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MODELING AND STRUCTURAL ANALYSIS USING CAD/CAE TO REDESIGN AND OPTIMIZE A MECHANICAL ASSEMBLY OF A GAS TURBINE

F.S. Gocobachi[1], P. Pérez[1], N. J. Gámez[1, 2], and B. González[1, 2]

[1]Corporación Mexicana de Investigación en Materiales, S.A. de C.V.
Ciencia y Tecnología # 790 Frac. Saltillo 400
Saltillo, Coahuila, México, C.P. 25290
Telephone: 52 (844) 411 3200/Fax: 52 (844) 416 9346
Corresponding author's email: fgocobachi@comimsa.com

[2]Facultad de Ingeniería Mecánica y Eléctrica.
Universidad Autónoma de Nuevo León.
Ave. Universidad s/n.
San Nicolás de los Garza, N. L.
México, C.P. 66450

Abstract: This research shows a hybrid methodology using CAD (Computer Aided Design) and CAE (Computer Aided Engineering) for modeling and developing the structural analysis of a mechanical assembly. The coupling sleeve and the coupling flange assembly of a gas turbine are used as an example. In this methodology, a parametric design was developed that contains a set of parameters to create the geometry under certain restrictions and design parameters. The parametric design was analyzed to understand the dependency and relations. Additionally, a finite element analysis was applied to the models in order to compare the resistance of two types of steel with the objective to find faults due to the material and to observe possible improvements in the design. The results and conclusions of this methodology are presented.

1. INTRODUCTION

The metal mechanical industry in a constant effort to reduce costs, produce high quality products and increase production seeks to apply advanced technologies in its design and manufacturing processes.

The application of CAD / CAE tools are part of this technology when we want to determine critical regions of a model for possible faults in material or design, this is of vital importance for pieces that are part of a complex and expensive product. In this way we can say that a turbine is a complex product where every component must be manufactured with high quality in order to avoid possible faults in its operation, which causes loss of time, stop by repair cost and possible damages to other components.

This investigation focuses in the application of a methodology using tools CAD/CAE for the modeling and finite element analysis for two components of a gas turbine: Coupling Sleeve and the Coupling Flange. The function of the Coupling Sleeve is to hold the axis of the box of gears and the Coupling Flange holds the axis of the turbine. Both couplings are united to connect the gas turbine with the box of gears. The box of gears is important part of the turbine because it is connected with the machine that will carry out the work, for example a pump to extract crude or a generating machine of energy. Here the importance stands out that has the performance and good operation of the Coupling Sleeve and the Coupling Flange that must transmit the required power from a machine to another one with the aim of taking advantage the maximum generated energy. The greatest problem than presents both components is the wearing down in the area flank by the constant contact in the process of operation of the gas turbine.

In order to develop a good model of both components and to predict possible faults a methodology was developed based on Parametric Design and Simulation by Finite Element in search to find a model optimal, for this the commercial programs Unigraphics/NX7 and Abaqus/CAE were used. With the CAD software the parametric model was realized with the help of the handling of expressions that allows the correlation between parameters that give a complete associative design for the control of the geometry of the model. In software CAE is realized the Finite Element Analysis with the aim of finding the regions design critics and identifying improvements.

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LEVELING OF DEMAND AND PRODUCTION BASED ON COOPERATIVE GAMES WITH TRANSFERABLE UTILITY

Darwin Young, Giovanni Lizarraga, and Pedro Pérez

Department of Industrial and Manufacturing Engineering
Corporación Mexicana de Investigación en Materiales
Ciencia y Tecnología # 790, Fracc. Saltillo 400
Saltillo, Coahuila, México, C.P. 25290
Corresponding author's e-mail: dyoung@comimsa.com

Abstract: The globalization of economic markets are requiring companies to improve their production systems and create processes for demand planning and production scheduling in order to enable them to maintain cash flows to meet its financial commitments without creating high inventory level. The focus of this work is based on the feasibility of using game theory to determine strategies to generate alternatives for negotiation with suppliers, or inter-plants, to generate points of equilibrium to reduce inventories of finished product, meet delivery and maintain excellent levels of customer satisfaction. Besides generating a decision-making process based on production to meet purchase orders or to fill inventories. The proposal for the implementation of transfer utility games within supply chains considers the integration of factors or variables in the global value chain that can cause failures, generating a payoff matrix that allow decisions on possible strategies in the leveling process of demand and production scheduling.

1. INTRODUCTION

Today, companies need to improve their production systems to be competitive with the globalization of economic markets, it causes companies have to maintain operational flows as agile and flexible as possible and reduced inventory levels to not affect the cash flow of companies, within the global supply chain presents the processes of demand planning and production scheduling problems presented by not having identified the factors that create uncertainty and that in most cases end with the generation of high inventories.

Within the planning process, usually involving different areas of a company, and on many occasions to not consider the variables of uncertainty, the programs must be adjusted during the production period, creating inefficiencies that end with process in work and finished goods inventories above to inventories budgeted, also cause non-delivery of products and customer dissatisfaction. Every time there is a modification in a production plan, the effect obtained is an increase in the breakeven point of the plant, as a result of inefficiencies due to lack of raw materials, stoppages due to changes in product line, material deviations and other factors.

Figure 1 shows the displacement of the equilibrium point is obtained by modifying a production schedule, where mainly the variable cost of production is the item concerned. This cause the areas of production scheduling require the ability to adjust their sales forecasts to a flexible process to adjust the production schedule daily sales levels, particularly in those companies that have sales that exceed seasonal production capacity, having the need to generate inventories of finished product.

In general, problems of making decisions or relating to conflicts of interest are characterized by the existence of a group of individuals who are confronted with a situation that can have more than one outcome, where everyone has a certain personal preference. Each individual also controls some of the variables that determine the end result, but does not control all (Meyer, 2004). Each of these situations is called a game. In a game must consider the existence of a specific number of players who know each other and are certain all possible outcomes of the game, each individual has a preference between the different results can be expressed in terms of a utility function and the goal of each player is to maximize the utility obtained on the outcome of the game. The problem for each area is to determine the strategy to be followed, so that their partial influence in the game will be as beneficial as possible. Faced with this situation is the first ranking among games: the cooperative and uncooperative. The non-cooperative game theory deals with the behavior of actors in the game in situations where the choice of the optimal strategy of each player depends on the outcome of the decisions of opponents and seeks to maximize its own benefit without knowing the choice made by others.

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LINEAR REGRESSION MODELING USING TO PREDICT TEMPERATURE IN MACHINING OF TI 6AL 4V ALLOY

I. Escamilla[1,2], L. Torres[2], B. Gonzalez[2], F.Garcia[2], K. Escamilla[2], P. Perez[1], and P. Zambrano[2]

[1]Corporación Mexicana de Investigación en Materiales
Ciencia y Tecnología # 790, Frac. Saltillo 400,
Saltillo, Coahuila, México
Corresponding author's email: indiraescamilla@comimsa.com

[2]Facultad de Ingeniería Mecánica y Eléctrica.
Ave. Universidad s/n,
San Nicolás de los Garza, N. L.

Abstract: Titanium alloy (Ti-6Al-4V) is one of the materials extensively used in the aerospace industry due to its excellent properties of high specific strength and corrosion resistance, but it also presents problems wherein it is an extremely difficult material to machine. The cost associated with titanium machining is also high due to lower cutting speeds and shorter tool life. The process of machining of titanium in the aerospace industry is by trial and error. It does not produce efficient results, because this material is classified by the high chemical reactions with other materials. It also has a low thermal conductivity which makes it difficult to machine. Hence, the process of finding the correct parameters for machining is hard to determine. Researchers are looking to develop new models to predict and optimize these parameters. The objective of this work is present a methodology to predict the temperature during the machining process of titanium with linear regression. It is used to model and predict process outputs of titanium's machining process considering the parameters of speed rate, feed and depth as an input. Rectangular pieces of titanium Ti-6Al-4V were cut, the tool was an endmill coated with Aluminum Titanium Nitride with 4 cutting edges and 3/8" on a diameter of the tool. The milling was carried out over a length of 47 mm, using a design of experiment with 3 factors and 3 levels, giving a total of 27 experiments with 3 replies. Temperature was measure with an Infrared Non-Contact Thermometer Fluke 574, it is determined considering the mean of the measurements made.

1. INTRODUCTION

Despite the increased usage and production of titanium and its alloys, these materials fall under the category of the most difficult for machining. One of the most required customer specifications in machining is surface quality. A major indication of surface quality on machined parts is surface roughness. Surface roughness is the result of process parameters such as tool geometry and cutting conditions (feed rate, cutting speed, depth of cut, temperature and others). Regression Models have been used in many engineering problems as a data analysis tool to map linear relationships between process inputs and outputs. Rico (2005) used the methodology Surface Response and neural networks to predict the roughness. Developing a model for predicted temperature and roughness of the cutting tool on the machining of the steel 1018. Dimla, et al. (1997) reported that neural networks could be employed in machining process modeling by using experimental data. Öze,l et al. (2005) used advanced neural network designing techniques to predict the tool life. This technology has become an important computing tool for solving engineering problems (Pawadea, 2007). It has also led to increased research on a wide variety of industrial applications, such as product manufacturability control, process planning, and others.

1.1 Linear Regression

Regression analysis is a general technique used to model the relation between a set of significant variables saw in the equation 1 and an output response variable Y, with the objective of fit a suitable empirical model that in matrix form is given by Eq.(2) (Montgomery, 2005).

$$X = \{x_1, ..., x_k\} \tag{1}$$

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MULTIPROCESS EVALUATION BY Z - VALUE PROCESS CAPABILITY INDEX, CONSIDERING GAGE MEASUREMENT ERROR

Darwin Young, Mario Cantú, Pedro Pérez, and Mauricio Garza

Department of Industrial and Manufacturing Engineering
Corporación Mexicana de Investigación en Materiales
Ciencia y Tecnología # 790, Fracc. Saltillo 400
Saltillo, Coahuila, México, C.P. 25290
Corresponding author's e-mail: dyoung@comimsa.com

Abstract: In recent years, the importance of measurement systems and evaluation of process capability have been part of the methodologies, models, and tools that have been developed for the analysis and optimization of manufacturing systems. In order to identify the performance and control processes, companies can apply this techniques for decision making and development of improvements. This paper presents the first results of a research project to integrate the process capability analysis using Z-values (short and long term) for continuous data considering the error of measurement systems.

1. INTRODUCTION

The multi-process system are distinguished by different subgroups of variables to be measured and controlled to maintain the required levels of performance and production, which can be identified as discrete or continuous variables that are related to the integration of different types of data to be analyzed, such as quality, time, costs, resource capacity, productivity and flexibility in an integrated performance index. The process capability index Z-value determines the ability of a process that is grouped around a target. And you can interact directly with the yield of the process in parts per million non-conforming. When the Z-value is calculated using discrete data is considered the throughput yield or defects per opportunity for the calculation of probability.

In general, when calculating the process capability indicators are assumed to have reliable measurement systems and these indicators are calculated without considering the measurement errors. This assumption does not correspond to real situations in which measurement systems can generate dispersion in the accuracy of the data, generating conclusions from unreliable process capabilities. In this paper, we consider the calculation of process capability indicator Z-value considering the measurement errors for real process capability.

In the case study, the mixture of normal distributions are determined for different periods of production being delivered to the client as a mixture of different qualities due to adjustment of equipment or process improvements. Denoting the process capability on real time and capacity delivered to the customer by the mixture of products manufactured at various periods of time correcting the confidence intervals of indicator processes and action limits.

2. Z-VALUE PROCESS CAPABILITY INDEX

The process capability measured by Z-values in a short and long term, has been adopted by several companies that perform processes under the parameters of the six sigma methodology.

$$Z = \frac{x-\mu}{\sigma} \tag{1}$$

It compares the value of specification, with the average from the process and is divided by the value of standard deviation. One advantage of using this indicator is that capacity can easily be obtained for continuous and discrete characteristics. And measuring the potential short-term information, and the actual capacity to the application of rational subgroups, considering that at least 80% of the variation factors of the process.

The Z-value short-term capacity (Zst) is calculated from data taken over a period short enough so that no external influences on the process. While the Z-value long-term capacity (Zlt) is calculated from data taken over a period of time

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STATISTICAL CONTROL & PROCESS CAPABILITY: A CRITERION FOR OPTIMIZING PRODUCT DESIGN AND MANUFACTURING PROCESS

Luis Saucedo[1], Darwin Young[2], and Pedro Perez[3]

[12]Department of Industrial Engineering
Corporación Mexicana de Investigación en Materiales
Ciencia y Tecnología # 790, Fracc. Saltillo 400
Saltillo, Coahuila, México
Corresponding author's email: lsaucedo@comimsa.com

Abstract: The monitoring of production processes is a necessary element to reduce the manufacture of defective products and determine the time at which a process has instability problems and loss of capacity. This paper shows the development and implementation of a statistical control system to maintain effectiveness in the manufacturing process of metal kitchen utensils (metal cookware) where the majority of the operations are manual, the critical variables of product and process are identified through Failure, Mode and Effect Analysis (FMEA) and controlled under IMR control charts and process capability indicators. The system considers the estimation of confidence intervals on indicators of process capability based on the normal distribution. As a result of this work will develop control plans to ensure production under conditions of variation during the manufacturing process generating actions that allow manufacturing flexibility by eliminating defects and improving the process by identifying the conditions of instability.

1. INTRODUCTION

Currently companies are required to have efficient and effective production processes if they want to remain in force in a market increasingly competitive and globalize world, therefore the knowledge and application of technologies and philosophies that produce significant advances in production processes can not be deferred more. In Mexico since the opening of tariff manufacturing aluminum cookware (MAC) has increased competition due to imports, so that the search for high quality standards become one of the basic strategies and operational intentions the MAC. If companies want to be the best must be competitive in the field of quality management. It is therefore constantly seeking to address more efficient ways to produce services and products. The practice over time of improved quality has created and developed several methods using mathematical applications to succeed where these applications are part and base of most manufacturing operations in quality control (Burlikowska, 2005).

Each process is subject to the influence of many factors (many of which could not be checked) so there is variability in the outcome of the process. In practice there will always be factors that can not be controlled by what the product will have a variable quality.

As time statistical process control is to observe the process and find out periodically through the process graphics when assignable causes are acting in order to discover and remove them from the process. The statistical quality control refers to the use of statistical techniques for measuring and improving quality and include in the technical processes such as statistical process control (SPC), sampling plans, experimental designs, reducing variation, process capability analysis and process improvement plans (Burlikowska, 2005).

Capability indices associated with short-term variations are Cp, Cpk and CPU on the other hand, those associated with long-term variation are Pp, Ppk and PPU. In practice, 1.33 is generally considered the minimum acceptable value for an index-building (ie any value below this data would indicate that, although this statistical control, the process does not meet the required specifications.) Cp and Cpk indicators belong to a group of indices that relate to the needs of clients in connection with the performance of the process. To improve the performance of the process should focus on reductions in variation and , or closer to the goal, where increasing the size of the indexes are best meets customer requirements. In each case, the higher the index is the process more capable.

Of the research there aren't many applications of the statistical process control for the manufacture of kitchen utensils (cookware) where the majority of the processes are manual and the quality bases in some cases are corrective.

In this paper, selected problems connected with creation of control charts type IM-R and estimation of quality capability of process has been presented. And also suitable examples of quality estimation of production process in Grupo Industrial Saltillo companies have been given.

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Luis Saucedo[1], Darwin Young[2], and Pedro Perez[3]

[12]Department of Industrial Engineering
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Corresponding author's email: lsaucedo@comimsa.com

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Preliminary Meanline Design for Gas Turbines Using Multi–objective Optimization.

Giovanni Lizarraga
Gerencia de Desarrollo Humano
line 2: COMIMSA
line 3: Saltillo, Coahuila
line 4: Email: glizarraga@comimsa.com

Pedro Perez
Gerencia de Desarrollo Humano
line 2: COMIMSA
line 3: Saltillo, Coahuila
line 4: Email: pperez@comimsa.co

***Abstract*—Designing gas turbines is a very complex task. It is not a linear procedure but an iterative one, composed by several phases. In the initial phase, the general geometric characteristics and estimate efficiency of the turbine are determined. This phase is known as the meanline design, and it is very important because it determines the starting point for more complex analysis. In this work we use a multi–objective evolutionary algorithm to calculate the meanline design. We consider two conflicting objectives: the number of stages of the turbine, and the efficiency of the stages.**

***Keywords*-Multiobjective; turbines; evolutionary; design;**

I. Introduction

Gas turbines are devices that extract energy from a fluid and transform this energy into useful work. As the name suggest, gas turbines use gas a the working fluid. Other kinds of turbines use other fluids to generate work. Turbines work with a continuously flowing fluid that interacts with a rotating blades in order to generate work. Gas turbines are classified in axial turbines and radial turbines. In axial turbines, the fluid flows mainly in an axial direction through the length of the turbine. In radial turbines, the fluid enters to the turbine in a plane perpendicular to the turbine axis, then the fluid is turned and leaves the turbine following the axial direction. In this work we focus on axial turbines for power generation. In Figure 1, an outline of a turbine is presented.

Two of the most important components of a turbine are the rotor and the stator. The stator is a fixed ring of blades or airfoils, that receives the fluid with an angle α_1. Then, the stator accelerates the flow so it arrives to the rotor with an angle α_2. The rotor is a circular array of blades, that turns as the fluid passes through it. The movement of the rotor turns a shaft, and this shaft transmit power that is transformed into movement or electricity. The fluid enters to the rotor with an angle α_2, and leaves the rotor with an angle α_3. The change in the flow of the fluid $(\alpha_3 - \alpha_2)$ is very important, because it is related with quantity of work that is performed by the rotor.

The combination of a rotor with its corresponding stator is called a stage. In order to extract as much energy as possible from a fluid, several stages may be necessary. There exist a trade off between the number of stages and the efficiency

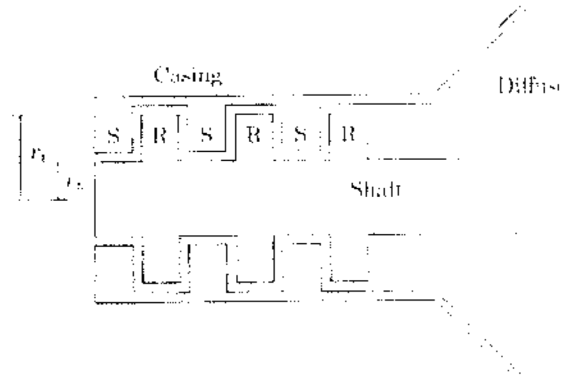

Figure 1. An axial of a turbine. S= stator, R=rotor.

of a turbine. The amount of energy extracted from a fluid in a stage is directly proportional to the losses due to friction. Incrementing the number of stages in a turbine increases its initial cost. But, it is possible to improve the efficiency of a turbine using several stages. Small increments in efficiency may result in huges saves in combustible in the long term.

The losses due to friction and the quantity of work done by an stage depends highly on the angles α_1, α_2 and α_3. The designer have infinite number of options with respect to what set of angles must be used. It is common to use a set of angles that fulfil the requirements of the turbine, but this set of angles not necessarily are the optimum with respect to efficiency.

In this work we use a multi–objective evolutionary algorithm to optimize the incidence angles α, so that the number of stages and the losses due to friction are minimized. The rest of the article is divided as follows: in Section II we give and introduction to multi–objective evolutionary optimization. In Section III we explain briefly the preliminary meanline design procedure for a gas turbine. In Section IV, we state the multi–objective problem to solve. In Section V, we present some experiments to evaluate the feasibility of our approach. Finally, in Section VI we state our conclusions.

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