DESIGN AND BUILD YOUR OWN SYNCHRONOUS
STAND-ALONE MECHANISM DRIVE

The “Stand-Alone” refers to control being shared between two or more drive systems. The method of making just one mechanism a slave to a different manufacture’s drive system is discussed elsewhere. The mechanical connection of motor and mechanism can be exactly the same as below in the “Multi-Motor” section.

As an example, consider the case of a transfer wheel. Whether it’s bolted to the side of the conveyor or part of its own stand with wheels to roll it into position, the mechanism will still have the same motor connected to the same mechanical parts and the same sensors for either the “Stand-Alone” or “Multi-Motor” configuration. The only difference is in the “Multi-Motor” configuration, the speed (bottles/minute) is a data entry through a computer and in the “Stand-Alone” configuration, the speed is obtained via a proximity switch mounted on another mechanism (such as the feeder).

The Synphase card is universal and will control the mechanism as a single stand-alone drive or when integrated into a system. Both programs are part of the standard Synphase firmware and are accessed by a single switch.

DESIGN AND BUILD YOUR OWN SYNCHRONOUS
MULTI-MOTOR MACHINE DRIVE

Every so often it becomes desirable to upgrade a drive system on a piece of production equipment for any of a number of reasons.

- Perhaps production speeds have increased and the old drive is now unstable or oscillates.
- Perhaps you just acquired a piece of used equipment and the original drive is incomplete or totally missing.
- Perhaps the old drive contains obsolete parts that are no longer available.

Although TCD Systems has its roots in the glass container industry, there is no reason the design will not work on any production line requiring multiple motors running at steady speed. The IS machine is the workhorse of the glass container industry. The following step-by-step instructions for upgrading an IS machine are instructive for upgrading other synchronous drives such as those on press ware and HE-28 machines used in other parts of the glass industry or production equipment outside this industry.

When the IS machine was first introduced, production speeds were on the order of 10 bottles per minute. It was driven by a single motor and used “line shafting” to synchronously power the entire production line. Now production speeds are 50 to 70 times faster and most, if not the entire range, of original special manufacture equipment such as double bevel gears, helical gears, or corner drives have worn out and, unless you remanufacture them yourself, are impossible to replace.

Historically, as the production speeds increased, the “line shafting” became increasingly inadequate to maintain synchronization. The various mechanisms involved in the production line (such as feeder, gob distributor, IS machine, conveyor, and transfer wheel) were gradually given their own motor and drive train as they were shed from the “line shaft”. Various solutions then arose to maintain the synchronization among these now individual mechanisms. The solutions carried such names as Synchrotie, Sel-syn, or Turner Drive, among others.

Specifying the Parts

The balance of this page is a broad overview of things that need to be considered when selecting the parts for your drive. Specific examples of these considerations used on glass container production lines are detailed in the links at the bottom of the page.

Fundamental to any design is a basic understanding of what needs to be accomplished. A good place to start is to consider what type of motor / motor controllers are commercially available and what are the advantages and disadvantages of each combination? When making this decision, some things to consider include:

- Production range (3:1 ratio or 10:1 ratio?)
- Maintenance (Brushes of DC motors wear and need periodic replacement. The brushless DC motor is another name for a permanent magnet (PM) synchronous AC motor.)
- Lubrication requirements (Do I need an extra employee to grease the motor shafts?)
- Availability (What is the typical backorder period for my selection? How about keeping 1 or more in inventory as a spare?)
- Will the motor take the environment? (heat dissipation)
- Cost (probably not that important considering the cost of downtime)
- Accuracy (stability of production)
- Type of transmission required to connect the motor to the mechanism

Step 1 – Mechanical Connections

No matter which type of motor is chosen, its output shaft must be connected to the input shaft of the mechanism being driven. Most motors run at similar RPMs so the type of motor selected is not of great importance here.

Generally if the ratio of RPM of the motor shaft and mechanism shaft is on the order of 2:1 use either chain and sprocket or rubber timing belt and timing pulleys. Chain and sprockets are preferred for low speed, high torque, while timing belts are better suited for high RPM.

When larger differences in RPM are required, consider a gear reducer (typically worm). Try to choose a gearbox with a standard reduction ratio to keep cost down. The gear reducer is either directly coupled to the motor shaft or a timing belt and pulleys are used. The gear reducer also needs coupling to the mechanism input shaft. Again decide between either direct coupling or chain and sprocket.

Step 2 - Size

Horsepower throughput is important. Reduction ratios can be perfect and backlash problems can be worked out, but if the parts selected are too small for the forces involved, excessive heat dissipation or outright mechanical failure can cause failure within hours of start up. If unfamiliar with ratings, contact your vendor for these parts and ask for assistance. It is their job. They should be able to guide you to an acceptable solution.

Step 3 - Accuracy

What amount of tolerance and hence what types of part do you have to specify? Measurements made on the gob distributor running production speeds above 500 bottles per minute required only 2% accuracy.

Mechanical parts have manufacturing tolerances. Higher speeds usually translate into better positioning requirements and just specifying a motor with better positioning control does not guaranty better or even acceptable performance.

- A rubber belt-timing pulley is manufactured within .005 inch run out. The actual pitch diameter can be .005 inches out of position from the shaft bore of the pulley. Even though the shaft the pulley is mounted on may be running at a very exact RPM, the linear speed (inches per minute) of the timing belt will be varying. For a 2 inch pitch diameter, the variation will be on the order of .005inch /2 inch = 0.0025 or 0.25%. If the driven pulley has the same run out specification, the driven shaft could have a speed variation of 0.5% compared to the input shaft.

- When two shafts are positioned end to end, they are connected with a coupling. Different types of couplings have different stiffness. A standard “spider” coupling relies on the hardness of the rubber between the two shaft mounted housings. Shaft misalignments and pulsating loads will place varying torques on that rubber piece. The result will show up as an RPM variation in the driven shaft as referenced to the drive shaft. If the inaccuracies caused by the flexing of the rubber are intolerable, a different type of coupling exists. The rubber is replaced with a metal disk with alternating bolts attaching the metal disk to the input and output housings.
- Without going into details, there are different types of gear reducers. The antibacklash gearing is available, but the cost and maintenance requirements are higher than standard gear reducers.

A good rule of thumb is to look at the type of mechanical power transmission components supplied by the original manufacturers of the equipment you are modifying. Do not be fooled into thinking more accuracy is required from the motor than these mechanical parts are capable of transferring.