DESIGN PROCESS FOR HIGH LOADED FRICTION SYSTEMS WITH ADVANCED CERAMICS

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New outperforming engineering materials like advanced ceramics tend to fail when using the ordinary design process. Excerpts from the adapted design process of high loaded friction systems with high performance ceramics using the working surface pair theory are presented and explained. An adapted design process as well as the analytical background are explained. It is shown that the necessary special tools and methods can be integrated well. The proposed designs are realised as prototypes and investigated intensely on test benches. Results show that they are more efficient than common solutions. The selected tools and methods have shown to be appropriate for the design process. They can be made available as guideline for design engineers.

MECHANISM UPGRADE USING PRESCRIPTIVE MODEL OF PART BASED PRODUCT UPGRADE

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At NIKO d.d. company, a producer of binding mechanisms, the improvements are usually a trial-and-error process. For this reason, our company has taken a more systematic approach. The prescriptive model of searching for changes has been used. The use of the model on the mechanism M75 has shown that the model is also suitable for companies with limited R&D human resources. It also has a positive effect on the creativeness of the process of searching for changes. Its deficiency lies in the fact that decomposition does not keep the relations between the parts. Searching and assessing the changes proved the main problem. The proposed changes should contribute to a better competitiveness of the product on the market.

DEVELOPMENT OF MODULAR ACTUATOR SYSTEMS

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Aiming to decrease the development risk for the individual applications, the idea of a modular system for actuators with shape memory elements has arisen. The development of the modular actuator system, beginning with the analysis of application characteristics up to the embodiment design of the actuator modules, is described to report about the experiences gained and to discuss the approach used. In developing the modular system, the MFD-method, systematics and different combination matrices and schemes as well as CAD-modelling have been utilized. Problems with the methods applied and topics for further research are mentioned. Thereby, there is a particular focus on the modularization and the interface design of modular systems.

A NEW METHOD FOR SELECTION AND DESIGN OF COMPOSITE ELEMENTS FOR IMPACT LOADING

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The proposed method brings together routines of geometry modeling, properly designed experiments, computer identification of the structure dynamic response, and the determination of a mathematical model for simulation. This model is parametric one, and the parameters are optimized in respect of the best approximation of the real structure properties. In the paper the authors present: The problem outline, general description of the method for selection and design of mechanical element characteristics, implementation of the simulation model to establish the optimized characteristics of the investigated element, illustrative example of the method application.

A SOFT COMPUTING METHODOLOGY APPLIED TO ABS

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The aim of this paper is to create a new ABS (Antilock Braking System) control system of a Soft-Computing type, on the grounds of the excellent results obtained in the field of automobiles in former studies. Such a system should make it possible to enhance performance in all conditions. In this way the performance of the system may be improved or alternatively the control logic may be simplified for the same degree of performance, offering satisfactory results in all possible conditions. The target performance aimed at may be summarised in two points: reduction in braking distance and improved directional control of the vehicle. The study was optimised on a monocorner model, subsequently to be extended to a complete vehicle model.

DESIGN FOR MICROGRAVITY - TOOLS FOR THE DESIGN OF HABITATS WITH NO GRAVITY

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This paper illustrates the results of a doctoral thesis on the “Habitability in space in microgravity condition”. In the thesis, aimed at improving the habitability condition of the International Space Station, particular relevance has the research of a method for the design of habitats and equipments for the crew living aloft. In the past manned space travels there are several examples of interesting design solutions, still, there is no clearance of a design method for microgravity conditions. The doctoral thesis has evidenced the opportunity of an approach that integrates the typical engineering planning systems with typical design tools such as definition and visualisation of operational scenarios, as illustrated the paper.

INFLUENCE OF PITCH ERRORS ON LOAD DISTRIBUTION ON SPUR INVOLUTE HCR GEARS TEETH

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High contact ratio (HCR) gears are more frequently in use because of their increased load-carrying capacity compared to low contact ratio gears, although they are very sensitive to manufacturing errors. The choice of quality grade has the major influence on load distribution on mating teeth, and consequently on tooth root and contact stresses. The stresses can be significantly increased if theoretical contact isn't equal to the real contact. In this paper the expressions for calculation of load distribution on spur involute HCR gears teeth with pitch errors are established. The use of these espressions enables better estimation of appropriate gear quality grade.

THE CONCEPTUAL DESIGN OF THE MERCEDES - BENZ CONCEPT MIDIBUS USING METHODIC DESIGN

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The application of systematic design , especially in the conceptual design phase of complex technical systems is quite difficult. The main reason is the methods, which are used for the analysis and the synthesis of technical systems are too difficult and abstract to use which is a problem for engineers who are used to work with concrete objects. The aim of the study is to apply the systematic design steps on the design of a midibus. The problem during the design of the midibus is the assembly of the engine and the transmission elements at the rear part of the midibus because of the insufficient space. Different solution alternatives are designed and examined using steps of systematic design methods and the best design is determined.

DESIGN OPTIMIZATION FOR A VIBRATING VERTICAL CANTILEVER

Gooch S., Raine J., McCallion H. - *University of Canterbury (NZL)* 1263

This paper determines the maximum practical economic size to which a vertical cantilever beam, in the form of Len Lye's kinetic sculpture Blade, can be built. The artists intentions in the performance of Blade where formulated in engineering terms and a set of design constraint equations produced. This study gave a quantitive measure of the performance of candidate materials for a vertical cantilever. High strength titanium alloys were found to be significantly cheaper than a low alloy steels when considered on a cost per performance basis.

DESIGN TARGET CASCADING FOR VIBRO-ACOUSTIC CONCEPTUAL DESIGN OF AN AUTOMOBILE SUBFRAME

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Product decomposition speeds up design stages, allows concurrent engineering and improves product quality. In the conceptual design stage, design teams focus separately on each subsystem and develop physical models (principle solution) which must meet some independent design requirements. But these requirements at the subsystems levels must be synthesized so as to meet at best the system performance targets. The paper applies a target cascading strategy to the optimization of the road noise performance of an automotive system. It focuses on how vibro-acoustic performance targets are specified and aggregated at a subsystem level (the front subframe) and how the current vibro-acoustic performances are assessed and optimized.

DAMAGE MECHANISMS OF HEAVY LOAD WHEELS IN LOGISTIC APPLICATIONS

Künne B., Langenohl A. - *University of Dortmund (DEU)* 1295

Nowadays the logistic jobs need heavier and more powerful floor conveyor systems with high-performance weehls. Standstill period in logistic systems due to unexpected malfunction of those rollers can cause great economic damage. To guarantee the most potential availability of those systems different damage processes must be analysed so that the conditions can be improved. The mechanisms are recorded which can lead to a failure of the heavy load wheels. Depending on the kind of load and the external boundary conditions those wheehls can fail through abrasive wear, thermal failure, or tyre delamination.

MICRO INTERLOCKING MANUFACTURED BY LASER ABLATION

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Piezoelectrically driven linear actuator devices, e.g. inchworm motors are widely spread in technique and research. The inherent disadvantage of those actuator devices is the insufficient carrying capability. To overcome those problems the traditional friction clamping mechanism can be substituted with diverse interlocking mechanism. Micro ridges based on silicon structures support maximum loads up to 500N. This paper presents the advantages of micro interlocking mechanism in steel to significantly increase the carrying capability up to kN ranges of piezoelectric actuators. Furthermore it offers a technique to process these structures by using laser ablation. Additionally ways of a cost-efficient mass production were discussed.

SUPPORT FOR DESIGNERS USING FEA

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To push the integration of design and analysis, design engineers are forced to perform FE-Analyses by themselves, especially the simple and repeating ones. Complex and more difficult tasks remain to the analysis engineer. To perform these types of analyses the designer faces a huge number of aspects of a FE-Analysis. One of these aspects is investigated in detail: the selection of elements. Based on mechanical states of stress the impacts of element selection on the result quality of FE-Analyses are investigated and evaluated. To get in touch with the designer, an extended form of design catalogue is developed covering certain aspects of FE-Analyses. Several examples of real-life design parts show the application of the catalogue.

PART BASED UPGRADE OF A VACUUM CLEANER MOTOR

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Upgrading is the most frequent way of keeping an existing product competitive on the market. On the example of a vacuum cleaner motor, the article presents the use of prescriptive model for upgrading existing products. Improvements on the parts that have been subject to the smallest number of changes in the past have been proposed, as it is presumed that they have the greatest potential for economically justifiable changes. Using the descriptive statistics, it was our aim to eliminate subjectivity from defining the future changes. The method is suitable for products with some tradition as it forces seeking improvements in the areas that have not been subject to appropriate attention in the past.

DOMAIN ALLOCATION IN MECHATRONIC PRODUCTS

Welp E. G., Jansen S. - *Ruhr-University Bochum (DEU)* 1349

The appropriate allocation of the different domains (mechanics, electronics and software) to the functions within a mechatronic product is one of the essential problems in mechatronics. Nevertheless, an analysis of existing methods for the development of mechatronic systems shows that domain allocation is not sufficiently supported. In order to develop a new allocation method, the interfaces between the different domains as well as the influencing factors are analyzed. It is found, that the interfaces between the electrical and the mechanical domain are of major importance for domain allocation. Based on the results of the analysis, a new approach for a method which can support the process of domain allocation is presented.

THE DEVELOPMENT OF THE THERMAL CONTROL SYSTEM FOR A SPACE EXPERIMENT

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This paper describes the development of a thermal control system based on fin heat exchangers for an application under microgravity conditions. The system belongs to an experiment accommodated within a so-called Experimental Container that will be launched in 2005 to be integrated into the Fluid Science Laboratory of the International Space Station. Due to the very constricted volume inside the Experimental Container the main emphasis of the thermal control system development is high cooling performance at an exceedingly compact design. The thermal control system is a very critical part of the experiment, as it must guarantee the homogenous heat removal for an accurate execution of the experiment.

FLUID-SOLID INTERACTION IN DESIGN OF MULTIFUNCTIONAL SCREW MACHINES

Kovacevic A., Stosic N., Smith I. K., Mujic E. - *City University London (GBR)* 1289

Screw machines operate either as compressors or expanders. Since these functions are accompanied by large pressure and temperature changes, the rotors deform. The calculation of this deformation is very important if the simultaneous expansion and compression in the same pair of rotors is required. To determine these effects, previously developed 3-D numerical methods have been combined into a design management interface to enable simultaneous calculation of fluid flow and rotor deformation with continuous feedback to the elementary design processes. Examples presented in this paper, are the compressor-expanders for fuel cell and high pressure CO2 refrigeration and a two stage compressor in one pair of rotors.

SIMULATION OF AN ADAPTIVE ER DAMPER SUPPORTED BY AN EFFECT-CATALOG

Kahlert M., Iriondo A., Schweiger W. - *University of Erlangen-Nuremberg (DEU)* 1277

In the early stages of design the computer-aided modelling support is still insufficient. It is here shown as an efficient tool for material selection criteria, an effect-catalogue followed by a model simulation. This catalogue is a continuous application system which enables the search of the adequate material for a specific construction problem. It offers the required material equations and, if desired, it simplifies the further calculation as it provides a simulation block for each particular material equation. A semi-active suspension system including an adjustable ER damper will be considered in order to explain the use of this effect-catalogue.

CONSIDERATION OF SAFETY FACTORS FOR CYCLIC STRESSED MACHINE PARTS CALCULATED WITH FE METHOD - CASE STUDY

Butkovic M., OrèiæB., TevèiæM. - *Faculty of Engineering, University of Rijeka (HRV)* 1205

Analysed are only stress related and cyclic related safety factors. Stresses are calculated with FEM-linear and FEM-non-linear. Material data are based on Smith diagram or modified Goodman diagram. Recalculation of stresses are necessary for averaging and for correction of stress concentration. Two examples of safety calculations of power machines components, turbine blade and fan hub are shown.

NUMERICAL METHOD TO ESTIMATE TOLERANCES COMBINED EFFECTS ON A MECHANICAL SYSTEM

Cambiaghi D., Magalini A., Vetturi D. - *Universita degli Studi di Brescia (ITA)* 1215

This contribution deals with a numerical method developed to estimate how the combined effects of several form and dimensional tolerances, to be applied on a mechanical structure, influence the final three-dimensional location of a single constituting element of this. Reference is made to the space program Planck: problems of misalignment in receivers mounted on a short waves measurement instrument have been analysed. A general numerical approach based on statistical methods has been developed to evaluate the propagation of uncertainties associated with the imposed design specifications. This method has to be thought of as a possible general means for the optimisation of tolerancing during the design phase.

PHOTOELASTIC RESEARCH OF THE HERTZIAN STRESS IN HCR-GEARS

Lovrin N., Krizan B., FranuloviæM. - *Faculty of Engineering, University of Rijeka (HRV)* 1309

This paper deals with the analysis of the Hertzian stress in high transverse contact ratio (HCR) gearing. Based on the realistic load distribution on tooth pairs in mesh and using our own method, the Hertzian stresses along the path of contact have been calculated. Photoelastic research of Hertzian stresses in HCR gears were carried out. The model was to simulate the real total load distribution on teeth pairs. The experimental results showed significant concordance with the theoretical calculations. A comparison of experimental results with the values obtained by using the DIN- Standard HCR-gears calculation shows that DIN-Standard procedure gives rather inaccurate results, although they are "on the safe side".

A MODEL-BASED DESIGN STUDY OF GEARBOX INDUCED NOISE

Sellgren U., Akerblom M. - *Royal Institute of Technology (KTH) (SWE)* 1337

A clear trend in recent years is increased legal and customer demands for lower noise levels for construction machinery.Even if the gear whine type of noise is not the loudest source, its pure tone is easily distinguished from other noise sources and it is perceived as highly unpleasant and gives an impression of poor quality. A general design requirement is to the gear whine related noise at least 15 dB lower than other noise sources. The origin of this noise is the gear mesh, where vibrations are excited, mainly due to the transmission error. This paper presents ongoing model-based research at Volvo CE that is focused on investigating the influence of design parameters, gear-finishing methods, and assembly operations on gear whine noise.

SELECTION AND MODIFICATION OF CONNECTIONS

Klett J., Blessing L. - *Technical University of Berlin (DEU)* 1283

Products should be optimized through improving the functionality of connections and the process of (dis-)connecting. Also the complexity of connections is considered. At present no established systematic approach for designing connections exists which leads to the assumption, that connections are selected in an unsystematic manner. To improve connections and thus the product, a systematic approach was developed for systematically selecting and modifying connections. With the developed table of connections, a selection according to the required functionality and the desired (dis-)connecting process can be performed. For the case, that requirements cannot be met completely, a procedure for modifying connections systematically was described.

FATIGUE ANALYSIS OF WELDED ALUMINIUM JOINTS WITH LONGITUDINAL AND ROUND STIFFENER SUBJECTED TO BENDING LOADS BY …

Domazet Ž., MatiæT., KrstuloviæA. - *University of Split (HRV)* 1227

Fatigue behaviour of welded aluminium joints with longitudinal and round stiffener subjected to bending loads are systematically investigated in this study. Fatigue analysis based on nominal stress range approach, two local approaches based on structural (hot spot) as well as notch stress respectively are applied. A possibility of using existing design S-N curves, usually assuming joints subjected to axial load, for the joints subjected to bending loads, was investigated in this work. Fatigue test results of specimens subjected to bending loads have been assessed using a nominal, structural, and notch stress range approach, and compared with appropriate design S-N curves.

ELASTIC DEFORMATIONS IN COMPUTER AIDED TOLERANCE ANALYSIS: A FOCUS ON TWO-DIMENSIONAL CONTACT SURFACES

Lustig R., Hochmuth R., Meerkamm H. - *Universität Erlangen-Nürnberg (DEU)* 1315

The analysis of fabrication deviations and elastic deformations gains more and more in importance. Presently no reliable approach of this combined simulation of both factors is available. By the example of a strongly simplified tool machine, one possible coupling concept is to be demonstrated. It is based upon the superposition of waviness functions and/or works directly with point coordinates and uses a commercial tolerance analysis system as a simulation kernel. The data of functional relevant surfaces is integrated into the software system in terms of the four statistical moments. Exemplary a deviation of concentricity of the axes of the tool carrier and workpiece carrier is determined through the method.