Quiet Personal Computers

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Introduction

As computer performance increases, so does the amount of noise generated. Computer manufacturers spend huge amounts of money developing the next generation of high performance computers, without considering noise and vibration issues.

As a result, quiet computers are becoming highly desirable, particularly for low noise environments such as recording studios and bedrooms.

There are now numerous products available, all stating that they will significantly reduce the amount of noise generated by the computer. This paper investigates the effectiveness of different noise attenuation methods, and looks at some potential pitfalls of a quiet computer.

The Quest for Silence

Computers are commonplace in many bedrooms and living areas as they become more widely used for entertainment and music.

The last thing you want to hear during a period of suspenseful silence in a movie is the whine of a cooling fan or the howl of a DVD drive.

Noisy computers in the workplace may influence productivity. In addition, where computers are used for speech recognition a quiet computer has been shown to improve the accuracy of the software.

For the hardcore gamers the aim is all out performance, they desire high frame rates, smooth textures and fluid game play. It is these people who essentially drive the need for increased performance in computing.

But performance comes at a cost... HEAT, and the cheapest and most effective method for removing heat is airflow.

Data storage is another issue. Audio and video files take up large amounts of space. This has increased the need for fast hard-drives and high-speed optical media such as CDs and DVDs.

Manufacturers tend to focus on performance and stability, but pay very little attention to the issue of noise.

One family of high-end graphics cards released last year were quickly dubbed "dustbusters" due to their noisy cooling fans. Such mistakes can quickly damage a manufacturer's reputation, particularly in the fickle world of computing.

Criteria

If computers are too noisy, how much noise does an average computer make? Typically noise from computers is 40 to 50 dBA at around 1m.

When is computer noise likely to affect sleep disturbance? The WHO

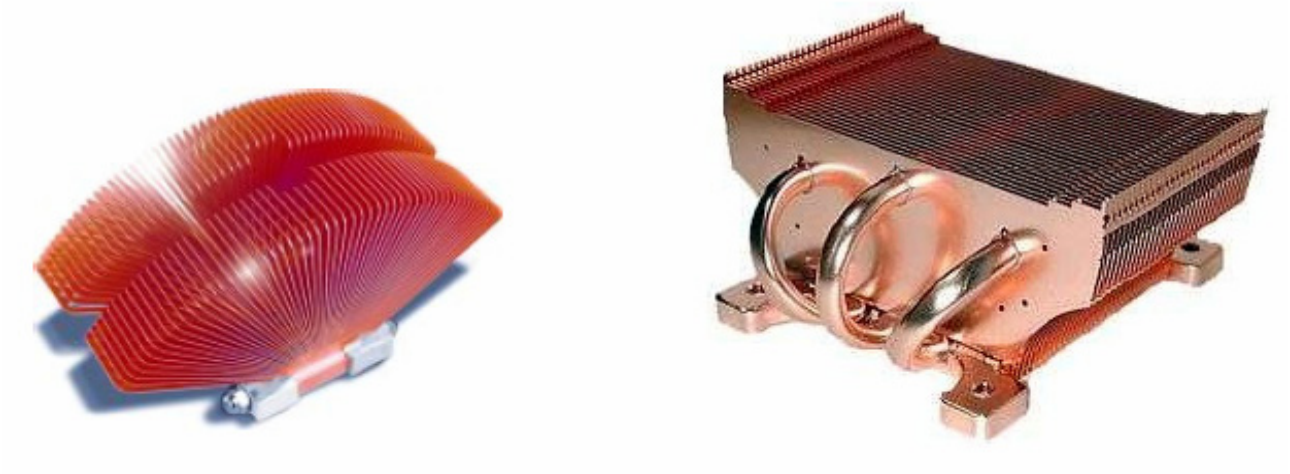

Figure 1. – High performance heat sinks: flower cooler (left) and heatpipe (right)

guidelines for sleep disturbance suggest that noise levels inside bedrooms should be lower than 30 dBA.

What is a reasonable level? Ideally, we would like to have our computers as quiet as possible so that they were essentially inaudible. However, a more realistic target would be around 20 to 30 dBA.

The only downside to a quiet computer is that noisy computers often provide useful masking, where there otherwise may be none. For example, in an open-plan office environment where there is no air-conditioning present.

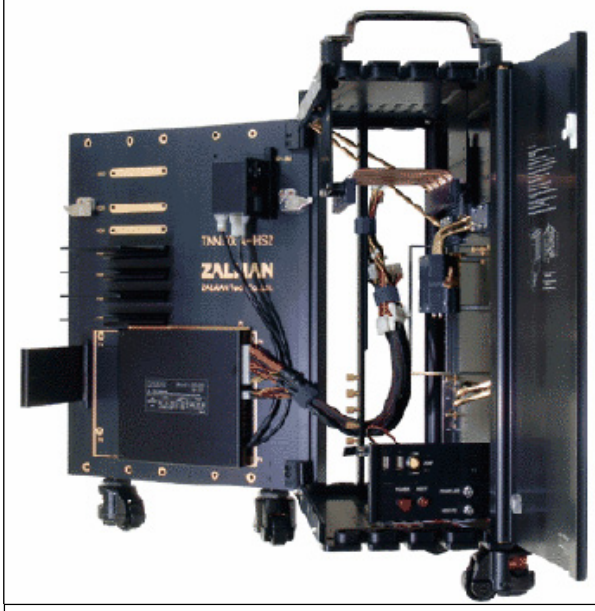

Figure 2. – Acoustic case with in-built heatpipe cooling system

Sources of Noise

Typically it is the moving parts within a computer that generate all the noise. Fans, hard-drives and optical drives all generate noise. The exception to this is the power supply transformer which may hum or buzz a little. However, the cooling fans in the power supplies would typically mask this, and it is only likely to be audible on passively cooled power supplies.

Noise from fans is typically dominated by the noise of air passing over the fan itself.

Fans with bearings rather than bushes may become noisy after time as the bearings become worn. A fan also has the potential to generate some vibration too if poorly mounted.

Noise from hard-drives is often more of a vibration issue rather than noise from the drive itself.

Even a relatively quiet hard-drive can generate excessive noise if mounted poorly.

Noise from optical drives is often overlooked, since they only generate noise when they are in use.

However, if a computer is to be used as an entertainment centre to listen to music or play DVDs noise from optical drives may be of concern.

Figure 3. - Hush™ ATX silent computer

Solutions

There are a lot of products available that are designed to reduce computer noise. Most of these are not particularly cheap when compared to standard components.

There are several different types of cooling fan used in computers. The CPU will often have a dedicated cooling fan, as will most decent graphics cards.

Most power supplies, unless passively cooled, have at least one cooling fan. Case fans are also now commonplace on most computers.

The CPU fan can, in most cases, be removed completely if a high performance replacement heat-sink is used. These heat-sinks still rely on air-flow from case fans in order to cool the processor effectively. They are often made of copper and many of the newer models also incorporate heat-pipes, this makes them are also quite expensive at around $50 to $80.

Fanless cooling solutions are also available for the replacement of fans on high-performance graphics cards.

As already mentioned hard-drives tend to be a major cause of vibration in a computer. One of the key improvements to hard-drives has been the introduction of fluid dynamic bearings, which reduce vibration considerably.

Since noise from hard-drive tends to be mostly a vibration issue, hard-drive noise can often be reduced by using isolation mounts.

There is very little that can be done to reduce noise from optical drives. The best solution is to choose a quiet one when purchasing your computer.

Power supplies are often a dominant source of noise. Silent power supplies are available, the quietest ones are passively cooled so there is no noise from cooling fans.

Small case fans can be replaced with larger fans which still achieve the same flowrate while running at lower speeds. Simple fan speed controllers are available which allow the speed of the fan to be adjusted manually.

Many motherboards now have integrated speed controller also. They vary the fan speed depending on system temperature. The downside with thermal speed controllers, is that the computer may be quiet idling, but it may be very noisy under load. Vibration from fans is also an issue, gaskets and grommets can be used to isolate fans from cases.

Attenuators may be fitted to the case to reduce noise from cooling fans. These tend to be bulky and are not particularly cheap. Flanking of noise through cooling slots may also be an issue. As a result, attenuators are not very popular.

If an owner values silence over performance they may choose to underclock their computer, since this can significantly reduce the amount of heat generated and therefore reduce the amount of cooling required.

Although this method sounds complicated, many new CPU employ thermal throttling. So by simply reducing the fan speed manually, the CPU would underclock itself when it begins to overheat.

Air is not the most efficient fluid for moving heat. Water-cooling allow huge amounts of heat to be removed quickly.

Water-cooling was once the domain of hardcore enthusiasts only. However, several products have been recently released which offer the benefits of water-cooling to mainstream users.

A basic water-cooling kit consists of a waterblock, mounted directly to the heat source; a radiator, to dump the heat; a pump, to circulate water around the system; and silicon tubing, to connect it all up.

These tend to be very expensive

Figure 4. - Toaster sized Small Form Factor (SFF) Shuttle® computer

because of the cost of individual components. Cooling fans may also be required on the radiator and noise from the pump may also be an issue. The threat of leaks is likely to deter most rational users.

There are several acoustic absorptive foam kits available for lining the inside of computer cases.

These products reduce noise levels in two ways. Firstly, reducing the reverberant noise level inside the case. Secondly, dampening panel vibration by making panels more rigid.

The downside to foam kits is that they increase the temperature inside the case and as a result cooling fans may need to work harder generating more noise than usual.

Specially designed acoustic cases are another alternative, however they tend to be expensive. The one shown in figure 2 costs almost $2,000 alone and weighs in at around 25kg.

The ultimate solution is the purpose built silent computers which are now available "off the shelf".

These have limited upgradability and are very expensive, costing around $3,000 to $5,000, and that's just for the computer, no screen, keyboard or mouse is included.

Application: My Shuttle PC

I own a small form factor shuttle PC. Given its relatively small size it sits on top of the desk and sits approximately 400mm – 500mm from my nearest ear when I am seated. I found the computer to be a little noisy at times. So I figured it might be worthwhile attempting to reduce noise levels using "off the shelf" accessories.

The dominant noise sources were as follows.

- The power supply
- The graphics card cooling fan
- The case/CPU fan
- The hard-drive
- The optical drive

"Silent-X" power supply

My first port of call was the manufacturers web site, where I noted the release of an upgraded power supply named the "Silent-X". The manufacturer marketed the product as "An amazing 250W ultrasilent PSU with High efficiency and high reliability." I had been concerned that the current 200W power supply was not providing quite enough juice for my memory, so I figured that even if it didn't reduce noise levels significantly then at least it would increase the stability of my computer. The cost of the "Silent-X" power supply was around $120.

Figure 5. – Silent-X power supply unit

During installation I noticed that the new power supply had 2 cooling fans, whereas the "stock" power supply only had one. I measured noise from the computer as "stock", then measured it with the new power supply installed. Interestingly, the computer was around 1 - 2 dBA noisier with the "Silent-X" power supply installed.

Subjectively, there was a little more of a low frequency hum to the new power supply. So not much luck there then.

Graphics card cooling fan

The loudest noise source in my case was the fan on my graphics card. However, the fan only seems to run when the graphics card is running in "3D" mode.

I was not too concerned since most of the applications I run on my computer are "2D".

The case/CPU fan

The shuttle is an interesting design in that is uses a heatpipe cooling solution in combination with a case fan to cool the CPU. This means that only one cooling fan is required. I did not bother to replace the case fan since my research showed that the existing fan was supposedly very quiet already.

"Smart Drive 2002C" hard-drive enclosure

Noise from the hard-drive was the next noise source on my list. There are only a couple of hard-drive enclosures on the market, and only one of these was suitable for my particular hard-drive due to the heat generated by its high operating speed. The Smart Drive 2002C is an aluminium case with copper linings to increase heat transfer. Dense spongy foam lines the inside of the enclosure. The cost of the enclosure was around $100 plus shipping.

The improvement from the enclosure was around 1 – 2 dBA.

Although the measured improvement was not great, subjectively I was quite impressed with the reduction in hard-drive noise. Although the hard-drive was still audible, there was a definite decrease in that hard-drive "bubbling" sound.

The small reduction may also be due to other sources, such as the "Silent-X" power supply, dominating. It is also worth pointing out that I tested the hard-drive running under idle conditions.

The noise reduction would be much greater for a hard-drive intensive activity such as defragging.

The optical drive

To install the hard-drive enclosure into my case I had to remove my optical drive. I may look at getting an external optical drive at a later stage.

The Future for Quiet Computers

Most of the current solutions for quietening computers are very expensive since they typically involve a retrofit of components. Many manufacturers are beginning to wake up to the need for quieter computers, but there is still a long way to go.

Noise needs to be considered at the design stage rather than as an afterthought. Hard-drives are a good example of considerate design manufacturers putting a lot of development into noise and vibration issues.

Manufacturers will need to implement new technologies in order to keep noise levels down as performance increases. Active noise control is already being developed for use with controlling fan noise in computers. ❑

Figure 6. – Smart Drive 2002C hard drive enclosure