

CHAPTER 1

Introduction

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“ We are continually faced with a series of great opportunities brilliantly disguised as insoluble problems. ”

—John W. Gardner

1.1 Background

SAE International formed an IVHM (Integrated Vehicle Health Management) Steering Group in the fall of 2010. The idea reflected the large number of groups, given below, within SAE's organization, that deal with health management of systems or subsystems (but without the integrated, holistic view of the vehicle asset or fleet).

- S-18: Aircraft and Systems Development and Safety Assessment
- E-32: Aerospace Propulsion Systems Health Management
- G-11: Reliability, Maintainability/Supportability and Probabilistic Methods Group
- G-11 SHM: Structural Health Monitoring and Management
- AS-3: Fiber-Optics and Applied Photonics
- A-6: Aerospace Actuation, Control and Fluid Power Systems
- AE-5: Aerospace Fuel, Oil and Oxidizer Systems Steering Group
- A-5 Aerospace Landing Gear Systems

The newly formed group, through the IVHM HM-1 technical group, proceeded to organize an IVHM technical track for the SAE AeroTech meeting in Toulouse in October 2011 and also had the idea for a book on IVHM that could be handed out to participants to promote engagement in this exciting new field. The book: *IVHM Perspectives on an Emerging Field* [Jennions, ed. 2011] was the result and, surprisingly, it spawned a trilogy of books.

This first book explored the overall subject of IVHM at a very high level, sufficient for senior decision makers and technical people interested in the field, who were not familiar with IVHM, to be able to understand the overall subject and value proposition. What

emerged during writing of the book, and the conversations that naturally ensued, was the realization that the major barrier to IVHM adoption lay not in the technology itself but in an ability to express a clear business case for its adoption. Such a case would lay out the cost of the engineering design, equipment, and development needed, as well as the organizational (cultural) cost of instilling service thinking along with training on new procedures and processes.

This resulted in the second book: *IVHM: Business Case Theory and Practice* [Jennions, ed. 2012]. It was predicated on the paradigm shift observed by the transformation of businesses from selling a product, and deriving future income from spare part sales, to selling a service in which regular income is received in return for effective maintenance of the asset. The resulting service business requires a much deeper understanding of how the asset is used and how parts degrade, and hence can be maintained, thus providing the rationale for IVHM. The objective of the book was to provide the tools and techniques for constructing a business case while also providing some of the context in which they are framed. It is essentially a book for the commercial, rather than the technical, side of the organization, but should prove readable by both.

1.2 Scope

The scope of the current book returns to the taxonomy introduced in the first book and replicated here as Figure 1.1. It was originally produced by the IVHM Centre and has been adopted by the SAE IVHM steering group; it is not intended to be all encompassing but rather to show the essential elements and how they fit together.

Each of the broad themes in the taxonomy (e.g., architecture—Systems Engineering), system's design (Design Tools and Toolkits),

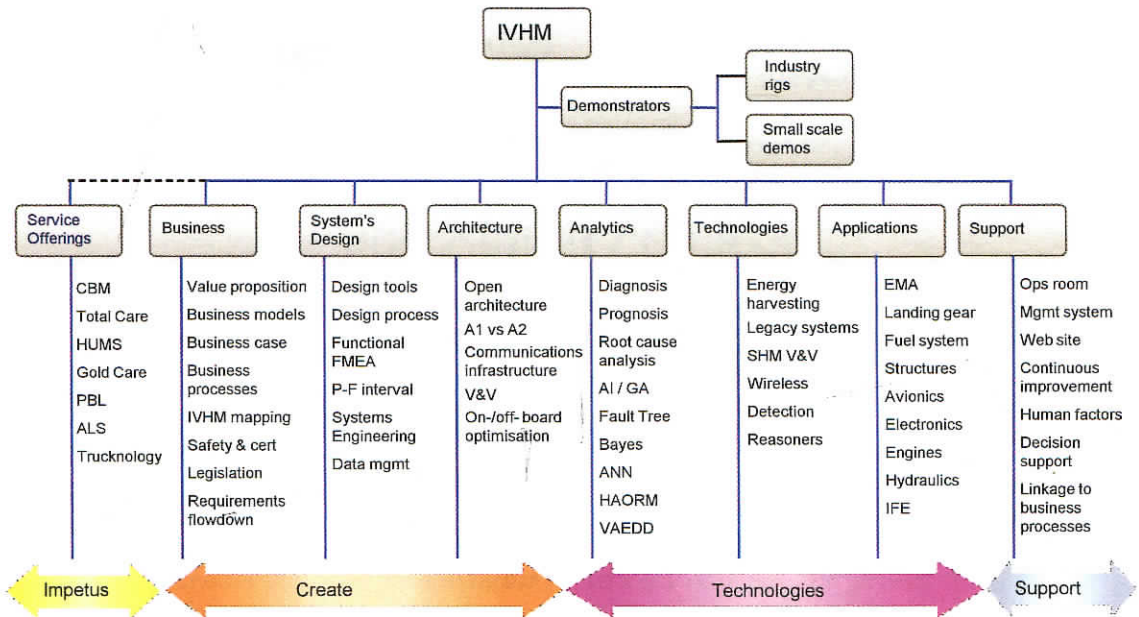


Figure 1.1 Generic IVHM taxonomy [Jennions 2011].

and analytics (Algorithms), were covered at a high level in the first book. It is the intention of this book to revisit these themes and add the detail necessary for an interested reader to go from the high-level view to the technical papers in each individual subject area. As such, this is an IVHM technology primer, all of which may not be easily understood and assimilated. If your background is in sensors, then you might not understand prognostics; if reasoning, then architecture may prove difficult. Either way, this book provides the technically literate a route to pursue and develop their knowledge in this broad subject area.

1.3 Book Structure

This book is broadly organized in three parts. The first eight chapters, after this, deal in detail with a number of the technologies at the center of this field. They are written

by some of the leading practitioners in the world and offer a unique collection of technical material supplemented with real-world examples. Next is a chapter that looks at applications of IVHM technology in four very different fields: structures, rotating machinery, motorsport, and wind turbines. The third part is a chapter on disruptive technologies. Although IVHM is seen as being a disruptive technology in its own right, given its ability to radically change a business model, there are other technologies on the horizon that are thought to provide the next wave of disruption; these are examined here in some detail. Finally, a summary is given and some concluding remarks made.

1.4 References

Jennions, I. K., ed. 2011. *Integrated Vehicle Health Management—Perspectives on an Emerging Field*, ISBN 978-0-7680-6432-2.

Integrated Vehicle Health Management

Jennions, I. K., ed. 2012. *Integrated Vehicle Health Management—Business Case Theory and Practice*, ISBN 978-0-7680-6432-2.

Jennions, I. K. 2011. "The Story so Far, the Development of an IVHM Centre," 14th Australian International Aerospace Conference, March 2011 (<http://www.cranfield.ac.uk/ivhm/>).