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Maintenance Informatics Dashboard Design for Through-Life Engineering Services

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Abstract

This article introduces maintenance informatics dashboard design approach for visualising maintenance, repair and overhaul events on a timeline. This paper presents a proposed methodology for aggregate visualisation techniques and a 2D graphical plot method as well as a summary of events on a timeline. In this paper, these events are occurrences which are classified and categorised into levels. The occurrences are accumulated over time as historical information and represented in a visual format over a timeline based on an entity relationship diagram. The information modelling technique with respect to data visualisation is emphasised. The result is a single-page-view of maintenance activities. The maintenance activities of aircraft engines are visualised to ease the accessibility of getting accurate and relevant information for making better maintenance decision. The result can be used to gain insight of the root cause of the events from inception to end of life of the engine.

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1. Introduction

Visualisation is changing the way information is presented in through-life engineering perspective [1]. Through-life events can occur at a precise point-in-time or an interval-in-time [2]. These events experienced by an asset or an object as well as times of occurrences can be envisioned on a timeline. The timeline is a graphical concept display of historical events from the aerospace, manufacturing and operations domains.

Point-in-time refers to the date of the event in time. The interval-in-time relates to an event with a given start and end date typically used to inform maintenance decision between periods A and B. There is also a downtime or lag in operation of the engine in-service. The duration of the occurrence is also often captured to give quick feedback to decision makers. The swift alternative decision to scheduled condition-based maintenance can be provided on time.

Information modelling of engine event histories is discussed to demonstrate the data organisation displayed in a concise and accurate way. The modelling of information for visualisation has become essential in the through-life perspective because of the increasing amount of data that cannot that be viewed on a single screen. In order to achieve this, the entity-relationship diagram (ERD) is required to capture relevant attributes that will be used to describe the semantics of engine past events to support temporal queries, information presentation and representation [3].

This paper reports on an abstract model to display maintenance activities. This article illustrates how historic engine information is represented in an interactive timeline

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display based on levels and a group of events. This paper introduces a summarising technique to fuse complex semantic information into single data points, thereby representing multiple points on a timeline as a 2D graphical plot [4],[5]. This paper reports a new hybrid visualisation technique to view events on a timeline. An information modelling strategy is utilised to model historical engine events. This article illustrates multiple assets with levels on a timeline as a single view. This work can be introduced to show manufacturing and design events on a timeline. This paper reports aggregate attributes as detailed information.

2. Related Work

Karam [6] used timelines extensively in electrical engineering to represent electrical signals, the most common timeline display generator being the oscilloscope (and its relatives such as logic analysers). Karam discussed three major processes used in the timeline display generation. The event interpretation - deriving information about a system given a record of its actions (a trace of events); rendering activity- the display of derived information on a timeline; and display presentation - the organisation of the screen (the set of timelines) for suitable viewing.

Kumar et al. [7] represented timeline in a familiar means of demonstrating the relationship amongst historical events. The point and click restructuring capability help the user to prepare a better mental model of the content of a document. Kumar explored the use of interactive documents as interfaces to historical data, starting with the basis of the popular representation of a timeline.

Allen [8] showed that timelines could be an effective aid for understanding relationships amongst events which deliver several types of cognitive advantages for a user, such as inform, show context, encapsulate and link. Allen introduced semantic zooming with the view to scale the space in 2D. The semantic zoom relates to pinch-to-zoom. The interface and functionalities are described in the implementation section.

Alonso et al. [9] produced timelines on novel organisers for digital libraries of the historical information. It is a challenging and time-consuming nature to get an overview of the historical information on youths. Alonso et al. determined and compared the LifeLines graphical data representation to the tabular data representation commonly used in computer applications.

Plaisant et al. [10], [11] created LifeLines to provide a general visualisation environment for personal histories. LifeLines were implemented to present a personal history overview on a single screen, offer direct access to all comprehensive information from the overview with a single or double mouse click. It makes critical information or alerts visible at the overview level. In the visual display of quantitative data, Tufte [12] described timelines as a common and powerful form of graphic design such as data maps and time series. Kocherlakota [13] argue that techniques be designed for the automated, unsupervised analysis and exploration of raw data, followed by the generation of effective abstracts based on the analysis.

The remaining sections of the paper are as follows: Section 3 describes the methodology for graphing the timeline, section 4 defines the information modelling technique, section 5 describes the implementation of the events timeline application, section 6 is the case study, section 7 presents the results and discussion, and section 8 is the conclusion with future work.

3. Methodology

The proposed new Summarisation of Engine Events (SUMEE) methodology utilises an aggregate visualisation technique and 2D graphical plot method to design and provide a summary of events on a timeline.

This methodology observes both scientific and information visualisation [14]. The scientific visualisation is the interactive visual representation of data to strengthen insight and information visualisation is the interactive visual representations of abstracts to increase knowledge [15]. Scientific visualisations are used to clarify familiar observations, while information visualisations are utilised for finding out interesting pattern. The scientific visualisation relates to the real world and the information visualisation is abstract in nature. The goal of the visualisation is for characterisation, prediction, gaining insight and decision making.

The physical object under investigation is an engine with related activities of events and time being represented in an abstract view form in the maintenance domain. The relationship between information and scientific visualisation is the activities and engine object. The hybrid visualisation will incorporate multivariate attributes of independent and dependent variables on a 2D graphical plot. The document of the event description contains complex and detailed information. The information is the activities which have been observed and documented by service engineers which tell the stages of the story of the impact on the asset. This information can contain pictures as visual evidence that such an event happened at a point in time of an interval of time. It keeps track of the activities and life of the asset to understand the way it degrades based on the operating conditions.

This paper focuses on the knowledge building phase of the semantic decision and inference relevant attributes to the on-demand information in a database, but not discussed in detail since the work relates to the application. In this case, the semantic fusion refers to the integration, representation and