

REDUCE TIME, COSTS AND UNCERTAINTY

WHY FURTHER EFFICIENCY IS WORTHWHILE

While the aviation industry has always focused on efficiency, there is still opportunity for operators of all kinds to become more efficient and to reduce costs.

For the military, air ambulance and medevac organizations, efficiency can help stretch limited budgets while improving mission readiness and enabling organizations to fly more missions. Airlines and business jet operators can more efficiently use workers and assets to enhance service reliability and help keep passengers and pilots happy. For all operators, from the largest airline to the smallest general aviation owner, efficiency can help control variables in the cockpit and improve flight safety. How can any discussion of efficiency apply to the diverse mission and business objectives that different operators face? By focusing on the tested principles built into efficiency frameworks like Lean Six Sigma, Agile and others.

Few industries are as susceptible to unknown variables, such as weather, as aviation. Nonetheless, progress is possible. This e-book examines how the aviation industry can put tested principles to work to control uncertainty and reduce time and costs

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MIND-SETS ARE MERGING

Lean processes and efficiency programs are common in manufacturing, which is not surprising since the industry is the birthplace of the assembly line. Today, operational efficiency has expanded beyond the manufacturing lines and maintenance departments.

It matters just as much to the head of customer relations as it does to the chief of maintenance. Its importance is clear to mission commanders and aircraft owners. From ground handling to flight operations to equipment and procurement, operational efficiency is vital. Simply put, operational efficiency is at the core of your success.

With a strong appreciation and appetite for operational efficiency in place, the industry has reached a turning point to achieve it.



PUTTING TESTED PRINCIPLES TO WORK

Data alone does not provide what's needed for action. Often, data and data collection systems reach a point of being merely descriptive: They can tell you what happened. Diagnostic systems take it a step further by telling you why something happened.

Descriptive and diagnostic systems are common throughoutTo reach predictive systems, though, you need to analyze dataaviation. Most aviation operators are just beginning to takeand patterns from past events, make assumptions, and testthe journey to predictive or prescriptive. Doing so involvesthem to provide probabilities about the future. And in the verythe journey to predictive systems, you can even receive prescriptions thatbest predictive systems, you can even receive prescriptions thatvendors who understand software and data well enough tohelp operators take advantage of the advanced data analysisnecessary for prediction.

	How you go from collections of data that are descriptive or
ý	diagnostic to those that are predictive and prescriptive relies
	on advanced data analysis, and increasingly on the power of
	artificial intelligence.

EFFECTIVE USE OF RESOURCES

Fuel is the single biggest expense in aviation. Fuel efficiency not only means financial savings, it also correlates directly to the distance an aircraft can fly, the amount of payload it can carry and better environmental performance.

The industry is exploring many different approaches to fuel efficiency to better control costs and to meet commitments on CO2 production, including:

- Alternative fuel sources
- Changes in aircraft design and componentry, including:
 - Influencing drag and weight through wings and shape _
 - Reduced wiring for in-flight, wireless and control-surface management systems
 - Changes in auxiliary power units from fuel-powered units to direct installation of electrical supplies

- Lighter composite materials and components such as brakes and wheels
- Different types of engines (turboprops, turbofans, hybridelectric, open-rotor)
- Longer-lasting coatings
- Planning and management tools that offer:
 - The ability to understand prevailing wind conditions, calculate precise fuel loads and achieve the most aerodynamic and economic performance possible
 - Predictive models of future fuel requirements
 - Delay-prediction software
- Global changes in airspace practices for more efficient use of airspace
- New approaches to takeoffs and landings to task engines less
- Cooperative practices with airports, such as on-the-ground electrical power use

We'll address the optimization of other critical resources, like crew, in the pages ahead.



1. Economic Performance of the Airline Industry, IATA, Dec. 12, 2018, https://www.iata.org/publications/economics/Reports/ Industry-Econ-Performance/IATA-Economic-Performance-of-the-Industry-end-year-2018-report.pdf.

ELIMINATION OF BOTTLENECKS

Fuel may be an operator's largest single expense, but time is unquestionably the most valuable resource. Aircraft maintenance, ground activities, communications and the logging of information and data are all tasks that take time. Inefficiencies in one area can negatively affect multiple other areas, decreasing productivity and efficiency overall and wasting resources.

Efficient communication and use of flight plan or flight management apps can eliminate time spent on the wrong tasks before, during or after a flight. Better communication also reduces pilot and crew workloads.

Related to communication is the need for current data. The ability to load data quickly on critical devices makes it possible to have information where it's needed, when it's needed.

Voice recognition tools are one example of a tool that can eliminate bottlenecks. Maintenance crews can easily record serial numbers or parts lists while staying on task. These tools can also reduce data entry errors, so crews make fewer mistakes that can cause operational disruption.

Tracking tasks digitally, in visually clear ways, can help crews stay on task and help management or command foresee bottlenecks

such as supply or staffing levels. As the aviation industry uses data-based tracking and assessment tools more broadly, it will reduce delays and improve arrival and departure times, as well as mission readiness.





to tap into an aircraft's systems through the electrical data buses. Information like oil levels. engine temperature, torque and more can be recorded and plotted so it is immediately available to ground crews. This can save those



CONTROL OF VARIABLES

While storms affect every industry, few companies have to respond by cancelling hundreds or thousands of orders, shifting orders to new facilities, and still completing them within a few days. Yet this is exactly what is expected of airlines when major storms cause flight cancellations.

For helicopter rescue, storms can not only increase demand – by causing accidents that require medevac, for instance – but also increase the danger of those missions. Storms can lead to business jets not being able to serve important clients, to mission commanders being unable to support forward operations, and to increased danger for pilots of all aircraft. In short, weather is by far the most challenging variable for the aviation industry. It can ground aircraft or missions, disrupt flight paths or even cause equipment damage. The wear and tear on aircraft due to weather events is variable and hard to predict.

When other operators change their flight patterns to avoid weather and/or other aircraft, these shifts can ripple throughout an airspace, requiring further changes from all. As airspace expands and becomes more crowded, this complexity will only increase.



However, storms and the other variables are not entirely unpredictable. To better prepare for and control these variables, forward-thinking operators in aviation are using:

- Data and predictive insights to see where storms are going so they can plan ahead
- Improved communications to ensure smooth operations within airspaces and between aircraft
- Enhanced situational awareness to enable pilots to adjust fight plans themselves, reducing the future impact of changes
- Greater precision in takeoffs and landings to enable aircraft to operate safely in conditions that would otherwise ground them

A FOCUS ON HIGHER QUALITY

Higher-quality materials and systems often carry higher prices initially, leading to pressure on operators to get by with "good-enough" solutions. The truth, however, is that higher-quality components can save money in the long run.

More reliable parts and components, actuators that provide better control, and systems that prevent damage or loss are all examples of higher-quality elements that save organizations money over time. Even a simple element – such as highly durable paint that requires less reapplication – can save money in both the reduced maintenance costs and the costs of the paint itself.

Being diligent about upgrades can also lead to operational efficiencies. Retrofit, modification and upgrade (RMU) solutions can cost-effectively enhance operational capabilities, improve aircraft efficiencies and extend platform life.

QUALITY COMPONENTS THAT MAKE A DIFFERENCE

ACTUATORS

Depending on the type of actuation system, valuable hours can be lost on tests, maintenance and repairs between every flight. Thus the quality of the actuator strongly influences the efficiency of turnaround operations.

APUS

Improved auxiliary power units (APUs) not only save fuel directly, but can be lighter or easier to maintain, leading to additional efficiencies in multiple parts of the organization.

ENGINES

Issues with engines endanger crews and passengers and can lead to lengthy maintenance downtime. Engine innovations can allow pilots to fly farther, faster and more efficiently.



can save both time and fuel.²



2. Honeywell Provides Dassault Falcon 5X with New Cockpit Technologies that Enhance Safety, Reduce Fuel Costs," Honeywell press release, June 2015, https://aerospace.honeywell.com/en/press-release-listing/2015/june/honeywell-provides-dassault-falcon-5x-with-new-cockpit-technologies.

THE ABLITY TO ADAPT

As a heavily regulated industry that's reliant on advanced technologies, changes occur rapidly in aviation. Achieving operational excellence in this context requires organizations to remain agile.

The aviation industry has approached the goal of adaptability from two primary angles:

- **Engineering**. The industry is studying new kinds of motors and engines, such as turbofans, hybrid-electric and open-rotor systems, and new wing shapes and body designs.
- **Data analytics**. Aviation organizations can study the past, predict possible futures and invest in systems that will help them remain flexible.

To stay up to date on this innovation, operators should consider operational efficiency an ongoing goal. There will always be opportunities to improve.



3. George Koilpillai, "Safeguarding Future Flights through Technologies: An Engineer's View on Innovation," Honeywell blog, Nov. 19, 2018, https://aerospace.honeywell.com/en/blogs/2018/november/safeguardingfuture-flights-through-technologies.

"IN SENSORS, MICRO-ELECTRICAL-MECHANICAL SYSTEMS (MEMS) AND NANOTECHNOLOGIES WILL BRING A REVOLUTION, WHILE CONNECTIVITY AND MACHINE LEARNING ARE TAKING AVIONICS TOWARD NEW DISRUPTIONS. AVIONICS HARDWARE ALSO IS GOING THROUGH PHENOMENAL CHANGE, AND GRADUALLY WILL BE REPLACED BY SOFTWARE FUNCTIONALITY AND NEW PROCESSORS LIKE SYSTEMS ON A CHIP (SOCS).³" - GEORGE KOILPILLAI, ENGINEER CHIEF, HONEYWELL AEROSPACE

SPOTLGHT ON UNMANNED FLIGHT

Unmanned flight has enormous potential – particularly for the role it will play in urban air mobility – but will also bring operational efficiency challenges. The industry is already working on ways to get the most from unmanned aerial vehicles (UAVs).

Some of the same technologies that go into ground proximity warning and collision avoidance systems are being adapted for use in UAVs, along with several other innovative ways to improve their ability to detect and avoid obstacles. Manuferiation of the same technologies that go into ground proximity overall, as unmanned flight continues to develop, manufacturers and operators will make advances in situational awareness, emissions control and precision in all aspects of flight. These developments will result in greater operational efficiency and safety.

Manufacturers of UAVs are also focusing on building models with electric motors and other components that are lower maintenance than large engines or that can be serviced with readily available parts.



Keeping all the future UAVs connected to their operators and running safely will be crucial. Many of the advances in connectivity that have changed traditional aviation are being applied to UAVs, as well as advances in cellular networks and other communication technologies.

SPOTLIGHT ON THE CONNECTED AIRCRAFT

The Connected Aircraft is the world of connected machines and Internet of Things (IoT) capabilities brought to aviation. It includes data and communications capabilities, sensors, and tracking from nose to tail and from aircraft to ground. The Connected Aircraft can have an enormous impact on operational efficiency.

Integrated systems enable you to benefit from data and streaming communications so that flight crews, commanders and maintenance chiefs can all perform their jobs more efficiently and effectively.

- Connected communications provide communication in real time, wherever needed, greatly improving decision making.
- Tracking solutions provide an understanding of turnaround tasks, maintenance activities and efficient flight planning.
- Connected diagnostics can reduce operational disruptions by as much as 35%. Operators can avoid issues with preventive or predictive maintenance. They can also minimize time on the ground and cut troubleshooting costs by sending maintenance crews directly to the part of the aircraft that needs attention, armed with the tools and parts they need.
- Connected flight bags and situational information helps pilots and other flight crew select the best flight paths and avoid adverse weather, leading to more efficient flights.

The Connected Aircraft also makes it much easier to monitor fuel use and gain insights on how flights individually and collectively can be more efficient.



HONEYWELL SOLUTIONS DRIVE EFFICIENCY AND CONTROL COSTS

We're committed to helping the aviation industry drive efficiency and control costs with solutions designed to save time and reduce waste. We offer a variety of planning and management tools, as well as a full suite of Connected Aircraft solutions. Together these tools can decrease time and workload through intelligent use of data and monitoring, and through allowing for faster turnaround time with less possibility of operational disruptions.

	Satellite communication system
JETWAVE AND ASPIRE	- Aspire
	Our Aspire 350 satellite com services throughout their flight
	- JetWave
	Improve the passenger expe enables fast, consistent, reli
	A nose-to-tail solution that ana prescriptive alerts. It:
	- Provides notifications with p
GODIRECT CONNECTED	fault down to the subcompone
MAINTENANCE	– Ingests fault data, system pe data, maintenance data, shop d
	 Goes well beyond the capabil monitoring and trend analysis

n systems that can help you synchronize flights and operations:

ite communication system enables pilots to stay connected with data and voice their flight path, anywhere in the world.

er experience while helping make the crew more productive with hardware that ent, reliable global connectivity.

hat analyzes aircraft data and delivers diagnostics as well as predictive and

with prescribed maintenance actions to help maintenance crews pinpoint the mponent level

tem performance reports, flight schedules, unscheduled disruptions, flight , shop data and weather data

capabilities of current-generation solutions, which focus on system health nalysis

GODIRECT FLIGHT SERVICES	Designed to help operat fuel usage, navigation c board.
GODIRECT GROUND HANDLING	Gives ground crews the long – in the air – quick rounds, reduce flight de
HEALTH AND USAGE MONITORING SYSTEMS (HUMS)	Provides diagnostic info diagnostic software hel ponents. HUMS increas management, enhances
INTUVUE RDR-4000 3D WEATHER RADAR SYSTEM	3-D volumetric scannin from 0 to 60,000 feet ac ment in weather hazard
WEATHER INFORMATION SERVICE	An electronic flight bag to weather information
TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS)	We pioneered TCAS for n more collision avoidance offers three models of co
ENHANCED GROUND PROXIMITY WARNING SYSTEM	Honeywell developed th the enhanced ground p A terrain awareness and trolled flight into terrain
	Our Surface Indicatio r whether their aircraft wi
LANDING SOLUTIONS	SmartRunway and Sm sions by alerting crew m landing.
	The SmartView synthe bases, GPSes and inerti forward terrain.
HONEYWELL VOCOLLECT	Honeywell's voice recog information without put production-data-entry o

tors make flight operation decisions by collecting all flight data (flight plans, charts, weather, aircraft performance and more) in to one easy-to-access dash-

tools they need to manage turnarounds and get aircraft back where they bely and efficiently. The software solution uses mobile devices to manage turnaelays by 22% and improve on-time performance by 30%.

ormation required for optimum performance. HUMS sensors and embedded p monitor and communicate the health and maintenance needs of critical comses aircraft availability, reduces maintenance costs, optimizes parts inventory s safety and more.

ng and pulse compression technologies provide a complete view of the weather cross a 320 nm detection range. IntuVue has demonstrated a 26% improve-I detection over conventional radar systems.

app to assist the flight crew in making strategic in-flight decisions with respect by providing up-to-date weather data.

nilitary and commercial aircraft more than a half-century ago and have delivered systems (CASes) than anyone else. Today, our **SmartTraffic® CAS 100** system mmercial TCAS.

he first ground proximity warning system (GPWS) in the 1970s and introduced roximity warning system (EGPWS) in 1996. Our Mark V EGPWS exceeds Class I warning system (TAWS) requirements and provides protection against conn (CFIT) and wind shear.

Is and Alert System (SURF IA) is the first system to visually show pilots Il come into contact with dangerous wake turbulence from other aircraft.

nartLanding improve flight safety and help reduce the risk of runway excurnembers if the aircraft is going too fast, is too high or is going to incur a long

etic vision system synthesizes flight information from multiple onboard dataial reference systems into a complete, easy-to-understand 3-D rendering of the

nition solutions can improve data-entry accuracy and help technicians record tting down their tools. They helped a leading aerospace manufacturer reduce cycle time by 30%, while making significant gains in accuracy

HONEYWELL SOLUTIONS FOR FOR FOCUSING ON QUALITY

Our products are made with the highest quality materials, rigor and testing you'd expect from a company that has focused on the aviation industry for 100 years. Our retrofits, modifications and upgrades (RMUs) are designed to help your aviation investments deliver the highest performance possible. Additionally, our protection plans and warranties are designed to keep your aircraft in the best possible condition.

RMUs	We have upgrades for a helicopters, defense airc platforms into complian
PROTECTION PLANS	We offer our GoDirect r engines and mechanica efficiently and take the u
PROTECTIVE COATINGS	We offer a range of coat Our antioxidant coating by deicing fluids and co
ENGINES AND ACTUATORS	Our engines have been provement has led to en Our actuators deliver p engine control, thrust re

large range of platforms, including business jets, airliners and cargo planes, craft, and general aviation aircraft. We also offer multiple upgrades to bring nce with mandates.

naintenance and service plans to help you control the costs of your avionics, l components. These plans help your maintenance teams budget, plan more uncertainty out of maintenance.

ings designed to protect various components of aircraft.

technologies have proven to be best-in-class against carbon oxidation caused ntaminants.

at the forefront of aircraft propulsion since 1953. Today our continuous imigines that provide more uptime and more power with less fuel.

precision load management and motion control for an array of uses, including everse, space missions, missile steering and numerous marine applications.

HONEYWELL SOLUTIONS FOR CHANGING ENVIRONMENTS

From our experience in **space technologies** to our pioneering work in **urban air mobility (UAM)**, we're constantly working on the future – and on bringing those innovations to all branches of aviation. You can see that in the advances we are making in engines, in situational awareness tools, in predictive and prescriptive insights, and in the Inertial Measurement Units (IMUs) we've designed for greater precision in unmanned flights.

When you buy from Honeywell, you can be certain that we are thinking about the needs of all those in the industry and its next steps.





Honeywell Aerospace 1944 East Sky Harbor Circle Phoenix, AZ 85034 aerospace.honeywell.com

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