The Aerospace Performance Factor:

How the APF is changing the way aviation views safety information

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Prepared for the
Flight Safety Foundation European Aviation Safety Seminar 2010
Lisbon, Portugal

Introduction.

How does a company best measure safety performance? What information provides the most comprehensive picture of an organization's ability to prevent accidents and unintended losses? Is there a way to present safety related data to decision makers that gives a clear view of how the organization's processes and safety programs are impacting operational performance? Answering these questions is an unending challenge to the aviation safety community. With the advent of a methodology known as the Aerospace Performance Factor or APF, and an APF trial program ongoing within easyJet Airlines, aviation is taking a giant step toward a decision management solution that answers these questions and paves the way toward a revolution in safety performance measurement.

This paper discusses the APF, its development, and how the methodology is being applied in a focused trial in the safety department of easyJet Airlines in the United Kingdom. The discussion begins by outlining the origins of the concept and the needs the APF aims to fill. The authors then explain the APF methodology, the resulting approach to displaying information to decision makers, and how the APF is being implemented at easyJet Airlines. Finally, future considerations and potential APF applications are presented that support the far reaching objectives of the international aviation community.

What are the Origins and Aims of the APF?

In early 2006, a small number of like-minded safety professionals first banded together to find a solution to a long standing and vexing problem in aviation – *How can the information available to an aviation organization be collected and mined to give an overarching and more complete view of organizational safety performance, and how can that information best be displayed to allow decision makers a clear and forward looking view of their safety performance.* The authors are members of this group. This cooperative effort was born from a chance phone call from which the group discovered that several different organizations were simultaneously seeking answers to these questions and pursing nearly identical methods to find the solutions.

The APF evolved from supportive efforts within the US Federal Aviation Administration (FAA) Air Traffic Operations Safety organization, and also involved the US Naval Safety Center, easyJet Airlines (UK), and the Imperial College of London. These organizations understood that historically, the aviation system has relied on basic metrics associated with traffic counts, delays, flight cancellations, incidents, accidents, etc. to gauge performance. These measurements never really evolved past the 'sophistication' of ratios, or were fully integrated into a system-wide performance measurement tool. easyJet recognizes the challenges associated with the systemic trending of performance, specifically safety performance, and has taken proactive steps to address this in the evolution of their Safety Management System (SMS) capability. The development of the APF is a focussed effort to develop a 'safety tool' to assess practical drift in an airline and meet the easyJet operational need.

The Aerospace Performance Factor methodology aims to graphically present a system's performance, initially safety performance, over a long period of time by comparing past and present performance against a specific and organizationally accepted baseline. The intent is to include all data of a large-scale operation, and the relative significance, or weighting, of one data set to another, to provide a balanced measure. The APF is a representation of system performance designed to operate, not as a sole indicator of performance, but as part of a larger system of processes, data mining and analysis practices, and organizational goals attainment measured as an integrated set of metrics.

In essence, and perhaps in its simplest form, the APF is a means to look at information in a different way for the purpose of making better decisions for an aviation organization. The underlying premise of the APF is rather uncomplicated:

- Decide what information is important to the organization;
- Figure out which of those pieces of information is the most influential on the performance of the system and by how much;
- Trend the information over time to determine aggregate organizational performance.

This straightforward approach can be applied to any division or function of an organization. It presents a distinctive way to look at performance in general, but offers unique support to an organization's risk reporting requirements and management's tracking of risk solutions. While the methodology is applicable to any part of a company's operating systems, the starting point in aviation, and at easyJet in particular, is safety.

Why Apply the APF to Safety First?

The Challenge of Safety Information. There are a number of reasons why using the APF to tackle challenges in the safety community is the perfect initial application. First, there is an understood need within the safety community to look at safety performance differently. It is safe to say that the aviation safety community is more motivated to install a new means of looking at performance because of a unique characteristic of the community: *success in safety is the absence of loss, and proving the basis for this success is extraordinarily difficult.* The aviation safety community also understands that the future success of commercial aviation depends upon the improvement of aviation safety performance. Both the NextGen and SESAR initiatives, the efforts in the United States and Europe respectively to prepare the air transportation systems for the anticipated increase in air traffic in the coming decades, have as underlying assumptions that the current rate of aviation accidents would produce numbers of losses unacceptable to sustain public confidence. The safety community understands that it must provide new ways to measure and improve safety performance to take the next big step toward the level of safety performance needed to support these broad reaching initiatives.

There are two aspects of dealing with safety information that currently limits its usefulness. First, safety information is typically reactive in nature, usually generated only when something goes wrong. Thus safety performance is typically measured as the freedom from misfortune or the length of periods between mishaps. Secondly, safety information tends to stay within its own silo. Safety data is not updated as often as operational data, nor is it based upon the same data inputs or parameters as operational information. It is therefore viewed separately and is difficult to relate directly to other organizational information. In the easyJet example, risk stakeholders view a manual representation of safety information and system risk once per month. easyJet seeks to break away from traditional safety performance measures with an enhanced capability to interpret a safety boundary or practical increase of risk per department. The desired approach would provide safety information to decision makers with increased regularity, increase the capacity to integrate safety information with operational needs, and provide a user friendly platform to more easily access objective safety performance information that is referenced against a historic baseline.

Let us address these two aspects in more detail.

Safety Data Collection. Traditionally, safety performance in aviation has been measured by counting the number of undesirable events that occur. There are many different names for the same category of event – accidents, mishaps, incidents, near-misses, operational errors, etc. They all describe something that has occurred other than that which was intended and resulted in an unacceptable deviation from standard practice and procedure, or worse the loss or damage to valuable assets, reputation, financial performance, or the injury or death of people.

After the undesirable event takes place, the aviation community initiates an investigation to discover why the event occurred and put in corrective measures for the purpose of ensuring it does not occur again. The rigor and energy put into the investigation, and the dedication of resources put toward correcting the causes of the event tend to vary in direct proportion to the severity of the incident and the resulting amount of damage or loss of life.

This way of dealing with safety information is analogous to driving a bus with eyes fixed to the rear view mirror, always looking backward at the things that have already passed by. While the aviation operations bus is forever on an express route and continues to roll on, the “safety driver” watches in his mirror as the incident gets smaller in the distance and the investigation teams tries to figure out what went wrong.

Operational Data Collection. In the meantime, in front of the operations bus are vast expanses of information from the present position all the way to the horizon. Long term, mid-term and near term plans are shaped and executed; weather forecasts impact near-term operational schedules; potential passengers make travel plans based on projected flight schedules and airfares; scheduled and unscheduled maintenance efforts strive to keep the fleet in revenue generating shape; flight operations continue unceasingly generating data on flight, flight crew, aircraft and maintenance performance. Data continues to pour into the organization and *much of this data has an impact on its operational risk and safety.*

In aviation organizations, the operational data streams are generally viewed with greater interest and urgency than safety information. These data are updated very frequently, give visibility into the events and factors that impact daily activities, and can be readily modeled for the purpose of forecasting future activity and operational output since they directly indicate process results.

There is a major difference between these two categories (safety and operational) of aviation information. Operational information is generally *expected* information. The variance of the data day to day and week to week is minimal, the reasons for deviations are comprehensible and often intuitive, the sources and types of data are easily understood, and the data relationships are readily grasped. On the other hand, safety data is *unexpected* information. Undesirable events are out of the ordinary, they are not predictable (at least not at present), and the relationships between the inputs and the results of the mistakes are not easily related or understood without a thorough investigation. Safety information is provided infrequently and is underreported, even in the most conscience safety programs, and the information is not easily mined since the most valuable sources are the stories and experiences of those involved. As with any human endeavor, the greatest interest and energy goes towards that which is easy and simple. In our case, the effort goes toward collection and analysis of operational information versus safety information.

Goals of the APF. Given these factors, the aviation community would benefit greatly from a means to view operational information with a safety bias, and safety information as a component of organizational operations. Integrating these information categories would provide a regular safety input to operational analysis and discussions, and provide a forward looking operational view to safety performance. The goals of the Aerospace Performance Factor are to answer these needs.

The goals of the APF methodology are twofold:

- Improve the integration of safety information into organizational and operational decision making
- Shift the focus on safety information to a full field of view looking forward as well as backward

Before discussing how the APF helps to achieve these goals, we must first describe the APF methodology and its intended uses within the flying organization.

What is the APF Methodology?

The first experimentation and application of the APF methodology occurred in the Air Traffic Management (ATM) community. The efforts of the United States Federal Aviation Administration and EUROCONTROL are documented in previous papers on the APF, as is a thorough background to the APF methodology as it is applied for use with air navigation service providers.[1]

In this paper the methodology is summarized in general, and then described in more detail as to how it is applied for use in a flying organization, specifically the progress of the initial APF project ongoing with easyJet.

The APF methodology is, at its core, quite simple. It can be described as a five step process, not unlike an aviation checklist:

- ✓ Determine the organizational factors that influence performance
- ✓ Determine the information available on those factors
- ✓ Organize the influencing factors
- ✓ Determine the relative importance or weighting of the factors
- ✓ Display information for decision makers

Let us take a look at each of these steps individually and explore how they provide a new and improved way to view organizational safety performance.

Determine Organizational Safety Factors. Recall that one of the goals of the APF is to give a more integrated and forward looking view of performance to organizational decision makers. In order to do that, the organization must incorporate data and information from all available sources, not just the traditional information that resides in the safety department.

In addition to the attitudes of Senior Management, the safety performance of an organization is directly influenced by the procedures and practices developed in all departments. Safety performance is influenced by the behaviors and performance of maintenance department personnel. Safety performance is influenced by the physical abilities and actions of the pilots and flight crew. Factors such as these are difficult for the safety department to track because they do not normally "own" the data unless the data comes from an incident or accident investigation. But factors such as these must be taken into account to get a complete picture of safety performance.

The APF methodology as it applies to safety begins by determining what organizational factors have an influence on safety performance. This is accomplished by convening a panel of experts from the different divisions within the organization. In an airline, the panel might consist of representatives from senior management, flight operations, dispatch, training, maintenance, flight crew (pilots and flight attendants) and the safety team. In a smaller flying organization, the panel might have fewer members, but those members should have broad reaching knowledge of all organizational divisions. It might seem logical for the panelists to be the safety representatives from the individual divisions, but there is great value in including panelists with no specific administrative responsibilities to the organizational safety processes. Persons from outside the safety structure can come in with fresh eyes and no bias toward one or more particular sources of information.

Here are examples of the types of safety factors the easyJet subject matter experts selected as inputs to their safety APF:

- Unstable Approaches
- TCAS Alerts
- Maintenance Documentation Errors
- Animal and Bird Strikes
- Aircraft Configuration Issues
- Passenger Issues
- ATC Communications
- Airport Jet Bridge Procedures
- Airport Ramp Lighting
- Runway and Taxiway Lighting and Markings

These are ten examples from a list of nearly 450 data inputs easyJet is using to feed their safety APF.

Determine Availability of Information. It is very important that the panel members have a strong background in the types and formats of information gathered in their division. It is important because the data collected for analysis must be able to show the history of the organization. One of the functions of the APF is to track performance over time, thus the input to the APF must come from current data sources that have been in place for a reasonable period.

Using currently available organizational information has two important benefits that enhance the use of the APF. First, available data will already be familiar to decision makers. There is no learning curve to understand the source and value of the information. Secondly, using data that already exists and is routinely collected by the organization minimizes or prevents any additional tasks being placed upon any employees. This is vital for organizational acceptance of a new concept such as the APF. Even if there is no additional labor required to collect APF related information, the perception of additional tasks can pose a risk to the success of the effort. Experience has shown that a data analyst can perceive an unacceptable increase in workload even if the required tasks to support the APF involve nothing more than sending via e-mail an already developed and formatted report to an additional recipient within the company.[*]

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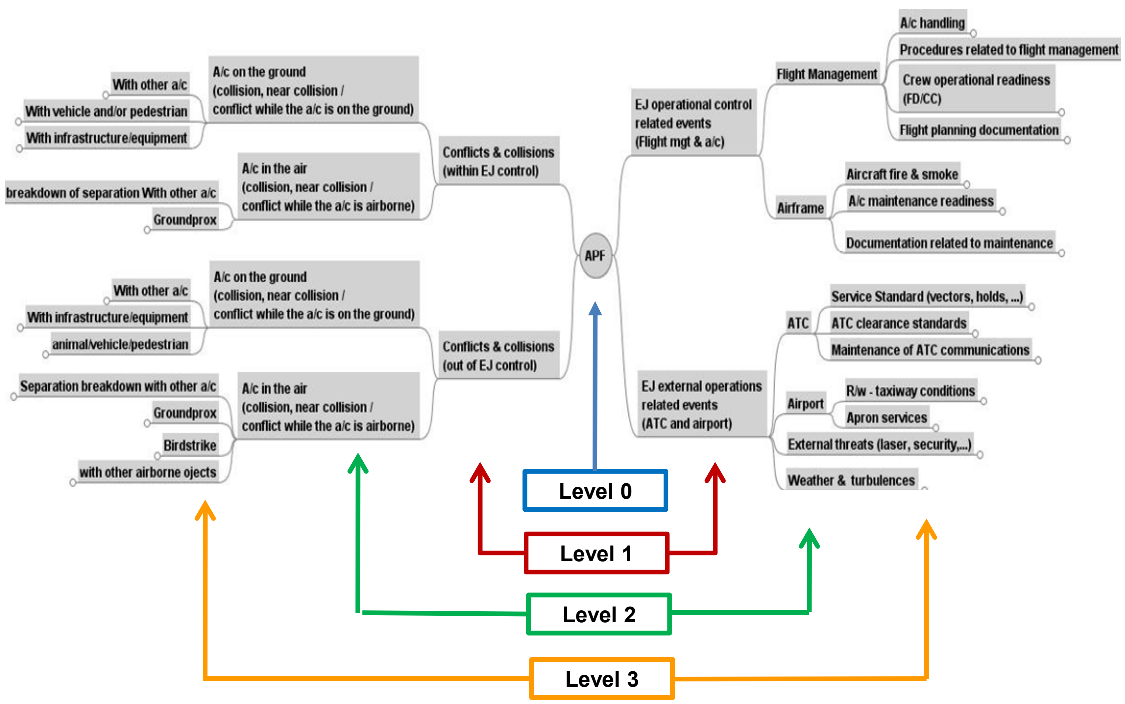
[*] During the initial 2006 proof of concept project on the U.S. Navy's Operational Risk Management Assessment System (ORMAS - the Naval Aviation equivalent of the APF), two helicopter squadrons were selected as the test organizations. In one of the squadrons, the currency of the information displayed by ORMAS was compromised by the reluctance of certain squadron personnel responsible for the

It is very possible that during the course of deliberations, the panel of experts could determine that a certain performance measure would greatly enhance the view of organizational safety performance, but that piece of information is not collected at present. In this situation, it must then be determined how the data can be collected, if there are additional costs to the organization to gather the new data, and how long it will take to establish the process before data is available. Provisions can be made in the APF structure to allow for the addition of the new data element in anticipation of its future use as an APF input.

Organize the Influencing Factors. Once the expert panel has determined the organizational factors that could serve as inputs to the APF, the next step is to organize the factors. The data elements are organized into categories and form what is called the APF Mind Map. The Mind Map is a graphical depiction of the categories and relationships of the selected data elements. An example of an early easyJet APF Mind Map is shown in Figure 1. The Mind Map consists of branches and levels that organize the APF inputs into related categories.

Figure 1: Example an early easyJet APF Mind Map



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transmission of ORMAS data inputs to perform their assigned tasks in a timely manner due to a perceived increase in workload. In each case, the additional required task involved no more than an additional three or four computer key strokes, or attaching an already produced and distributed document to one additional e-mail. Thus the perception of added work can serve as a challenging road block to success.

The Mind Map not only provides the foundation for the development of the APF, but aids the company as a whole simply by going through the APF development process. During the course of Mind Map development, those participating are able to either review or learn in greater detail about the types of information collected by the organization. Through this data source review, the Mind Map participants are asked to view the company information in terms of data relationships rather than as individual indicators. The information gathered to form the Mind Map begins to show in more depth how the processes that yield data in one part of the organization affect the output of processes in other parts.

Finally, the data elements organized in the Mind Map framework create the foundation for the development and structure of the APF and its displays. But the information alone, even when organized in a disciplined manor, cannot provide optimum value to decision makers unless each data element is given a level of importance within the organizational system.

Determine the Relative Importance of the Data. There are any number of ways to categorize the information that is generated through the daily functions and processes of a flying organization. What makes the APF methodology different is the way each APF data element is given a weighting of its global importance to the safety performance of the organization as a whole. It is the weighted data elements that act as the input to the APF displays.

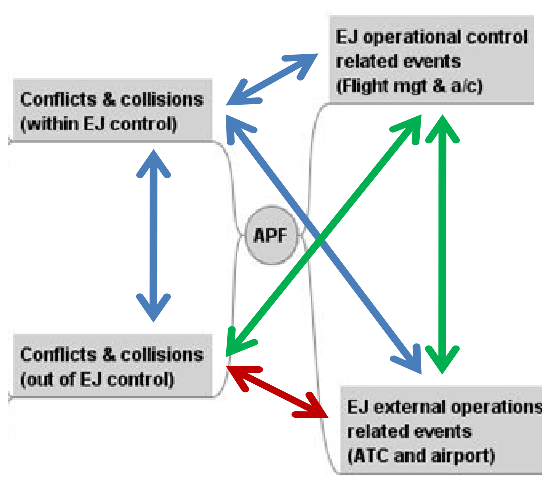
The overarching goal of collecting information is to provide decision makers with actionable knowledge about the needs of the organization. Individual pieces of information can tell a piece of the organizational story; such as how a particular change in maintenance procedures has produced an improvement in aircraft systems performance, or how starting engines away from the gate saves a certain percentage on annual fuel consumption. But these individual pieces of information do not give decision makers a holistic view of their system. Without a measure of the relative importance of each system input or data element, which particular pieces of information warrant action, and what the real impacts of those actions are, is problematic.

For that reason, the APF methodology utilizes the Analytical Hierarchy Process (AHP) to provide data element weighting and give a greatly increased level of validity and value to the information presented to decision makers. AHP is a decision making process that narrows the number of choices available to the decision maker to those most logically effective. This narrowing of choices is based upon the opinion of subject matter experts and their views on the influence of the various inputs on the system as a whole or on the decision to be made.[2]

In practice, the APF methodology does not make use of the entire analytical hierarchy process. Taking AHP to its conclusion yields a decision recommendation based on a comparison of the relative importance of the inputs available to answer a specific query. The APF stops short of a decision recommendation and simply uses AHP to relate the data inputs as to their level of global influence on the safety performance of the organization.

As stated, the level of importance or value of influence to the system is determined by sampling the opinions of the organization's subject matter experts (SME). In applying the AHP, each member of the panel of experts is asked to complete a set of pair wise comparisons on the elements in each data category within a level of the APF Mind Map. For example, in the easyJet Mind Map, the SME is asked to first compare each of the four primary categories of information (Level 1) comprised in the APF (Level 0). They are asked to render their opinion as to which category has a greater influence on the safety of easyJet Airlines. They would start by comparing Conflicts and Collisions (Within EJ Control) and easyJet Operational Control Related Events (Flight Management and Aircraft). Then they are asked which has the greater influence between easyJet Operational Control Related Events (Flight Management and Aircraft) and easyJet External Operations Related Events (ATC and Airport). They then move to a comparison of easyJet External Operations Related Events (ATC and Airport) and Conflicts and Collisions (Out of EJ Control). This process continues until all possible pairs within the level are covered. (See Figure 2). In each comparison, the SME is asked to render an opinion as to the degree to which one has a greater influence over the other. This is accomplished using a numeric scale. An example scale might be from 1 to 9, where a value of 1 means they have equal influence to the opposite extreme of a 9, one element is extremely more influential than the other.

Figure 2: easyJet APF Pair Wise Comparisons for Level 1



easyJet APF Level 1 Pair Wise Comparisons:
Which has a greater influence on system safety performance?

This same AHP comparison method is completed for the subcategories at Levels 2 and 3. For example, the SME would then move to comparing the Level 2 data subcategories within easyJet Operational Control Events (Flt Mgt and A/C) (Level 1). In this example, the comparisons would be done by paring up the two Level 2 subcategories: Flight Management and Airframe. The pair wise comparisons are completed at Mind Map Levels 1 through 3. (See Figure 3.) Going beyond level three in the easyJet case would bring too many data elements in play for weighting. (See Figure 4 for an example of the number of data elements that populate a subcategory at Level 4.) Going beyond seven elements in a comparison group can interject a level of complexity that minimizes the consistency of the comparisons. The consistency of comparisons is evaluated for each SME and for the panel as a whole once the pair wise comparison exercise is complete. The consistency evaluation ensures that if an SME made the comparison that Element A was of greater influence than Element B (A>B), and that Element B was greater than Element C (B>C), the SME did not then rate Element C as having a greater influence on the system than Element A (C>A). If the SME did, then he would be asked to review his evaluations.

Figure 3: easyJet APF Mind Map Subcategories at the Different Levels for Pair Wise Comparison

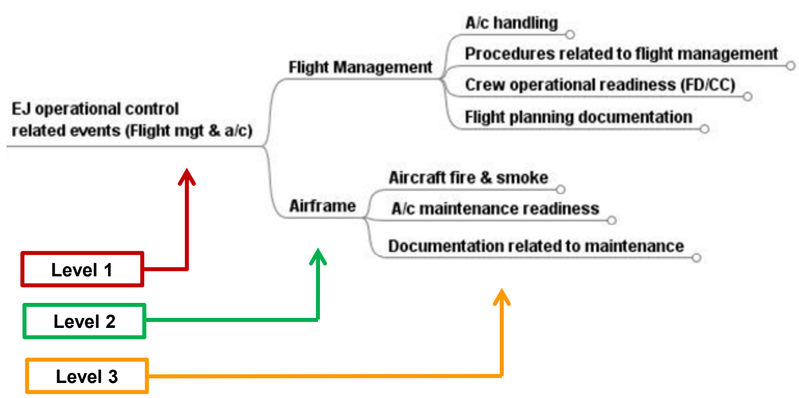
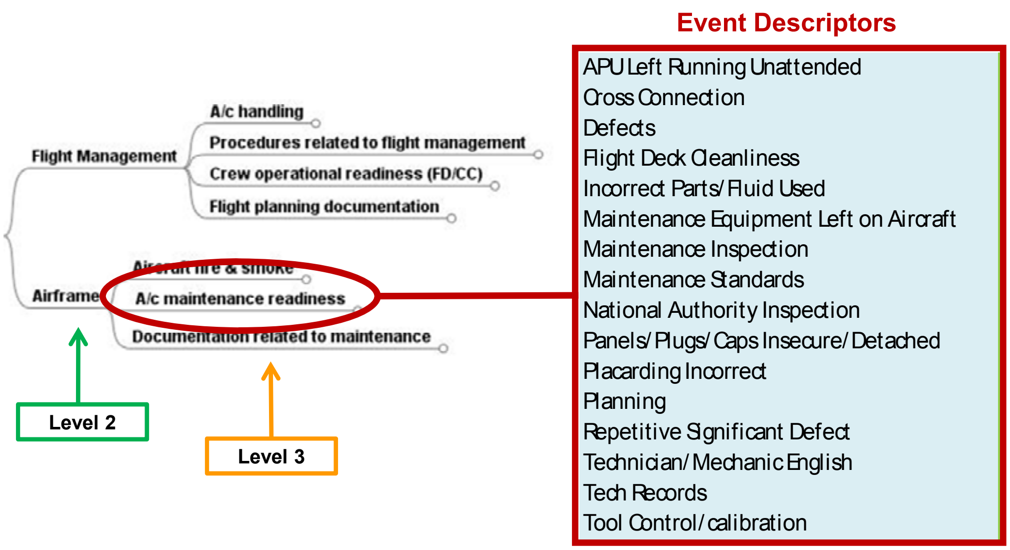


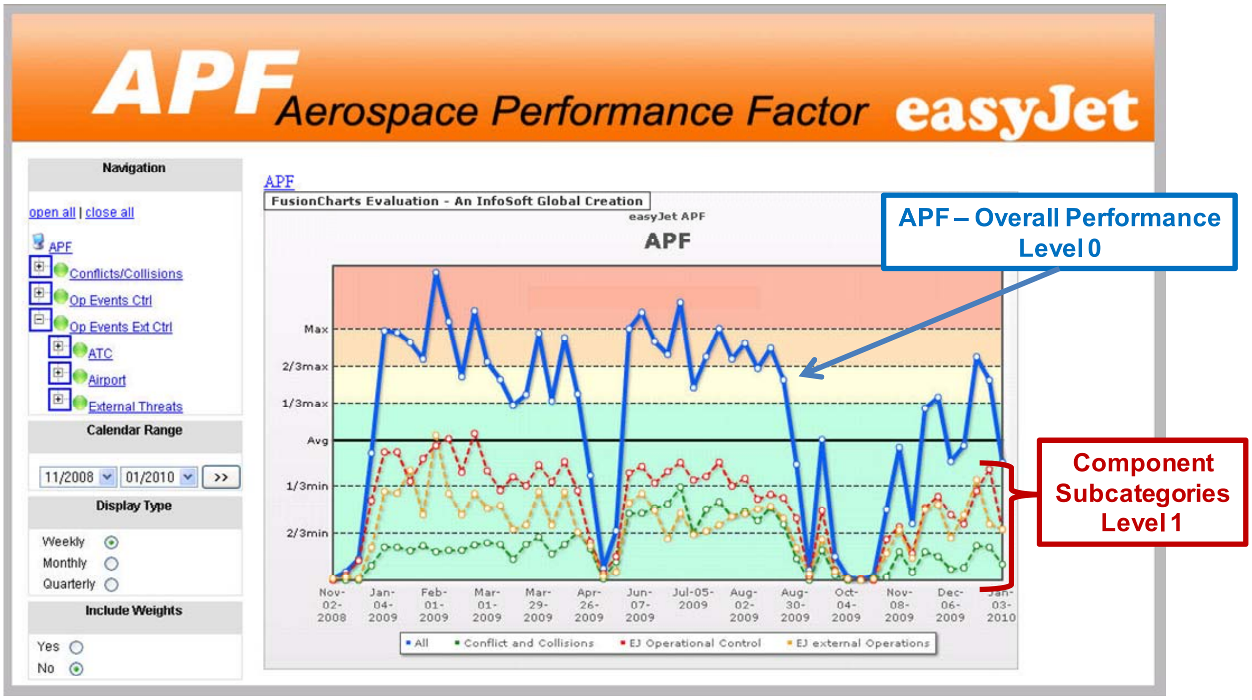
Figure 4: Example of easyJet Data Inputs to APF Mind Map Levels



In the case of easyJet, the AHP pair wise comparisons and the subsequent calculation of the data element or category weighting factors were accomplished using an AHP based software program called Expert Choice. The output of the software used is an individual weighting factor for each APF data element. These weights are then fed into the APF calculations to generate the displays of safety performance that are the output of the APF.

Display Information for Decision Makers. The final step of the APF development is the display of the information to decision makers. The display is intended to provide a comprehensive and intuitive picture of organizational safety performance. This is done by graphically displaying the weighted Mind Map values as they change over time. The main easyJet Trial APF display page is shown in Figure 5. The easyJet Trial APF is populated with sample data made available for the trial rather than current operational data.

Figure 5: easyJet Trial APF – Main Page

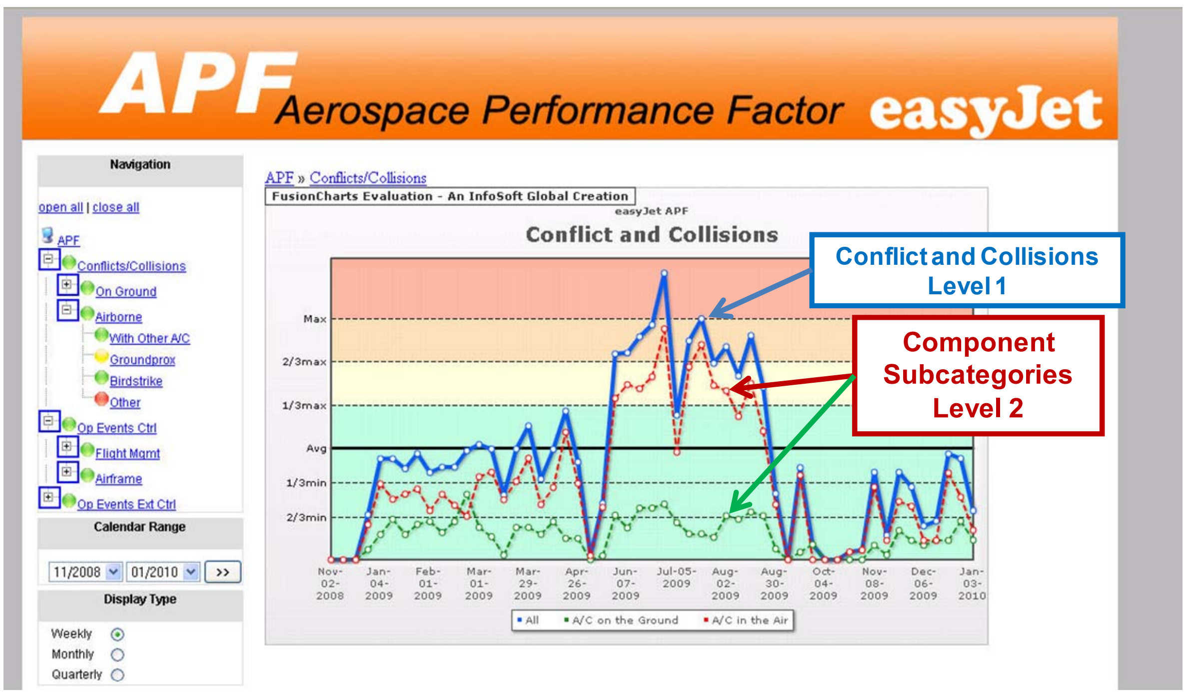


What the APF display is showing the decision maker is a view of safety performance over time. The APF trend line (the solid blue line in Figure 5) gives the overall level of performance over the period of time displayed on the X-axis. The APF trend line is given meaning by establishing a baseline level of performance so that decision makers are given a visual picture of their company's current performance as compared to a specific period of time where company decision makers determined that the level of safety performance was acceptable. In the APF model for easyJet shown here, the simulated period of acceptable safety performance is from March through April of 2009. The maximum, minimum, and average APF values for that period establish the min, max, and avg displayed on the Y-axis. What this offers decision makers is a view of when the performance is exceeding the established maximum acceptable level of performance (perhaps an indication of negative performance), when the performance falls below the minimum value (a potential increased level of positive performance), and the overall trends of performance in the predetermined and related operational areas. Each of these conditions would warrant further analysis and investigation as to why these changes occurred.

The APF line or graph is the result of the summation of the component lines (or weighted categories) shown by the dashed lines in the lower part of the chart. The higher the value of the component category (the higher the Y-axis value of the dashed line) the more influential that category has on the APF value. In the easyJet trial APF, the most influential Level 1 category is easyJet Operational Control Related Events (Flight Management and Aircraft), labeled on the screen as EJ Operational Control and shown by the dashed red line.

From the main page, the user is able to drill into the individual categories to get a closer, more detailed look at the organization's performance. This can be done by clicking on a specific subcategory line or by selecting the subcategory from the expandable navigation menu on the left side of the screen. An example of a Level 1 subcategory display is shown in Figure 6, which in this case is showing Conflict and Collisions. The information in the subcategory is displayed in the same manner as the parent level. A status light for each subcategory is shown in the navigation menu. The lights show the current status based on the latest data input to the APF. In this example, while the status of Conflict and Collision is currently Green, there are two Level 3 subcategories (A/C In the Air/Airborne being the Level 2 subcategory) that indicate values approaching or above the maximum. The drill down can continue to Level 3 of the Mind Map and would allow for further investigation as to what factors are causing these adverse values.

Figure 6: easyJet Trial APF – Level One Drill Down Example



Past Level 3, the weighting of the components reaches a level of complexity that limits the usefulness of the AHP. An additional format of data display for Level 4 categories and higher in the easyJet model is under development at the time of this writing. The intent of the Level 4 displays, or Diagnostics Pages, is to show the number of occurrences for each individual data element that populates the APF categories, and potentially the percentage of contribution to their subcategories. A practical application or the APF is to guide decision makers toward the specific areas of organizational performance that are causing degradations in performance and may be in need of dedicated resources. The drill down function of the APF provides that vision and guidance.

How Does the APF Support easyJet's Safety and Risk Management Efforts?

For easyJet Airlines, the primary aim of the APF capability is to represent operational risk from current operations to the Senior Management Team (via the Safety Action Group and Safety Review Board) in a clear and understandable format to focus the direction of resources to reduce future risk. Additionally, easyJet is adopting the APF methodology to enhance their capabilities to manage risk and improve safety performance, and as a means to support and meet the requirements of international aviation safety initiatives. The easyJet APF is thus designed to assist in visualizing the performance of a department and hence aggregate information to show total company wide performance.

easyJet views the APF as a constant, real-time risk representation tool for both current and historical information that supports decision making. Incorporating the APF into their business practices will provide two important capabilities:

- A means to quantify company risk levels for simplified analysis and appropriate escalation of risk with numerical departmental 'Risk Boundaries and Baselines'.
- Daily Performance Risk Factor calculations are made available to enable trend analysis and fast subsequent 'drill down' to 'causal' factors behind operational events.

These capabilities help the airline meet the goals, guidance and requirements laid out by the International Civil Aviation Organization (ICAO) and their requirements to implement and support a Safety Management System (SMS), as well as the HILAS (Human Integration into the Lifecycle of Aviation Systems) project to improve safety performance measurement.

Supporting ICAO SMS Requirements. The International Civil Aviation Organization Safety Management Manual calls for an airline's SMS to be *systematic*; where the SMS employs a range of safety tools within a 'toolbox' to support hazard identification and safety risk management.[3] Safety tools are applied in context (of the risk) by suitably trained safety officers to support task assessment.[4] The nature and type of tools employed are commensurate with the size, nature and complexity of an airlines operation. The safety tools can be categorized into *reactive*, *proactive* and *predictive* capabilities and are embedded within an operator Risk Management System (RMS).

These 'risk logics' support the continuous monitoring of operational activities through the collection, evaluation and analysis of routine safety data on hazards to detect 'practical drift' from an acceptable performance safety baseline. easyJet sees this as a primary output of the APF. This capability in turn allows evidenced based organizational decisions on safety risks and their control.

The ICAO Safety Management Manual goes on to state that formally capturing what takes place within 'practical drift' as 'collective domain expertise' holds considerable learning potential for the control of safety risks. The APF methodology allows easyJet operators to integrate multiple sources of safety information, gleaned from the evaluation and investigation of system hazards, into a 'converging indicator over time' from which to evaluate systemic safety performance trending against an acceptable baseline indicator. Therefore, easyJet views the APF as an integral supporting tool for the success of the airline's safety management system.

Supporting HILAS Improvements in Safety Performance. HILAS was a project supported by the European Commission's 6th Framework Program between 2005 and 2009 and was focused on using Ergonomic/Human Factor knowledge and methodology in addressing key issues of performance, including performance for safety in the aviation sector mainly in flight operations and maintenance. A series of five SMS Workshops was organized in the project in 2008-2009 where partners from five airlines, three maintenance providers and eight research organizations in Europe integrated knowledge on SMS from their respective perspectives. The following is an extract from the summary of a Risk Management System Review conducted by participant airlines in the HILAS SMS workshop series. The findings are pertinent to current airline capability and needs, and understanding the representation of operational risk and performance trending over time.

> *"Accountable managers within all levels of the airline organizational structure need to have an appreciation of the risks they own. Risk representation that is not transparent and easily assimilated causes managers to defer to individual investigations to understand the nature of the risk exposure".*[5]
>
> *"Airlines have multiple sources of safety information within their SMS, which are collected across individual departments however they are not effectively integrated into a Knowledge Management System (KMS). Airline investigators and FDM (Flight Data Management) analysts appear to be manually extracting information from the aircrew management system, Flight documentation (flight plans, weather, and journey logs) and/or crew training records. Safety Reports do not appear to be linked into FDM. Fatigue Risk Management System (FRMS) investigations appear to be standalone. Some airlines may have a statistical analysis tool, e.g. SPSS, installed, however, it appears that data will have to be extracted manually and then re-entered into this program to enable limited proactive analysis of safety information. In addition, safety reports and audit reports appear to be managed separately within the safety data-base platform".*[6]

easyJet views the APF as a means to address both of these issues; issues that seriously hinder the improvement of both safety performance and overall airline performance, and degrade airline decision making.

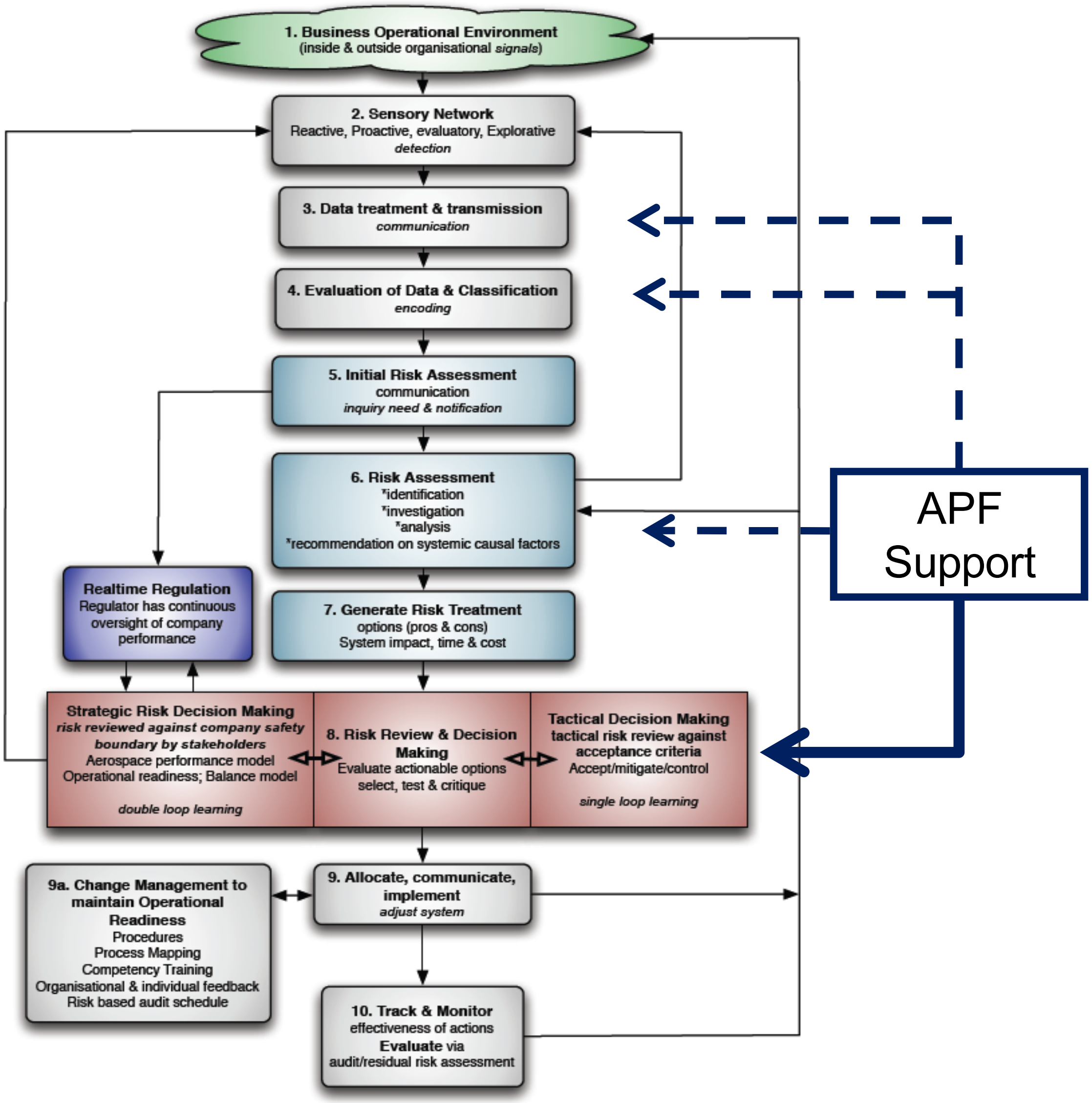
Supporting Increased Safety Performance Reporting Periodicity and Risk Management. The airlines within the HILAS project generally report safety performance to Safety Action Group (SAG) or Safety Review Board (SRB) meetings on a monthly basis. The airlines present company system risk via a number of various report and chart formats. This representation is typically a manually generated amalgam of reactive incidents (Air Safety Reports and FDM events) for a reporting period that are risk graded and weighted (against the risk category) and summated (normalized against number of flights or flight hours). This current representation has no drill down capability into contributing individual departments and sub department levels. The data utilized is updated manually each month based on risk level. The representation can be biased by individual department high-risk events distorting the perception of the whole system performance. In order to present to the SAG and SRB an analytically credible baseline for operational risk and measurable changes from that baseline, the operation needs to account for the frequency of safety events/measurements and be able to differentiate between event categories (i.e. unstable approaches, step events), through application of risk weighting factors applied by domain experts (experts within each department that allocate the weighting of risk for the event categories) within the airline operation. easyJet intends to meet this need by incorporating and integrating APF capabilities into the Systems Integrated Risk Assessment (SIRA) Model.

easyJet and HILAS developed a risk management framework to suit an aviation SMS known as the SIRA Model (Figure 7).[7] The process integrates safety assessment, multi-criteria decision making and organizational learning. The process is based on a risk radar approach, acting as a system sensory net, scanning the risk environment and gathering a wide range of technical, human performance and system data. The data is managed within the company in safety and quality database (e.g. Aviation Quality Database-AQD) and an intelligence process classifies and analyses causal patterns. This drives decision-making, intervention design and monitoring against the operational system. The cycle then continues utilizing feedback loop processes as a function of risk management from both strategic and tactical interventions. As a result, the SIRA process embodies strategic organizational learning with a reporting stage based on a risk modeling platform and a weighted risk boundary calculation index.

The APF supports the SIRA Model at several levels. The most significant contribution is made to Step 8 of the model. This stage of SIRA reflects the tactical and strategic processes represented as system cogs. The smaller tactical cog spins faster than the larger strategic cog, and shows tactical management of risk being dealt with in silo activity for day to day, time critical risk decisions set against safety criteria. The strategic cog spins slower as it reviews all system inputs against a safety boundary facilitated by the APF before initiating strategic investigations and change management.

The strategic process involves the risk stakeholder group and is actioned through the board safety reporting meetings monthly and the management quality review meeting quarterly. Real-time regulation is supported by National Aviation Authority Flight Operations Inspector (FOI) access to the APF tool which provides access and risk transparency at all organizational levels. Links from the APF graphical representation extends into the company risk registers facilitating continuous risk oversight of the operation. This process allows performance based regulation instead of simple binary compliance and facilitates the regulator to design focussed audits which benefit the airline. Where SMS performance and risk management practice is within mutually accepted tolerance levels, the APF provides evidence for the insurance community on risk signature, and evidence to the regulator for a reduction in formal oversight visits and regulating authority fees.

Figure 7: easyJet APF Support to the SIRA Model



Conclusions.

The ultimate purpose of the APF is to provide decision makers with a picture of safety performance that yields actionable knowledge. Organizational information displayed using the APF methodology has three distinct benefits in the decision making process. First, it provides a trended view of safety performance over time. Second, the drilldown feature of the APF displays allows decision makers to identify likely reasons for excursions of the APF values outside of predetermined acceptable performance limits. Finally, the APF Methodology allows decisions makers to use this knowledge, knowledge derived from their own internal information and synthesized by their own subject matter experts, to better direct the utilization of resources.

This paper has shown how an APF is developed for an organization, examples of how the APF information can be displayed to support decision making, and how easyJet airlines envisions the APF, currently under a trial implementation in the airline's Safety Division, enhancing the success of their safety management system and risk management abilities.

The future vision for the APF is the evolution of the methodology into a means to forecast risk. The APF currently categorizes organizational information and trends the data over time. The next steps involve the modeling of the information and the development of simulation methods that allow decision makers to look at potential APF values and outcomes. The goal of risk forecasting is to identify the likely conditions that could result in a mishap or serious incident. Initiating proactive, preventative actions to ensure the protection of the people and assets and make an organization more successful or profitable is the ultimate goal of all safety professionals. The introduction of the Aerospace Performance Factor to the aviation industry is a giant step toward achieving that goal.

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