MAINTAINING DIGITAL EQUIPMENT

KNOW USER-SERVICEABLE PARTS

Technology is great. Except when the blasted things break and the question of whom to call becomes the crux of the matter. In the past, studios had personnel on hand to care for the equipment. However, even with an adequate tech staff, the philosophy of dealing with equipment servicing and/or failure is different today.

For one thing, personnel qualified to perform component-level repair are becoming more and more expensive; even manufacturers have difficulty retaining people of this caliber. To the end-user, repairs are more difficult and the equipment's reliability becomes an important factor. Many manufacturers have responded to this situation by engineering more careful designs. Televisions don't break every six months, and the PC clone with the cheap motherboard seems to last forever.

The "average" commercial studio ***today*** has invested significantly in sophisticated signal processing gear. While a studio operator may have a common sense understanding of the technology, in order for the facility to function smoothly there has to be at least one person on staff who can operate each piece of equipment in the place. Without complete equipment understanding, the studio cannot effectively recognize and deal with equipment malfunctions.

A Builder's Perspective

Most manufacturers place a lot of weight in customer service. Since the end-user is not usually fully literate in technical matters, suppliers need to have a multilevel support system in place. This is true for things analog as well as digital. Support from the manufacturer includes: training, regional spare parts and/or repair, field service, warranty replacement, module replacement/exchange, service contracts ("uptime insurance"), telephone advice, loaner units and modules, etc.

An educated consumer is the supplier's best customer. Just understanding how audio commonly works is no longer sufficient to cope with today's advanced technology. To perform any troubleshooting to reduce the problem area to a subsystem, we need to know what the subsystems are and how they interact. To this end, many manufacturers supply technical training and product-specific information. This sometimes takes the form of in-depth classroom education for either the owner or the technical staff from independent schools. With a fundamental understanding of what goes on inside the gear, you can operate as the eyes and ears of the factory personnel for troubleshooting purposes.

Service contracts are not very popular, since they are little more than an extended warranty; but this doesn't have to be the case. Equipment reliability expectations of a unit can be measured via the availability, price and quality of a manufacturer's service contract. The company that is willing to back up its product without additional expense is confident in its product's reliability.

When the Stuff Hits the Fan

The help you get from the manufacturer depends on a number of factors, not the least of which is the price of the unit and your geographic location. You will find help in New York, L.A., Nashville and Chicago in the form of spare units, replacement PC boards and field service personnel for most of the industry players (if not from the factory, then from their dealers and reps). In the secondary markets and beyond help can get a little spottier. What this means to you as an owner is significant differences in what is required from you in way of preparedness.

Here in New York (at least when the unit is still under warranty), you can usually get a factory rep to come in and swap the defective subassembly. From the supplier's position, it is always far wiser to replace a defective ***assembly*** than to attempt a component-level repair. The offending module is then returned to the shop and either repaired there or at the factory. Component-level restoration with modern, high-speed digital electronics is very difficult (or impossible) without specialized tools and test equipment. At least while the unit is under warranty, this work is best left to the factory. Expeditious service is the goal, and assembly-level replacement is usually the fastest route to relief.

The most common failures involve moving parts. Disk drives, switches, pots, connectors, motors, drums, guides and the like are most prone to an inopportune "vacation" from full and proper function. For instance, tape recorder electronics fail far less often than the transports.

Here in New York City, the troubleshooting process goes something like this:

1. Trouble is noted.
2. Determine that an actual failure

BY GREG HANKS

has occurred and call the manufacturer.

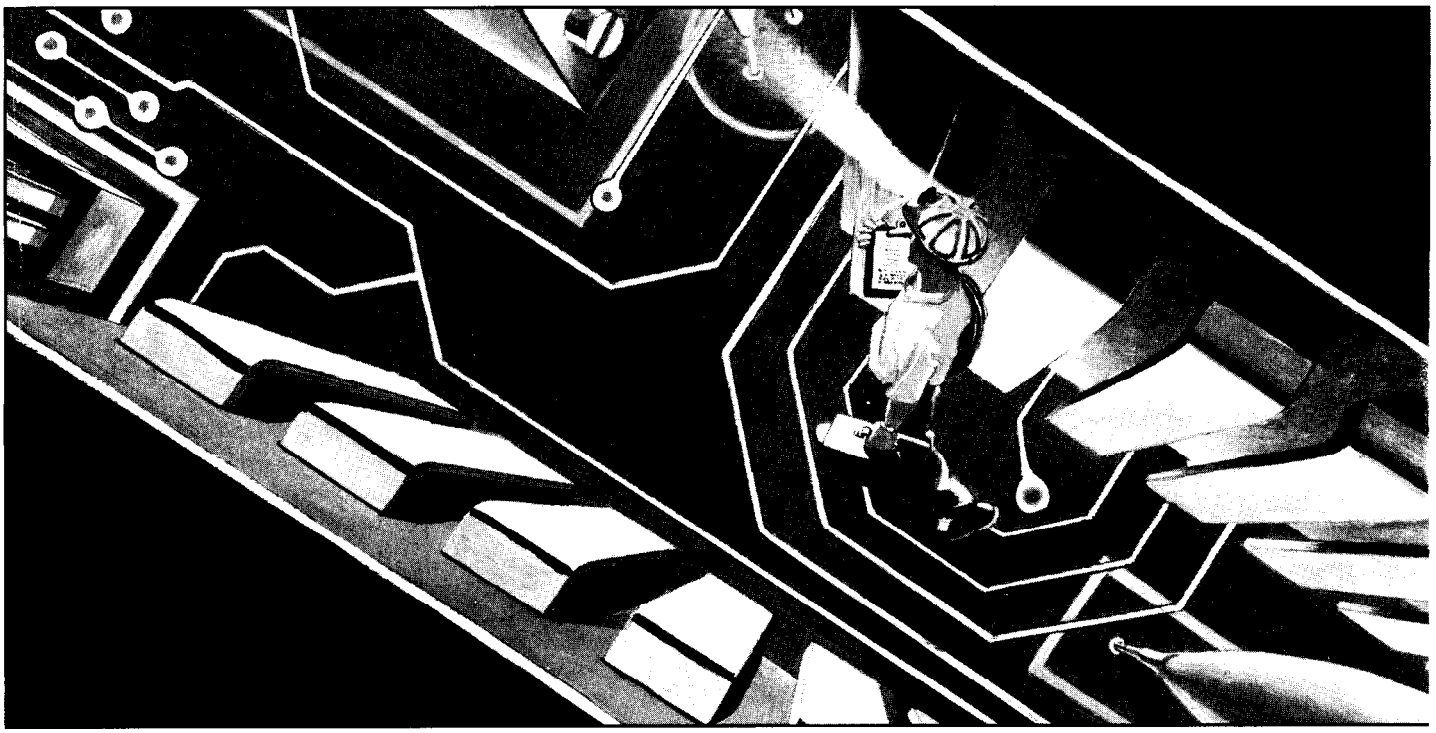
3. The factory rep walks through some of the system diagnostics and/or failure symptoms with the operator and gets an idea of what could possibly be wrong.

4. Some elementary tests are performed by the operator (with factory urging), and either the trouble is isolated and gotten around or a field service rep is dispatched with the appropriate modules.

5. The offending subassembly is replaced, and the studio is back online.

At least that's how it works in theory. It usually gets a little messier in reality. The financial powers in most successful companies feel that unless the service personnel are overworked then they must be overstaffed! This means you might not get the immediate attention you may require.

In less-populated areas, a growing number of suppliers have initiated 24-hour tech support hotlines. This makes it possible to at least talk to a human being at 2 a.m. who understands how the bloody piece is supposed to be working.



Tools of the Digital Repair Trade

Servicing digital electronics is fundamentally the same as any other form of technical repair. Working at a component level is sometimes not only feasible but mandatory, particularly with a piece of out-of-production gear that still retains its "most-favored" status among a studio's clients and engineers. Digital-based equipment of this nature will often require special attention, since the methods outlined above may not apply with older gear.

In addition to the standard armada of technical aids, digital repair is expedited with additional tools such as: system diagnostics, logic analyzer, logic comparator, logic probe, IC clips, surface-mount clips and surface-mount soldering/desoldering tools.

Every system has a user's manual. As systems become more complex and expensive, the manuals get heftier. They are your most important tools, as they usually include system diagnostic procedures. Diagnostics-in the form of embedded or free-standing software-will usually point to where the fault lies. Unfortunately, today's generally available diagnostics are often of limited value to the end-user. Logic analysis typically occurs only in the realm of the manufacturer, where the analyzer records the data and address bus activity of a system, rather than just telling you that "U12 is latched low on input A!" Logic stimulation and pattern recognition is the benefit of this type of equipment.

The Universal Logic Programmer is a useful new PC-based tool. Its primary function is to burn EPROMs, PALs, GALS and such. Since programming modern devices requires using a set of A/D and D/A converters, this tool can exercise and test logic devices. However, it only works with 24-pin and smaller devices. The primary equipment tested are 74 series, and with an extended IC clip hooked to a header it operates with in-circuit chips.

Don't attempt repairs on surface-mount technology unless you have the right tools. Workstations integrating soldering, vacuum materials handling (with static protection) and desoldering are available from Viking or SMD tools but can cost over $2,000! In most cases, when the unit employs VLSI attached via surface-mount technology, replace the board. It is really only feasible to work on SSI and MSI (74XXX, 46XX, 80XX and discrete) technology.

An Ounce **of Prevention..** .

With a preventative philosophy, the first order of business is to assure that the environment is not hostile. To ascertain the most efficient methods of preventing future difficulty, it's a good idea to figure out what types of failures are most common or most financially serious and attack the cause rather than the symptoms. This may include: optimizing the environment where the equipment is situated, performing routine service as recommended by the manufacturer, and

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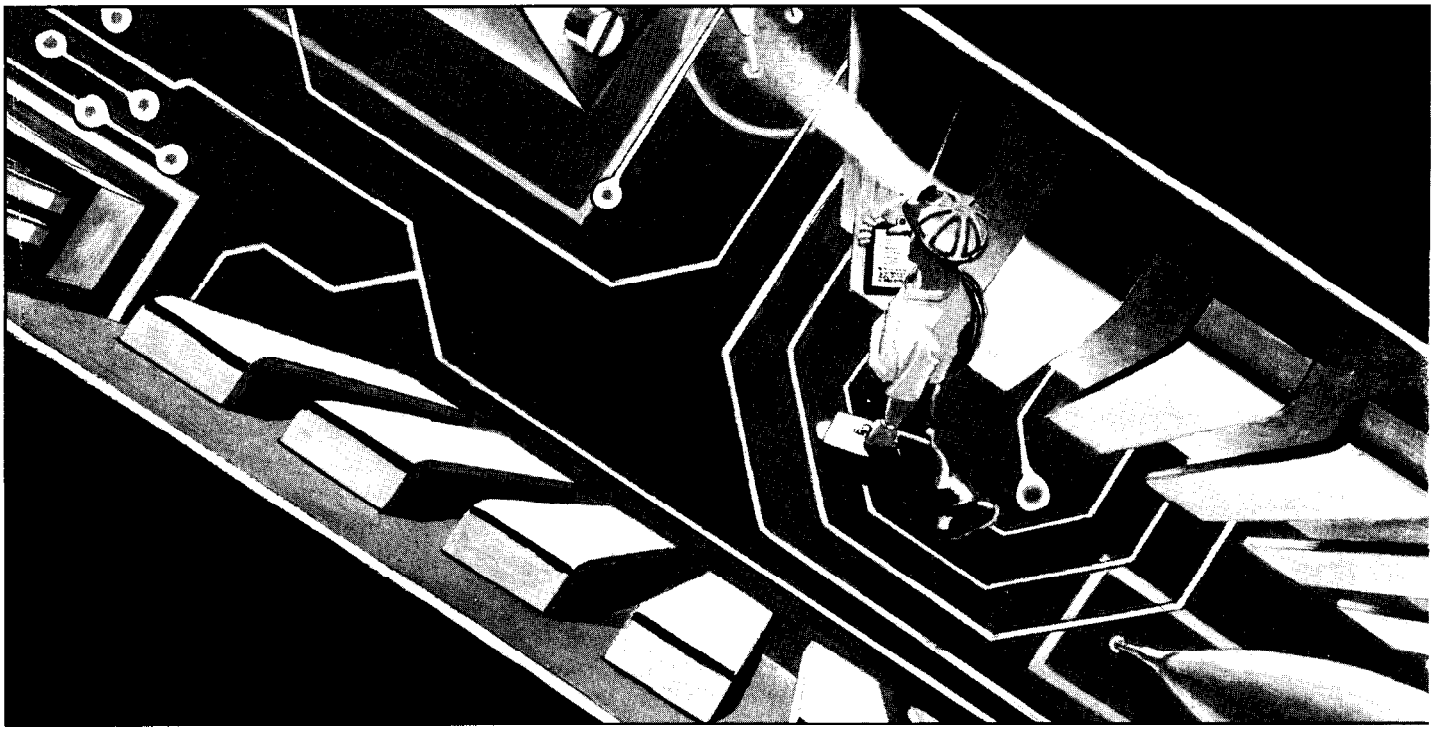

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ensuring that all service performed uses reliable methods.

Some factors that affect the long-term reliability of equipment are electrical service and ground integrity, temperature, humidity and the possible presence of electromagnetic or electrostatic fields.

The electrical service is common to all equipment. Urban environments traditionally require some form of power protection. Line sags, overvoltage conditions, spikes and line noise all contribute to reliability problems. In the past, most computer companies required power conditioning in order to honor the warranty. Nowadays, most equipment is manufactured with MOV and inductor protection as an integral part of the IEC power socket. You *really* need power conditioning when your computers begin latching up because of dirty power. Line sags lead to premature failure in motors and transformers due to increased heat loads, and in extreme cases the power rails can drop out of regulation, leading to all sorts of interesting phenomena.

Grounding is as important in digital circuitry as it is in analog, and it is necessary to keep signal common and electrostatic shield separate! Component interconnect lines may ring, SCSI devices fail to initialize, monitors will look fuzzy and other nasty things may happen.

We routinely recommend power conditioning throughout an entire facility to alleviate such concerns. Remember that a low source impedance is necessary to attenuate noise generated on the conditioned side of the line. Power conditioning is an effective form of insurance. One lightning strike to your power line can destroy every piece of equipment in your facility, and while that is exceedingly rare, it does happen.

Temperature affects the operation of electronics in many ways. The safe operating area of any semiconductor is a function of junction temperature. Bipolar devices have a positive temperature coefficient, meaning that when the temperature goes up, so does the current gain, which increases the current flow, which increases the junction temperature. FETs and CMOS devices have a negative temperature coefficient: When they get hot, the input capacitance goes up and the circuit slows down.

This latter condition is also true of bipolar devices, although to a lesser degree. The junction temperature of the devices employed must fall within the device rating. It is controlled through conduction to the surrounding air, either directly or through heat sinks. When the ambient temperature of the environment becomes elevated, the heat sink's ability to function decreases Linear increases in the ambient temperature become *logarithmic* increases in the junction temperature.

Operating equipment at elevated temperatures can lead to two different results: "soft" failures, such as timing errors, and "hard' failures, like component degradation or failure. Component degradation is an insidious problem, as it leads to component failure at some future time through a "weakening" process. Continued operation at higher temperature is one of the reasons that certain pieces of equipment become a service problem. A good rule of thumb is when the room is too warm for your personal comfort, the equipment is probably not happy. When the air-conditioning system breaks, you jeopardize the future reliability of your equipment by continuing to use it.

Humidity is also affected when the air conditioner breaks. Although it's a lesser problem than temperature, when the humidity is high the heat sinks work less efficiently. The two main consequences of excessive humidity are an increase in the overall capacitance of the exposed circuitry (which lowers the operating speed) and the increase in surface oxidation. Generally, humidity is not a concern unless you see condensation trails.

Field radiation is less of a problem now that the world is going digital, but is nevertheless worth mentioning. More common are problems relating to the fields radiated by our digital devices Unterminated lines or data bus extenders will sometimes "ring," and this can drive you nuts. Because of the relative immunity of most bit-based gear to field radiation, I was surprised to discover that a client's hard disk problem was traced to a tape degausser placed on top of the disk drive cabinet!

Spare Parts on Hand

The level of financial risk you face in case of failure will detennine the spare parts requirements of your facility. If you cannot afford to be down at all, then look at having full redundancy in all your equipment. However, you don't need to worry about this if you can live with the schedule and parts

availability of your technical service vendor. Most facilities find themselves somewhere between these two extremes.

It's no longer practical to maintain a complete collection of spare parts for all critical functions. Most of these new toys have an amortized life of two or three years, and they use far too many critical boards to keep spares in stock. When a piece is no longer being manufactured, then it's time to buy replacements for any boards that have a history of failure. What you should have on hand is determined by many things, not the least of which is how well the manufacturer stocks replacement assemblies. Another consideration may be what redundant features are designed into the unit to allow partial modular replacement with limited functionality. You no longer can carry the generic semis and passive components; more often than not it just ain't feasible! The spares you should concentrate on are spare sources of supply. Maintain a relationship with the factory reps on both coasts. Your Rolodex is one of your best tools.

Routine Maintenance

No generic routine service tasks exist for digital equipment other than keeping the cooling vents clear and the insides clean. Each equipment will have its own recommendations from the manufacturer. These things should be explained in the owner's manual. Read it! I usually learn something when I do.

Given that the most expeditious method of repair is on a board level, we must be conscientious in our methods. High-speed digital electronics coupled with a proliferation of CMOS has elevated static control to a required science. I used to think that it was sufficient to grab a grounded chassis before handling boards. Not so! One of the most important tools used by aspiring repair techs should be the static strap and ground lead. When you pull out a PCB, you need a grounded surface to lay it on, so carry a conductive mat. The preferred methodology is to wear a conductive wrist band that is physically hard-wired to a conductive mat, which in turn is tied to technical ground.

In addition to static control, always shut off the equipment before swapping modules: Hot plugging is about as close as you can come to Russian roulette with your electronics! Powering up equipment in the wrong sequence can introduce "soft" errors that corrupt the system's integrity. Another way to prevent premature failure is to turn off equipment before plugging and unplugging other equipment. You never know when you'll get the power and data lines terminated just a few microseconds before the system ground and electrostatic shields are made, creating potentials of much greater level than the system was designed to handle. I've "zorked" systems by unplugging the 422 data line with the power on. The equipment was unusable until we performed a full "hard" reset. Once you've corrupted the operation of a logic device, it is best to power everything down and start everything from ground zero.

Good work habits should carry over from your analog discipline, such as examining all traces on the PC board after a solder job to ensure that no "spooge" remains to short out adjacent traces. Use flux remover and clean the board after any repairs, as flux residue can provide a capacitive path between conductors, making for strange operation! Note: Don't install sockets when you replace a chip unless you are going to use gas-tight ones. There are more reliability problems with sockets in digital electronics than in the logic devices themselves. Conscientious work methods will provide for more satisfactory results.

Thanks to the increased reliability of today's systems we can realistically own, operate and service the technological wonders that fill our studios. Becoming educated to the topography of the individual systems, meeting and becoming friendly with the factory service personnel, keeping the necessary tools and parts on hand, and maintaining impeccable work habits all contribute to the long-term success of your facility.

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