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FNAME	LNAME	Title	Abstract
Eric	Bechhoefer	Signal Processing to Reduce the Effect of Gear Dynamics	An improved conditioning monitoring technique is provided for rotating components in gearboxes that accounts for gear system dynamics. A rotation rate for the component is generated from vibration data by estimating the rotation rate based on a tachometer measurement of another shaft and the shaft ratio. This estimated rotation rate is used, together with known configuration of the component, to estimate a known gear mesh frequency of the component. By filtering for a range of frequencies around the gear mesh frequency based on variation in the shaft rate, the gear mesh frequency can be determined and from that signal, an actual rotation rate for the component can be determined. The actual rate can then be used in deriving an analytic vibration spectrum for the component that is not degraded due to gear system dynamics effects. This paper goes into analysis technique needed for a guided reconstruction of the tachometer from measured vibration in order to correct for geared shaft dynamics. We cover some examples, and present results based on real world helicopter gearbox data. This technique is computationally intensive, but due to newly available microcontrollers, should be implemented early next year in an edge processing, smart sensor. This can greatly reduce the cost of system implementation. For example, it is anticipated that this technique could be used on the compressor section of of the PT6T3 on a Bell 212, which would normally require two additional tachometer interfaces
Eric	Bechhoefer	Improved Spectral Estimation of Signals using Quadratic Interpolation	Common in many fields of science and industry is the estimation of the magnitude and frequency of signals generated by periodic, sinusoidal signals. This process is ubiquitous and the foundation of many standards and procedures, and often involves use of the Fourier transform. In application, this is done with a Fast Fourier Transform (FFT). The FFT is defined only for frequencies that are exactly integers of the sample rate (fs). For other frequencies, this causes spectral leakage and error in the estimation of the FFT amplitude for frequency. On average, the magnitude error is 4%. This paper discuses an improved technique for the estimation of magnitude and frequency of a sinusoidal signal using the FFT, which reduces the magnitude error to a fraction of a percent. The improved estimation uses a transformation of the data to make the spectral peak parabolic, from which a quadratic solver is used to estimate the true magnitude peak value and frequency. This method can be proved to be optimal by reducing the FFT error in sum of square errors sense.
Mantosh	Bhattacharya	Right sizing of gear box for a centrifugal compressor with synchronous motor as driver	In oil & gas industry, for high speed centrifugal compressors speed increasing gear boxes are used to achieve high polytrophic head and flow. API standards and project specifications (as addendum to API) are the guidelines used to design compressor trains. The proposed paper presents a study in order to stimulate a thought process for end users / purchasers to prudently use API 613, 5th edition standard, where gear box sizing can be hugely impacted by driver motor rating, in order to comply to the guideline for mechanical rating of gear boxes bulleted clause stated as "For electric motor drivers, the gear unit rated power shall be the motor nameplate rating multiplied by the motor service factor". As the gear box size is increased to meet above requirement, torsional parametric changes result in a larger coupling to avoid crucial torsional vibration modes affecting the driven part particularly during start up. Various options to counter torsional instability in driven part may be proposed by OEM but they may not be explicitly categorized in API 671 as a dry flexible coupling. The larger coupling may lead to higher windage loss, causing very high temperature in coupling guard violating API 671 requirement. The issue becomes more aggravated due to a synchronous motor as driver with a hot start requirement, which may lead to redesign of the complete motor to avoid overheating during start up. The ramifications to incorporate this requirement are an increase in overall foot print of the train, a new and bigger motor, with larger gear, lubrication oil requirements and oil cooler size. A detailed internal study, including sensitivity analysis of subject gear box, for varied operating process conditions reveals that incorporation of such a clause into the specification may not be very fruitful, as such a higher polytrophic head requires a higher peripheral speed where a fixed speed driver is used. Additionally, a higher flow to extract the maximum installed driver power may lead to an operating point at the stonewall zone, based on steep slope of performance curve of subject compressor. The paper finally concludes that this particular API clause should be prudently applied on specifications based on well production and depletion profile with a future plan of bundle replacement of the compressor.
Mantosh	Bhattacharya	Cases of vibrations in high speed pinion in low load condition in API 613 turbo-gears.	In Oil & Gas, Petrochemical and Refinery industries, API 613 compliant double helical speed increasing gear boxes are widely used for high speed turbo-compressor trains. During operation of such trains, the selected gear box model normally has vibrations within acceptable limits as mandated by API standard or jointly agreed by OEM (Original equipment manufacturer) and End user. However, during low load operation during mechanical run test / coast down of a turbomachinery train the pinion of speed increasing gear box may show up high vibration and cause concerns. Gear box vibration signature also gives a tell tale indication of compressor flow related issue as well . The proposed paper discusses several case studies where pinion vibration issues faced during various scenario such as API 613 no / low load full speed run / during coast down or operating the train below actual performance map at site. The case studies include high vibration at pinion non- drive end, low frequency vibration at bull gear and pinion, vibration due to casing resonance, superficial indication of pinion whirl & whip ,vibration caused by torsional lateral interaction during coast down of turbomachine and sometimes due to flow related issue . The paper concludes that correcting the such vibration issues at vendor works / site during no load – low load condition based on test results does not necessarily mean a silver bullet solution and may not guarantee the smooth operation of gear box at rated load, hence detailed analysis is needed. A deeper understanding is needed to address such vibration phenomena as case to case basis to decide whether issue to be considered as genuine or benign and further studies and actions are required .
Nazli	EshKalak	A Two-Plane Balancing Method for Detection and Correction of Shaft Unbalance	In rotating machinery, vibrations generated due to unbalance are considered to be a significant problem that adversely affects the performance of these machine systems. Hence, monitoring and minimizing such vibrations is of importance in order to prevent consequences such as unexpected damage and catastrophic failures. This study presents numerical and experimental investigations of two-plane balancing to suppress the vibration of a rigid rotating shaft by means of an influence coefficient method. The main goal is to gain solid understanding of the balancing hardware and algorithm. In order to examine the influence coefficient method, a test stand containing a rotating shaft supported by two ball bearings is provided. Balancing is attained by adding a set of weights into two circular balancing planes that are attached to the bearings. Experiments are conducted by utilizing the sensing and data acquisition hardware that consists of two accelerometers (one per bearing), a mag-pickup (MPU), and a data acquisition system. Each balancing iteration is composed of a three-step process. First, the initial vibrations of the two balancing planes, together with the resultant vibrations after adding a trial weight onto the circumference of each plane, are measured. Then, the amplitude and phase information is extracted from the three vibration measurements, and the influence coefficient matrix, which represents the correction plane interferences between two planes, is calculated. It is worth mentioning that the correction plane interference is a cross effect that occurs when an indicated vibration at one balancing plane is a result of an existing unbalance on the other balancing plane. Finally, the correction weights required to offset the initial vibrations on the two balancing planes are obtained. Given the practical constraints on the number and locations of balancing holes and the types of trial/correction weights on each balancing plane, a calculated correction weight may not be directly used for balancing purposes, and in such cases, weight splitting by employing the least squares method is conducted to approximate the calculated correction weight. The approximate correction weights obtained from weight splitting are then added to the balancing plane in order to minimize the residual vibration of the shaft.

J	Pattabiraman	Management of Stress--A Mechanical System Simulation Approach	With many years of interaction with great many institutions and Industries and meeting with people of all backgrounds in India and abroad, one tends to become more philosophical in nature. This study is prompted by the lack of peace and harmony in the human lives leading to global unrest, poverty and upsurge of emotions, creating disturbing thoughts and events all over. This topic assumes even more importance in view of the Pandemic Covid-19 which is posing a threat to safe and peaceful living in local and Global dimensions. During the Covid times, people are facing tremendous stress due to lockdown curbing social meetings, professional/business meetings in person, gatherings, and travel and forced to remain indoors for attending online classes, office work, shopping or entertainment. If professionals divert their attention on the human aspects as well, apart from their engineering and scientific inputs to society, their job would be much more rewarding and would have a direct uplifting effort on the society and thus create more satisfaction for them. In the management sciences, especially for Human Resources Development personnel, this would be essential. A mechanical engineer is likely to deal with several types of systems and mathematically simulate them according to the laws of physics and nature, with a view to understanding their behaviour better. My endeavour through this paper is to share ideas that provide some means to simulate human stress behaviour through an understanding of mechanical dynamic systems and their constituent elements, thus establishing a correspondence between the two systems. The article does not contain any equations or experimental findings but merely conveys the similarities between the two by an appropriate simulation model and gives scope for improving the behavioral response especially under stress in the fast-moving world of today. I felt it necessary to communicate to the scientific and engineering community, the parallelism in the approach and the apparent equivalence between the two analogous systems. Human behaviour plays a much more significant role especially in today's context, to understand, appreciate and utilize the fruits of scientific advancements and Inventions, without which the influence of science on society may not assure the desired comfort and safety in life.The right understanding and remaining calm even under stress will definitely help in the correct decision making. Identification of the real owner and reducing the dominant role of 'I ' and 'Mine ' and increasing the role of ' We ' and ' Ours ' will help maintain inner peace and harmony with the mind getting free from anxiety and worry.
Marc	Pepi	ADDITIVELY MANUFACTURED METAL POWDER GAS ATOMIZED IN A MOBILE FOUNDRY FROM RECYCLED SCRAP FOR LIGHTWEIGHT PROTECTION APPLICATIONS	US Army Directive 2019-29 (“Enabling Readiness and Modernization Through Advanced Manufacturing”) envisions advanced manufacturing transforming battlefield logistics through on-demand fabrication of parts close to the point of need. Towards this end goal, the Combat Capabilities Development Center – Army Research Laboratory (CCDC-ARL) is researching technologies that will make it possible for the warfighter to manufacture or repair components at the point of need with scrap materials on-hand, thus increasing operational readiness while reducing the military logistics footprint. The objective of this project was to show a proof-of-concept of additively manufacturing metal powder that was gas atomized from scrap rolled homogeneous armor (RHA) steel in a Mobile Foundry housed within a shipping container. The resultant alloy powder was subjected to laser powder bed fusion (LPBF), for builds that were tested metallurgically and ballistically. Cursory results showed that the builds from powder made from recycled RHA had a martensitic structure, exhibited excellent mechanical properties, and improved ballistic properties versus this alloy in the wrought condition.
Zlatan	Racic	Resonance Effect, Critical and Resonance Velocities Applied to Diagnostics, Stability and Balancing Methods of Turbine and Generator Rotors over 40 MVA	Standard power generation industry practices of inspection, machining, balancing, assembly and bearings and couplings alignment have been developed and streamlined by OEMs for newly manufactured rotors, and implicitly assume that rotors being installed are within design dimensional specifications and tolerances. However, applying these standard practices in the service industry can fall short of expected performance, when dealing with continuous rotors with inherent eccentricities outside such specifications. In practice the measured rotors’ runouts are equated “unbalances”, which excite specific mode at specific operating angular velocity. In this paper we will determine the range of velocities of unsteady rotor’s rotation. It is shown that resonance velocities of continuous rotor are not dependent on rotor natural fundamental harmonic resonance frequency, but on the value of accelerating rotating moment that ensures increase of rotor’s angular velocity and transfer of rotating and non-rotating reference frames through critical velocity. It is explained also that the critical velocity is not equivalent to harmonic resonance oscillation theory in physics. The specific role of rotor inherent resonance in preparation of rotor to transfer rotating and inertial reference frames through critical velocity range is addressed. It is shown that the resonance phenomenon changes the location of center of mass of the rotor body relative to the journals rotation axis and rotor’s geometric center as well as creates conditions for self centering of rotor’s body mass axis. The presented research is based on inertial theory of rotor’s dynamics based on equation of motion developed impulse and momentum method. The result of this research and understanding of continuous rotor dynamics is of particular importance when developing balancing methods of rotors in power generation industry of T-G set over ~40 MVA of generating electric power, which should be introduced as a separate subsection of the ISO21940-1 standard.
Jeremy	Sheldon	Combining Wear Debris and Vibration for a More Complete Understanding of Machinery Health	This paper thoroughly discusses vibration and oil debris monitoring. The application of each sensing technology to an actual real-world wind turbine application will be presented in detail. A focus of the paper will be the use of vibration and oil debris together to improve overall CBM metrics. By combining oil debris and vibration, the CBM practitioner will realize improved visibility to the health of their target machine.