# A CONCURRENT ENGINEERING FRAMEWORK FOR RELIABILITY PREDICTION OF PRODUCTS

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**Abstract:** The application of concurrent engineering techniques for designing reliable products requires investments in advanced techniques for prediction and simulation on computer, in order to realize a software prototype before the physical trial of the prototype. There are also necessary laboratory experiments to confirm the predictions and simulations on products. Within these considerations, the purpose of the paper is to develop a framework based on concurrent engineering techniques in order to continuously improve the reliability of products.

## 1. INTRODUCTION

Now, the development of complex products, the technology progress and the growth of the global competition have led to the enlargement of the quality notion, so that it includes aspects regarding the variation in time of products performances. They have to correspond to customers' expectations not only at the first use but also for the entire function period.

The capability of products to preserve their performances for a specified period of time has become a specific notion named reliability. Many studies prove that reliability was one of the most desired characteristics by the customers at the beginning of the twenty first century. Initially the researches in reliability field were developed for the components and systems in the aeronautics industry and military industry because of the cost and their importance, but afterwards the researches were generalized - application for any type of product.

The actual development of the products is characterize by the continuous growth of their complexity level, because of the different components used (specific for different field from traditional point of view: electronics, IT, mechanics, optics, etc.) but also because of the implementation of a higher grade of intelligence. Top-companies, in their pursuit of excellence for their new products, have generated a new strategy of engineering art within their competition: concurrent engineering. The objectives of concurrent engineering are: reducing time cycles, reducing production costs, continuous improving of product quality and product reliability [9].

The spreading out of stations and computer networks, as well as of advanced techniques of product simulation, creates new possibilities of a real, significant integration of reliability conditions starting even with the stage of product designing. Development of rapid prototyping technologies and coordinate measurements validate the simulation by physical modeling achievement, which offers the visualization of how the respective product answers the requirements. The use of concurrent engineering techniques in order to ensure product reliabilities requires both software for prediction and simulation and modern equipments to confirm the simulation results.

Under these circumstances, the present paper aims the development of a framework which would make possible the integration of concurrent engineering techniques in order to achieve the prediction of product reliability.

## 2. CONCURRENT ENGINEERING IN RELIABILITY MODELING OF PRODUCTS

Within the classic strategy of achieving a product, there is a sequential linear demarche, prolonging the duration of the cycle of product-creation. The researches undertaken lately indicate Concurrent Engineering as a possible solution for reducing the times of conception, development and achievement of a product. Within concurrent engineering, the linearity of sequential organizing is to be replaced by the simultaneity of product-achievement activities [9], the products made through this strategy being sooner accomplished and complying better with the requirements of the beneficiaries.

The development of more and more sophisticated products, the rapid progress of technology as long as the intensification of global competition have led to a more poignant integration within the quality domain of aspects referring to time variation of product performances, irrespectively of their reliability. Reliability is one of the features most wanted by beneficiaries, the present-day products should meet the beneficiaries` expectations regarding not only the moment of their setting in function, but also regarding their whole duration of functioning.

Several researches [3, 5, 8] point to the necessity of studying in a concurrent engineering context the aspects referring to the reliability of products.

The software calculation of prototype has been configured lately by means of the programmes Computer Aided Design (CAD) and Computer Aided Engineering (CAE) [7, 10,11]. The continuous development of CAD/CAE techniques creates new opportunities for a significant integration of reliability considerations even starting with the parametric-designed process, offering the possibilities to utilize data and analysis methods during the design stage, in order to evaluate the features of reliability, as soon as the products are created in a CAD/CAE modeling medium.

The realist validation of simulation and prediction results can be done through the rapid development of the product, Rapid Prototyping being one of the most employed methods [1, 4]. Rapid Prototyping is presently an essential instrument of concurrent engineering [6], Rapid Prototyping models being used to compare alternative solutions of project in its early stages, to verify computer simulations and to effectuate different physical experiments, thus minimizing the risks and costs of fabrication.

Verifying the conformity of the physical model with the product specifications can be done by coordinate measuring machines. The possibilities of utilizing coordinate measuring machines in a concurrent engineering context are highlighted in [2], the authors presenting an informational model which allows the integration of CMM inspection throughout the whole cycle of product achievement. At the same time, the measurement of quality of physical model's surface is necessary, along with the measurement of its durity, for this purpose being used modern roughness tester and durimeter.

Once the products are achieved in accordance with the required specifications, they are to be tested for reliability, in order to obtain experimental data necessary for modeling the reliability. The data obtained through reliability studies are then used to elaborate the optimum maintenance strategies, including both predictive maintenance and preventive maintenance.

## 3. A FRAMEWORK FOR RELIABILITY MODELING AND PREDICTION OF PRODUCTS WITH CONCURRENT ENGINEERING

The complexity of nowadays products, synergic integration and causal relationships between component subsystems makes that modeling product reliability should become in turn very complex. Analysis and synthesis of product reliability must base on their definition, so that they may be modeled as intricately as possible by means of nowadays techniques, where concurrent engineering assumes a special role. By its emergence, concurrent engineering asserts itself through a synergetic approach of a whole life-cycle of a system, taking also into account its features of reliability and safety in functioning.

In order to design product reliability applying concurrent engineering techniques, special investments in advanced techniques of computer simulation and prediction are necessary, leading to the achievement of a software prototype before its physical testing. Laboratory experiments are also required so as to confirm the predictions and simulations on the products.

Therefore, reliability modeling and prediction of products using concurrent engineering requires:

a) product-geometry modeling;
b) prediction of tensions, displacements and structural factors of performance;
c) simulation of dynamic performances of the constitutive parts/elements of the products;
d) prediction of product reliability;
e) validation of computer predictions and computer simulations by the rapid achievement of the product and coordinate measuring.

Hardware and software support will allow the evaluation/assessment of different features of reliability as soon as they are designed, before the actual manufacturing and testing of product prototypes, along with the optimization of the features of reliability with other features of performance embodied by the product.

In order that this requires should be carried into execution, the next specialized equipments and software have been established:

1) Top computer network, so as they can support the prediction and simulation software;
2) CAD software for product-geometry modeling;
3) CAE software in order to perform: finite element analysis of products' structure, estimation of tensions, displacements and of structural performance factors, irrespectively the dynamic simulation for the prediction of product components, of wear and durability of products;
4) Equipment of rapid manufacture of prototypes and a coordinate measuring machine for the validation of prediction and simulation on computer.

## 4. CONCLUSIONS

The development of a framework based on concurrent engineering techniques for modeling and prediction of product reliability, grounded in adequate hardware and specialized software, adaptable to tangible, particular situations, becomes a viable solution for the ensurance of product reliability.

The concurrent engineering framework will allow the replacement of static, serial approaches with new convergent, dynamic approaches, which will have a great impact on products reliability assurance. The economic impact of the concurrent engineering consists of the assurance of durable economic development and the increase of economic competitiveness of products, by reconsidering and detailed accounting for the whole life-cycle of products, and by eliminating the disadvantages inherent to the end of the cycle ( remanufacturing, recycling).

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