ANNALS OF THE ORADEA UNIVERSITY
Fascicle of Management and Technological Engineering
ISSUE #1, JULY 2013, http://www.imtuoradea.ro/auo.fmte/

SOFTWARE APPLICATION FOR OPEL CARS' MAINTENANCE MANAGEMENT

Lucian ROMAN[1], Adrian FLOREA[2], Ileana Ioana COFARU[3]
[1]Industrial Engineering and Management Department, lucian.roman@autohaushuber.ro
[2]Computer Science and Electrical Engineering Department, adrian.florea@ulbsibiu.ro
[3]Industrial Engineering and Management Department, ioanalogistictop@gmail.com

***Abstract*—**Our application is based on a 3-tier database architecture composed by Presentation, Logic and Database layers. Though the Crawler module we extract relevant data from archive of orders with maintenance operations and spare parts. In this paper, we focus on Presentation layer, the topmost level of application by which users have directly access such as a web page or application GUI (graphical user interface). Through this layer the user ask for information, it communicates with other architectural layers in order to output, the text or graphical results. Showing users a bulk table of data is not always a good approach. Instead, this GUI shows especially graphic drawings of the data and diagrams. Using this representation of data in an open friendly interface the user is empowered with great understanding of the patterns that might occur on part assembly or dependencies between changing some parts and damaging others.

***Keywords*—**Database, Reliability, Data mining, SQL.

I. INTRODUCTION

THIS work is part of a broader application dedicated studying Opel cars' reliability that we developed. Previously we designed a 3-tier database architecture composed by Presentation, Logic and Database layers. In [1] we have implemented the Crawler module that extract relevant data from Microsoft Excel files and have conceived and designed the conceptual scheme of relational database, tables and relationships that that supports time analysis of defects cars.

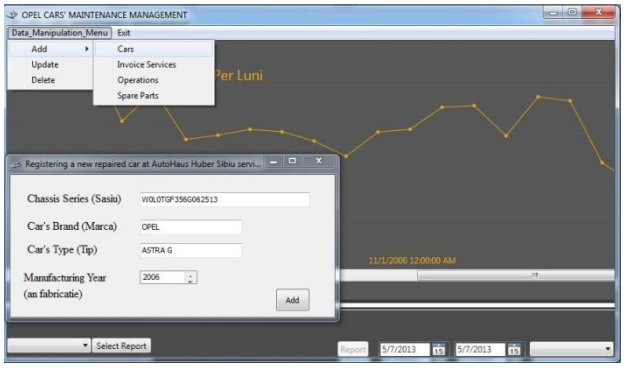

Fig. 1. The user friendly input interface

Although the main purpose of our software application was the automatic processing of invoice services and highlighting various analyzes about cars' reliability and maintenance, we have additionally built a module by which to allow inserting / modifying / deleting individual data from the database (taking care for ensuring consistency) (see Figure 1).

In this paper we present our developed software application for studying OPEL cars' maintenance management. We implemented in Microsoft Visual Studio 2012 (C#), .NET Framework, using Microsoft SQL Server 2008, a Data Visualization Module able to show graphical results about spare parts, operating mode, and supports time analysis of defects cars. We focus on Presentation layer, the topmost level of application by which users have directly access such as a web page or application graphical user interface. Through this layer the user ask for information, it communicates with other architectural layers in order to output, the text or graphical results. Showing users a bulk table of data is not always a good approach. Instead, this GUI shows especially graphic drawings of the data and diagrams. Using this representation of data in an open friendly interface the user is empowered with great understanding of the patterns that might occur on part assembly or dependencies between changing some parts and damaging others. We nominated several features of our application:

- comparative statistics on years of relevant mechanical components that were repaired
- quantifying the frequency of defects' occurrence on certain types of cars and vice versa,
- which certain type of car get parts with the lowest reliability
- identifying the operations frequently carried out to a certain car for a well-defined period of time

At present, the database is customized to serve at AutoHaus Huber SRL Sibiu, OPEL dealer, but with small modifications it could be extended to any auto service from Romania or outside.

With the help of this software application, based on huge history information from any car service, the manager obtains an extremely agile understanding of the common malfunctions that a car system can suffer and

even point out to parts producer, patterns that appear in their design ("*Business intelligence*", one of the key factors in planning marketing strategies). This will improve the quality of spare parts production through focusing on specific directions depending on the geographic area, the infrastructure of the region, environmental conditions, characteristics of fuels, etc.

The present application is extremely useful because the processing and interpretation of data extracted obtain a fairly accurate understanding of the common faults that may occur in operating a motor vehicle, may determine the causes of breakdowns, can identify abnormal wear.

The organization of the rest of this paper is as follows. In section II we shortly review the challenges regarding the cars' reliability operating in Romania, emphasizing on OPEL vehicles. Section III represents the centerpiece of this work and describes the Relational Database Management System. It starts with presenting the main features of SQL language, then it review the most used database queries for highlighting the behavior in operating of OPEL cars' and it finishes detailing the Presentation layer concept: the user guide and Data Visualization Module. Section IV graphically illustrates the most important experimental results that we obtain with our application. Finally, section V suggests directions for future work and concludes the paper.

II. RELIABILITY

The reliability domain is extremely large. When discussing about cars even we have to split the diagnosis in two: the electronic system reliability and the mechanical system reliability. Therefore, in this paragraph we first intend to explain some basic concepts about reliability and then to focus on some challenges in terms of vehicles' reliability, mainly of mechanical's system, exemplifying with OPEL cars.

A. Basic concepts

The *availability* of a system at time *t* is the probability that the system is operating correctly at time *t*. The *reliability* of a system at time *t* is the probability that the system has been operating correctly from time zero until time *t* [2]. However, many times reliability is less appropriate metric. In the event of a catastrophic system failure car, reliability is a less useful metric than availability. *Maintainability* is the probability that maintenance of the system will retain the system in, or restore it to, a specified condition within a given time period. Reliability, availability, maintainability (RAM) are fundamental features of any system and the RAM performance should be optimized to get the best value from the engineering design and enable a system to meet the service expectations.

After duration and mode of occurrence there are known three kinds of faults and errors:

- *Transient* (due to electronics circuits),
- *Permanent* (due to physical wear-out, fabrication defects or design bugs)
- *Intermittent*.

The complicate design of technical systems, in order to assure high performance may represent, in some cases, even their degradation sources. In these conditions, it can reach a critical level of development and improvement of systems, in which the recovery time would equal the production of new products. Avoiding such situations is the basic principle of terotechnology which involves a continuous improvement in reliability in parallel with technological development [3].

B. Challenges in the vehicles reliability

Regarding cars' reliability, the points of views converge for both the customers and manufacturers. The first want that their car to be safety (or ask how often it needs repairing) and liveness, despite the possibility of faults, and in such case, how much it will cost them to put right. Thus, as more reliable the car is as more satisfied are them. On the other hand, the manufacturers are interested to produce reliable cars in order to thank the customers, therefore could ask for a higher price or will attract more customers.

However, the cost of the operations, maintenance, and support of vehicles is quite large due to a reduced cars' reliability. One of the reasons for the difficulty of managing cars' costs is due to the complexity of predicting the performance and reliability of a vehicle early in the design cycle, over the vehicle's life, or the car usage over time [4]. Nowadays mathematical and computer science researchers face with challenges of predicting vehicle's reliability and performance, reliability-based design optimization, condition-based maintenance, methods of handling large data sets and models (*data mining*). A major challenge is to find accurate methods to assess vehicle reliability using modeling and simulation. Reliability is a highly complex field, involving many different physics-of-failure, including fatigue, thermal stress, corrosion, and erosion. Reliability is based on stochastic methods because involves uncertainty in the input data. The evaluation of cars' reliability in many different physics-of-failure is a huge computational challenge.

In the next sections we focus on handling these large data sets in order to emphasize the most important results regarding to cars' reliability and maintainability from AutoHaus Huber Sibiu.

Whatever invests in order to ensure the reliability of a complex system as the car cannot achieve an ideal reliability, i.e. a system that basically do not degrade over time. It is required accurate knowledge of the real level of reliability as well as existing operating conditions (in Romania) [5], so that, according to them, to establish lasting operation without failures, periods for maintenance. Due to operating conditions, the car manufacturers differentiate the period in which they perform maintenance revision, depending by country, geographic area, etc.

Next, we give some examples regarding OPEL cars' reliability. To reduce friction from piston group it is used only oil provided by the manufacturer (General Motors). Through the viscosity controls the friction regime and the lubrication one. Using another type of oil leads to