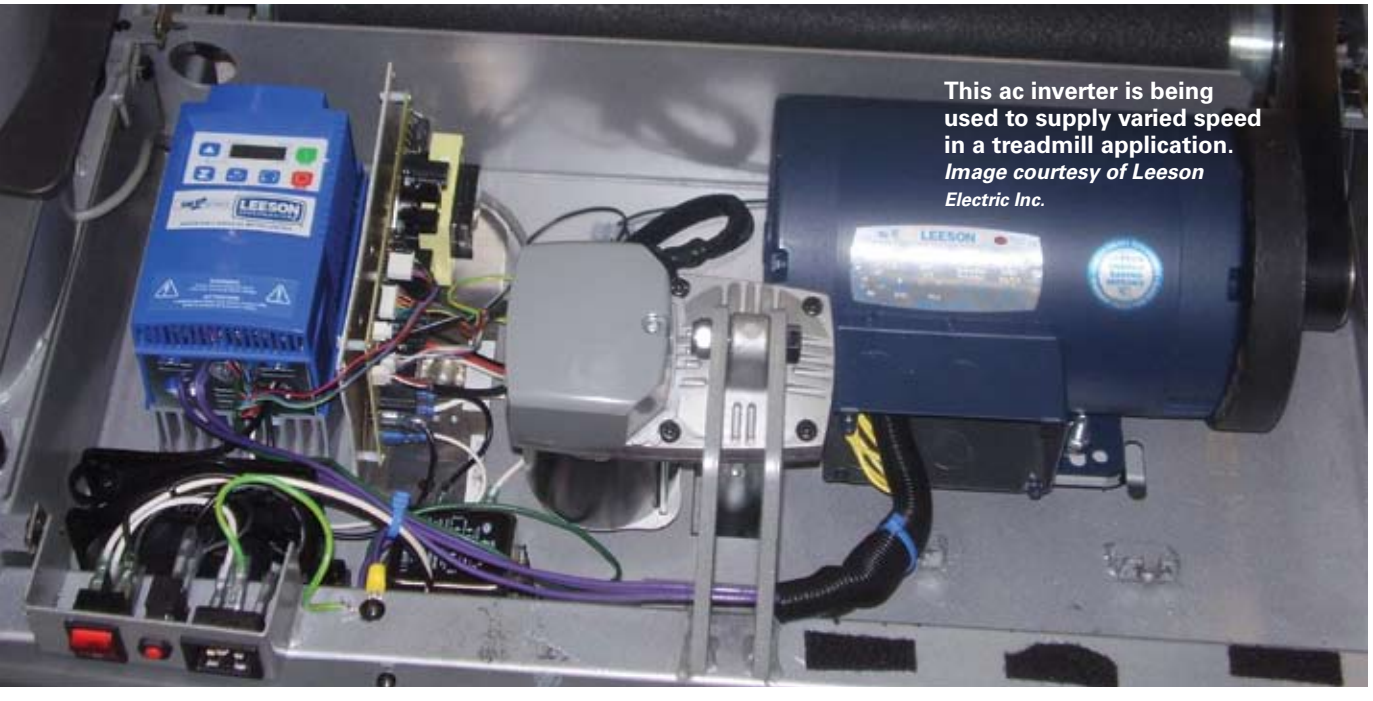
Adjustable speed drives
serve up efficiency

Choosing the right drive can go a long way toward optimizing machine throughput and productivity. If you need to put your manufacturing processes into overdrive (and who doesn't these days), learn from our panel of experts how a well-chosen drive can fine tune speed, torque, or position control.



This ac inverter is being used to supply varied speed in a treadmill application. ***Image courtesy of Leeson Electric Inc.***

Electric drive decisions

How do electric drives contribute to productivity in today's automation environment?

Rich • SEW: The most basic principle for achieving productivity gains by using variable frequency drives (VFDs) is control: not just motion, but when to move, based upon what condition, how fast, to where, when to stop, and how? (If it asks why, get a new VFD). Simply installing a VFD into the system is useless without control. You probably don't just need variable speed; you need motion — well coordinated and executed motion. That's productivity.

Len • Bodine: In the past, when an application required variable speeds, designers were forced to turn to brush-type dc or costly servomotor drive systems. The availability of small adjustable speed drives (ASDs) and of variable speed ac gearmotors and motors now allows equipment designers to leverage their unique characteristics to improve productivity. Unlike brush-type motors that require routine brush replacement, ac inverter duty, three-phase gearmotors and motors are virtually maintenance free. And contrary to variable-speed dc drive systems, ac drives and motors can operate at higher-than-rated motor speeds, meaning that manufacturing can be accelerated if the need arises. Ac drives offer a variety of functions

as well, including start, stop, reverse, acceleration ramp, deceleration ramp, and timed operations.

Steven • Lenze-AC Tech: Drives boost productivity with the ability to gain precise control of processes. Whether it's speed, torque, or position control (or any combination), drives offer the ability to fine tune and control electrically driven machines to make them more efficient for high volume, high-quality production. Controllability and tuning make machines more adaptable and compatible with changing production materials and processes. Drives also allow easy monitoring of machine production through digital and analog signals as well as serial communication. Drives often reduce energy costs when used to decrease speed or torque, particularly with centrifugal-type loads such as fans or pumps.

Manufacturers want packaging equipment to be easy to monitor and diagnose line performance, perform with greater reliability, and quickly change to accommodate different products. *Image courtesy of SEW-Eurodrive Inc.*

Rick • Baldor: Drives are usually used for one of two reasons: To control the speed of a process because the process simply requires variable speed to function properly, or to provide energy savings. In the first case, drives allow speed motor variation (which in most cases cannot be varied without a drive) so that mechanical speed changing devices are not needed. In the second case, the system (often a fan or pump) can always run at full speed and work in the application; however, considerable energy can be saved if motor speed is reduced. These savings are governed by the Affinity Laws, but in general, the amount of energy consumed is proportional to the cube of speed. So, if a motor can be operated at half speed and still perform the required job, then required energy is reduced by seven eighths.

Chris • Leeson: In today's rapidly changing automated production environment, the drive is key: Its (correct) use improves application profitability through the drive's ability to control speed, resulting in reduced energy consumption. Drives can also optimize performance and quality through programmability and the ability to communicate with other devices. Also, because inverters are "soft start" devices, they reduce stresses on equipment.

Specs and sizing

What's your best advice on specifying, sizing, and applying adjustable speed drives where productivity is the main goal?

Rich • SEW: Following are some considerations to keep in mind:

• **Multitasking.** Using a VFD may allow you to do several things at once instead of sequentially.

• **Safety.** Many VFD systems implement certified safety control; this means you may be able to allow motion to continue in areas where you previously required it to stop because of personnel safety. And even if stopping is required, say to clear a jam, certified integrated safety may prevent untimely and expensive procedures for preventing accidental motion.

• **Decentralized control.** Placing VFDs near motors instead of in central control cabinets allows for much faster servicing. It also accelerates initial installations, so the system is productive sooner. Decentralized intelligence, the practice of putting motion control into drives instead of in central PLCs, results in simpler PLC programs that interface with smart drives rather than complicated programs that are large and difficult to handle.

• **Electronic line shafting.** In contrast with machines in which all components are linked together like a big watch, individual control of multiple axes electronically provides ultimate flexibility. How is this helpful? In applications such as packaging, where user needs change on an unpredictable schedule, retooling and changeovers waste the only thing users can't make more — time. Electronically controlled systems have significantly fewer mechanical components, so even in everyday operations such as cleaning and jam clearing, these compact, modern designs allow better access for shorter interruptions. Changeovers are done with touch screens, not tools, and recipes rather than wrenches.

• **Blame game.** When component faults, failures, and mishaps occur, across-line starter systems can't tell a designer what the conditions were just prior to the fault. Do they have Ethernet capability to allow remote access by personnel for quick problem solving? Can they monitor motor currents and other data for predictive maintenance? Probably

not. In contrast, these functions are standard on many VFDs. Unfortunately, many designers don't leverage all of these features.

Steven • Lenze-AC Tech: Follow these tips to get the most out of your drives:

• Always verify the motor full load amperage (FLA) rating and choose a drive with an equal or higher amperage rating.

• Evaluate the environment in which the drive will be located and choose an appropriate enclosure.

• Bigger is not always better — especially in torque control applications. Drives that are drastically oversized can have poor response in torque-control applications because here, the torque set point is only utilizing a small portion of overall torque resolution.

• Choose a drive that offers the right level of features for the application. Drives that offer a staggering range of features also typically introduce a staggering level of complexity. Look for drives that are feature-rich, but also user-friendly. A good benchmark for usability is the user manual. If the manual is several hundred pages long, then the drive is likely to be complex and commissioning could be arduous.

• Where productivity is paramount (in other words, you want quick commissioning or to be able to quickly replace drives in the event of failure) choose a drive with removable programmable memory. This allows drive preprogramming for fast installation and commissioning. It also allows transport of configurations and parameter settings from an old drive to a new drive in the event of failure. This is especially productive for OEMs needing to duplicate drive settings in every new machine they build. It can save many hours of programming time and eliminate human errors that are possible when programming by hand.

Rick • Baldor: Match the FLA of the motor to the drive. Do not oversize the drive unless the application requires it. Also, make sure to match the type of application (constant or variable torque) to the drive rating. Next, check the overload requirements of the application. Many drives allow for 150% current in the standard case — 50% overload for a full minute. If only 10% overload is required, then a normal-duty drive will work.

Be sure to check application torque performance requirements (both steady state and dynamic) and select the appropriate drive — either V/Hz, sensorless vector, full vector, servo, and so on. Don't forget to consider the application's environmental requirements. If a higher enclosure integrity is required (such as NEMA 12/IP55 or NEMA 4X/IP66), some drives can provide this out of the box while others will have to be "enclosed" in a separate host enclosure to obtain these levels.

Avoiding drive disasters

What's the worst that can happen if a motor or drive is not specified or installed correctly?

Len • Bodine: As with other advanced speed control systems, initial setup of the drive and motor parameters is critical. Most inverters accept a 50/60 Hz line input. However, aside from this input capability, an internal setting for the motor frequency is often required as well. If this setting is not made, the motor or gearmotor overheats and

can even burn out. Ac inverter-duty motor windings are often designed for either 50 Hz line (for most of Europe), or 60 Hz line (in North America); the inverter (ASD) needs to be configured for the motor.

Steven • Lenze-AC Tech: The worst that can happen is a failure to the drive power section. This can happen in two situations: if line power applied to the drive is higher than the drive rating (i.e. 600 Vac line power is applied to a 240 Vac-rated drive), or if the drive is miswired such that input line power is connected to the output terminals. Unfortunately, both of these scenarios are fairly common and are usually due to haste in installation. This is why drives manufacturers urge users to read and understand all the ratings and installation procedures before attempting to wire or commission the drive.

Another worst-case scenario occurs when load requirements exceed the rating of the drive and/or motor. Often, older speed-control technology such as variable-ratio belts or older dc drive systems are replaced with new drives. These are great applications for new ac drive technology, but care must be taken when sizing and selecting the ac motors and drives here. Designers must identify load speed and torque requirements and choose the appropriate drive and motor (and possibly gearing) to accommodate these.

For example, if the selected drive and/ motor cannot produce the torque needed, then the application may never perform to expected levels. There is also a high risk of overload. All drives have built-in protection for overload conditions, so there is no danger of damaging the drive; the danger is having a machine or process that cannot operate to its full potential, or possibly not at all.

Rick • Baldor: Here are a few of the mishaps that can happen with drives: The drive will not function in the application (in other words, will not start, will not run, shuts down, and so on); the drive functions, but the quality of the product being manufactured is not high enough (here, the wrong type of drive/motor is probably selected); the application appears to work, but experiences nuisance trips that impact productivity; the drive works, but only after advanced manual tuning efforts. The drive should run properly out-of-the-box after executing an autotuning routine.

Shad • Leeson: The worst scenario is loss of productivity or damage to equipment. Example: A customer uses one of our inverters on a machine that de-ices airplanes at an airport. The equipment was working just fine when the temperature outside was above freezing. However, when the temperature dropped below freezing, the motor either wouldn't start or wouldn't operate properly. In the hangar, everything seemed to work fine. After receiving a phone call from the upset operator, we determined that the inverter was acting up due to cold temperatures, as ambient temperature fell below the inverter's recommended specification. We recommended that they install a heater by the inverter's power board and this solved the problem.

Desirable drives

If you could create the ideal adjustable speed drive, what would it include and what would it do?

Len • Bodine: The ideal ac motor speed control offers a combination of digital drive with some programming capabilities. The most common control functions we're asked about are speed, torque, acceleration ramp, deceleration ramp, run, stop, direction, over-current protection, and speed read-out capability. Many of our customers want the "all-in-one" solution as well; eliminating components and simplifying set-up is key.

Steven • Lenze-AC Tech: The ideal drive is, among other things, transportable, with preprogrammable memory, and available in a range of enclosure styles from chassis IP20 to fully enclosed NEMA 4X IP65; available in a range of powers up to 30 hp/22 kW; available in a range of voltages from 120 to 600 Vac for worldwide acceptability; and offers speed and torque control (sensorless vector technology) in a single package.

Rick • Baldor: The ideal drive supports all known communication interfaces, is easily programmed and modified, integrates simply with all known PLCs and building automation systems, neither fails nor trips, and costs 30% less than today's average drive.

Chris • Leeson: Drives of the future will control both ac and dc motors equally. They will communicate and interface wirelessly to a control center as well as interface with other devices. This will allow for simple installation, maintenance, information processing, and fine optimization. The end result will be improved productivity of entire facilities, beyond just applications. **MSD**

Industry expertise

Rich Mintz
SEW-Eurodrive Inc.
seweurodrive.com
(864) 439-8792

Len Sikora
Bodine Electric Company
bodine-electric.com
(773) 478-3515

Steven Dextraze
Lenze-AC Tech
lenze-actech.com
(800) 217-9100

Rick Kirkpatrick
Baldor Electric Co.
baldor.com
(479) 646-4711

Chris Medinger
Shad Doughty
Leeson Electric Corp.
leeson.com
(262) 377-8810