

# A Model to Improve the Quality Products

**Gratiela Dana BOCA**

[bocagratiela@yahoo.com](mailto:bocagratiela@yahoo.com)

*North University of Baia Mare, Romania*

**Hasan GOKKAYA**

[hgokkaya@hotmail.com](mailto:hgokkaya@hotmail.com)

*Karabuk University, Turkey*

## Abstract

The topic of this paper is to present a solution who can improve product quality following the idea: "Unlike people who have verbal skills, machines use "sign language" to communicate what hurts or what has invaded their system'. Recognizing the "signs" or symptoms that the machine conveys is a required skill for those who work with machines and are responsible for their care and feeding. The acoustic behavior of technical products is predominantly defined in the design stage, although the acoustic characteristics of machine structures can be analyze and give a solution for the actual products and create a new generation of products. The paper describes the steps in technological process for a product and the solution who will reduce the costs with the non-quality of product and improve the management quality.

**Keywords:** improvement quality, iceberg quality costs, virtual simulation, model product design, low design product.

## 1. Introduction

### 1.1. Quality costs

The quality of a product is one of the most important factors that determine a company's sales and profit. Quality is measured in relation with the characteristics of the products that customers' expect to find on it, so the quality level of the products is ultimately determined by the customers. The customers' expectations about a product's performance, reliability and attributes are translated into Critical-To-Quality (CTQ) characteristics and integrated in the products' design by the design engineers. While designing the products, they must also take into account the resources' capabilities (machines, people, materials), their ability to produce products that meet the customers' expectations.

They specify with exactitude the quality targets for every aspect of the products, but quality comes with a cost. If we take in consideration the Cost of Quality, there is cost of non-conformance, how much producing nonconforming products would cost a company. This is a one sided approach since it does not consider the cost incurred to prevent non conformance and above all in a competitive market, the cost of improving the quality targets. We can identify that the lowest loss the client's exact needs are being met (Figure 1.). Movement to either the right or left the loss is according the client's desires. The management professional routinely language use in improving the quality it is a cycle that effective is enhancing quality. The PDSA model, continuously applied, helps, helps us to identify causes of poor translation quality or areas that can be further enhanced.

Recognize that one of the most crucial steps to increasing the quality of outcomes for any given project is creating a comprehensive understanding of client and supplier expectations, processes, terms, quality measures and other factors.

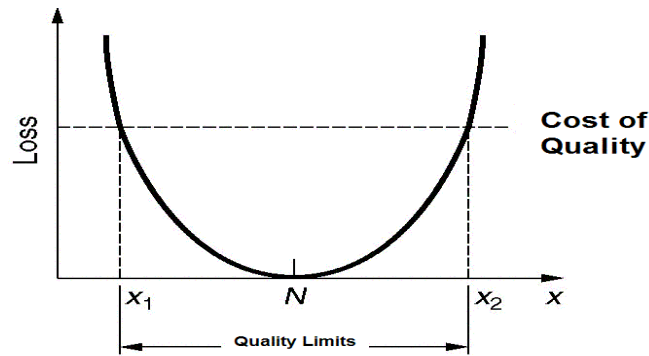


Figure 1. Quality Limits

### 1.2. Product - quality problem

The paper is the result of the investigation and diagnose realize in a factory who produce a product who has some quality problems.

The research work was realize under the topic of improving the quality and reliability of industrial products and identify new methods which can be use in technological process having as feed back result the low costs.

The quality costs permit an short evaluation of the situation, the conclusion was that the only solution that can reduce the costs was to diagnose the prevention cost and help the economical activity (Figure 2.).

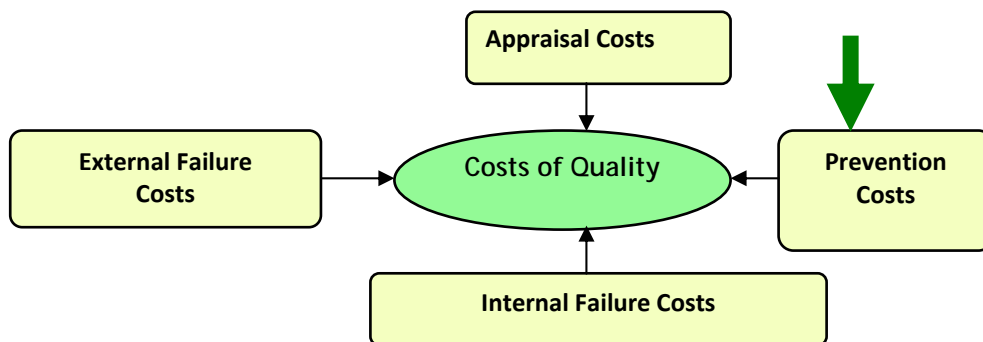


Figure 2. Quality Costs

Because the research was concentrated on the improvement of quality and reliability the investigation start from the number of failures of the product.

Using the fish bone diagram we establish a correlation between the causes and the effect, in this case:

- a) the effect = failure of the product,
- b) the causes = factors who can influence the quality of the product.

Not at last the product has some problems regarding the noise in function and vibration who influence in time the cycle life of product and increasing the number of failures and damage. This are the problems unsolved yet and needs a immediately solution from economical and engineering point of view

### 1.3. Which are the non-conformity costs for the product?

The collaboration with the engineering department present the internal and external costs made with the reliability product and identify the problems in different stage of product cycle life.

The results after a complete investigation present the non-conformity costs, the iceberg (Figure 3).

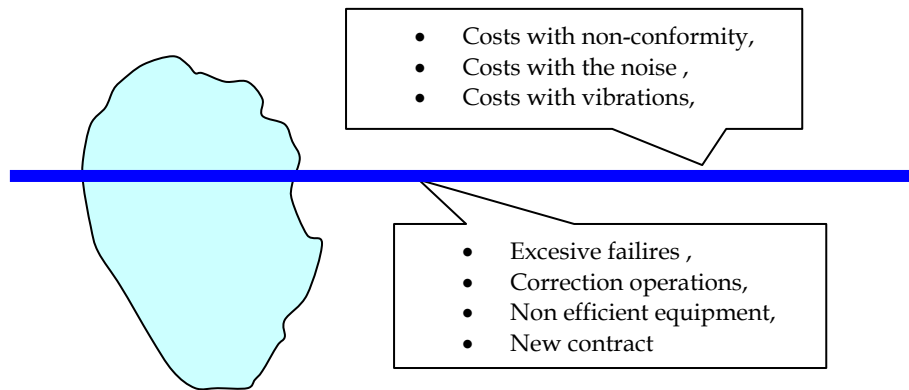


Figure.3. The non- conformity iceberg costs

A deep analyze of quality product in technological process and non-conformity costs identify the visible and the most important un-visible costs with the non-conformity , costs done by the economical agent with a product the target of the research.

Our conclusion was, the preventive costs can be done if the factory will invest in quality using a new program who gives the possibility to design the products and in this way to be able to create low frequencies from the first stage of manufacturing design stage.

The effort if they invest in ANSYS program using the simulation and virtual model of the product will reduce the costs of the entire technological process.

**How is working this?** Using the FEM method in design product it is not necessary to realize the product and wait the failures or damage of the product and only in the old stage of life cycle, to identify the causes.

## 2. Quality design of products

When charting measurements for the technological process and product, "lower consumer tolerance" or "upper consumer tolerance" level designations replace traditional engineering-driven "specification" levels.

This allows an organization to focus on the actual consumer response to, and the measurable financial impact of, variances in performance as opposed to specification-driven parameters. Numerous theories on how to improve quality and performance have emerged over the years. The theories and tools developed by Juran, Deming and Taguchi have been particularly instrumental in shaping the quality goals, processes and successes of the language management team. If the research works identify the solution it was necessary to present the results of the quality new product. For that reason we start with the engineering part from technological process who will assure the economical success. The answer to the question: *Which is the connection between noise and quality?* We establish the connection starting from effect- to cause using the fish bone diagram for planetary gear, our study product.

The answer was that in time the noise it is done by the first sign of wear which modify the life cycle of the product, so we can use the noise as a tool in determination of the health of the planetary gear. The most important thing is that it is not necessary to wait until the product will fail and determine the causes, we can improve the quality and reliability from the design stage. Learning Machine "Sign Language" by learning how vibration signals reveal problems from planetary gear it is important from reliability point of view, as we know the bath curve also can give us a sign about the health of system.

The topic of this paper is to show that a solution for improvement quality can be the following idea:

*Unlike people who have verbal skills, machines use "sign language" to communicate what hurts or what has invaded their system.*

Recognizing the "signs" or symptoms that the machine conveys is a required skill for those who work with machines and are responsible for their care and feeding. This involves training, practice and motivation, but not at last give to the engineer the opportunity to design from the beginning the product by using the mathematical model of the planetary gear, more useful in improving the quality of the system and not waiting until the product will be failed and establish the cause. This involves training, practice and motivation, but not at last give to the engineer the opportunity to design from the beginning the product by using the mathematical model of the planetary gear, more useful in improving the quality of the system and not waiting until the product will be failed and establish the cause. Following the total quality management we must to start from the data and information, especially for our industry which still uses old generation machine and tools. The quality is the only factor who can assure the top market competition and also the customer's expectation

### 3. How quality product can be improved?

#### 3.1. FE DESIGN - proven partner for industrial manufacturers and suppliers

Demands for state -of-the -art product development are stronger than ever. Nowadays all industries are subject to accelerating changes in production and development and increasing aggressive competition. Complex demands can be fulfilled by applying simulation and optimization technologies in a virtual product developing process. The use of structural optimization in the early design phase leads to optimal design proposal that eliminate the need to perform numerous design variations.

The FE DESIGN approach goes beyond the usual analysis of single engineering problems. Therefore customers are able to make better product development decisions in the earlier design phase using a multi-disciplinary approach which includes the combination of static and dynamic FE analyses with simulation, with durability analyses, or calculation with life cycle predictions. The scheme from figure 4. show the efficiency of the introduction of the new method FEM - finite element method in industrial process which guarantees the quality, and the reliability of the products. The scheme present the influence upon quality, the efforts in time and the implementation of the new method which develop the virtual simulation of products, a method which gain in time to market position and bring profit from the early use of simulation and optimization technologies.

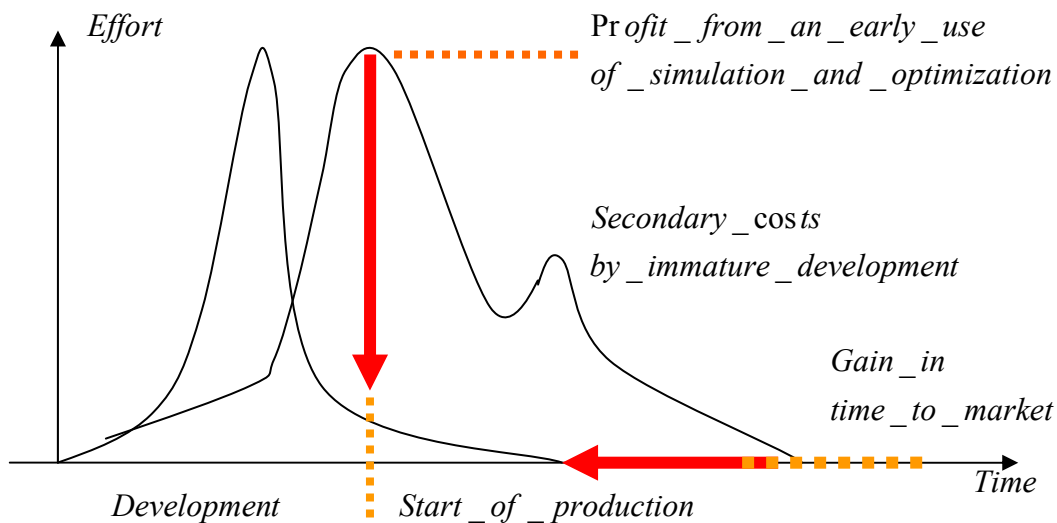


Figure 4. The influence of new method upon the production activity

### 3.2. FE DESIGN service and engineering approach

Improving quality system can be considered as a success if we will realize the products under the customer's expectations.

The system success can be realized in time by using the new method FEM (Figure 5.). Finite element method design the service and engineering approach

- Optimization of existing model product,
- Management of cross- disciplinary simulation projects for industry and research and development applications,
- Consulting and transfer of knowledge and expertise in optimization technologies,
- Training and coaching of designers, engineers and technical executive management staff,
- Customization to integrate the simulation programs into an existing enterprise -individual design and analyses environment.

The scheme present the connection between the reliability and quality and one of the most important things is that from the stage of design and conception of the product, we can model the characteristics and the performance of the costumer's expectation (Figure 6.). The virtual simulation using finite element method for the technical products is predominantly defined in the design stage, although the acoustic characteristics of machine structures can be analyze and give a solution create a new generation of products. I consider that the finite element method it is the only solution for simulation and determination of vibration and capable to give an answer regarding the wear, the contact zone and the friction law. The idea of the research was:

*How we can use modulation design for products as an instrument for determination of the vibration as a parameter for wear.  
 Can we improve the quality from the beginning for the new product?*

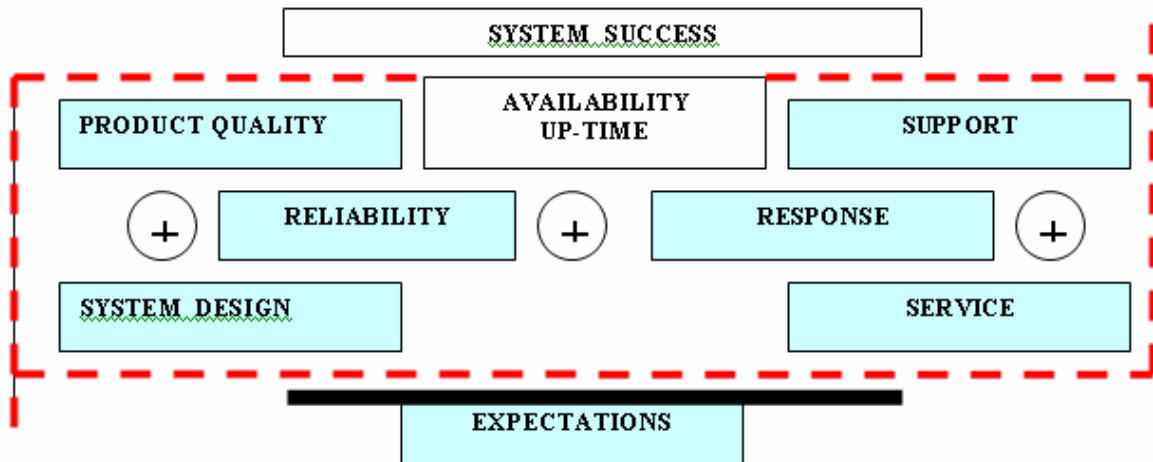


Figure 5. The scheme of the connection between quality and reliability of products

Dynamic and static analyses for products it is from this point of view a little complicated because by using the virtual simulation we need to realize the natural and real habitat of products. By using as modells the schemes of determination of the wears and of the contact zone, I was trying to establish a mathematical modell and a conection between wear and qualitiy which permite me to identify the parameters characteristics. Starting from the physical conditions and using the technical documentations we can determine from the beginning the limits and the significant values for different situations. All this put together present a possible solution to influence the reliability of the system and improve the quality system defining the elements of wear, I realise the theoretical wear matrix (Figure 6.).

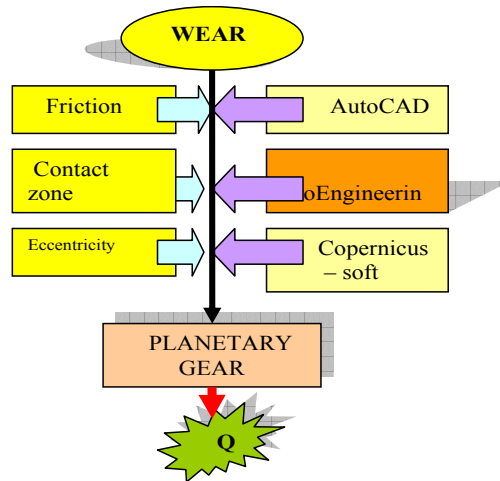


Figure 6. Wear Matrix

The virtual simulation of product can be done to different torques and materials and factors which can present the future work activity and work condition considering the real parameters from industry. By developing a mathematical model for product and after I analyze the factors who can influence the quality and reliability, it was possible to realize The Quality Matrix (Figure 7.).

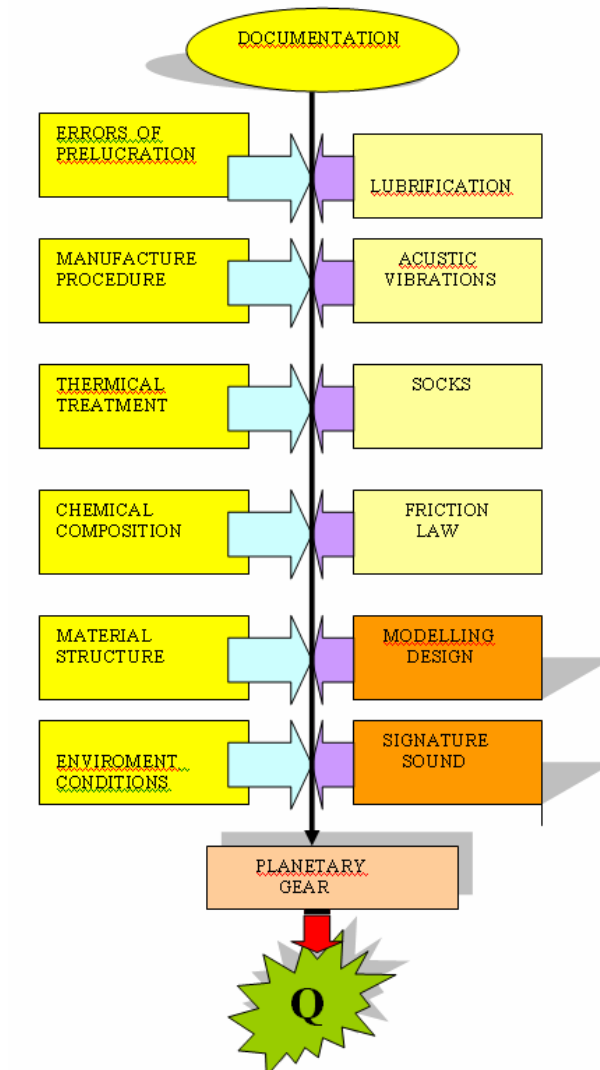


Figure 7. Quality Matrix

The Quality Matrix show that the improvement of quality in direct correlation with different factors who can induce the first sign of wear and the fatigue for industrial products. The investigation give the answer, in frame of the available work the nonlinear friction law for the numeric investigations, FEM for the determination of the direct influence between eccentricity of the connections and wear. Because the wear and quality are in a very strong influence relation, my attention was focus to the aperence of the wear and how it is influence the cycle life of gears.

Because the wear and quality are in a very strong relation and influence the reliability of mechanical sistem, my attention was focus to the aperence of the first sign of failures and damage. The Quality Matrix show that the improvment of quality depends of different factors which can induce the first sign of wear and the fatigue of the planetary gears and not only. The mathematical modell and FEM method put in evidence the elements who can indicate the first signals of wear, the next step it was to find a solution to show how the first sign transform the sound in vibration in time as a result of the health communication of the system. For that reason I realise the experimental research for the planetary gear with rigide montage asambly and for the floating planetary gear system, after the examinations of results, the conclusion show that the new type of planetary gear improve the quality.

#### 4. Modeling and design quality product

The FEM methods for the new product help us to discover the fragile parts of our hybrid planetary gear. The color solution - result obtain by using the finite element method help for a better understanding of the mechanism who take place inside the planetary gear system especially in this study case upon the solar pinion and the three satellites in the contact zone between tooth, red color present the maximum value, the place of higher friction contact (Figure 8.). The conclusion is that the wear it is present even from the design solution, which makes us once again to think that only the analytical method and theoretical part will not improve the quality. The ANSYS solutions program present the influence of the total stress von Misses under the real product already manufacture by the economical agent, form this point the things become more easy (Figure 9.). Having the program solution and define a base of dates for product (mathematical model), the engineer can improve the quality of product step by step, simulate different situation with all this dates considering like normal parameters and characteristics of the product.

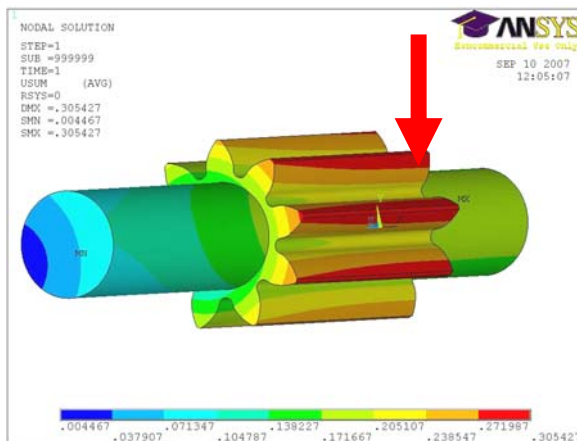


Figure 8. Total displacement USUM for solar pinion

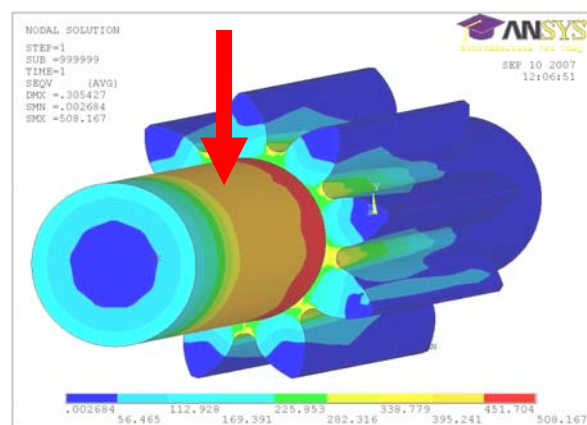


Figure 9. Solution for solar pinion total stress SEQV von Misses

The program give the opportunity to change the type of material, temperature, torques, pressure and also the possibility to optimize the weakest point of the product. Because the topic of my research was especially in the field of quality and reliability which remain a great problem for planetary gears and especially the noise, I consider that not at last by modeling the product and simulate him virtual we are able to define and determine the limits for the new products generation.

Having the solutions a specialist will consider the results as a suggestion for a future optimize of flank profile of the teeth a problem which can be solve with the help of TOSCA program, by using the similar mathematical model realize with the FEM method who is consider the base of data. In this way we can discover earlier the possible factors and the parameters which can improve the quality.

In this way I consider that connection between wear - noise - quality was done completely by the mathematical model, realize for the new planetary gear as a matrix for the future improvement which will bring to the planetary gear. The quality management of product was realized and we find the optimal solution by using FE DESIGN - who proves to be a good partner for industrial manufacturers and suppliers.

That solution brings benefits from economical point of view, material; reduce the cost, increasing the quality and the optimization of technological process. Not at last an analyze of the contact zone under different factors, pressure, friction, figure 11 under the penetration, can make the investigation of the solar pinion more complex and give the final solution regarding the improvement of reliability of all system.

This results make the affirmation of the connection between wear-sounds-quality become to reality, remain that the experimental research and the harmonic, modal and transient analyzes to sustain same values.

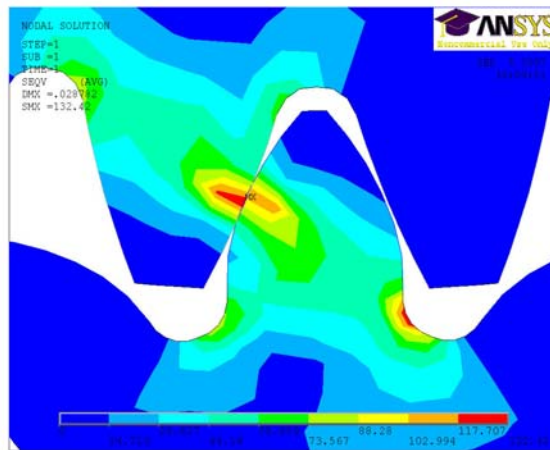


Figure 10. Von Mises stress between the solar pinion and satellites

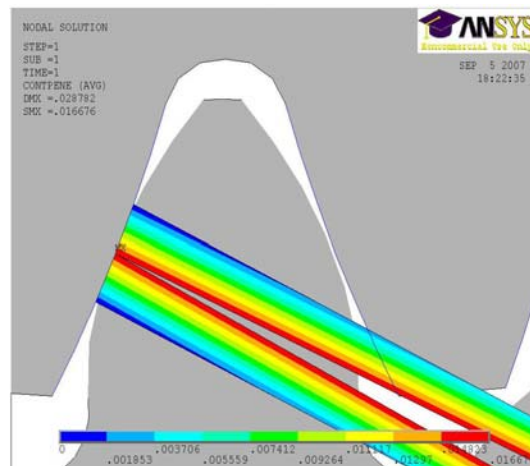


Figure 11. Contact zone between the solar pinion and satellite



#### 4.1. Dynamic analyze for product (solar pinion)

Dynamic analyses for solar pinion in this stage design of life-cycle case permit the explanation of the factors which induct frequencies and the first signal of the future failures of the product.

By visualization of the influence of the product for different impulse values, forces and torques be can obtain some values which can be compare with the results obtain from experimental research make with the help of the PULSE program confirm the improvement of quality, the acoustic vibration for the product will appears only to 100 Hz. the conclusion it is that the product it is under the standards A curve for industry (Figure 12.).

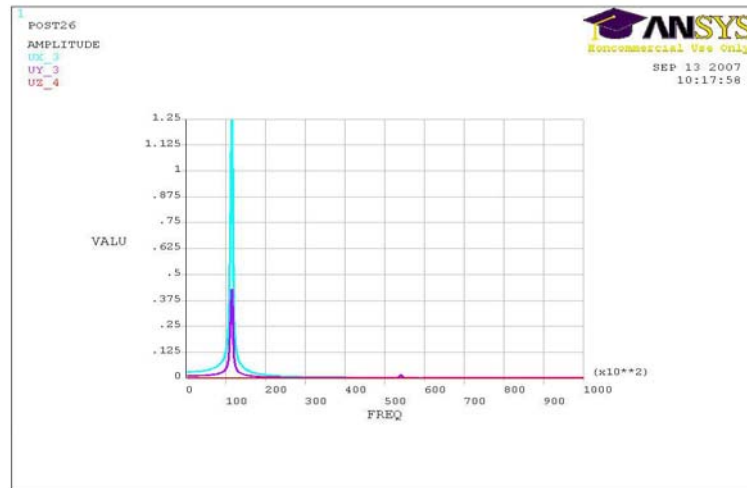


Figure 12. Harmonic analyze for solar pinion USUM

Another investigation was done by using the transient analyze for solar pinion. By modeling and modifying the shape of the products from the first stage of design we can simulate the real product and can improve the design even to low frequencies.

#### 5. Conclusions

The influence of Manufacturing Quality upon gears -transmission using low noise design will give us a solution for a future increasing reliability for the planetary gear, a way for a better maintenance of the system machinery, a permanent and quickly diagnosis for the new born signature sign of wear.

Also using the new programs as ANSYS, TOSCA, FEMFAT, the future for quality product it is a reality, in this way we can improve quality from the first stage of life cycle of the product. Each individual issue requires typically dedicated analyses and modeling tools, which leads to the introduction of various fields of application and corresponding domain and research. I summaries these goals as an analysis dedicated to some of the following interest:

- analyses the transfer path from the vibration source to the noise planetary gear,
- design and implementation of control,
- development of control algorithms, to reduce loads, noise, to optimize the efficiency to guard the planetary gear system.

This method in design product will help customers to:

- 1- make early decision in the design cycle,
- 2-reduce the product development cycle,
- 3-improve time-to -market,
- 4-reduce design and manufacturing cost:
  1. reduce design cycle,
  2. reduce cost of materials,
  3. reduce number of prototypes and physical testes.

### References

1. [1]. Boca, G.-Finite Element method a solution for the planetary gears to improve the Quality Matrix, 7-th International Conference in the field of gears, North University Baia Mare, 2007
2. [2]. Boca, G. - The influence of Manufacturing Quality upon gears –transmission using low Noise design, 7-th International Conference in the field of gears, North University Baia Mare, 2007
3. [3]. Boca, G.-Contribution regarding the improvement of Quality and Reliability of planetary Gear, 7<sup>th</sup> Edition the International Conference of the Carpathian Euro regions specialists In Industrial Systems, North University of Baia Mare, pp. 35-40, 2008
4. [4]. Boca, G. - Improvement quality and reliability of the planetary gear, 7<sup>th</sup> Edition, The International Conference of the Carpathian Euro regions specialists in Industrial Systems, North University of Baia Mare, pp. 41-46, 2008
5. [5]. Boca, G.- A solution which can improve the Quality Management in Technological Process, International Symposium Sustainable Development Strategies, North University Baia Mare, 2008
6. [6] Boca, G.- How we can improve the Total Quality Management and Life Recycle Assesment, International Symposium Sustainable Development Strategies, North University Baia Mare, 2008
7. [7]. Boca, G. A solution which can improve the quality management in technological process, International Symposium Sustainable Development Strategies, North University Baia Mare, 2008
8. [8]. Boca, G.-FEM a solution which improve the quality and reliability of products, 5<sup>th</sup> International Advance Technologies Symposium IATS 09, Karabuk University, Turkey, pp.1464-1467, 2009
9. [9]. Boca, G.- Modeling design can improve the quality and reliability of planetary gear, 5<sup>th</sup> International Advance Technologies Symposium IATS 09. Karabuk University, Turkey, pp. 1468-1471, 2009
10. [10]. Boca G, GOKKAYA, H. - Eco Age a new provocation for TQM ? International Conference, The Knowledge, Economy, Management Congress,-Yalova, Turkey, vol I, pp. 1329-1341, 2009.