

## 1: Automotive Engineering Solutions and Services

*The third volume in the Integrated Vehicle Health Management (IVHM) series focuses on the technology that actually supports the implementation of IVHM in real-life situations. Edited by Ian K. Jennions, Director of the IVHM Center at Cranfield University, UK, this book was written collaboratively by.*

Growing Adoption of Decision Support System 3. Rising Uptake of Advanced Data Analytics 3. Lack of Skilled Labour 3. Growth Potential in Developing Asian Countries 4. Bargaining Power of Suppliers 8. Bargaining Power of Buyers 8. Threat of Substitutes 8. Threat of New Entrants 8. Intensive of Competitive Rivalry 9. Airbus Group Company Overview 9. Airbus Group Company Sales, 9. Airbus Group Products Offered 9. Airbus Group Recent Developments 9. Airbus Group Key Financial Ratios 9. Boeing Company Sales, 9. Boeing Company Sales in Commercial Airplanes 9. Boeing Company Net Income 9. Boeing Company Products Offered 9. Boeing Company Recent Developments 9. Boeing Company Key Financial Ratios 9. GE Company Sales, 9. GE Company Products Offered 9. GE Company Recent Developments 9. Company Sales, 9. Key Financial Ratios 9. Rockwell Collins Inc Company Sales, 9. Rockwell Collins Inc Products Offered 9. Rockwell Collins Inc Recent Development 9. United Technologies Corporation 9. United Technologies Corporation Company Overview 9. United Technologies Corporation Company Sales, 9. United Technologies Corporation Sales in Aerospace 9. United Technologies Corporation Net Income 9. United Technologies Corporation Products Offered 9. United Technologies Corporation Recent Developments 9. Conclusion List of Tables Table 3. Airbus Group Profile Table 9. Airbus Group Product Portfolio Table 9. Airbus Group Recent Developments Table 9. Boeing Company Profile Table 9. Boeing Company Product Portfolio Table 9. Boeing Company Recent Developments Table 9. GE Profile Table 9. GE Product Portfolio Table 9. GE Recent Developments Table 9. Profile Table 9. Product Portfolio Table 9. Recent Developments Table 9. Ultra Electronics Profile Table 9. Ultra Electronics Product Portfolio Table 9. Ultra Electronics Recent Developments Table 9. UTC Profile Table 9.

## 2: NASA - Integrated Vehicle Health Management (IVHM)

*Integrated vehicle health management (IVHM) or integrated system health management (ISHM) is the unified capability of systems to assess the current or future state of the member system health and integrate that picture of system health within a framework of available resources and operational demand.*

Improve safety through use of diagnostics and prognostics to fix faults before they are an issue. Improve availability through better maintenance scheduling Improve reliability through a more thorough understanding of the current health of the system and prognosis based maintenance Reduce total cost of maintenance through reduction of unnecessary maintenance and avoidance of unscheduled maintenance This is achieved through correct use of reliable sensing and prognosis systems to monitor part health and also using usage data to assist in understanding the load experienced and likely future vehicle load. Origins[ edit ] It has been suggested that IVHM as a named concept has been around since the s [2]. However, there does not seem to be much in the way of written evidence of this. IVHM as a concept grew out of popular aviation maintenance methods. It was a natural next step from condition based maintenance. As sensors improved and our understanding of the systems concerned grew, it became possible to not just detect failure but also to predict it. NASA [3] was one of the first organisations to use the name IVHM to describe how they wanted to approach maintenance of spacecraft in the future. Many companies since then have become interested in IVHM and body of literature has increased substantially. Further development[ edit ] One of the key milestones in the creation of IVHM for aircraft was the series of ARINC standards that enabled different manufacturers to create equipment that would work together and be able to send diagnostic data from the aircraft to the maintenance organisation on the ground. This has led to concepts which have been adopted in IVHM. Another milestone was the creation of health and usage monitoring systems HUMS for helicopters operating in support of the Oil rigs in the North Sea. This is key concept that usage data can be used to assist maintenance planning. They are useful for IVHM in the same way as they allow the usage of the vehicle to be thoroughly understood which aids in the design of future vehicles. It also allows excessive loads and usage to be identified and corrected. For example, if an aircraft was experiencing frequent heavy landings the maintenance schedule for the undercarriage could be changed to ensure that they are not wearing too fast under the increased load. The load carried by the aircraft could be lessened in future or operators could be given additional training to improve the quality of the landings. The growing nature of this field led Boeing [7] to set up an IVHM centre with Cranfield University in to act as a world leading research hub. This graphic also appears in a similar form in the IVHM book. IVHM examines the vehicle health against the vehicle usage data and within the context of similar information for other vehicles within the fleet. In use vehicles display unique usage characteristics and also some characteristics common across the fleet. Where usage data and system health data is available these can be analysed to identify these characteristics. This is useful in the Identification of problems unique to one vehicle as well as identifying trends in vehicle degradation across the entire fleet. IVHM is a concept for the complete maintenance life cycle of a vehicle or machine plant installation. It makes extensive use of embedded sensors and self-monitoring equipment combined with prognostics and diagnostic reasoning. In the case of vehicles it is typical for there to be a data acquisition module on-board and a diagnostic unit. Some vehicles can transfer selected data back to base while in use through various rf systems. Whenever the vehicle is at base the data is also transferred to a set of maintenance computers that also process that data for a deeper understanding of the true health of the vehicle. The usage of the vehicle can also be matched to the degradation of parts and improve the prognostics prediction accuracy. The remaining useful life is used to plan replacement or repair of the part at some convenient time prior to failure. The inconvenience of taking the vehicle out of service is balanced against the cost of unscheduled maintenance to ensure that the part is replaced at the optimum point prior to failure. This process has been compared to the process of choosing when to buy financial options as the cost of scheduled maintenance must be balanced against the risk of failure and the cost of unscheduled maintenance. It is preferable to use an IVHM approach to replace it at the most convenient time. This allows the reduction in waste component life caused by replacing the part too early and also reducing cost incurred by

unscheduled maintenance. This is possible due to the increased prognostic distance provided by an IVHM solution. There are many technologies that are used in IVHM. The field itself is still growing and many techniques are still being added to the body of knowledge. Architecture[ edit ] Health monitoring sensors are designed into the vehicle and report to a data processing unit. Some of the data may be manipulated on board for immediate system diagnosis and prognosis. Less time critical data is processed off board. All the historical data for the vehicle can be compared with current performance to identify degradation trends at a more detailed level than could be done on board the vehicle. This is all used to improve reliability and availability and the data is also fed back to the manufacturer for them to improve their product. This is intended to facilitate interoperability between IVHM systems of different suppliers.

### 3: Integrated vehicle health management - Wikipedia

*Integrated Vehicle Health Management (IVHM) is a relatively new subject, with its roots back in the space sector of the early s. Although many of the papers written around that time did not refer to it as IVHM, the fundamental principles of considering an integrated end-to-end system to monitor.*

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