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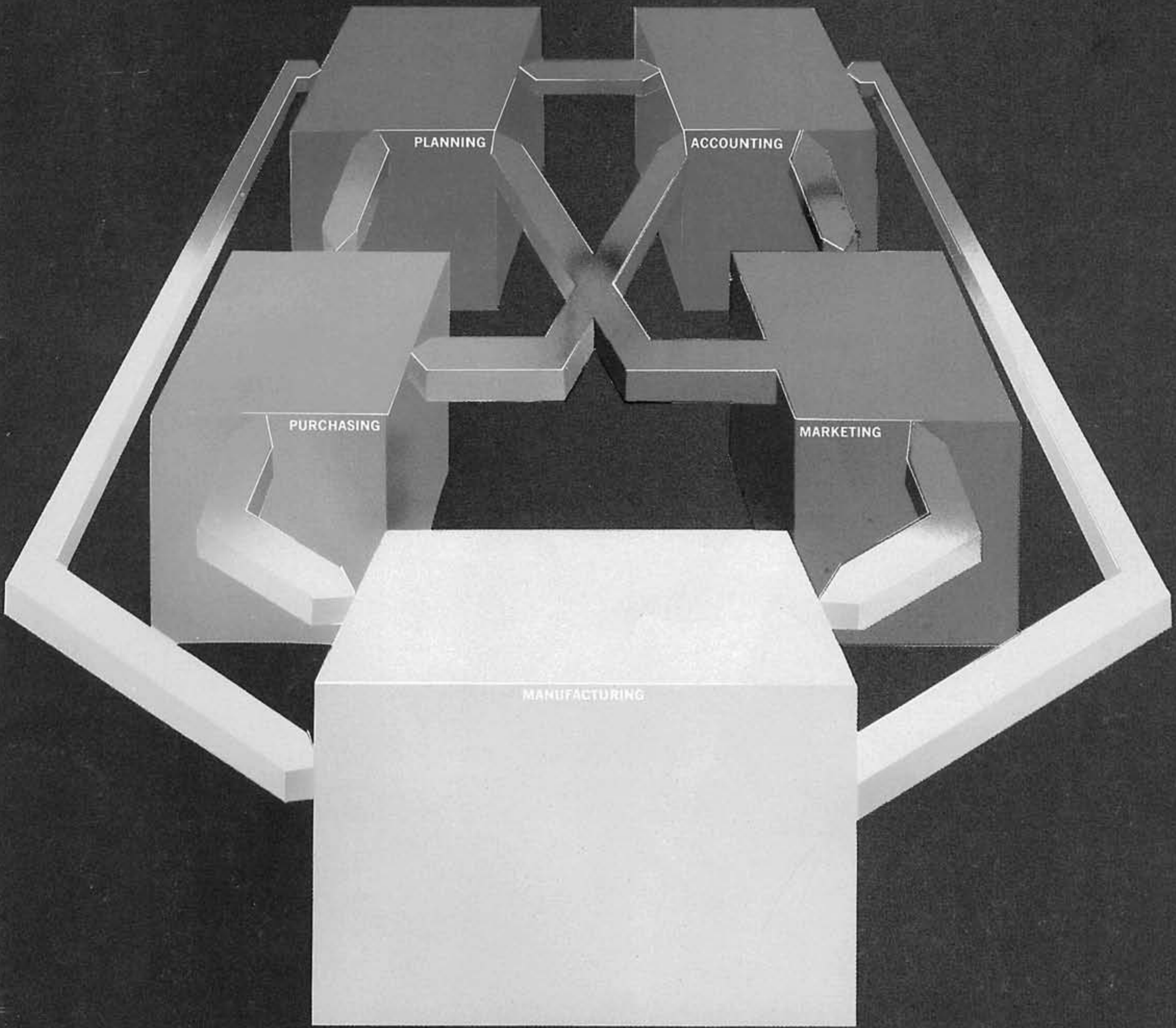

Manufacturing-control software

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Reducing NC/CNC downtime

Simple preventive steps eliminate recurrent failures in electronic and computer equipment and reduce maintenance. Here's how it can be done

HEAT, VIBRATION, DIRT, oxidation, and power disturbances are the most common causes of electronic and computer-equipment breakdown, and the breakdowns they cause have one thing in common: they can easily be prevented. Simple preventive measures not only eliminate recurrent failures but also significantly reduce the need for future maintenance. More than 200 case histories indicate that controlling the environment within which NCs and CNCs operate is the most cost-effective way to increase uptime and reduce maintenance.

Electronic controllers and computer systems comprise a variety of integrated circuits (ICs), transistors, diodes, and other components—each with its own heat-tolerance level. Each component operates between a specific low- and high-temperature limit above or below which they fail. A transistor, for example, considered to have the lowest temperature-failure limit, fails at temperatures around 150F. At such temperatures, not only transistors but entire circuit boards develop "hot spots," where they eventually wear. Similarly, most electronic components malfunction if their temperature dips below 50F.

Therefore, cabinets housing these components must maintain a temperature that is well within each component's high- and low-cutoff limit. In addition, temperature should not fluctuate too much since fluctuations are responsible for servodrive misalignments and cause condensation and oxidation.

A properly installed cabinet air conditioner should maintain a specific temperature range, usually between 75F and 100F and, with a properly designed cabinet, should eliminate temperature fluctuations beyond this range. In case shop temperature drops to a level that lowers cabinet temperature as well, the air conditioner should direct warm gases into cold coils and plates to keep components from cooling below their low-cutoff point. Similarly, when shop air raises cabinet temperature above 100F, the air conditioner should step up cooling. Electronic-cabinet air conditioners are available for OEM or retrofit needs and are easily installed.

Cabinet design should prevent cold air from the air conditioner from hitting circuit boards directly. Baffles and fans, engineered into cabinets, should help hot air rise up and away from the circuitry. Temperature gages on cabinets can provide maintenance staff an accurate measure of conditions inside each cabinet.

Electrical transients and spikes, which manifest themselves as power disturbances, are a major source of electronic- and computer-equipment failure and need to be eliminated. Transients are short-duration overvoltages that rise to peaks of several thousand volts. They frequently occur in the brief period between when a switch is closed and the circuit reaches a steady state. In addition, lightning, magnetic storms, wind, snow, power-line short circuits, loose connections, generators, transformers, and virtually any electrical or electronic equipment cause transients.

Spikes are long-duration transients and may be more destructive. They cause line voltage to rise from a few hundred to several thousand volts and then return to normal usually in less than 1 msec.

Transients are much more common than spikes and are of concern because they can damage integrated circuits. Transients rise to peak amplitudes within a few nanoseconds and decay away within several microseconds. They cause data errors and, over time, will accumulate inside ICs. Since ICs pack several thousand transistors on a chip as small as 0.1 sq in. and perform several million operations per second, detecting voltage-level changes between 0 and 5V, the introduction of transients into their circuits disrupt performance.

Once in a circuit, a transient is interpreted as data pulses, and an NC or a computer system under its influence will perform a function not called for or will temporarily forget the function it is currently performing. The effect is disruptive, typically causing the system to "lock up" or the computer to "lose memory," but no physical damage actually occurs. Once the system is rebooted, circuits are reset and proper memory data is loaded, the system returns to normal.

Transients may not demonstrate any immediate effect, but this does not imply that the circuit is rid of them. Quite the contrary. Transients often accumulate inside ICs, and a group of small transients can cause a circuit-board failure.

Controlling the environment within which NCs and CNCs operate is the most cost-effective way to increase uptime and reduce maintenance

Transients are not the only cause of power disturbance, however. Power-company grid switching in regulating power distribution is a frequent cause of power disruption and contamination.

Since this same power feeds computers and electronic equipment, which are sensitive and react negatively to such contamination, "commercial-grade" power must be conditioned to "computer-grade" power.

Several transient-suppression devices are available. Suppressors lessen a transient's excess energy once it exceeds the nominal peak voltage of the electronic equipment. Some shunt this excess energy to ground; others dissipate it as heat, which is absorbed in the device.

A good suppression device has several requirements:

- Speed or response time of less than 1 nanosec. A slower device would allow a portion of the transient to pass.
- Between 6000- and 20,000-A current-absorbing capacity.
- Voltage-clamping capability at least 15-20% above nominal peak voltages.
- Radio-frequency traps and voltage-smoothing filters in high-speed and high-energy suppressors to kill harmonic ring-

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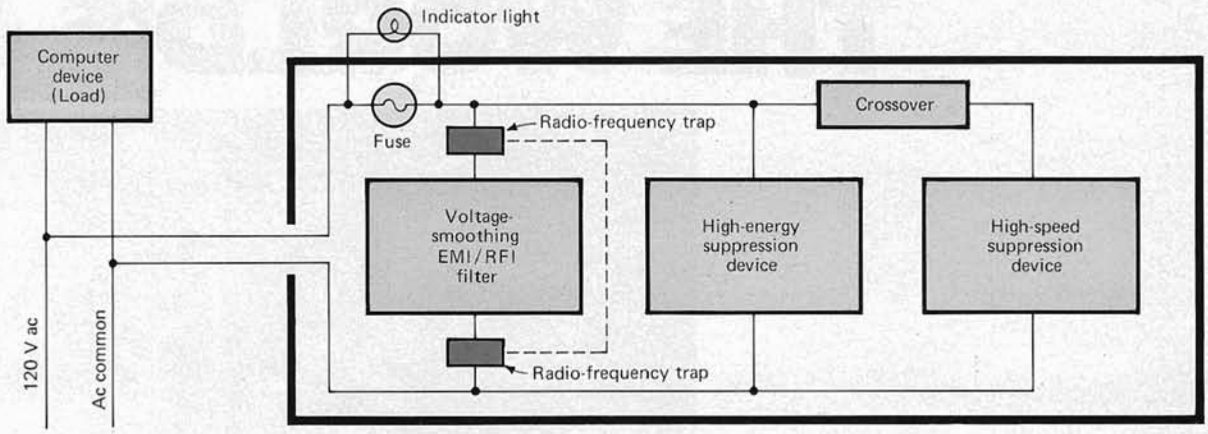
Transient-suppression network



ing, generated when a transient is clipped off to low-amplitude square wave on a voltage-time graph.

Most computer and electronic-equipment problems—since they are frequently generated by transients—can be eliminated with the simple addition of transient-suppression networks, which are also much more cost-effective than other devices used to eliminate transients. Of such networks, those that combine advantages of high-speed and high-energy suppression with voltage filtering and radio-frequency trapping are the most successful.

Other problems require power-conditioning equipment, such as regulators, isolation transformers, generators, voltage synthesizers, inductive filters, dedicated lines, special grounding, and uninterrupted-power-supply equipment.

The cost of power-conditioning devices ranges from $200 to $300,000, and no single device can be considered a "cure-all." Each is designed to solve specific problems, and, although effective at solving a specific problem, it might have little or no effect on others. No matter what the cost, if the right device is not used, the problem will not be solved.

Many NCs, CNCs, and computers and automation controllers have built-in power-conditioning devices—such as regulators, filters, and isolation transformers—but these are not effective against the most frequent problem: spikes and transients. Suppression networks, however, are rarely built in.

One widely used technique is often expected to solve all computer- and electronic-equipment problems. A dedicated line is nothing more than a separate power line brought directly from the main distribution power panel to a piece of equipment. It provides a dedicated grounding from the source to the computer or the load, ensuring that common-mode problems are prevented and that suppression equipment functions more efficiently. However, it prevents only those power disruptions caused by other pieces of equipment on a common line but does not stop disruptions from utility-company lines or from other equipment fed by the same distribution panel.

Shop air contaminates

Other factors besides the electricity supply can cause problems. Many electronic control cabinets, for example, are insufficiently sealed against shop air. Layers of oily dirt or black iron filings accumulate on circuit boards creating resistive paths that short wires and boards and often cause permanent hardware damage. The dust enters cabinets through wire ducts, vent panels, around switches, and door edges if the cabinet is improperly sealed.

Shop air circulated through cabinets, a practice common in cooling dc motor drives, is a major cause of dirt accumulation inside cabinets. This practice dates back to when drives were always motor-generator sets, which required a lot of shop-air circulation to cool, and their relay controls were not damaged by contamination.

Today motor generator sets are obsolete; instead, drives use semiconductor devices like silicon-controlled rectifiers (SCRs) and like all equipment with semiconductor devices, are extremely sensitive to heat and dirt.

To keep dirt out of cabinets, all ventilation systems must be sealed off, and the air conditioner is required to both cool the drive and recirculate air. Doors and edges should be sealed off with commercially available foam-rubber strips, and cable holes should be sealed with nonflammable sealing material.

In addition to dirt, physical vibration continues to be a major reason for controller and computer failure. Circuit boards can gradually vibrate out of their sockets causing intermittent or lost connections and, thus, equipment breakdowns. Continued vibration often shears components and lead connections. Also, vibration causes movement of frictional connectors, which are used in circuit-board socket and plug-socket connections. Shock-absorbing pads under cabinets can reduce vibration.

Lost connections can also be caused by normal aging or oxidation of a component. Although a deoxidizing agent can clean an oxidized connector, the right solution must be used: some solutions clean contacts but cause them to corrode faster; others form a thin film on connectors, preventing future oxidation but often attracting dirt. The use of an eraser to remove dirt and oxidation on circuit-board pins is discouraged since the eraser wears away the thin layer of gold or silver plating, destroying the conductive surface.

Computer and electronic equipment work best in the proper environment. In a business-computer installation, floors are often raised and insulated, and a lot of effort goes into planning the right air- and power-conditioning. However, such planning is not often evident in industrial computer- and electronic-equipment installations even though the industrial systems use the same electronic components as the business systems. ■