

TRANSFORMING FLIGHT THROUGH USABILITY

A Better User Experience from Takeoff to Landing

Honeywell

Ease of use is not just nice to have in aviation design. It's critical for efficiency and safety.

Usability is a measure of how effectively and efficiently a product helps users achieve their goals. In aviation, where the human operator plays such a crucial role in safety and efficiency, system designers must keep usability top of mind.

That means always designing systems with an eye toward balancing what is helpful and what is distracting, especially in the cockpit. For instance, in making changes to improve pilots' situational awareness, it's important not to increase their workload by requiring too much interaction.

The aviation industry has come a long way. We've replaced buttons with touch screens and moved from circular gauges to 3D, animated diagrams. Overall, designs have evolved to provide more information for pilots while reducing complexity, workload and fatigue.

Those changes have helped make a huge difference. During the past 20 years, commercial aviation fatalities in the United States have decreased by 95%, according to the Federal Aviation Administration.¹

Usability's impact on reducing errors is well documented, and today's tools reflect the focus on making it easier to fly safely and efficiently

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1. https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=22975

APPLYING USABILITY TO THE FLIGHT TASK PATH

Usability is, obviously, centered on the user. It can be helpful, then, to think about ease of use across a path covering the range of tasks required of a pilot. This task path includes:

- Flight planning
- Takeoff
- In-air navigation, including communication with others, route decisions and hazard management
- Landing and taxiing, including landing decisions and hazard management

This user-centered approach considers:

- The tasks that must be accomplished
- The intuitiveness of the tools designed for those tasks
- How easy it is to learn to use those tools
- Consistency within the set of tools
- The reduction of irrelevant information or interfaces
- Assurances that the actions are being successfully executed
- Clear transitions from one task to the next
- Availability of system help

PLANNING

TAKEOFF

**IN-AIR
NAVIGATION**

**LANDING
AND TAXI**



This e-book will focus on advances in usability in the cockpit - across the task path - and how usability will continue to affect design. We will also look briefly at usability in the areas of maintenance and parts purchasing.



ADVANCES THROUGH HUMAN-FACTORS AND USER-EXPERIENCE RESEARCH

When we talk about human-factors research, we mean taking a careful, systematic look - through the framework of systems engineering - at how people interact with machines and the world around them. In aviation, that means looking at how pilots and other aviation workers interact with their equipment and their environment.

Human-factors and human-experience specialists work to reduce human error in aviation and lessen the impact if an error does occur. At the same time, they try to improve human performance for increased efficiency. These specialists have expertise in the design and evaluation of aircraft systems, maintenance, operations, procedures and pilot performance.

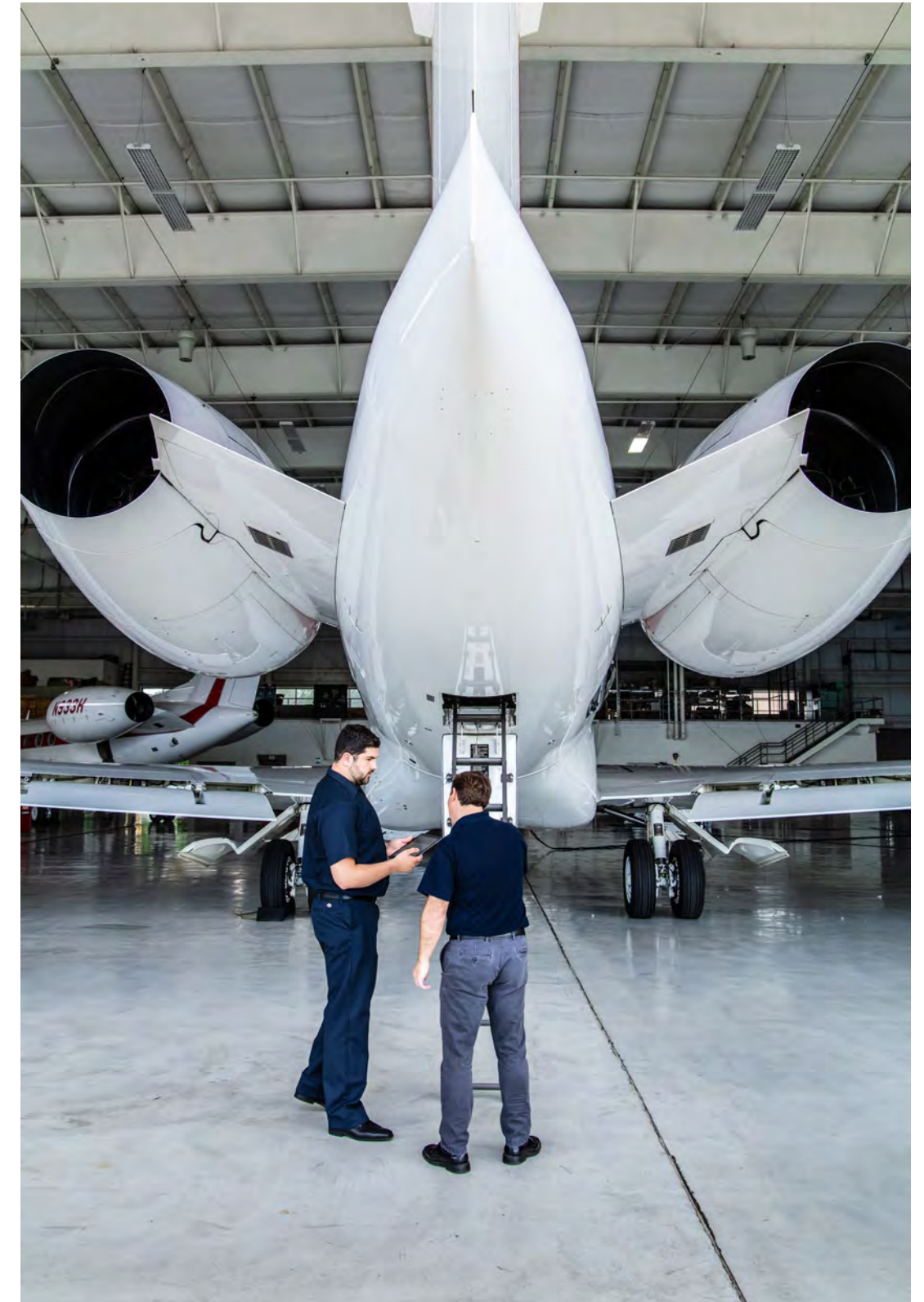
Some of the issues aviation user-experience specialists examine include:

- Fatigue and stress
- How humans process information and make decisions
- Resource management on the flight deck

- Management of air traffic control resources
- The design of checklists and standard operating procedures
- How threats and errors are managed in flight operations, cabin operations and air traffic control³

A list of common human elements that can cause workers to make mistakes was developed in the early 1990s regarding aviation maintenance workers. It remains relevant today across all areas of aviation, not just maintenance.

“When applied to aviation operations, human-factors knowledge is used to optimize the fit between people and the systems in which they work in order to improve safety and performance.”² - IATA website



THE HUMAN-FACTORS “DIRTY DOZEN”⁴

Lack of communication	Distraction	Lack of resources	Stress
Complacency	Lack of teamwork	Pressure	Lack of awareness
Lack of knowledge	Fatigue	Lack of assertiveness	Unsafe norms

2. 3. <https://www.iata.org/training/courses/Pages/aviation-human-factors-tcvt05.aspx>

4. https://www.skybrary.aero/index.php/The_Human_Factors_%22Dirty_Dozen%22

USABILITY TESTING

Testing is critical in usability. Whether in aviation or any other field, usability testing often involves checking how a product actually works by having a representative group of users complete tasks using the product while the testers observe them and take notes.

The idea is to identify any problems before a product is launched and gauge the typical users' satisfaction with it.

The qualitative and quantitative data gathered during testing gives the design and development teams insights they need to make refinements. The earlier in the process that this testing is done, the less costly it will be to make changes.

This assessment process should identify⁵:

- Whether users can actually complete the tested tasks
- How long it takes them to complete them
- How well they like the product
- What changes would improve how well they complete the task
- What changes would improve the users' satisfaction

In aviation, this is sometimes done using flight simulators. While this careful testing sometimes means new products must be redesigned, the process is leading steadily toward more safety and efficiency.⁶



5. <https://www.usability.gov/how-to-and-tools/methods/usability-testing.html>

6. <https://flightsafety.org/iata-data-show-continuing-decline-aviation-accidents/>

FLIGHT DECK ADVANCES

Technological advances have dramatically changed the flight deck. Although flying an airplane is still a critical skill, computers are sharing the workload now.

Now navigation and autopilot are integrated, with planes flying precise paths and pilots continually aware of how much fuel they have remaining and their estimated time of arrival.

Communication is also better, thanks to satellite and improved VHF radios. Weather radar gives pilots much more detailed information about the conditions they're flying into, such as wind shear.

Human-factors and user-experience principles - which consider issues such as how easy tools are to use, consistency among tools and reduction of irrelevant information - have had a direct impact on the design of the modern flight deck. These are some of the advances we've seen:

- Critical information is placed where it can be most easily viewed.
- Autosensing features indicate when tasks are completed.
- Graphical elements make it easier to understand scenarios the pilot may be facing.
- Directions and assurances are given verbally.
- Ease of training and availability of system help improve the likelihood that systems will be used correctly.
- Head-up displays provide critical information (airspeed, heading, altitude) at eye level so pilots can easily scan it at the same time they're looking out of the aircraft.



Today's cockpits can be equipped with synthetic vision systems that provide flight crews with realistic images of surrounding terrain, regardless of the conditions outside. Flight crews receive continually updated weather information, allowing them to avoid difficult conditions, and runway awareness advisory systems help them minimize risks when landing.

These advances and more have been created with help from user-experience testing and improved with input from working pilots. Advances and research continue around improving predictive insights to aid in hazard avoidance and in voice recognition to manage controls in the cockpit.

IMPORTANT ADVANCES THAT SUPPORT FLIGHT CREWS

Progressive taxi assistance	Multifunctional displays can show runway positions, lines and incursion hotspots, which is especially helpful when landing in an unfamiliar place.
Terrain awareness	3D displays can provide a synthetic representation of known obstacles.
Enhanced weather understanding	Today's cockpit displays give pilots enhanced views of current and likely weather to help them make decisions.

TOUCH-SCREEN TECHNOLOGY ON THE FLIGHT DECK

As touch screens began to proliferate in consumer products - things like ATMs, kiosks, smartphones and tablets - they also began to show up in aviation. Honeywell and the Federal Aviation Administration conducted critical research in 2014 to look at the use of touch screens in the cockpit.⁷ They wanted to understand how the size, touch technology and location of touch screens would affect performance, workload perception and fatigue.

Using a medium-fidelity motion flight simulator set at varying levels of turbulence, they found that display size, display location and touch-screen technology could all affect the speed and accuracy of inputs, especially in turbulence.

Since that study, touch-screen technology has continued to be studied and adapted, based on needs and potential problems with the technology for various aviation users.

POTENTIAL ISSUES WITH TOUCH-SCREEN TECHNOLOGY IN DIFFERENT FIELDS OF AVIATION

Commercial/cargo, personal and business jets	<ul style="list-style-type: none">- Usability in turbulence- Positioning and locations to reduce fatigue- Ease of understanding and training- Balancing automated and human function
Helicopters	<ul style="list-style-type: none">- Turbulence- General instability- Head-up ability- Ease of use
Military	<ul style="list-style-type: none">- Ruggedness- Usability with gloves- Head-up ability- Speed/information processing with primary and secondary mission tasks- Intuitive use



7. <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6979570>

MANAGING USER CHALLENGES IN FLIGHT PLANNING

Thanks to advances in technology in the last couple of decades, pilots have been able to shift from lugging 40-pound flight bags full of paper documents to accessing electronic flight-bag (EFB) applications on tablets.

They now routinely use EFBs to create and file flight plans, calculate and compare aircraft cruise modes and view airport approach plates. They can view frequently cleared and optimized routes for best aircraft performance and, thanks to in-flight connectivity, they can make adjustments in the air to maximize efficiency. In addition, receiving up-to-the minute weather updates on their EFBs can lead to better in-flight decisions.

New EFB apps are being developed all the time, aimed at reducing pilot workload and leading to improvements in safety, fuel efficiency and maintenance.

We can expect continued progress. Modern usability

in flight planning has sought to go beyond just the use of tablet devices to provide more usable interfaces. Further advances are being made in the use of integrated resources to mine information from a variety of sources to simplify the complexities of flight planning. Information today can include real-time weather, aircraft performance data, original equipment manufacturer information and aircraft-specific weight and balance. Additional support happens outside of digital plans, from professional flight data specialists and licensed dispatchers.



MANAGING USER CHALLENGES AT TAKEOFF AND LANDING

Combining technology with user-experience design, flight deck design improvements are resulting in safer and more efficient taxi, takeoff, approach and landing operations. This is reducing risks such as:

- **Runway incursions.** Technology now alerts pilots to the unauthorized presence of an airplane, vehicle or person on a runway.
- **Runway confusion.** Alerts help prevent pilots from inadvertently taking off or landing on the wrong runway or on a taxiway.
- **Runway excursions.** New solutions help airplanes avoid veering off the side or overrunning the end of a runway.

Avionics is evolving quickly, with the latest systems providing more and more information to help pilots avoid potential accidents, including:

- Visual insights
- Alerts
- Synthetic or 3D visualization
- Data and predictive insights



MANAGING IN-AIR USER CHALLENGES

Whether pilots are flying a commercial/cargo plane, their own aircraft, a helicopter or military aircraft, they all face in-air challenges: weather and turbulence, terrain or other hazards, and problems with communication.

Fortunately, satellite communication has improved the reliability and clarity of communications. It has also provided a bigger data pipe so more sources of information can be accessed and integrated, to help pilots navigate bad weather and possible dangers in the airspace.

Technological and user-experience improvements will grow even more important as pilots face increasingly crowded skies and the advent of urban air mobility - autonomous aircraft that will take off vertically and fly at low altitudes across cities. Automation and integration of data will help reduce the stress of managing these issues in flight.

Connected aircraft technology now provides sensors and up-to-date information about how an aircraft is performing, along with real-time information to easily allow pilots to navigate issues in the air.

These technologies are now available for small personal aircraft as well as the largest aircraft. In commercial, business and personal aircraft, that can improve safety and passenger comfort. For military and helicopter flights, it can make the difference between success or failure of a mission.



ADVANCES IN MANAGING IN-AIR USER CHALLENGES

Weather/turbulence	Use of historic data, crowd-sourced data and visual depiction of choices
Hazard awareness	Alerts, visual depictions and data providing real-time and predictive insights about geologic hazards and other aircraft
Communication	Satellite-communication-based systems that improve communications and data use Automatic Dependent Surveillance-Broadcast (ADS-B) upgrades that provide for automatic communications between aircraft, constantly updating position and locations Satellite communications that enable improved Wi-Fi services

SPOTLIGHT ON COMMERCIAL FLIGHTS

Much of the usability research that has been done has focused on commercial aircraft. Commercial pilots need advances that can help them:

- Reduce fatigue.
- Make better decisions in real time.
- Be aware of hazards in the air and on the ground.
- Find controls and information easily.
- Reduce errors.
- Verify that the right steps are being taken.
- Understand how to use and respond to the systems of the aircraft.

Increasingly, manufacturers are trying to provide interfaces that are similar to those devices pilots use at home. Research will focus on continuing to:

- Make displays easier to use.
- Make verbal and visual information readily available.
- Provide visualization and new ecosystems of information to help pilots make better decisions and make them faster.

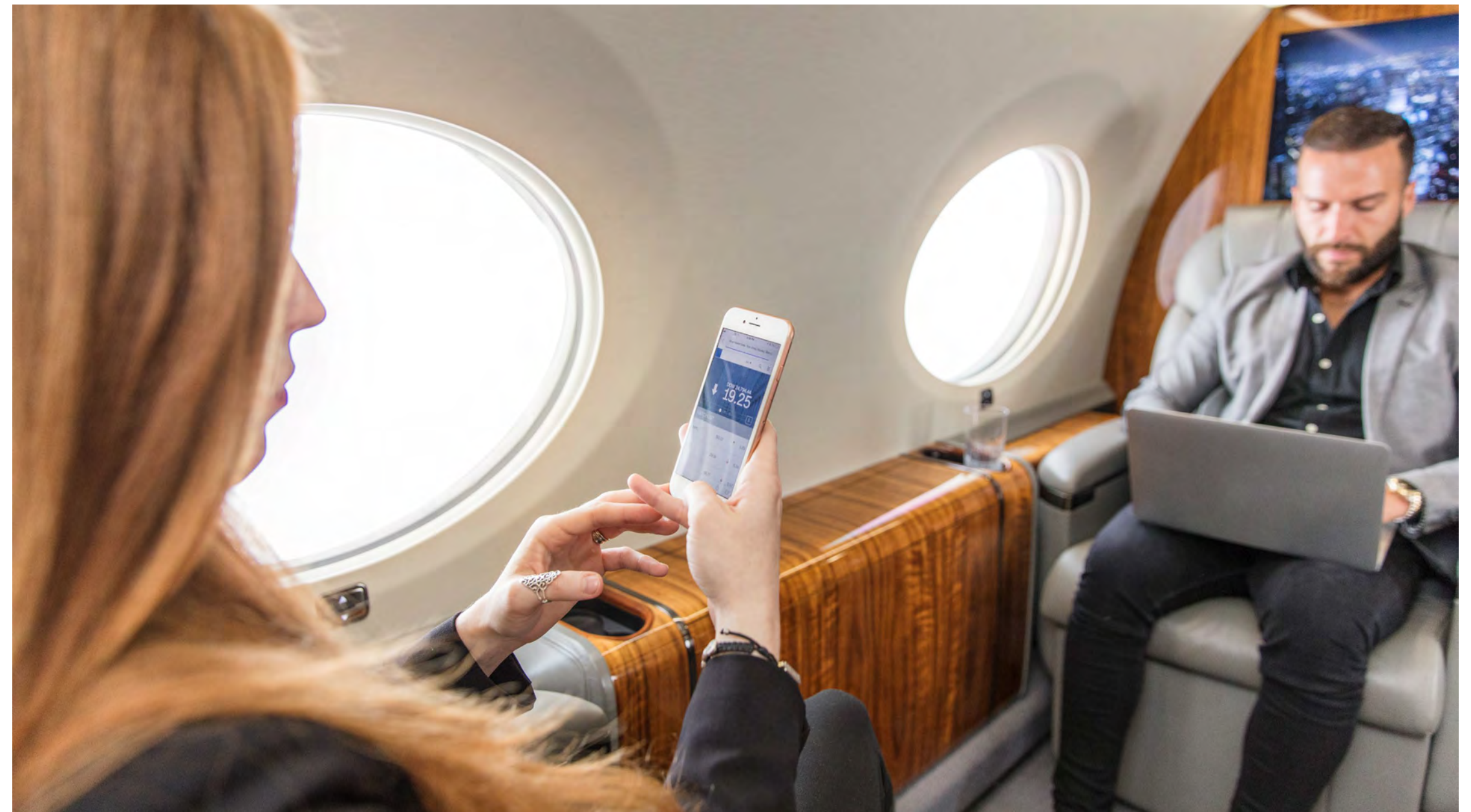


SPOTLIGHT ON BUSINESS OR PERSONAL JETS

Pilots of business or personal aircraft have much the same usability needs as other pilots - they benefit from technology that can make tasks more intuitive, clearer and easier.

Their communication needs can often extend beyond airspace or ground communication, to include Wi-Fi that can accommodate conference calls, email communication or streaming video.

In addition, advances that provide a better understanding of fuel needs can enable them to safely and conveniently make decisions about flying outside of traditional routes.



SPOTLIGHT ON HELICOPTERS

Helicopter pilots face special challenges. On top of all the complex issues other pilots deal with, they find themselves coping with even more problems with downdrafts, microbursts, vortices and low-level wind shear.⁸

Plus, they often have to operate in tight spaces and under stressful conditions, such as shipboard operations, military missions and emergency search-and-rescue missions. Connectivity is critical - especially when helicopters are flying in remote areas, above water or in mountainous regions.

User-experience research is showing that advances in these areas can be important for helicopter pilots:

- Augmented-reality displays visualizing local airflow hazards
- Other improvements in visualizing hazards and predicting the management of hazards
- Improvements in communications and connectivity



SPOTLIGHT ON DEFENSE

The need for a high-quality user experience is especially great with military aircraft because these pilots typically have more than one task.

Their mission involves more than just transportation - they may need to reach a target, accomplish reconnaissance or set in motion another set of tasks. The environment is often rugged, and pilots must choose the best route for the mission, not necessarily for an ideal flight.

Advances and research in military aircraft have focused on:

- Improving communications
- Improving awareness of hazards and terrain
- Understanding air traffic collision possibilities



USABILITY OUTSIDE THE COCKPIT

Usability applies to all aspects of aviation, including maintenance. Modern technologies using sensors, data and automation are making maintenance easier and more effective.

Now maintenance workers can know in advance what needs to be done during turnaround times. Automated checklists, predictive maintenance alerts and suggested solutions to operational issues help them work more efficiently.

Usability is also an issue in aircraft parts supply. User-experience tests have long been a tool for website evaluation. Now, as aircraft parts are being sold on e-commerce platforms, smart manufacturers are testing to ensure that their platforms make the job of purchasing simple and transparent.



HONEYWELL LEADS THE WAY ON USABILITY

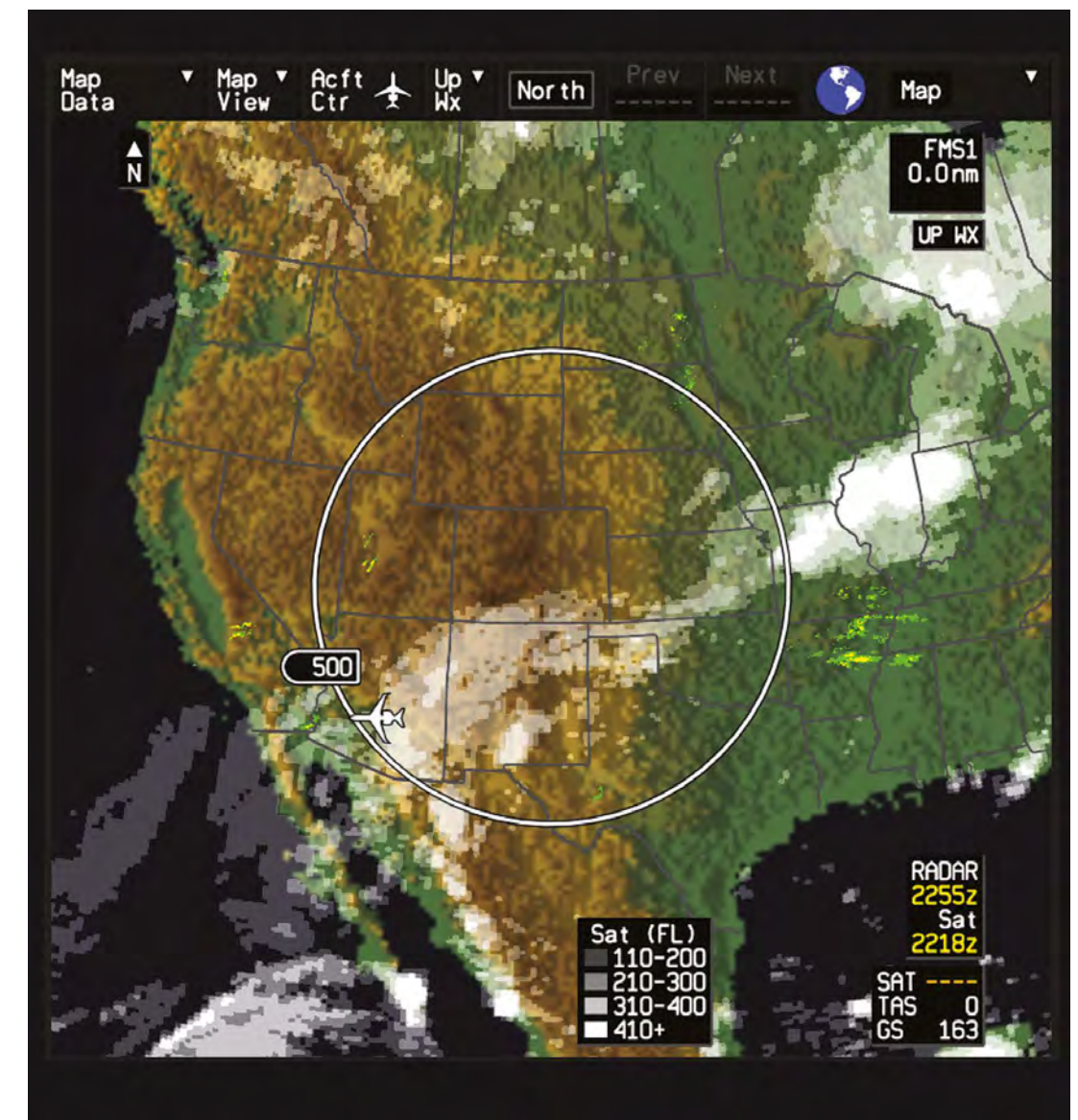
Honeywell has been the leading provider of navigation, display systems, flight controls and flight management systems since the early days of aviation and space exploration. We led the evolution from electromechanical instruments to cathode ray tube (CRT) displays, then from CRTs to high-performance color liquid crystal displays (LCDs).

We accelerated the transition away from analog cockpits, minimized the number of analog instruments, presented flight data on a need-to-know basis and advanced three-axis autopilots.⁹

Our design teams use a structured evaluation process called the functional allocation matrix, in which they consider what information needs to be directly in front of the pilot, what needs to be one button push away and what could be five button pushes away.¹⁰

We have teams of professionals who are continually exploring new technology to improve aviation, including work on gesture-based avionics manipulation, haptic feedback devices, voice controls and even neural sensing.

The Honeywell User Experience is a key process initiative that helps us best understand the needs of our customers, installers, maintainers, channel partners and employees - then design intuitive products and services that meet those needs.



HONEYWELL AEROSPACE PRODUCTS MEET THE USABILITY CHALLENGES OF THE FUTURE

Honeywell's family of flight management systems are used on over 90% of commercial air transport aircraft and 70% of military aircraft flying today, with millions of reliable flight hours.¹¹

Honeywell technologies are playing a major role in improving usability and user experience in the aviation industry.

ADVANCED COCKPIT SOLUTIONS

As a leading provider of navigation, display systems, flight controls and flight management systems, our portfolio of hardware and software products provides value for a wide range of aircraft configurations. Our advanced cockpit solutions include the **Primus Epic® 2.0 and Primus Epic 2.0+** integrated avionics systems, the latest evolution of the Primus cockpit family.

The **Primus® Elite 875/885** cockpit display unit includes situational awareness capabilities, enhanced graphical features and color-changing assurances that tasks are being accomplished. Other features include 3D airport moving maps and traffic information on an LCD screen with bright, clear resolution.

For helicopters and military use, the **Primus Epic control display system/retrofit (CDS/R)** provides advanced flight deck functionality, improved situational awareness and increased system flexibility. This system features large flat-panel displays, modular avionics, a fully functional helicopter flight management system and a four-axis autopilot.

The BendixKing AeroVue™ Touch is a fast, simple and powerful flight display that can be installed as a primary flight display in a new certified aircraft or as a replacement for outdated steam gauges in an existing aircraft. The 10.1-inch display provides near-4K resolution, the highest in the industry.

11. <https://aerospace.honeywell.com/en/product-listing/cockpit-systems-and-displays>

<p>GoDIRECT FLIGHT BAG PRO</p>	<p>The GoDirect® Flight Bag Pro app lets you create and file a flight plan, calculate and compare aircraft cruise modes, download trip kits, access up-to-the-minute weather updates and airspace information, and view airport approach plates. It can help:</p> <ul style="list-style-type: none"> - Save time and reduce pilot workload with app tools designed to optimize flight planning. - Cut operating costs with precise fuel burn and time calculations for every flight route. - Increase awareness with features like real-time weather and aircraft performance data. - Create faster and more efficient flight plans with support from professional flight data specialists and licensed dispatchers available 24/7.
<p>GoDIRECT CONNECTED MAINTENANCE</p>	<p>GoDirect Connected Maintenance monitors aircraft technology in real time and postflight to ensure that your teams catch potential issues early. This nose-to-tail solution analyzes aircraft data and delivers diagnostics as well as predictive, prescriptive alerts to reduce aircraft downtime and lower costs</p>
<p>NEXT GENERATION FLIGHT MANAGEMENT SYSTEMS</p>	<p>The Honeywell Next Generation Flight Management Systems (NGFMS) can meet the needs of all aircraft sizes. Optimized for future air traffic management functionality, NGFMS can help improve fuel efficiency, reduce operating costs, reduce pilot workload and improve safety</p>
<p>HAZARD AVOIDANCE SOLUTIONS</p>	<p>The Honeywell Enhanced Ground Proximity Warning System minimizes risks and maximizes reaction time by constantly and unobtrusively monitoring terrain and obstacles near the aircraft. It uses various aircraft inputs and an internal database to predict and warn flight crews of potential conflicts with obstacles or terrain.</p> <p>SmartRunway® and SmartLanding® software, for commercial and business jets, use audio alerts and visual messaging to improve situational awareness for pilots and crew during taxi, takeoff, approach and landing.</p> <p>The latest system for military aircraft - the MILACAS-XR - represents a generational improvement over most of the military collision avoidance systems flying today. Compared with the current enhanced traffic collision avoidance systems now flying in military transports and tankers, the MILACAS-XR offers significantly greater active and passive surveillance range.</p>
<p>SATELLITE COMMUNICATIONS SYSTEMS</p>	<p>The Aspire™ suite of satellite communication offerings provides in-flight connectivity for business aviation, airlines and helicopters. Aspire 300 and Aspire 350 use the Iridium satellite constellation to bring greater reliability, cost savings and efficiency, from pole to pole.</p>

SYNTHETIC VISION	The Honeywell SmartView® synthetic vision system synthesizes flight information from multiple onboard databases, GPS records and inertial reference systems into a complete, easy-to-understand 3D rendering of the forward terrain. Its unparalleled resolution provides a view that pilots would see only on a clear day
HEAD-UP DISPLAY/ VISUAL GUIDANCE	<p>The Honeywell compact HUD 2020 electro-optical overhead unit provides pilots with head-up, real-time flight and aircraft performance data.</p> <p>The integrated Visual Guidance System eliminates the need for a dedicated head-up display by using a computing module within the Primus Epic system.</p>
WEATHER SOLUTIONS	<p>The IntuView® RDR-7000 3D weather radar provides a broad, robust view of the weather with a patented 3D volumetric buffer. It has features specific to military operations, with the hazard avoidance benefits of commercial radar systems. Features include:</p> <ul style="list-style-type: none"> - Rapid visual capture of precise weather conditions - High-resolution ground mapping - Doppler beam-sharpened precision ground mapping <p>The Honeywell Weather Information Service application gives flight crews updated, in-flight weather information - beyond what they can access with onboard weather radar - on an easy-to-read map.</p>

E-COMMERCE

A superior user experience is not confined to the products we design. It's also part of how we help you do business.

Purchasers can shop for Honeywell products and services at [MyAerospace](#), an award-winning site designed with personalization capabilities to serve relevant information to multiple audiences: pilots, maintenance engineers, and passengers. Extensive research in 25 different countries went into making MyAerospace the easiest-to-use portal in aviation.

Our innovative, user-friendly approach doesn't stop there. Honeywell has created an e-commerce site, [GoDirect Trade](#), that not only provides access to Honeywell products and services, but also connects buyers and sellers of both new and used aircraft parts using blockchain technology. Purchasers can buy inventory directly from the website, with price, product images and quality documents available for each listing.

It's just one more example of the way Honeywell continues to innovate to serve the aviation industry.

The screenshot displays the GoDirect Trade website interface. At the top, the GoDirect Trade logo is visible, along with a search bar containing the text "Single Part" and "Enter a part number or keyword". Navigation links for "STOREFRONT" and "LEARN" are present, along with icons for a shopping cart and a user profile.

The main content area features a breadcrumb trail: "Home > VALVE-TURBINE BLADE/VANE". A large image of the turbine blade/vane is shown on the left. To the right of the image, the product details are listed:

- Part Number: **1110V0700-5**
- Product Name: **VALVE-TURBINE BLADE/VANE**
- Seller: [Honeywell Aerospace Trading](#)
- Price: **\$16,400.00**
- Condition: **OVERHAULED**

Below the product details, there are three buttons: "ASK THE SELLER", "+ADD TO MY LIST", and "SHARE LISTING". A prominent blue button labeled "+ ADD TO CART" is positioned below these.

A table of specifications is provided below the buttons:

Serial Number	1482A
Warranty	12 Months
Location	Phoenix, Arizona, USA
Available For Exchange	Not available for exchange

At the bottom of the listing, there are three document icons with labels: "CAAC.pdf", "CAFE.pdf", and "8130.pdf".

**THE
FUTURE
IS**

**WHAT
WE
MAKE
IT.**

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