

ABSTRACT

Nowadays, manufacturing organizations operate in a global world, where they are facing the pressure of an intense competition. To remain competitive in today's global economy, manufacturing companies have to take advantage of any potential factors that improve the effectiveness of their equipment and machinery. Among such factors, reliability and maintainability are recognized as having a major influence on the effectiveness of the technical systems. On the other hand, the present technical systems are characterized by a higher degree of sophistication, which conducts to a more difficult estimation of the reliability measures and maintenance planning of such systems. Moreover, the successful employment of the state-of-the-art reliability and maintenance techniques and tools requires an increasingly knowledgeable and trained human resource.

In this context, the habilitation thesis presents the most relevant achievements of the author after receiving his doctoral degree in 2002, which are related to the following fields: a) Reliability analysis and maintenance planning; b) Supporting the transition from higher education to a successful engineering career. Therefore, the structure of the thesis reflects the main preoccupations of the author in these fields and includes three parts: (I) Research and contributions, (II) Career evolution and development plan, and (III) References.

The main achievements of the author are described in the first part of the habilitation thesis, **Research and contributions**. The first section of this part, *Reliability analysis and maintenance planning* presents the main achievements of research activities for the improvement of the technical systems effectiveness through the reliability modeling and the planning of maintenance policies. Although the modern systems involve not only hardware but also software and human resources, our thesis focuses on the first approach-the reliability of the components, subsystems and the whole technical system.

While the theory of probability and statistical approach have a major role in the reliability analysis of the technical items, the maintenance planning can be performed in different ways. The planning of maintenance policies has evolved from reactive maintenance to preventive maintenance and to condition-based maintenance. Accordingly, both the preventive and condition-based maintenance approaches have been used in the author's research, each providing specific advantages and limitations in practice. The minimization of the average maintenance cost rate or the assurance of a minimum reliability level have been

employed as criteria for formulating the preventive renewal policies. The inspection planning has also been used to improve the systems effectiveness. The employment of an integrated system for reliability modeling and maintenance planning is also presented. On the other hand, the rapid development of different techniques for monitoring the condition of items makes the implementation of condition-based maintenance more affordable. The vibration and temperature monitoring have been employed for monitoring the condition of items. However, the assessment of the evolution of the state of the systems can be affected by the limitations of the condition monitoring process, including some degree of uncertainty and imprecise information. A fuzzy logic approach has been used to overcome such limitations of the condition-based maintenance and to plan the maintenance actions.

In today's competitive environment, a faster response time is required to answer the requests of increasingly demanding global customers and concurrent engineering can be employed for this purpose. The rapid development of hardware performance of computers and software tools creates new opportunities for the integration of different characteristics of the product, including the reliability one, early on in the design process of products. By combining CAD and CAE software tools, a soft (digital) prototype of products can be created, in which the features of the products can be easily evaluated. Accordingly, a framework of reliability prediction based on a concurrent engineering approach was developed by the author. In addition, reverse engineering is considered as an effective tool in implementing concurrent engineering. Thus, by using CAD, CAE and reverse engineering technologies, prototypes of products can be faster developed. Nevertheless, the results of the computer simulation and prediction must be validated in practice and Rapid Prototyping is more and more used for such purpose. Finally, the verification of the product conformance with its specifications has to be carried out. In this context, a system for rapid development of products was shown, which integrated a digitizing system based on an optical scanner, a reverse engineering software, a 3D printer and a quality inspection software.

Since disciplines such as concurrent engineering, the management of automotive services, or reverse engineering are not mandatory in Romanian technical faculties, there are universities that not necessarily included in their undergraduate specialization such disciplines. Therefore, the section *Supporting the transition from higher education to a successful engineering career* of the

first part of the habilitation thesis presents the results of a simulated enterprise approach for the training of the students, when some competencies are not offered during their study programs. In this context, specific knowledge maps were presented that correlate the competencies that have to be achieved with the activities that should be carried out in several departments of a simulated enterprise in the automotive maintenance and repair field. Considering the results of an investigation among the participants in the training activities within a simulated enterprise in reverse engineering, the maps of the useful knowledge to be acquired in a reverse engineering discipline were also depicted.

At the beginning of the second part of the habilitation thesis, **Career evolution and development plan**, the *Main academic, scientific and professional achievements* of the author after receiving his doctoral degree are summarized. In this section are presented the evolution of his academic career, the courses that are currently taught, the books and teaching materials published as first author or co-author, as well as the scientific articles published in journals or conference proceedings. The involvement, as a director or activities coordinator in different projects, is also shown. Several of the professional achievements are briefly described.

The Career development plan is also depicted **in the second part** of the habilitation thesis. The author's scientific development plans will be oriented towards the reliability modeling and maintenance planning of the modern technical systems, which will continue and extend his actual research. Special attention will be given in the author's future research to the employment of different combinations of soft computing and/or other artificial intelligence techniques for the reliability analysis and optimization, and maintenance planning.

In manufacturing organizations, most attention has been given to the hardware reliability and most efforts, including those of the author, have been oriented to solve technical issues. Nevertheless, the human factor has also an essential influence on reliability and maintainability, while safety and safety culture are generally considered to be key aspects of the workplace environment. Although some exploratory research concerning the safety and safety culture was carried out by the author, his work in these fields is only at the beginning. Therefore, the author's future research will address aspects of the human reliability and safety in the complex technical systems, and particularly in the advanced manufacturing systems.

The proposal of new research projects, both at a national or international level will represent an important objective in the future work of the author. Research projects with companies concerning the diagnosis, reliability analysis and the maintenance assurance of their equipment and machines will also be proposed. Special attention will be given to the involvement of the young researchers in these projects, including the future doctoral students of the author. The results of the future scientific activities are expected to be published in different journals or conferences indexed in international databases, and especially in Web of Science^{TR}. They will also be disseminated through different scientific organizations and/or networks. The publication and dissemination of these results will be achieved with the teams involved in each research. The teaching materials that author aims to elaborate are also presented.

The third part of the habilitation thesis provides the **bibliographic references** employed in this thesis.