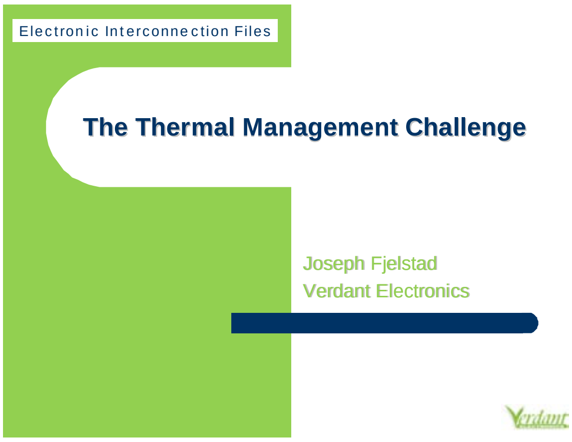
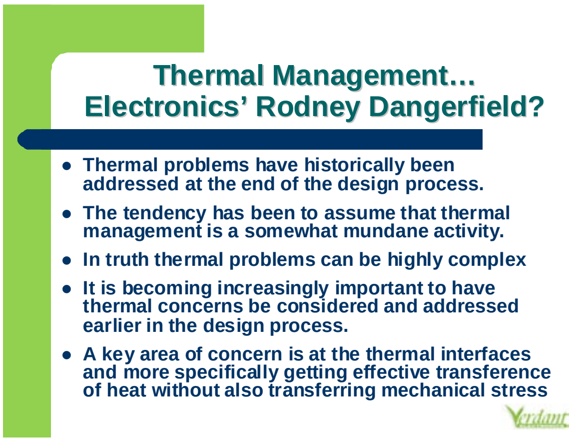
The thermal management challenge



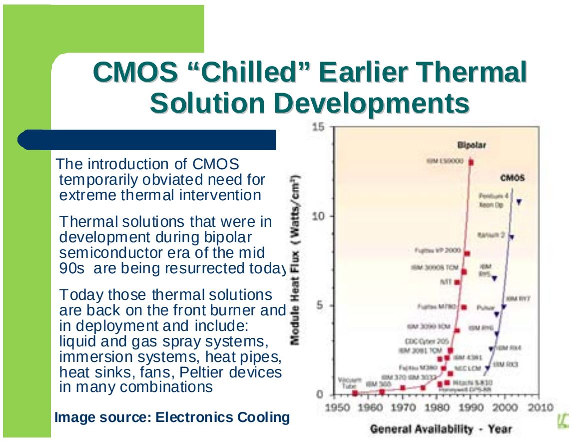
Welcome to the electronic interconnection files, brought to you by iconnect 007. I'm Joe Fjelstad.

This week the topic is thermal management challenge and how to address it, especially as we find ourselves now with much denser and much more energy-intense electronic assemblies.



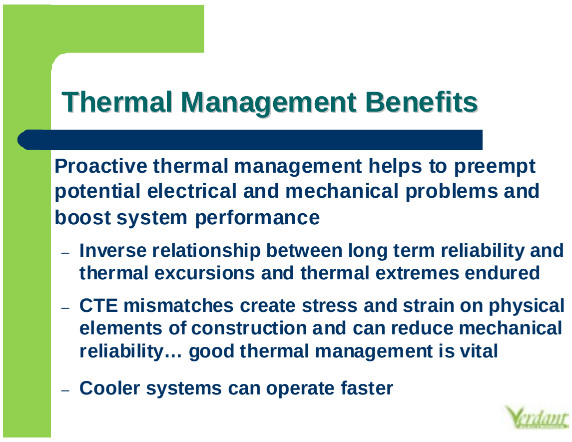
Thermal management has been something of a electronics industry Rodney Dangerfield in that it has not always gotten the respect that it deserves. Thermal problems have historically been addressed only at the end of the design process. The tendency has been to assume that thermal management is a somewhat mundane activity: simply throw on a heat spreader and you've done your job. The truth is that thermal problems can be highly complex and today it's becoming increasingly important to have thermal concerns be considered and addressed much earlier in the design process.

A key area of concern is at the thermal interfaces and, more specifically, getting effective transference of heat without also transferring mechanical stresses which can damage parts and reduce overall product reliability.

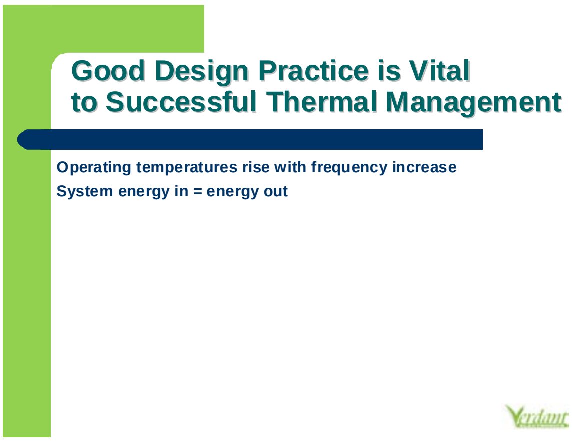


While thermal management is presently, shall I say, a hot topic, actually it's a replay of about 20 years ago. As you can see in the graph provided, bipolar technology was having extreme, almost exponential rate of rise in terms of watt density and the introduction of CMOS actually caused that problem to evaporate and, as a result, the thermal solutions that were being developed during the bipolar area are now being resurrected. Today many of those thermal solutions are back on the front burner and being deployed. Those include various liquid and gas spray systems, immersion technology, heat pipes, heat sinks, fans, and Peltier devices, and many of these in combination.

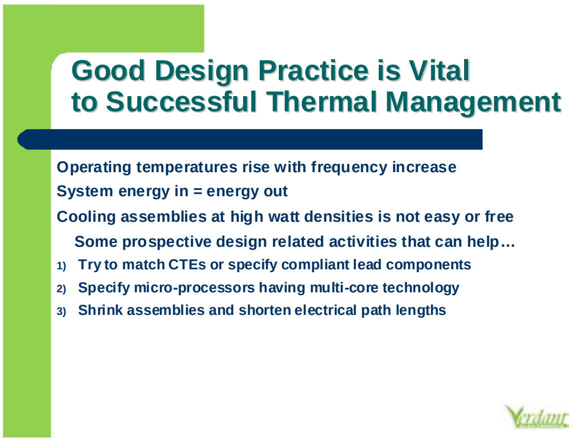
The thermal management challenge



There are some significant benefits to exercising good thermal management. Proactive thermal management, for example, helps to prevent potential electrical and mechanical problems and, as well, can boost the overall system performance. For example, there's an inverse relationship between long-term reliability of electronic devices and thermal excursions and extremes that are endured by the part. Coefficient of thermal expansion mismatches creates stress and strain on physical elements of the construction and can thus reduce mechanical reliability. Again, good thermal management is key in being able to solve those problems. Finally, cooler systems can actually operate faster.

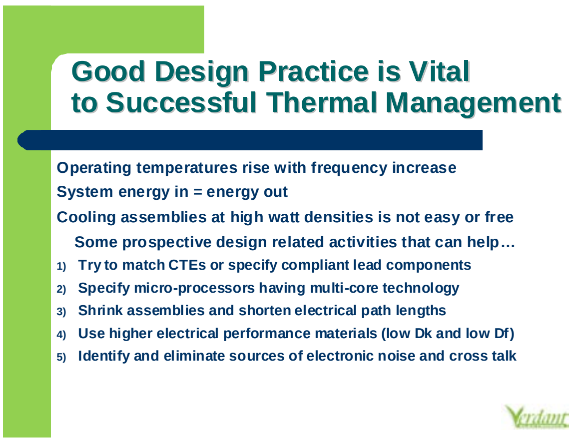


To obtain the benefits of thermal management, good design practice is required. But it needs to be framed against some certain realities within the industry. For example, operating temperatures rise with frequency increase and frequency increase has been one of the hallmark objectives of the electronics industry since near its beginnings. There's also the matter of system energy in must equal system energy out and so, if you're working in a closed system, it means that for every watt you put in, you're going to have to spend another watt to help to cool the system.



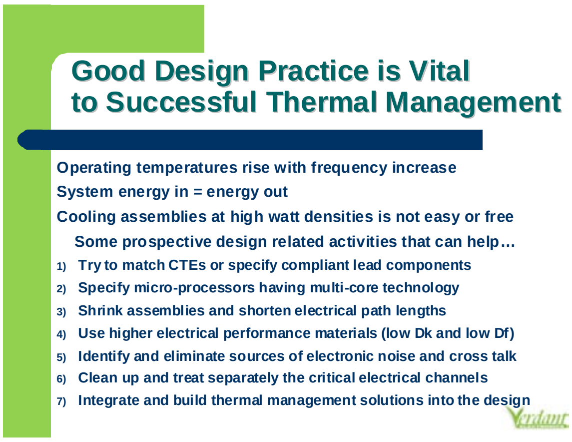
Cooling assemblies at high watt densities is not easy or free but some design practices at the early end can help to reduce the problem.

Here are some examples. One, we can try to match the CTEs of the materials that are used in the system design and/or specify compliant leads on components. Two, we can specify microprocessors that have multi-core technology. These devices tend to run much cooler, as they switch between cores as required to keep the system running cool. We can shrink the assemblies and shorten the electrical pathways. Shorter electrical paths require less energy to transmit along.

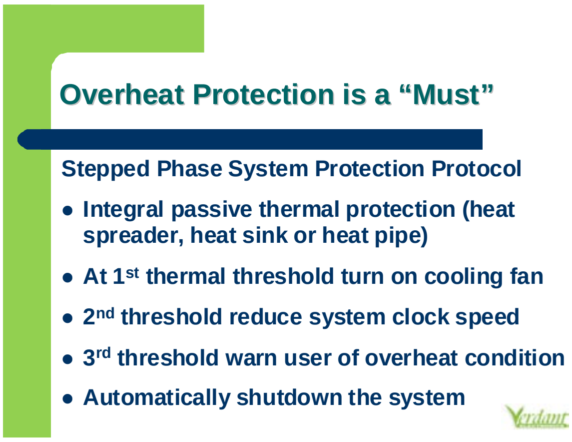


We can use higher performance materials, in terms of their electrical qualities, that is, lower dielectric constant and lower DF, which help to promote higher propagation speed and reduce attenuation.

We can also identify and eliminate the sources of electronic noise and cross-talk, which can damage the circuits and require additional cycles to be able to decipher where a 1 or a 0 is sent.

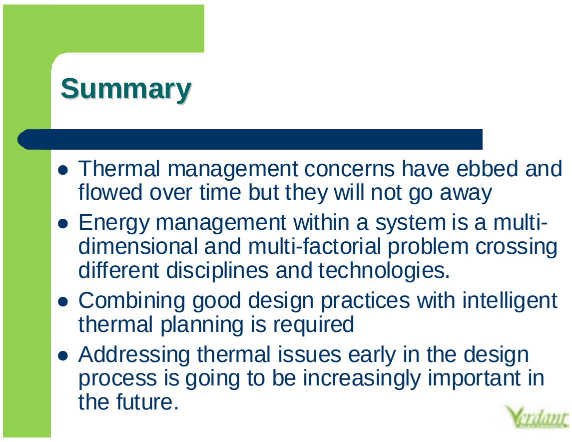


We can also clean up and treat separately the critical electrical channel lengths, perhaps even by partitioning the design into a three dimensional interconnection scheme, as opposed to the two dimensional structures that we've looked at traditionally. Finally, for this look, we can integrate and build and integrate thermal management solutions into the design at the front end.



Even in the best designed system, overheating is a real threat, so having some sort of system overheat protection is a requirement for many designs.

Here is an example of a step phase system protection protocol. The first level is fundamentally to have some sort of integral passive thermal protection: this would be the heat spreaders, heat sinks and heat pipes. When the first thermal threshold is crossed, it could be a simple thing like turning on a cooling fan. At a second threshold, the system could have its clock speed reduced. When the third threshold is crossed, it could warn the user of an overheat condition and, if there's no response, it would automatically shut down.



To summarise, the level of concern relative to thermal management has ebbed and flowed over time but it's not likely ever to go away. Energy management within a system is actually a multi dimensional and multi factorial problem that crosses many different disciplines and technologies. Combining good practices with intelligent thermal planning is a requirement for ultimate success.

Addressing the thermal issues early in the design process is going to be an increasingly important concern for the future.

That's all for this week. Thanks for listening. Until next time. I'm Joe Fjelstad.