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Through-Life Data Exploitation to Reduce Downtime and Costs

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Abstract

Aerospace, vehicle and technology sectors all depend heavily on through-life recording, reviewing and managing user, support and technical data: from design, through in-service support, to disposal. The ability to exploit this kind of data efficiently and effectively is vital to improving safety, reliability, maintainability, supportability and affordability. The volume, inconsistency and relevance of raw data needs to be addressed, as does the ability to make it contextual – but without applying human bias to make the data fit or support a preconceived assumption or forecast. The task is made even harder when complementary sources of data in an organisation are not connected or integrated, leading to "islands of data".

This paper draws on practical experience to propose a number of techniques that can be applied to through-life data exploitation to successfully reduce downtime and costs. These techniques include correlation of symptom/fault/fix data to enhance diagnostic strategies; integration of outputs from "islands of data"; and maintenance categorisation techniques to identify poor performing repair practice. The paper also specifies in what way, if correctly harnessed, these techniques can contribute directly to the improvement of availability and reliability of platforms and systems, and of their support and maintenance costs, before considering other industry sectors that might benefit from these strategies.

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1. Challenges in Data Exploitation

Analysing data is a common activity in all industry sectors and all walks of life, and the benefits of doing so are well documented in terms of the productivity, competitiveness and growth that can result from its successful exploitation[1]. Some organisations analyse a lot of data and *some* of them go on to make decisions based on what they learn from that data, whilst many organisations collect large amounts of data but simply do not know how to exploit it to benefit their operations: they are *data-rich but information-poor*.

Therefore the ability to select, collect and exploit the *right data* is an exacting activity, beset by many challenges. These challenges are common to many Through-Life Engineering (TLE) industry sectors and are considered in this Paper predominantly in the context of maintenance and repair.

1.1. Islands of Data

The wide availability of Information Technology (IT) in the workplace, multiplied by the increased connectivity and portability of devices, means that the ease with which data is created, shared and stored is constantly growing. This also leads to a corresponding increase in the quantity of non-standard and/or non-integrated Information Systems (IS), which is driven by a vast range of factors including department-specific requirements, performance management systems, budgets, time constraints and Human Factors. In short, this creates 'silos' or 'islands' of data[2].

At best this significantly duplicates effort and incurs non-value added activity; and at worst the resulting configuration control problems can be a safety hazard in circumstances where different people are working from different versions of safety-critical documents or data.

There are a variety of options to deal with the problem, including: replacing the entire range of IS with one new all-

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encompassing IS; introducing an IS to connect all the existing systems together; changing data policy using Lean or Continuous Improvement (CI) strategies to standardise and streamline the selection and exploitation of data; and not changing the IS at all but instead use the increasing power of 'agnostic' analytics solutions to exploit the contents of the IS 'islands'. These 4 options are compared below in terms of their relative cost, complexity and timescales to establish, plus the extent to which the solution is tailored to the user organisation's precise needs.

Table 1. Comparison of solutions to mitigate 'Islands' of Data

Solution	Complexity	Cost	Duration	Tailoring
New IS	H	H	H	L
Join current IS	H	H	H	M
Lean current IS	M	M	M	H
Apply Analytics	M	M	L	M

The first 2 options suffer from high cost and complexity of implementation, and the risk of failure in large, high-profile IT projects is well documented[3]. Applying CI or Lean to streamline IS to deliver what is actually required offers a potentially less risky route but requires robustly enforced top-down policy to embed and sustain the improvements. Again, as with many large transformation projects, the ability to embed and sustain the improvements is the hardest part of any improvement activity and so there is a significant risk that the organisation 'slides back' to where it started. Using an Analytics tool or service offers the best compromise in cost and flexibility, especially if the tool concerned can import and process the relevant outputs from all the 'islands' of data. The approach can also be strongly tailored to the user's needs, but it will require a major up-front investment in time by the user organization to achieve this.

The ideal scenario is a combination of these last 2 strategies: using Lean/CI as a foundation to identify the required Value from the IS' contents, implement policy to standardize and streamline the IS; and then apply Analytics to the post-Lean IS for efficient and optimized exploitation of the data.

1.2. Free Text

Fig. 1. A visibly defective tyre.

If a sample of people was shown the picture in Fig 1 and asked to write down what they saw in the picture, the results would show that the same, simple picture had been described in numerous ways. The people questioned on the picture may write down one of the following descriptions:

- "puncture"
- "flat tyre"
- "burst tyre"
- "punctured tyre"

There are 2 observations to make about these differing descriptions. Firstly, they are 4 different, free-text descriptions of exactly the same scenario. Secondly, only one of them – "flat tyre" – describes a visible symptom, whereas the other 3 all suggest a fault, and an assumed one at that. The tyre may be flat because of a puncture or it may be because there is another reason for it having no air in it – either through damage, through wearing out or from not being pumped up in the first place.

This free-text scenario is commonplace in through-life engineering and it is driven on a case-by-case basis by individual context and by human variability – itself caused by personal values, experiences and knowledge. Human beings all take in the same raw data – sights, sounds, smells – but we all apply subtle biases when processing the raw data to 'present it back to ourselves'[4]. This variability of context causes *information gaps*. An information gap can be defined as a break in common communication between persons and departments even though they may speak the same language; for example a Pilot will not necessarily think or speak or use the same terminology as the Technician, and as a result an Information Gap is formed. When reporting a problem with their aircraft, the Pilot describes a *symptom* whereas the Technician instinctively thinks in terms of a *fault*. The Tyre example above illustrates how easy it is to use *symptom* and *fault* terminology interchangeably. Coupled with the uncontrolled use of free text, this results in a situation whereby the ability to exploit repair history data is severely impeded[5].

1.3. Human Input vs Automation

There are 2 significant themes to be considered in terms of human vs automated analysis. The first concerns selection of the data itself. Arguably there is no such thing as 'raw' data since it is often structured according to someone's preferences or preconceived context[6]. TLE disciplines depend on empirical and objective data, so the issue of bias in data selection is not considered to be a significant one, albeit not impossible, so it is not discussed further here.

The second theme concerns the method of data analysis, ie whether it is undertaken by a human analyst or by an IT system. Virtually all data analysis is IT-enabled to some extent, even if it is simply the use of spreadsheets, because IT is extremely capable at saving and arranging data. Likewise, virtually all data analysis concludes with human input.

This is illustrated in the image at Fig. 2 overleaf. In TLE scenarios most data exploitation activities take place within the continuum above, ie involving both Human and IT analysis. Fig. 2 is a simplistic representation because an