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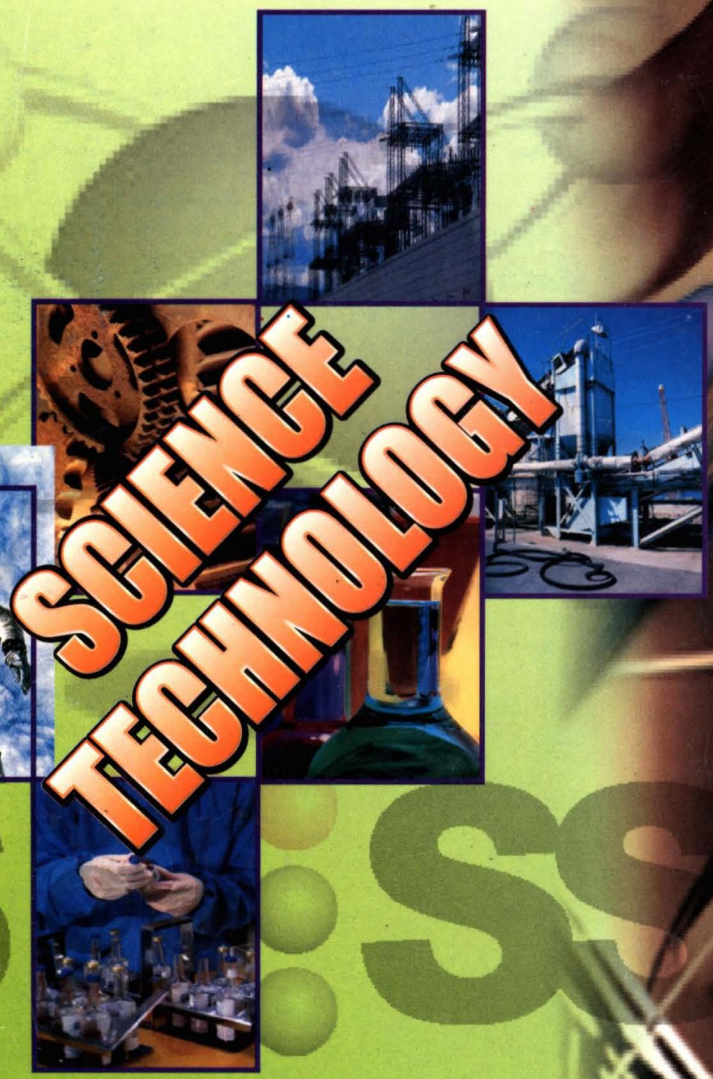

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Equipment Condition Monitoring System of Grounded Aircraft Propeller Engine: A Prototype Semi-Manual System

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ABSTRACT

The paper outlines the comprehensive and concise doctrines of the prototype of Equipment Condition Monitoring System (ECMS) of a grounded propeller engine of an aircraft. The intended engine is used by students of aviations in lieu with the modules of subjects offered at Universiti Kuala Lumpur Malaysian Institute of Aviation Technology. The condition of the engine, thus, should be at its zenith without constant breakdown or malfunction. The research group of this project projected a procreation of a prototype of ECMS to monitor this particular engine with the purpose of reducing the frequency of corrective maintenance. Corrective maintenance ushers the engine unusable during the tenure of the maintenance process, hence, accommodation of lectures is not parlayed. The paper discerns methods, postulations, axioms, and peripherals of the ECMS and the benefits of actuating this system.

Keywords: *Equipment Condition Monitoring System (ECMS), grounded aircraft propeller engine,*

Introduction

Equipment Condition Monitoring System

Equipment Condition Monitoring System or the acronym ECMS denotes a system that monitors the health and condition of an entity or subject particularly an aircraft (or the subset of an aircraft) with regard towards the peripherals and sub-components of the aircraft (Neilson 2002a). ECMS is deployed to achieve a prediction on the liability and life cycles of individual components that reside on an aircraft (Neilson 2002b). Within this context, spares of equipment or parts of the aircraft could be procured based on the diagnosis pertaining to the condition of the aircraft, thus, rendering optimization of the procurement process with the purchase of only gravely needed peripherals bounded by a pseudo accurate time frame. The paper elucidates the intended programme of ECMS that would be instilled upon the grounded propeller engine of the designated institution.

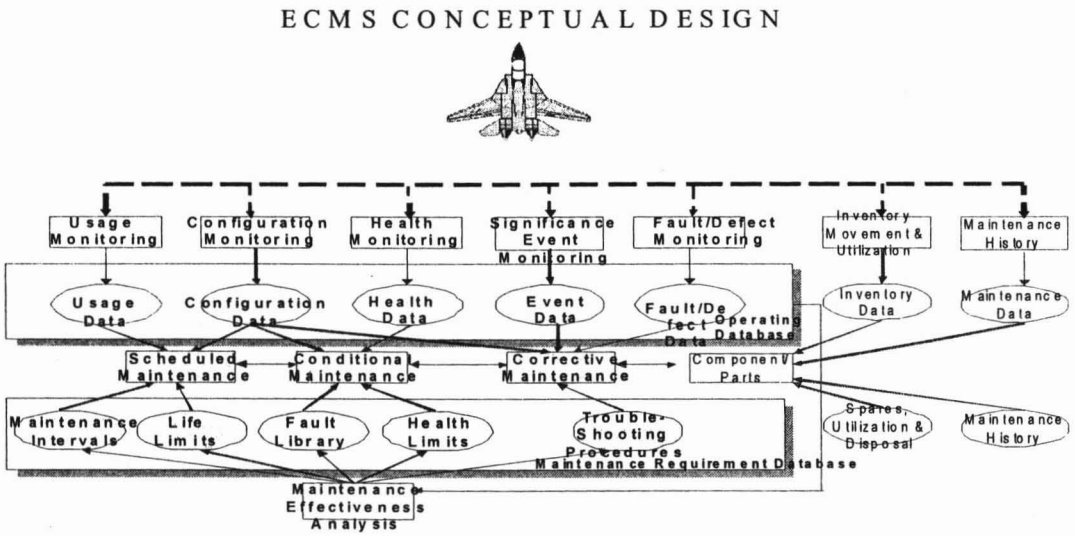

Fig. 1 : Discernation of ECMS (Caidmark 2003)

Universiti Kuala Lumpur Malaysian Institute of Aviation Technology

Lectures are procreated at Universiti Kuala Lumpur Malaysian Institute of Aviation Technology (UniKL MIAT) in the generic subjects of aviation, focusing primarily on maintenance, repair and overhaul of aircrafts (Universiti Kuala

Lumpur Bulletin 2004). UniKL MIAT is equipped with facilities and amenities that cater for the intended courses, inherently ingrained with aircrafts (commercial, transport and military), laboratories, experimental entities and grounded engines of aircrafts (gas turbines and propellers). These available nouns pose a reasonable account on the efficiency of lectures particularly within the 'hands-on' approach, discerning more on practicalities rather than theories.

ECMS upon Grounded Propeller Engine

There exist monitoring systems which are developed for the purpose of formulating indications of the health of engines of propeller type. These are individualistic entities without the holistic nature of combinations of monitoring of each equipment or part of the engine (The New Piper Aircraft Incorporated 1999a). The monitoring of peripherals is done without synchronizations (The New Piper Aircraft Incorporated 1999b). Hence, the amalgam of relevant data is not procreated, deducing only discrete minute predictions upon the propeller engine.

Axioms

Holistic Structure

The ECMS of the grounded propeller engine would manage data from 4 sources located at the engine. These sources are identified to be the cylinder head, exhaust, tube of fuel, and tube of manifold. Probes or gauges would be etched onto these 4 locations to parlay relevant data from these locations toward a database (locally located). The data in the database is in the form of binary. Application software (ad hoc internal procreation) of a desktop or laptop would coherently read these raw binary data and produce significant conversions from binary to format of ASCII, arranging the data into categories, columns and rows. Thus, data are readable to be interpreted.

The gauge that is etched onto the cylinder head measures the temperature of the cylinder head. The observation of this parameter collectively induces postulations regarding the trends of the rise and fall of the temperature of the designated location, deductively indicating an average time frame for the rise and fall of the temperature. Garnering of more data of the temperature would possibly enhance or table predictions on the behaviour of the engine primarily focusing on the efficiency of the engine during the fluctuations of temperature during operations. Behavioural aspects of the engine contribute to the changing of peripherals (due to 'wear and tear') that are encompassed or dependable upon the temperature of the engine.

The exhaust of the engine is susceptible to temperature rise and fall which could partially affect the potential performance of the engine. Hence, a gauge is postulated to be contained in the exhaust to measure the inconsistency of the temperature. The gauge or sensor would detect environmental temperature bounded by the exhaust.

The tube of fuel funnels fuel from the fuel tank of the airplane to the engine. A rapid fuel flow will ensures a comprehensive combustion of the engine that in affect deploy acceleration of the airplane. While a minute movement of fuel depicts an un-comprehensive combustion that would deny acceleration of the airplane (or only small increments of acceleration). Measurement of this fuel flow bestows readings that would delineate the trend or pattern of the flow of the fuel which in return could be used to attain the condition of the peripherals (tube of fuel, piston, cylinder and others) that are affected by the flow of the fuel.

The manifold tube of the aircraft is constantly induced with pressure during operational mode. It is within the genre of ECMS to observe the anomalies and the normal distribution of pressure that exist during the period of workable entity. A sensor or gauge would be placed at the manifold tube for this ad hoc purpose. It is plausible to obtain a profound set of data representing the traits of the pressure of the manifold tube.

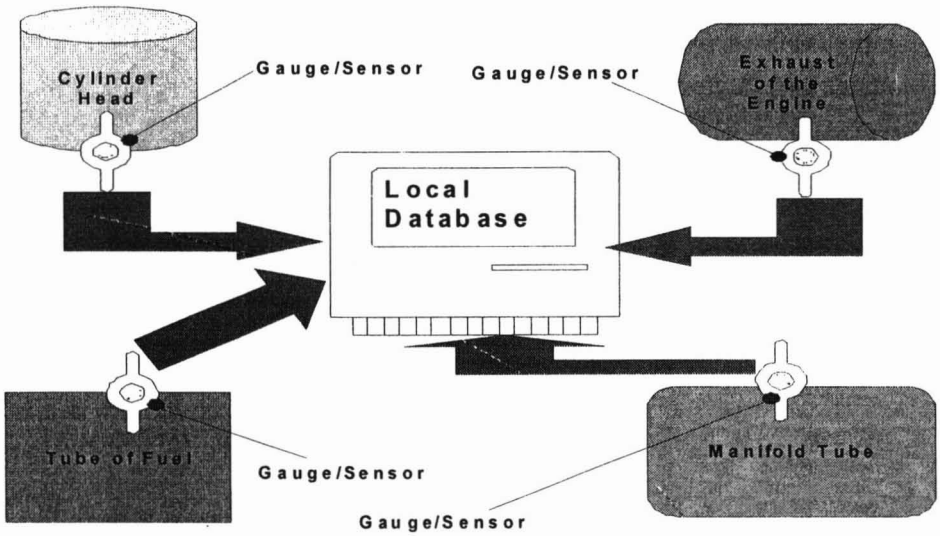

Fig. 2: Holistic Structure of ECMS of Grounded Propeller Engine

Doctrine of Information Flow

The information that is collected by the 4 gauges located at 4 distinct abodes is deducted to be concisely flowing from the gauges to the local database where this database is installed onto a Data Acquisition Unit (DAU) or a mini server. If a DAU is used, the DAU would be onboard with the engine, where after each completion of operations of the engine, the DAU would be uninstalled from the engine and connected to a portable laptop. The portable laptop would extract raw binary data from the DAU and save these data onto the laptop.

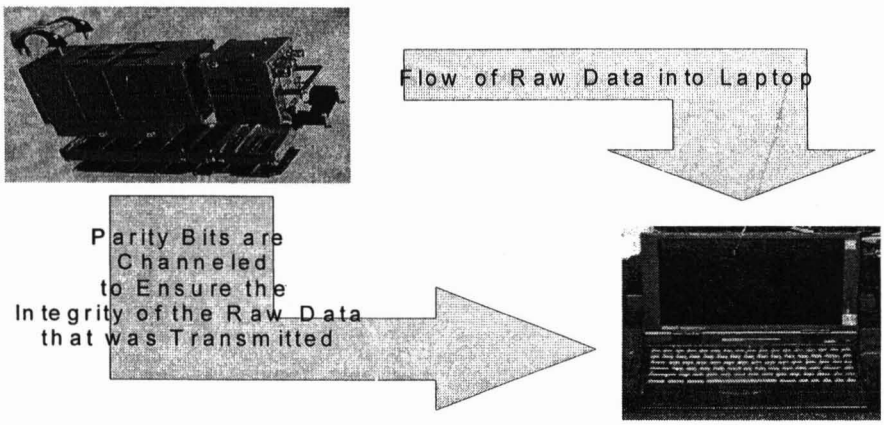

Fig. 3: Extraction of Raw Data from the DAU into the Laptop

If a mini server is used, the flow of information would be the same as mentioned earlier pertaining to the usage of DAU. The server would be connected to a laptop or desktop for the extraction of raw data and the saving of it.

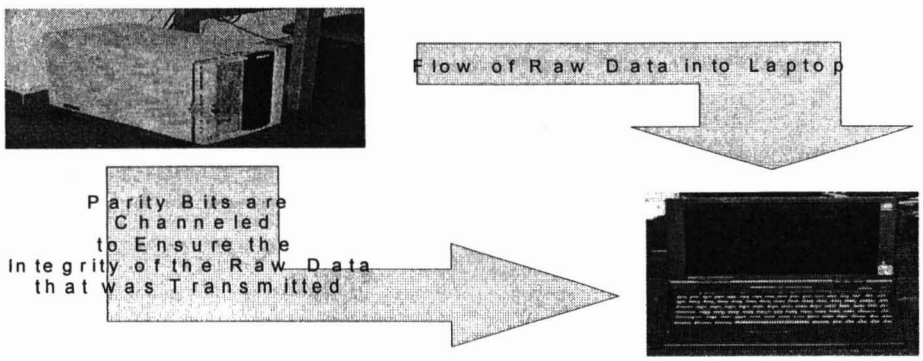

Fig. 4: Extraction of Raw Data from a Mini Server into a Laptop

Management of Data

The laptop has an application that would comprehensively manage the raw binary data that were transpired from the gauges. This application would be an internal 'in-house' procreation of UniKL MIAT. The ingrained function of the application would be the conversion process of the raw binary data into a format that is comprehensible (ASCII). The process would involve the adequate tempering of the data of the DAU or server by reading sections or partitions of the data (in accordance with the mapping of the data onto the DAU or server). After subsequent readings, the data would be dwelled onto the memory unit of the laptop. Within this memory unit, the data would be converted by the application and the converted data would be arranged into categories, columns and rows where these arrangement processes would enhance or abet the retrieval of data in tandem with analyses. The data that were converted and arranged would be saved onto the hard-disc of the laptop. The conversion to ASCII offers latitude of textual and numeric characters which are optimally delineated by analysts (Jaafar 2003).

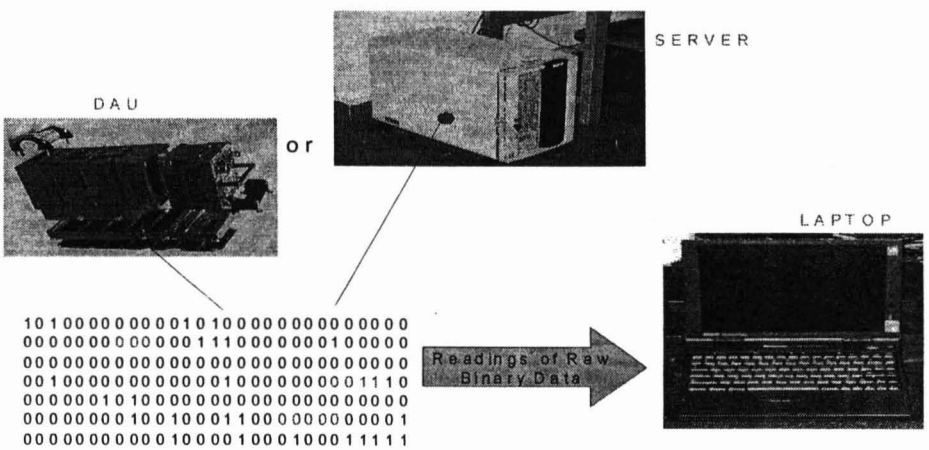

Fig. 5: Readings of Raw Binary Data by Application of Laptop

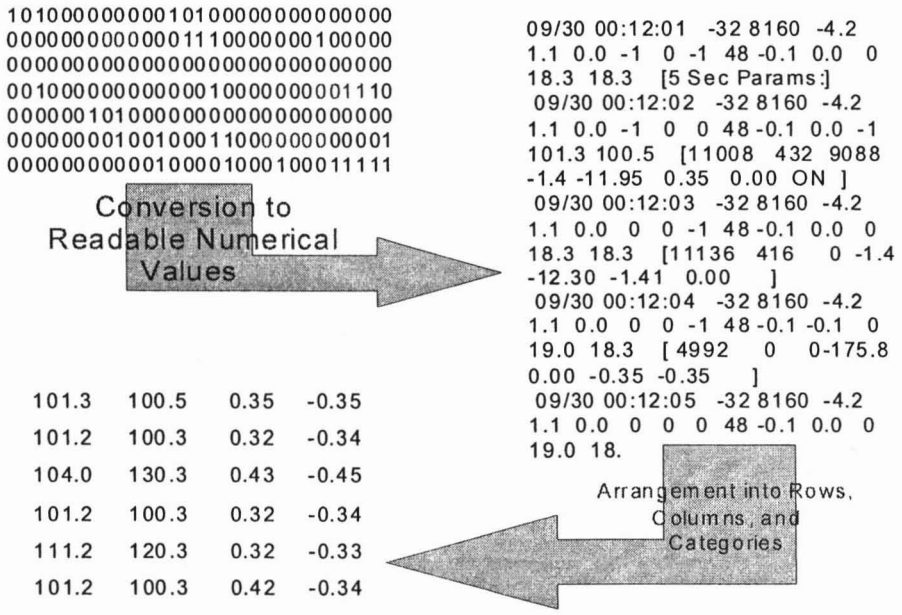

Fig. 6: Conversion of the Raw Binary Data and the Arrangement of the Converted Data

Software for Analysis of Data

The arranged data would then be analysed by another application (would be developed internally). This application bestows postulations, stipulations and deductions based on the parameters of data that had been predetermined or selected by the analysts or users. The postulations are in graphical forms which lead to optimum dissertations. Reasons and denotations regarding the results would be given.

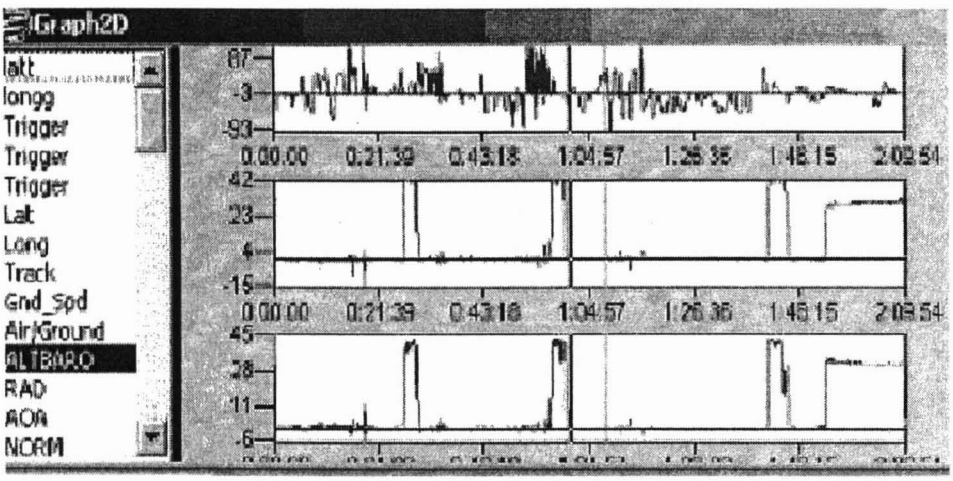

Fig. 7: Analyses Actuated within Graphical Form

Observations and Results

Postulated Trends and Patterns

Previous tenets regarding ECMS parlay results which indicate a pattern of reduced corrective maintenance and an increment in predictive maintenance (GasTops Limited 2000a). The shift from corrective to predictive maintenance

discerned factual agendas that viability in predictions outweighs corrective measures. By applying predictions onto masses of mechanical features, it deciphers the stipulations that a designated schedule gives ample time frame to personnel to manage maintenances, in contrast to sudden corrective maintenances which is due to sudden malfunctions of peripherals. Predictive maintenance will reduce or partially eliminate sudden malfunctions of elements (GasTops Limited 2000b). Predictive maintenance is referred to as preventive maintenance as it is a maintenance process that is actuated before the malfunction of peripherals occurs (GasTops Limited 2000c).

Predictions on Costs of Maintenance

As shown in Figure 8, as the level of preventive maintenance increases, the total costs of maintenance decreases but until a certain predetermined point. After this point, the total costs will increase. Thus, there is an area of optimization on the usage of preventive maintenance.

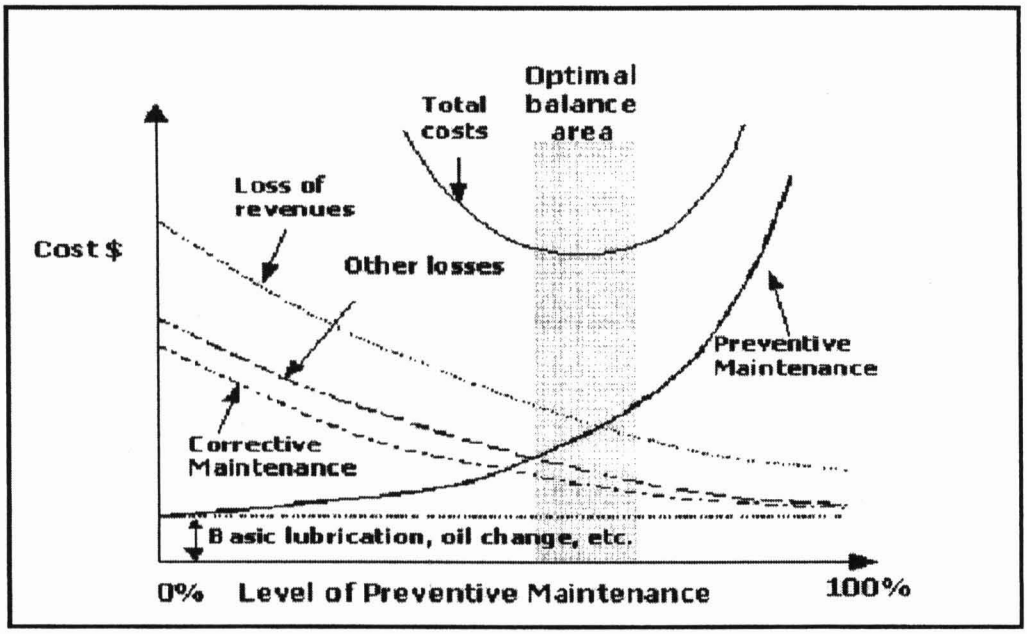

Fig. 8: The Relationship between Costs and Amount of Preventive Maintenance (GasTops Limited 2000d)

Conclusion

Ecology of the System

ECMS eradicates unwanted removal of peripherals due to malfunctions as the monitoring system predicts which peripherals are obliged to be serviced. These predictions are coherently bestowed because of the dissemination of knowledge or information by the system and the spreading of this knowledge, thus, creating a fusion of ecologies bounded by the system itself. This ecology of knowledge benefits personnel with chores revolving the maintenance process of the propeller engine, giving them boulevards on the exact time frames to overhaul peripherals instead of waiting for the degradation of the peripherals. This obliterates unwanted overhaul, maintenance, and removal of peripherals that are still within workable range or status. Hence, the overall costs of maintenances or overhauls are reduced due to minimizations of unwarranted entities.

Advent of ECMS

By industrial standard, ECMS is the best current practices being performed. In the field of aviation, ECMS is perpetually induced onto aircrafts to gain advantages in the manners of costs and optimization of time. The induction of ECMS within the parameters of UniKL MIAT will offer avenues to enhance the internal maintenance processes of grounded propeller engines of UniKL MIAT.

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