MECHANICAL ENGINEERING SEMINAR

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A new model for gear tooth contact analysis

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Gear tooth contact analysis (TCA) has been dominated for several decades by the models of Litvin and his associates, who have also communicated CAD-CAM models used by machine tools for the fabrication of all types of profile-modified and crowned parallel, bevel, hypoid, worm etc gears, by most companies, such as Gleason. Mathematically correct, but not quite robust as regards their numerical implementation, these models have been since improved by addressing peripheral considerations, such as the introduction of search algorithms for initial 'guess values' and the so-called 'local synthesis', which essentially pre-supposes a desired local function of transmission errors, then proceeds to construct a profile that would produce such a function. This assumes in a self-referencing manner that the resulting modified tooth surface would indeed produce the assumed function of transmission errors when meshing - the caveat being that most of the time transmission errors in the first place arise out of manufacturing errors and dynamic displacements, neither of which can be conveniently known a priori, or prescribed.

In this seminar, we shall discuss in-depth the inadequacies of the currently available methods, using case studies from spur and helical gears, as well as straight and spiral bevel gears under various conditions of in- and out-of-plane misalignment and in consideration of various profile modifications, both longitudinal and transversal. Then the quasi-static model of non-conjugate the three-dimensional geometrical contact problem for two gear tooth surfaces will be revisited. The set of contact equations is formulated by using a new parameterization that enables the reduction of the conventional system of five strongly non-linear equations with five unknowns to a system of only two equations with two unknowns. The novel model is shown to be computationally efficient and demonstrates increased accuracy and stability of the numerical solution, compared to the conventional model described by Litvin, which suffers from convergence problems and requires high computational effort. The new model is applied to various parallel and intersecting axis gear configurations to

parametrically estimate the sensitivity for various misalignments on the contact pressure, transmission error and path of contact.
In light of the demonstrated affordances of the new model, the seminar will discuss the significance of gear topology, geometry, and resulting kinematics to the dynamical response, efficiency, manufacturability, error sensitivity and strength of geared mechanisms and transmissions, as well as the implications on gear design, including new gear tooth geometries, and future research directions.

Biographical note:
Christos Spitas is professor of Machine Design with the Dept. of Mechanical and Aerospace Engineering and Head of the Space, Industry and Transportation Cluster at Nazarbayev University. Prior to this appointment he was Professor of Embodiment Design and head of the Product Engineering Section in the Dept. of Design Engineering at the Delft University of Technology and prior to that held a number of positions in the defense and high-tech industry, up to Manager R&D, and lead a number of technology development, design and manufacturing projects.

Note: the seminar will be given in English