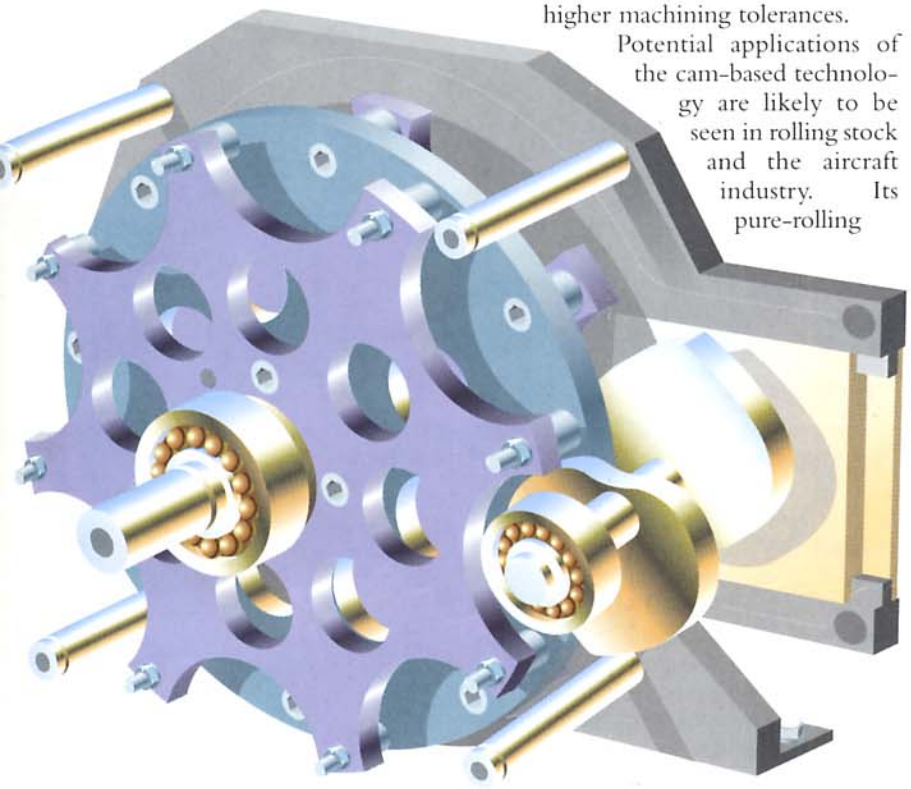
Surviving the backlash

Mark Fletcher looks at a friction-free speed reduction system

A cam-based speed reducer claims to overcome the problems associated with gear transmissions because it eliminates friction and backlash.

Low friction and backlash are crucial if a gear system is to work at maximum efficiency. In most cases they can be reduced to low levels, but this increases cost because of the need for higher machining tolerances.



With the casing removed it can be seen that the conjugate cams act upon drive pins which are secured by an internal plate and two external, off set scalloped plates. By offsetting the pin positions constant, as opposed to periodical, motion can be achieved

Potential applications of the cam-based technology are likely to be seen in rolling stock and the aircraft industry. Its pure-rolling operation allows for elimination of lubricants, which should be of special interest to the food processing industry, where lubricants should be used with extreme care.

Being developed at McGill University in Montreal, Canada by Professor Jorge Angeles and Max Antonio Gonzales-Palacios, the Speed-o-Cam project is supported by two industrial partners and the Natural Science and Engineering Research Council.

Backlash can be eliminated by using harmonic drives but, according to the developers, "the flexspline used in such drives brings about kinematic errors and hysteretic dynamical effects due to the visco-elasticity of the flexible materials involved".

Speed reduction is necessary to remove the need for massive direct drive systems which require large amounts of power at low speed. It is for this reason that constant development has been taking place to provide the simplest,, most efficient and practical way of doing this. This design goes some way towards meeting those needs.

Based on the layout of pure-rolling indexing cam mechanisms, Speed-o-Cam overcomes the problems associated with gear reduction stages and other mechanisms used to reduce output drive.

The method of operation and construction is fairly straight forward and all components can be constructed on standard CNC machinery. An indexing cam is usually used to create a periodical motion. Speed-o-Cam can produce a constant speed, which is a function of the number of stages. As with most other power transmission systems it is also reversible.

The design can be likened to a simple two-gear architecture, but the similarity ends there. The input shaft has two specially-shaped, conjugate cams attached to it, offset angularly relative to each other. Each of these cams straddles a centre plate and acts on drive pins secured on the inside by the central disk and on the outside by one of two 'scalloped' disks. The two sets of drive pins are offset, so that multi-point contact is guaranteed. Both the 'scalloped' disks and the central plate are attached to the output shaft which, in turn, transmits the reduced speed.

As well as zero backlash and zero friction losses, the unit also exhibits high stiffness - another essential attribute for high-torque applications. A planar prototype has been built and tested and a spherical model is under development, which will allow reduction between shafts intersecting at any angle.

The design of the spherical unit differs slightly from the planar unit, in that the cams straddle the inside and outside surfaces of a webbed 'hoop', which has drive pins projecting radially from its inner and outer diameter surfaces. One cam drives the inner pins, the other the outer pins. Again they are offset to guarantee multi-point contact. The centre of the hoop shares a common centre of rotation with the output shaft, which it is connected to by a web.

A patent application has been submitted and the university is looking to license the technology.

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