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From Paper to Digital Maintenance With Electronic Signature

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A Capstone Project Submitted to Embry-Riddle Aeronautical University in Partial Fulfillment of the Requirements for the Aviation Management Certificate Program

Embry-Riddle Aeronautical University

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This Capstone Project was prepared and approved under the direction of the Group's Capstone Project Chair, Dr. Peter E. O'Reilly.
It was submitted to Embry-Riddle Aeronautical University
in partial fulfillment of the requirements for the
Aviation Management Certificate Program.

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Abstract

Group: e-fficiency

Title: Digital Records – Improving Efficiency in Commercial Aviation

Institution: Embry-Riddle Aeronautical University

Year: 2017

This research paper reviewed the **impact of** the implementation of digital maintenance records replacing paper **document**s in the commercial **aviation** through gains in efficiency and cost reduction in airplane transitions. Throughout the lifecycle of a commercial airplane, repairs are incorporated, components are replaced and maintenance tasks are accomplished every day, each of those activities generate records that need to be kept and reconciled. Lessors have strict contract terms that require operators to keep all required maintenance documents stored and available so that asset value is maintained, this process is done today mostly with paper documents and is very costly and difficult for the Industry to manage. The implementation of electronic records can help eliminate usage of up to 30,000 sheets of paper a year per aircraft, while increasing control and efficiency in the airline daily operation. Such app**roach would optimize processes reducing labor hours in the Maintenance Records Quality Assurance process by 50%** or more. Other **savings incl**ude reduction delays in the airplane transition and duplication of maintenance activities due to missing record**s.** Besides the research, in**terviews were conducted with airline representatives and** personnel from digital records software solution provider. Result of the study demonstrated **that** the Aviation Industry **can greatly benefit from** the migration **to digital** records, such benefits come from **improving controls** and reduce errors**,** r**emote** reconciliation and audit**, and decreas**e **labor** in quality assurance**.**

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Chapter I

Introduction

The Team e-fficiency proposed the digitalization of historical maintenance records, implementation of full electronic tasks cards in conjunction with electronic signature and ultimately implementation of digital records management system to manage these digital records through existing systems in the market such as AerData STREAM, AMOS, EmpowerMx.

The objective of the project was to help the airlines gain efficiency on the daily maintenance records management, reduce errors and quality issues on maintenance documents and streamline the redelivery process labor. In addition, the project accrued savings on avoiding penalty delays in the redelivery process and reducing headcount in managing technical records.

Project Definition

The objective of this project was to assist airlines improve efficiency in the maintenance records quality assurance processing, controlling and management. The project also assisted airlines avoid extra costs in an airplane transition process usually related to incomplete or missing maintenance records. The efficiency gain and avoidance of extra costs in redelivery process would come from digitalization of historical data records and implementation of new full digital records system based on electronic tasks and electronic signature, and ultimately an implementation of a records management system that reconciles all maintenance tasks being generated, accomplished and stored by the airline. Paper is still the most used basis for airlines to produce, manage and control maintenance records, but the world and the industry are moving fast to a paperless environment.

Several areas of the airlines will greatly benefit with the result of the implementation of digital records and a digital records management system through this project are Maintenance, Quality Assurance, Fleet Management, Supply Chain and the Financial Department.

The implementation of a digital records process could help directly these areas as the amount of work processing documents and maintenance records will reduce at the same time that quality will be improved. Reducing clerical and operational errors would also have a positive impact in flight safety and support reduction of loss of revenue due to airplane being grounded for lack of documentation. Issues with records quality and accuracy can force the airline to ground an airplane when errors are discovered by local authorities through regular audits.

The project faces some particular challenges such as the need to convince Local Regulatory Agencies to accept digital documents as formal primary record of maintenance. With acceptance by Regulatory Agencies globally, the Lessors will start accepting them as well as their primary concerns if with ability to easily place their assets around the globe under different Regulatory Agencies coverage.

The global acceptance of digital records would benefit airlines can become more efficient and more costs efficient in maintenance by avoidance of records management errors. This process would also benefit greatly the Lessors that would be able to reduce labor currently spent in reviewing manually tenths or some cases hundreds of thousands of maintenance record pages per airplane transition. Finally, this new concept would also help Local Authorities reduce labor in auditing airplane maintenance records. Travels expenses from all three involved parties would also be reduced as all documents can be accessed by distance and workflow generated to have any discrepancy corrected.

Project Goals and Scope

The main goal of this project was to demonstrate that it is viable for airlines in Brazil to go paperless in maintenance records by usage of systems available in the market including electronic signature. This project could help the airlines be more efficient and more competitive by reducing its costs related to day-to-day maintenance records management and inefficient redelivery process. Digital information could also have a positive influence on the avoidance of delay penalties in redelivery process.

The adoption of digital records by the industry could collectively assist airlines avoid spending $2 billion on lease return costs. The more readily available digital records could help prevent failing to scrutinize redelivery conditions and processes, according to a new International Bureau of Aviation (IBA) white paper on redelivery expenditures.

While there extensive technology applied to the airplanes, airline back office operations still manage their daily tasks in a very old fashioned and time consuming manner. Paper files are their primary source of proving the compliance of maintenance tasks performed during the life of the airplane.

Definition of Terms

Electronic Signature	The online equivalent of a handwritten signature. It is an electronic sound, symbol, or process attached to or logically associated with a contract or other record and executed or adopted by an individual. It electronically identifies and authenticates an individual entering, verifying, or auditing computer-based records. An electronic signature combines cryptographic functions of digital signatures with the image of an individual's handwritten signature or some other visible mark considered acceptable in a traditional signing process. It authenticates data with a hash algorithm and provides permanent, secure user- authentication.
Tasks cards	Sometimes referred as job cards or work cards, while not a specific regulatory requirement, have evolved as a best practice. We consider work cards to be part of your air carrier manual and maintenance program. They are the "what to do" and the "how to do it" parts of your maintenance program. You use work cards as a simple means of complying with maintenance performance and recordkeeping regulations. Your work cards provide a control element to the performance of maintenance. They also provide the means of ensuring that all maintenance personnel comply with your air carrier maintenance manual. It is an easy way for you to make sure that your maintenance personnel, as well as other personnel, are following your procedures. The second primary function is to

	document maintenance activities, providing a means for you to comply with your air carrier maintenance recordkeeping requirements. Work cards may also document the results of inspections, checks, and tests for data collection and analysis. The work-in-progress audits that you conduct regarding work card activity as part of your CASS ensure that each individual who accomplishes work on your aircraft is following your manual.
Maintenance Records	Maintenance records are written notes that provide documentation about the upkeep of a certain piece of equipment. Most of the time when people talk about these sorts of records in an industrial setting they're referring to the formalized reports and files kept by fleet owners, industrial plant operators, or other business people engaged in some sort of work with machines. Keeping an adequate log of mechanical service and repairs in these scenarios is usually considered good business practice, and may also be required by law. Records are particularly useful in maintenance management because they help businesses ensure that their equipment is kept in good condition, and they also offer a way to manage and track repair and preventative upkeep expenses.
Redelivery process	A commercial aircraft operating lease sets forth processes for redelivery of the aircraft upon lease expiry in an effort to ease transferability of the asset to a new lessee. These processes consist of inspecting the aircraft and related documentation to confirm that

the lessee has fulfilled its obligation to return the aircraft to the lessor in accordance with the redelivery conditions set forth in the lease. Upon satisfactory completion, the lessor executes a redelivery certificate confirming that the aircraft and related documentation complies with such redelivery conditions.

List of Acronyms

ABEAR	Associação Brasileira das Empresas Aéreas
ANAC	Brazilian Civil Aviation Authority
ERAU	Embry-Riddle Aeronautical University
EASA	European Authority Safety Agency
FAA	Federal Aviation Authority
IBA	International Bureau of Aviation
MPD	Maintenance Planning Document

Chapter II

Review of Relevant Literature

Several industries have changed and are continuing to change their controls, processes, and methods from the paper to the digital form; it is a consequence of the new technology available, such as electronic signatures (IATA Aviation Identification & Authorization System – 2015).

In aviation industry, there is still reluctance to move to paperless and only a small percentage of airlines adopted digital records. As such, this makes the aviation industry a fertile turf for significant improvements that will bring various positive aspects to the entire value chain (IATA Paperles Aircraft Operation Group – 2017 Conference).

There are three pillars that this project studied concerning the digital transformation in the aviation industry: (a) the return to lessor (or redelivery) transition, (b) digital records and (c) maintenance records.

Return to lessor (or redelivery) transition

IATA and Boeing forecasted that approximately half of all aircraft in the world will be under an operating lease condition in 2020. Doug Walker, Technical Vice President of AerCap, stated at IATA Paperless Aircraft Operations Conference 2016 that electronic records offered a vastly improved and searchable level of record keeping, accountability and security, in addition to the obvious environmental and cost reduction benefits. The challenges to implement a paperless strategy rests with three stakeholders:

- Authorities: need additional regulatory guidance material, other than FAA (worldwide acceptance),
- Lessors: need to support establishing a standard for electronic records, and,

- Airlines: Fear of the new/comfort with the old (if it's not broken don't fix it mentality).

Doug Walker (2016) pointed out the advantages of this new electronic/digital method to manage records:

1. decrease the cost of printing and storing approximately 11,000 paper pages per aircraft per year;
2. reduce the need for consultants to be onsite for mid--term audits and the return process which lasts 30 days or more;
3. decrease disputes and costs caused by misfiled or lost records;
4. enable airlines to conduct due diligence remotely prior to accepting aircraft saving travel cost and stress;
5. increase record search efficiency because digital offered search and filter capabilities which paper does not offer;
6. reduce the potentially for delayed returns and associated exposure to continued lease payments.

In 2014, Shannon Ackert, Senior Vice President for Commercial at Jackson Square Aviation and owner of Aircraft Monitor, stated that matters relating to the redelivery of the aircraft can be a cumbersome and time-consuming. A well-organized process is vital to ensuring that both lessors and lessees effectively address the range of issues associated with redelivering an aircraft.

Shannon Ackert (2014) mentioned that during redelivery, the physical elements of the aircraft and the condition of the maintenance records, often form a large part of the discussion because they have financial significance for both the airline and lessor. The primary objective of

the records review is to ensure completeness, accuracy, ease of understanding, consistency with industry standards, and compliance with mandatory regulatory requirements. Therefore, every attempt should be made to uncover errors, inconsistencies, deficiencies, or other concerns associated with the records that could affect the aircraft's value or re-marketability. Ackert (2014) further pointed out that the records review is the most time consuming element of the redelivery process to complete and is, more often than not, the sole cause of transition delays.

In 2014, in the report "Redelivery Considerations in Aircraft Operating Leases" Ackert said there is a growing trend toward digitalized maintenance records. Many of these systems are offered to owners/operators on a commercial basis. While these are excellent systems, alone they normally do not meet aviation regulatory requirements. This is because certain Regulatory Authorities need to be convinced that an electronic task card has signatures and typed findings that remain secure after sign-off. Thus, the operator/lessee who uses such a system is required to ensure that it provides the information required, including signatures. If not, modification to make them complete is the operator's/lessee's responsibility and this responsibility may not be delegated (Ackert, 2014).

At the MRO Conference in 2017, Elentinus Margeirsson, Manager of Operational Cost Management, Safety and Flight Operations at IATA, and Gary Fitzgerald, Managing Director at Stratos, an independent advisory firm specializing in aircraft leasing and financing, agreed that documentation irregularities (such as records of repairs, how the repair was performed, traceability of work and providing back-to-birth information for components) cause the most nuisance to a smooth aircraft return. They have stated that if a lessee fails to redeliver an aircraft on time or in the agreed condition, the lessee will be liable to pay compensation costs to the lessor. In addition, late return rental payments can be increased by a factor of 150%, or even

twice the initial rate. This was intended to be a motivator for the lessee to redeliver the aircraft on time and compliant with the return conditions.

In 2016, at AIRCRAFT IT MRO Conference, Tim Scott, Vice President of Technical Services at AVITAS**,** stated that using digital/electronic records would help prevent many of previous aforementioned problems. He also asserted that with digital records, it was easy to send most of the package to the lessors, so their time on-site performing records review could be minimized. If there were any concerns around any maintenance records, it could be managed remotely.

Avitas (2016) at AIRCRAF IT MRO Conference presented a white paper entitled "Digital aircraft and engine lease returns", which describes how digital records also help with transitioning an aircraft. Whether it is owned or leased, airplanes need all maintenance records to be accurate and easily handled. Having organized digital records reduces the delays on airplane transitions, consequentially improving savings for airlines and Lessors.

Digital Records

Electronic Ticketing

Many success cases of products sold on Internet are related to travel, leisure, books, music, and computing (López-Bonilla & López-Bonilla, 2008). According to the International Air Transport Association (IATA, 2017), since 2012 the global revenue passengers kilometers (RPK) growth was from 5.3 billion to 7.4 billion, a 30% growth in 5 years.

In order to grow Airlines needed to adapt and move to e-ticket which represented another way to access the passengers and continually reduce costs.

As per the IATA Report (2008), since June 2008 the industry moved to 100% electronic ticketing. The paper ticket became outdated. Lopez and Bonilla (2013) believes e-ticket can be

considered as one of the Aviation Industry's biggest innovations, because airlines and its customers can perceive several benefits and efficiencies, such as:

- Better records tracking and financial control;
- Reducing of time-consuming;
- Lower dependence of indirect sales (travel agencies);
- Customer comfortable way of travelling self-servicing.

All the above advantages eliminated costs and represented a $3 billion US dollars in annual savings. This savings resulted because an e-ticket costs $1US dollar to process, versus $10 US dollars per paper ticket (IATA, 2008).

Mortgage Industry

In 2016, Oliver Wyman, a consulting company, in the report "The future of technology in mortgage originations" pointed out that nowadays, thanks to new technologies, the emergence of Fintechs, and the competitive origination market, a breakthrough finally seems imminent. Mortgage applications are becoming paperless. Underwriting is increasingly automated via data-rich rules engines. Electronic closing has become a reality.

In the same report, Oliver Wyman stated the environment has become increasingly challenging for lenders, with low interest rates, projected decreases in volume, rapidly evolving client needs, and increased regulation. On the other hand, the mortgage origination process has not fundamentally changed in decades, similar to aviation. Recent entrants like Quicken have taken share quickly with their new capabilities and focus on client experience. New players are looking to enter, and incumbents are rapidly changing their technology stacks, hoping to protect their market share. The report pointed out a few areas where these changes were more prominent:

1. Application Intake: Mobile image capture allowed clients to take a smart-phone photo of required borrower documentation and transmit them easily and securely to their lenders.
2. Decision making: Digital document management allowed lenders to automatically digitize paper documents (if any), use pattern recognition software to automatically recognize the document type, use OCR to intelligently extract and deliver data to the underwriter enabling easy verification or decision making, and automatically flag missing or inconsistent data.

   Storage of documents and extracted data meets the latest Mortgage Industry Standards Maintenance Organization (MISMO). It also meet other industry standards, aligned with future investors and secondary marketing requirements, while fulfilling regulatory compliance.
3. Processing and closing: eClosing allows borrowers to close a mortgage virtually using a web-based closing and title processing suite. eClosing infrastructure includes a secure digital portal for documents. eSignatures allow all parties to virtually sign documents, with robust security and audit trails that are admissible in a court of law.

According to Fannie Mae Company - Mortgage Lender Sentiment Survey, July 2016**,** by leveraging these capabilities, lenders have been able to drive down decision cycle times from days to minutes. In addition, lenders reduce several days on the decision-to-close cycle time.

Regulatory compliance has become vastly more efficient and mortgage unit costs were driven down by double-digit percentage points.

Maintenance Records

According to Mr. Shannon Ackert, Senior Vice President for Commercial at Jackson Square Aviation and owner of Aircraft Monitor, in the report "The Relationship between and Aircraft's Value and its Maintenance Status", the value of an aircraft is heavily dependent on the maintenance status of the airplane which is proved through the maintenance records. Poor quality or missing maintenance records will deteriorate the value of the airplane in the proportion of the tasks that cannot be proved to be appropriate accomplished (2014).

Poor quality in maintenance records come from inconsistencies, errors, missing documents and will drive significant additional costs to the owner or operator of the airplane.

In 2016, the report "Redeliveries Revisited", according IBA, the extra costs to the airline will come from the need to generate appropriate maintenance records through:

- Recertification of a part or component that does not have an appropriate document;
- Duplication of work of a missing maintenance task;
- Acquisition of new parts that could not be traced back to its origin.

Although there is an apparent scarcity of academic studies that could help understand the cost impact of bad quality in maintenance records, it is common sense for the Aviation Industry that errors and missing maintenance records lead to a huge financial impact to the Airlines and Lessors. Bad quality in maintenance records lead airlines to spend more in duplicated maintenance and redelivery delay penalties, and Lessors might lose business opportunities due to delays in the redelivery process.

Chapter III

Methodology

This chapter describes the methodology applied to determine if poor quality of maintenance records and poor management of maintenance records is perceived by the aviation industry as an issue, and if the proposed solution could address these problems.

It describes how information was collected, and from which sources, to determine if the proposed solution could help airlines be more efficient in managing maintenance records and reduce costs with maintenance and redelivery process.

The methodology used in the research had a qualitative approach;

- Research academic and professional literature that describes the problems with paper records management and quality and how it impacts the companies in aviation and other industries;
- Interview: One large and one small digital records management software company that sold systems to Brazilian carriers;
- Interview: Airline representatives in Quality Assurance, Maintenance, Maintenance Control of two major carriers in Brazil, one that has already started the digital records management process and another that is just starting implementation (the later went through a lengthy process to validate the value of the solution);
- Analysis of the collected information to validate the proposed solution.

Experimental Design

Doug Walker, Technical Vice President at AerCap, mentioned that an aircraft generates, on average, 10,000 pages a year. Since most of those pages are generated in the line maintenance

stations and base maintenance stations, all the pages are originated and executed in remote areas must correctly filled and filed well-organized fashion to facilitate the retrieval of documents when needed. The challenge is to assure the correctness and completion of all maintenance records and establish a process that guarantees the effectiveness of record storage process.

The Mortgage Industry had a similar situation with challenges on application intake (origination), decision making (correctness and completion of docs) and processing/closing (storage process).

Mortgage Industry applied a series of improvements to the process. In intake application process, clients want the application process to be easy and simple. To achieve it, Mortgage Industry applied four key technology-enabled capabilities. Making an analogy, facilitating that mechanics or employees located in outside the headquarter have tools and processes friendly enough to allow the records to send to a controlling department which is usually CTM at aviation.

Clients want the decision making process to be fast in the same manner that Lenders do want to speed up the process but also want to truly understand the underlying risk of the applicant in as automated a fashion as possible, and price the loan optimally. And, of course, lenders want efficiency and automated compliance. Making an analogy in aviation is to provide immediate feedback for correctness of documents in the filing process of maintenance records to avoid that incorrect records are filed and are only detected years later.

In processing/closing, lenders want speed, efficiency, and automated compliance. A robust workflow leads to higher efficiency while making it easier for lenders to comply with existing and upcoming regulation. Making an analogy to aviation is to comply with regulation and making more efficient retrieval process.

Data source, collection and analysis

Digitalization in aviation industry is at beginning of the journey, therefore, data sources of other industries were be used as reference.

The benchmark of other industries was used as reduction of cycle time, increase in efficiency through reduction of FTEs and reduction of mistakes by making checks to avoid crucial mistakes that affects compliance to move forward across value chain. An example of type of variables or outcomes that can be measured through a digitalization journey in a bank, see report that McKinsey published shown in Figure 1.

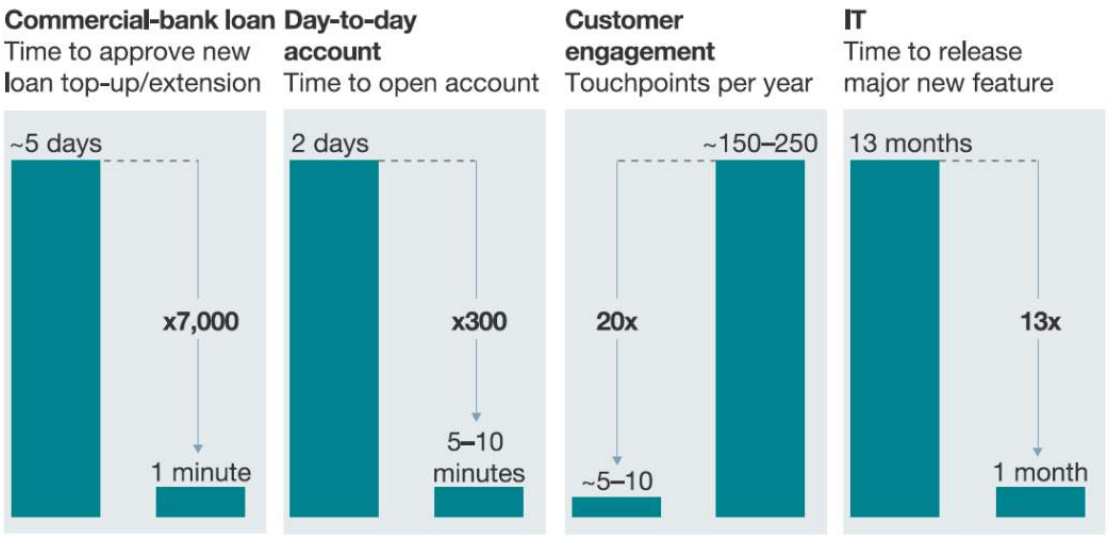

Figure 1. Digitizing customer journeys yields impressive results. From Interactive Advertising Bureau, Pew Research Center, Searchmetrics (2015).

In the redelivery process, there are two main topics important for the airlines and to the lessors: date of the return and the conditions of return. These are the two factors that can add significant cost to the airlines and to the lessors. For this process, besides the technical conditions of the aircraft, it is also relevant the quality of the maintenance records, which will determinate the value of the aircraft on the return moment.

One of the biggest challenge to keep a high quality of maintenance record is the decentralization of an airline operation. For instance, one aircraft fly around in large amounts of stations (airports) during its life, which means that at a redelivery process, all maintenance documentation processed for one particular aircraft in any place should be gathered, checked and stored. In this aspect, there are two important problems to be addressed: guarantee that records arrived at the records controlling department and were correctly filled.

The digitalization transformation journey has very similarities of in the financial industry and aviation. However, the financial industry is more advanced and mature in this digital journey. Aviation can reap similar results and take similar data sources to prove the effectiveness and efficiency of the digitalization transformation.

Chapter IV

Outcomes

This chapter describes the results achieved by Airlines that have migrated their maintenance records partially or completely from paper to digital. As the group participants works for different companies in the Brasilian aviation industry and to preserve competitive data, only international data is present in this chapter.

EasyJet, a successful low cost carrier in Europe significantly increased fleet size without increasing headcount in records department. Swaran Sidhu, head of fleet technical management at EasyJet, says that "paperless project" has allowed EasyJet to "develop process-driven workflows that have supported growth of the fleet from 166 aircraft in 2010 to 248 aircraft in 2016, with no associated increase in direct headcount within the records department."

Cathay Pacific is another example of an airline that achieved outstanding results transitioning from paper to digital records. Cathay has presented at the IATA conference in 2015 the results shown in the Table 1 (below), yearly savings of $2.2M and 470 man/days along with reduction of risks in overrunning mandatory maintenance and registry in components and engine maintenance. In the redelivery process, Cathay also experienced significant improvements, reducing the time required to prepare a records redelivery package from 4 - 6 months to 3 months, representing a reduction of 15 - 24 man/days of effort to 9 man/days.

In the aircraft acquisition and disposal process, Cathay was able to deliver consistently the following results within the last 10 lease returns (on time and on budget) and last 5 using electronic records:

Before

- 4 to 6 months elapsed time

- 15 – 24 man months of records preparation

After

- 3 months elapsed time (plannable)
- 9 man months of effort

The Table 1 (below), was extracted from Cathay presentation at the 2015 IATA conference. The column "Pre-DM Project (2012)" describes the status of the airline prior to adoption of Digital Records, Column "Post-DM Project (2015)" describes the status after implementation of the Digital Records, while column "Hong Kong $ (m)" is the monetized benefit that the airline collected in million of Hong Kong currency, and finally "Man Days" column refers to the gain in efficiency post project measured in days of work for one person.

Table 1. *Data Management Benefit Realization*

Description	**Pre-DM Project (2012)**	**Post-DM Project (As of 2015)**	**Hong Kong $ (m)**	**Man Days**
CX Risk Registry	No.5 on company risk register	Removed from risk registry		
ENG Risk Registry	No.1 on Eng risk register	Removed from risk registry		
Maintenance/AD task overrun risks	80 (Over 50% of which are data related)	Zero AD compliance errors as a result of data integrity		
Data Integrity Index	98% (2% = Red Traffic Light)	99.6% (Green Traffic Light)		
Component cost spending of lease return aircraft	ECC estimated 1m cost of component replacements per a/c	Actual reduction of 3.1M per aircraft (4 a/c in 2014 = 12.4m avoided)	12.4	

Improved RO Proforma	Unstructured Repair Order work scope causing uncontrolled cost (Value unknown)	Introduced in 2014. Part of 3M saving per year realized on similar ROs	3	
Issue Return AD	20% RO capture incorrect Part No/ Serial No. or inaccurate component hours/cycles (compliance). Corrected manually	Data correction reduction - 30 man days per month. Avoid incorrect works cope carried out – over-maintenance or out-of compliance risk, part of 2M saving per year	2	30
Duplicated item serial	Manual surveillance and correction	Avoid 180 corrupted events per month being corrected. Saving of 30 man days per month. Reducing of premature removal or out-of compliance, savings reflected above		30
Part Change	Manual data entry – effort and prone to errors	Saving of 410 man days		410
CADS & I/W per Asset Type (not yet delivered)	Configuration standards currently manually managed	Saving of 220 man days		

Gerald Frielinghaus, head of the "Paperless Maintenance" Program at Lufthansa Technik explained at the IATA Ops Conference that "electronic documentation, when used in combination with mobile devices, requires one-off data entry by the maintenance personnel

directly at the site when the information is acquired." With "paperless maintenance", Lufthansa Technik was not only saving paper, environmental resources, time and money, but, it was also accelerating the provision and transmission of information. It also made some work processes fully obsolete. Other processes, thanks to electronic documentation, were more streamlined, clearer, and less prone to error. Superfluous data entry was no longer necessary.

"Our colleagues working on the aircraft appreciate the new application. It brings noticeable relief in terms of necessary documentation work and allows personnel to concentrate more on their technical work," stated Dr. Rainer Sebus, who took over the leadership of the Program with positive immediate effect as Gerald Frielinghaus retired.

Jazz Aviation also embarked on the paperless/digital journey and reaped the following qualitative and quantitative benefits:

Quantitative Savings

- Went from 50% failure with the 'paper process' to 3% failure right away with the 'electronic process'. Today Jazz's record failure rate is below 1%.
- The upshot has been that Jazz has realized huge savings, in the region of USD $500,000 a year as soon as the new system was implemented
- Ensured optimal utilization of FTE (full time equivalent).
- Reduced the down time of the Aircraft and labor costs per check.
- Improved task card completion rate was already happening. It is making a big difference and will, ultimately, help Jazz to optimize resources more in the future.

Qualitative Savings

- New electronic process (optimized/removed steps/automated steps) drove the real savings by eliminating the inconsistent/inefficient manual paper process.
- Real Time data capture was driving more of a proactive process going back with BI (Business Intelligence) giving feedback and with improved Data Quality across all data flows, driving continual process improvement.
- Reduced walk time – having everything the mechanics need on their Tablets.
- Recently, one of the leasing companies stopped reviewing the paper records in favor of the electronic records. This contributed to improved time service for the entire leasing cycle.

Thus, the results experienced by Cathay, EasyJet, Lufthansa Technik and Jazz Aviation, when transitioning to digital maintenance records, demonstrated significant quantitative and qualitative savings in the aviation industry. The digital/paperless transformation would increase efficiency by:

1. reducing the need of resources to go through a redelivery process,
2. avoiding delays that will drive in additional leasing expenses,
3. reducing the amount of capital allocated to component changes due to lack of documentation,
4. making real time compliance with regulations,

In order to implement the digital strategy and benefit from significant savings and qualitative improvements, airlines need to invest in specialized software and new processes. With a massive adoption of a digital strategy, the entire industry will have benefits and become more cost competitive that either can drive increasing in margins/profits or reduction of ticket fare for customers generating more demand.

Chapter V

Conclusions and Recommendations

For safety reasons the Airline Industry demands a massive quantity of paper records to be produced, controlled and maintained over the lifetime of a commercial airplane. On average, a commercial aircraft have a life cycle of 20 years and produce 10,000 to 30,000 pages of maintenance records per airplane every year.

A commercial jet could reach an incredible 600,000 sheets of paper that need to be stored by airlines around the globe. These documents need to be readily available for regulatory agencies' audits and for airplane transitions.

The understanding that maintenance records assure safety will not change in aviation.

With this research study, we found a great opportunity for the aviation industry to shift from paper to digital records with several benefits.

We also found that digital records have been adopted by Hospitals, Judiciary and Real Estate industries and now are starting to be more common in the commercial aviation.

This shift seems to be inevitable and the early adopters are already collecting good results from the implementation of digital records in their maintenance areas.

Conclusions

This study demonstrated the advantage of adoption of digital maintenance records in lieu of paper.

Airlines are able to gain efficiency in the quality assurance process by reducing the number of labor hours required to review, store and retrieve maintenance records. Reduction of airplane transition costs and time is also a benefit of the digital records management.

For the regulatory agencies, digital records simplify audits and improve compliances.

Thera are some systems available in the market, such as AerData STREAM, Flydocs and AirVault, that are built to generate and control electronic maintenance tasks. These can also integrate to systems such as EmpowerMx that allow mechanics to sign off electronically the task cards.

The other important step to airlines achieve the desired results is the establishment of new internal processes that support the digital records technology.

One barrier that the industry faces today to move completely to an all-digital records industry is the lack of standardization. There are several regulatory agencies around the globe, for example: FAA (USA), EASA (Europe), ANAC (Brazil), DGAC (Chile), CAA (Canada), and CAAC (China), and not all regulators have a clear position on digital maintenance records. This situation forces lessors to require the airlines to keep paper records.

Lessors need flexibility of worldwide acceptance of airplane records so they can place airplanes anywhere in the world where there is a good business opportunity. For example, to move an airplane that is currently in Brazil to Australia under different Regulatory Authorities and rules.

The first large worldwide initiative was a creation of a committee comprised of major airlines, airplane manufacturers, IATA, Lessors and specialized software companies that already offer a digital records management system. This committee under the name of Paperless Aircraft Operation (PAO) has been working to define the industry standard that could be accepted by the regulators around the globe.

The committee already produced a draft of a guide for electronic aircraft maintenance records (EAMR), which will be an amendment to Airworthiness Manual ICAO Doc 9760 Air Navigation Work Programme (AIRP.009.01.EAMR).

The intent is to provide guidance to States on authorizing the use of EAMRs as an alternative to paper based aircraft maintenance records.

The committee working towards a standard in digital records need to move faster and bring FAA and EASA to be active parties in this effort. With the two major regulatory agencies worldwide on board the others will follow.

When the airline industry finally define a standard that will accepted by most of the regulatory agencies, lessors will be able to also accept electronic records. In addition, the airlines will then be able to move easily to the digital world.

Other point is that airlines needs to evolve in order to continue be competitive and viable. Margins of the aviation industry are rarely in the double digits. Historically, the industry has shown margins lower than 5%, therefore, inefficiencies need to be addressed. The airline industry has operated for too long under the shadow of paper documents.

The airlines need to help accelerate this change for the benefit of Industry by implementing digital records management systems and processes, even if they need to keep the paper process as a duplicated effort for the time being.

Recommendations

Based on the results of this research paper, the authors recommend that:

1. Airlines should move from paper to electronic maintenance records as soon as possible as change will result in:

a. Immediate elimination of missing returned maintenance records through automatic reconciliation;
b. Reduction to zero the labor and time spent with audits from lessors, which can take one person up to a full week accompanying the auditor onsite. Lessors will be able to audit by distance through access to airline system. Lessors will also reduce cost with travel;
c. Reduction of labor in quality assurance process in 50% or more as system can make reconciliation of 100% of the tasks that are produced and also verify that they have been properly signed off. Allowing for reduction in headcount in Quality Assurance department or increase of fleet maintain headcount.

2. Airlines need to move quickly to digital records to drive change in the industry. As end customer of the airplanes for lessors, airlines can influence the industry if they start implementing digital records systems and management and accept digital records coming from other operators. Lessors are just the intermediaries that will enforce what their next customer demands.
3. When industry moves to digital maintenance records the leasing community will be more efficient and able to pass cost reduction to airlines:
    a. Lease returns will be better planned with minor adjustments in the end of lease period. This will allow Lessor to be more precise on their contracts to the next airline;
    b. With on-time redeliveries, the airlines will avoid penalties on redelivery that in average is double of the lease rate per day of delay. Taking as an example

> a 787 lease that cost the airline $900,000 per month or $30,000 per day, a day of delay in lease return could cost the airline $60,000 per day and with the aggravating factor that airlines are not making any revenue with the airplane in this period.

Future Research Opportunities

Further studies within specific airlines adopting digital records would help build confidence with airlines to move in the same direction. There seems to be a reluctance of the industry in moving to digital records given that there is not much information on quantitative results achieved by airlines that adopted electronic records available that demonstrates the gains in moving from paper to digital records in the aviation industry.

A study on worldwide economic impact of the benefits of having the entire industry moving to digital maintenance records would also be a great leverage to push the industry to find a way to move to this new concept. This potential future study should include savings that can be gained by lessors, Regulatory Agencies, airlines and MRO's that have not been the focus of this specific study.

Key Lesson Learned

When the authors decided to research about moving from paper to electronic records in maintenance there was a common sense that it would be an interesting topic because of the potential immediate and sizeable benefits that the change would bring to the industry. What we did not foresee was the lack of information on quantitative results achieved by the implementation of such solution.

Our assumption is that airlines that moved to digital records either did not care for measuring the results carefully because intuitively the results would be achieved and were

significant or they do not want to share the information as the digital records adoption give them an advantage over the majority of the airlines around the world that did yet adopt this new technology and process.

Another point that the group underestimated was the size of the work that would be required to put together this study. We started with going to digital not only in maintenance but also in operations documents and quickly we realized that this would expand too much and turn the study too lengthy. If we could start again, the group would have reduced the study to one single process and go deeper into the analysis of the benefits.

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