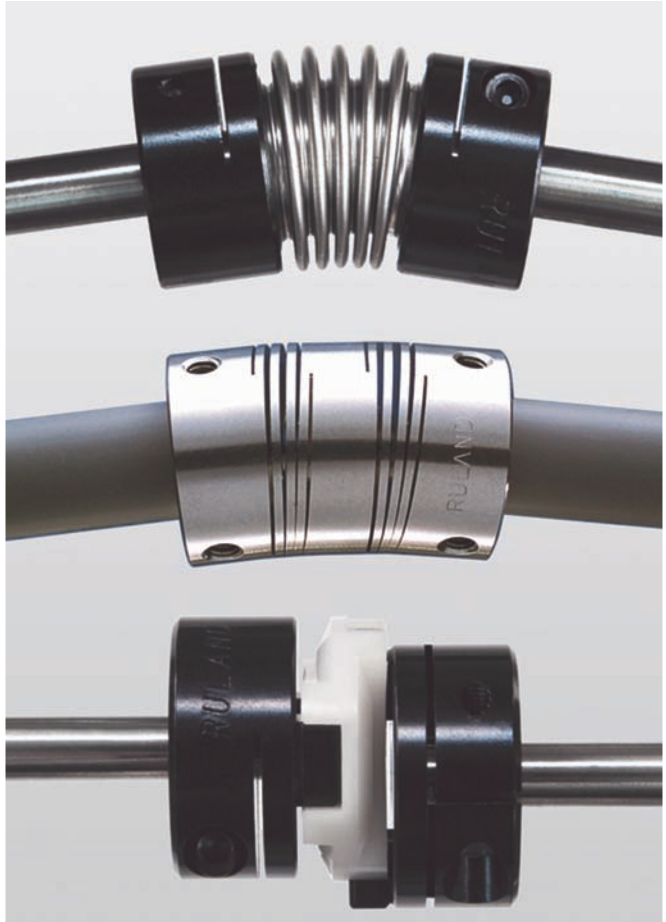
Choose your coupling with care

Machine vision and optical inspection systems are vital to many production processes and often rely on couplings to deliver accurate performance and high productivity. Bobby Watkins and Alex Ruland of Ruland Manufacturing offer advice on choosing the right coupling for the job.



Three types of shaft coupling (top to bottom): bellows, beam and Oldham

MACHINE VISION and optical inspection systems are demanding applications requiring precision components. One vital component is the zero-backlash coupling used to connect motors and gearboxes to the linear systems that move the optical components. System designers need to choose the best coupling to use based on the needs of the application.

Some types of zero-backlash coupling have vibration dampening characteristics. An important reason for reducing vibration in machine vision systems relates to "settling time" – the length of time that a vision system needs to stop vibrating after an optical component is moved into position to take an image. Images taken before the system has stopped vibrating can be blurred and inaccurate. Reducing settling time cuts the time spent waiting between movements, resulting in higher production rates.

No backlash: a jaw coupling

In the past, one way of reducing vibration in vision systems was to add a large mass to the machine, thus increasing its rigidity. The material would typically be granite or a dense composite material. But these are expensive, and the increased weight results in higher shipping costs.

By choosing dampening type zero-backlash couplings, and adding vibration isolation mounts to optical components, the need for a large mass can be reduced or eliminated. The result is a reduction in the cost of buying and shipping the machine.

Machine vision systems usually operate in one of two modes of movement. One is a stop-and-go motion that moves to a location, takes an image, and then moves to another location. This inherently suffers from vibration caused by rapid starts and stops. A second type of system operates in constant scanning mode that typically requires torsional rigidity.

In addition to vibration dampening and torsional rigidity, important coupling selection criteria for machine vision systems are misalignment, inertia, speed, and torque capabilities. We will now look at six types of coupling.

Beam couplings These use continuous cuts to transmit torque and accommodate misalignment. They are a good fit for machine vision systems operating at up to 6,000 rpm, and do not require high torsional rigidity. High flexibility results in low bearing loads under angular and axial motion. Beam couplings can undergo windup under torque, so they are less torsionally rigid than some other types of coupling. This property may be desirable, however, for stop-and-go applications requiring dampening, and can decrease settling time.

Rigid couplings These offer the highest torsional rigidity and can be made from several different materials and are available in several styles. They have no misalignment capability and do not dampen vibration, but offer excellent torque ratings. The bearing loads are the highest of all couplings and one must take care to ensure that the shafts are perfectly aligned.

Zero-backlash jaw couplings Composed of three parts – two aluminium hubs and an elastic insert referred to as the "spider" – the curved jaw coupling press-fits together for zero-backlash operation. The spider absorbs vibration, making it the best choice for systems that require dampening. This capability can be a used to decrease settling time. The spider is available in several levels of hardness. These couplings offer superior dampening characteristics. The ability to mix-and-match the spiders with the hubs is an advantage as well.

A double disc coupling

Oldham couplings Similar to the jaw coupling, the Oldham coupling is also made up of three components – two aluminium hubs and an insert – which press-fit together. Their advantages include the ability to accommodate a high level of parallel misalignment, because the centre disc slides over the tenons of the hubs. Oldham couplings also have the unique ability to act as mechanical fuses. The tenons of the hubs will not interlock if the centre disc fails and torque will stop being transmitted. The aluminium hubs help to keep inertia low. Oldham couplings are suitable for stop-and-go or rigid scanning operations.

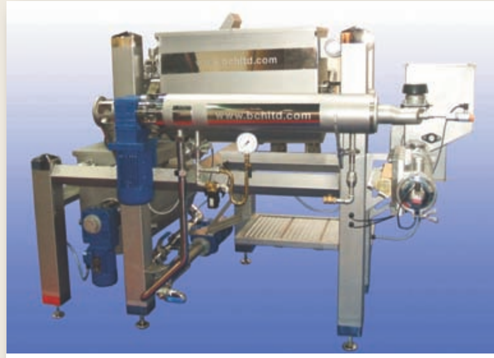
Disc couplings These are composed either of two hubs joined by a flexible metallic centre disc, or two hubs and a centrepiece joined by two metal discs. The double-disc couplings can accommodate parallel and angular misalignments because the discs can bend in different directions. Single-disc couplings can accommodate only angular misalignment. Bearing loads and inertia are low. Disc couplings can handle speeds up to 10,000 rpm, with low inertia. They allow misalignment in the shafts while retaining high torque capabilities. They are ideal for torsionally rigid applications with misalignment.

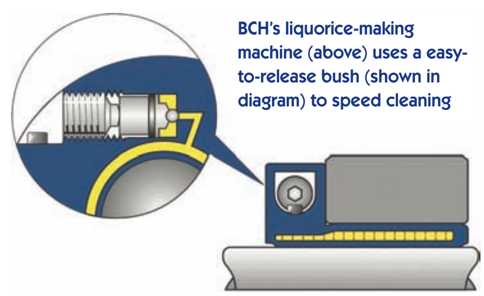
Bellows couplings These are made of two hubs connected, either by welding or an adhesive, to a metallic bellows. The flexibility of the bellows accommodates misalignment. Bearing loads are low and constant throughout all points of rotation. Bellows couplings have low inertia ratings, saving the system from unnecessary force and providing improved responses. They have a high torsional rigidity and are capable of speeds up to 10,000 rpm. The bellows coupling is ideal for machine vision systems requiring accuracy, although there is no vibration dampening. They can operate at high speeds, and have excellent torsionally rigidity and good misalignment capabilities.

A machine vision system can only operate as well as its components. Each of the couplings discussed above has its strengths and weaknesses. If a coupling's performance characteristics meet the operating goals of the system, the user can be assured of maximum system performance and longevity. D&C

Locking bush speeds cleaning on liquorice machine

BCH, a Lancashire-based engineering company that specialises in food production machinery, has developed a compact confectionery extrusion line aimed at start-up companies and at customers in developing markets wanting to enter the sector without making a large capital outlay. The line can extrude 150–300kg of liquorice in 300mm widths per hour.





BCH's liquorice-making machine (above) uses a easy-to-release bush (shown in diagram) to speed cleaning

The raw materials are heated in a rotary heat exchanger called a Viscotator – effectively a heated tube with an internal shaft and blades. As the raw materials pass through the tube under pressure, their temperature rises by about 100°C.

The Viscotator is driven by a helical-bevel geared motor designed to cope with the high axial loads from the pumped ingredients. At least once a fortnight, the shaft has to be disconnected from the gearbox to allow a thorough cleaning to take place. BCH rejected keyway and spline connectors because keyways can wear over time and jam, while splines are expensive to machine and need a non-standard gearbox, incurring extra costs and long leadtimes.

Instead, BCH has chosen to use a locking bush that is quick to fix and transmits both torque and axial forces – as well as costing less than a spline. The ETP-Express bush, supplied by Lenze, consists of a double-walled hardened steel sleeve filled with a pressure medium, and a flange. The flange contains a radially mounted pressure screw and piston. The bush sits between the Viscotator shaft and the gearbox hollow shaft.

When the single screw is tightened, the walls of the bush expand and create a friction connection that transmits both torque and axial force. As well as producing a simple, compact assembly without the cost of thrust bearings, the bush can also be disassembled easily for cleaning. Loosening the screw releases the shaft without sticking or jamming. The bush can be fixed and released repeatedly, and is expected to last as long as the machine.

BCH is a member of the Coates Engineering group.