, the laser might take a minute or two for each layer. A typical run might take six to twelve hours. Runs over several days are possible for large objects.

The process repeats, layer by layer, until the model is complete. Once the run is complete, the object is rinsed with a solvent and then "baked" in an ultraviolet oven that thoroughly cures the plastic.

A working stereolithographed computer mouse and the finished product.

A RECENT EXAMPLE – ANA

Our latest project, the All Nippon Airways First Class, was filled with client and customer-driven criteria and ergonomic considerations. In this case, form and function followed ergonomics, comfort, and privacy. The goal from day one was to create the widest, most comfortable and private seat/bed in the industry. Our ergonomic studies mandated armrests that articulate in height by following the recline motion and then become part of the bed surface. This dictated a six-inch armrest while seated and a 33-inch bed for sleeping.

Driven by reach and task studies, several new design approaches were developed. The design challenge included redesign of an existing Sicma seat, integrating the MASC entertainment system, accommodating PC power, headphones, reading and floor lighting, and several passenger amenity items. All controls, including the seat, entertainment, phone, lighting and power, were located in a single command center. This unit was angled toward the passenger and located within easy reach from all seating and bed positions. The dining tray was located forward of the passenger under the video and floats effortlessly to the precise dining position. This also offers easy access in and out of the seat and eliminates lifting the dining tray. These and many other creative solutions came from the program. Team members included ANA, Jamco, Sicma, MASC, KID, and PGA (a personal reward was having my two sons, Chad and Jorgen, as part of the design team).

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New seat console for ANA First Class, (marketing mockup) introduced December, 2002

Dining table stows under the video counter and effortlessly articulates aft to the precise dining height. It can be simply be pushed forward for entry and exit from seat.

Scale model of the new ANA first class for marketing and engineering review

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IFE CHALLENGES

When the first video monitors were packaged into the ceiling of a Canada Air 737, a whole new way of thinking and a whole new industry had to be created. Existing video equipment wouldn't fly. It was never designed to endure the shocks of take-off and landing. It was never built to endure the temperature extremes of spending a day in an airplane parked on an airport ramp on a middle-eastern desert or frozen tundra.

The evolution from ceiling to under-bin to seat-back dramatically impacted the aircraft environment. IFE viewing angles, head strike, deployment, systems controls, equipment weight, size, and stowage all had to become important considerations. Even heat from the units created much concern. Today, new electronics are paving the way for super-flat, low-heat LCDs, thin lightweight controllers, and remote wireless functions.

IFE, like many evolving industries, has had difficult moments. Although the GEC Marconi program didn't come to fruition, it did set the standard for video deployment, handset design, and system interface. Each program builds on the past; we can't move forward without it. As we know fully well, the world of IFE and commercial aviation is constantly changing.

Most design programs are challenging; that's what makes them enjoyable. We feed on demanding projects. That's when we are at our best. The most enjoyable projects are when a program involves the designer as a partner and as part of a team. Each member is encouraged and allowed the spirited discussions and decision-making that inevitably occurs.

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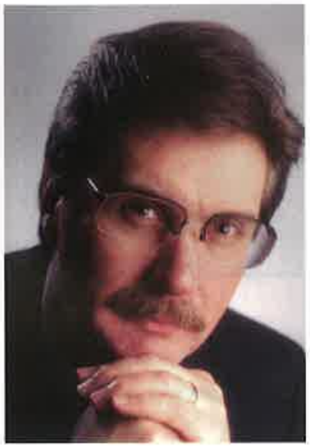

TOLA design

Wallace A. Peltola is Principal of TOLA design based near Seattle, Washington, and has a diverse background in transportation and product design. He has multiple years' experience in taking products from concept to production for industry-leading firms worldwide.

Starting this career at Ford Motor Design Center, Wallace's passion for development of three-dimensional forms and surfaces has carried throughout his career. He has worked as sculptor, designer, and director for both corporate in-house design and design consulting firms. He currently runs his own design consulting business, TOLA design. He holds a Bachelor of Fine Arts degree form Northern Michigan University and studied at the Center for Creative Studies in Detroit.

Wallace has been involved in the IFE industry for many years working with Boeing, United Airlines, ANA, MAS, and Jamco to name a few. From designing the first deployed seat console interactive system for United, to integrating the latest MASC system into All Nippon Airways' new First Class, he continues to be involved with leading-edge IFE design. Visit: www.toladesign.com *to learn more.*