Turn it off or leave it on?

It's a topic that results in debates more heated than the equipment. Unfortunately there isn't a simple answer. JOHN WATKINSON has fans everywhere and takes a cool look at the issues, with the help of penguins.

MOST AUDIO AND VIDEO production equipment is electrically powered and incredibly inefficient. Take the average TV studio, which uses several megaWatts to create 1volt into 75ohms, or a recording studio, which may consume tens of kilowatts to produce a milliWatt into 600ohms, if anyone still does that. The rest of the power? It becomes heat.

Oddly enough, about half of the heat coming from a production complex is due to the air conditioning that gets rid of the other half of the heat. In many respects video and audio installations are an environmental disaster from an energy point of view and only become acceptable because they are few in number and entertain a lot of people. The energy waste per person is then smaller. Nevertheless energy costs are bound to rise and the prudent manager will have an energy conservation strategy, or, having read this, will think about having one.

Clearly the least energy will be consumed by equipment that is designed to be efficient. Not much studio equipment is in this category yet, although there are signs of progress. Certainly great leaps have been made in lighting technology with new super efficient light sources becoming readily available. It won't be long before it will be technically feasible to ban the incandescent light bulb as a major polluter, although this will require technically educated politicians: something of an oxymoron. With any luck the Class A amplifier, sonically irrelevant due to developments in other technologies, will go the same way. It's the audio equivalent of a car with the throttle jammed open where the speed is controlled by applying the brakes.

In the absence of efficient equipment, the only alternative to save energy is to turn it off when it's not being used. This is where the fun starts because turning equipment on and off may or may not be good for it. I've read as much nonsense as sense about this in the audio industry, so I tend to rely on information gained elsewhere, not least from the computer industry.

When an electronic device is operating, everything that impedes the flow of current will dissipate heat. Unfortunately, every device also impedes the escape of heat because it has thermal resistance. This includes resistors, op amps, transistors, transformers, diodes and so on. The temperature inside the component will rise until the thermal gradient between the inside and the outside is such that the rate at which the component loses heat balances the rate at which it is being created. Thus in practice the interior of components will usually be hotter than the exterior. Clearly if the outside of a piece of equipment is hot, the inside must be hotter and the inside of the components hotter still.

The question must then be whether this matters. Provided the temperature is not so high that permanent changes can occur to materials, a high but constant temperature is not detrimental in many cases. The problem comes when the device is turned on and off. Thermal expansion causes dimensional changes with temperature. This in itself isn't necessarily bad, but it is when adjacent parts are made of different materials that expand at a different rate. This was discovered early by manufacturers of vacuum tubes who soon found that air would leak round the pins unless the latter were made of a suitable material that expanded at the same rate as glass. The same problem exists with chips, whether analogue chips such as op amps or digital chips such as RAMs and processors. While they don't contain a vacuum, the semiconductors inside them are very sensitive to contamination and this is kept out by the seal between the body of the chip and the leads.

Consumer grade chips have plastic bodies and metal leads and there is a differential expansion issue. The effectiveness of the seal can be compromised after repeated thermal cycling, allowing pollutants to enter the chip. Military grade chips have ceramic bodies to minimise this issue. Naturally this costs more and isn't often adopted in professional audio equipment. Cigarette smoke as well as fall out from hallucinatory substances must be classed as such a pollutant. It amuses me greatly to find an argument going on about whether or not to switch the console off at night when those arguing are using the console as an ashtray. I recall a mixing console being returned to its American manufacturers for repairs that was impounded by Customs because all of the fader slots were full of white powder. This must be why variable resistors are called pots.

I've also heard arguments that electrolytic capacitors are dried out by heat so equipment containing them should be switched off when not in use to reduce the effect. That's all very well if only the capacitors are being considered. Frankly if a piece of equipment is hot

enough to dry out the capacitors, it's hot enough to cause thermal cycling problems to the chips. Thus if you leave it on, the capacitors fail; if you switch it off, the chips fail. Neither of these is a solution.

The only real solution is to lower the temperature of the equipment. Enter economics once again. It's often cheaper to make equipment that gets hot, and also cheaper not to put a fan inside. Fans are a mixed blessing, because conventional fans make noise. In critical areas, fans need to have very large blades and turn slowly. This means they cost more.

Primarily, equipment reliability must come down to the designer. Equipment must be designed to be efficient, to reduce the heat generated, and further designed so that the remaining heat is removed without a large temperature rise. If this is done, it doesn't matter whether you turn the thing off or not as the thermal cycling is gone. Thus you may as well turn it off and save power.

Even if a piece of equipment has been reasonably well designed, the designer has no control over where it is put. Penguins huddle together so the effective surface area of the flock is reduced. The ones in the middle are quite comfortable when it's 30 below. An elephant actually eats a lot less than a sparrow when body weight is taken into account, because it has a much smaller ratio of surface area to body weight and doesn't lose heat so quickly. A rack filled with equipment suffers the same phenomenon.

Pieces of equipment that run cool individually will run hot when put together. Effects racks are notorious. Cooling can be improved by leaning the racks back and by leaving vertical spaces between units. Air can then convect up the sloping gaps between equipment. In some cases a fan can help. Normal AC-powered fans are far too noisy, but I have had some success connecting pairs of mains driven fans in series so each operates on half voltage. Tangent blowers, the ones with long cylindrical rotors, work very well in this mode. For fans to be effective, they must move air through the equipment. Just stirring the air inside is a waste of time. Some fan-equipped rack equipment cools front to back, some from back to front. Put one of each adjacent in the rack and you have a recirculating system where each adds to the heat load of the other.

The multitrack console is like a flock of penguins too. All those channel strips wedged together. But how many of these consoles do we see that are tastefully illuminated by incandescent reflector bulbs bathing the poor thing in infra-red radiation. To make matters worse, many of these are dimmed, further increasing the ratio of heat to light. It's hard doing a mix when you have to wear oven gloves. This must be why automation is so popular. Frying faders?

The rules are different for things like disk drives because they have different sensitivities than chips. A hard drive that is running has no wear mechanism. The motor is brushless, the bearings are contactless because they are floating on an oil film and the heads aren't in contact with the data surface because an air bearing is maintained between the two. Thus the correct procedure with a hard drive is to leave it running. Whenever a hard drive stops, the heads land on the disc and slide along until it stops. ■

Penguins arguing about who should go on the outside.

DO

- **Buy equipment having low power consumption.**
- **Consider switched mode audio amplifiers.**
- **Consider low energy light bulbs or LEDs as an alternative to anything with a filament, especially for console illumination.**
- **Check that effects racks have plenty of access to cooling air and leave spaces between units.**
- **Consider fitting low-speed silent fans to assist airflow.**

DON'T

- **Use dimmers with incandescent bulbs.**
- **Use Class A audio amps.**
- **Buy equipment that gets noticeably hot on the outside.**
- **Cram racks with equipment.**
- **Smoke near technical equipment. You and it will live longer.**
- **Switch off hard drives.**