Crazy with Power

Raj Master – GM, Packaging, Si, Quality, Reliability
Sridhar Canumalla – Principal Engineer

Microsoft

Can we afford to do this?

If you cannot afford to operate the product inside the refrigerator…

…operate the refrigerator inside the product.

IEEE Spectrum, Oct 2009.

Hot Crashes !

- Modern laptops generate a lot of heat which is mainly vented out of the bottom of the laptop but ventilation effectiveness is reduced when the laptop is placed on a solid surface or on your lap. Heat causes reliability issues, e.g. disk drive crashes and data loss!

Hot thighs !!

- The heat from some laptops can be enough to cause superficial skin burns, even through clothing! The Lancet medical journal reports the case of a healthy 50-year old scientist, fully dressed in trousers and underpants, who burned his genital area after placing his laptop on his lap for an hour. While using the laptop he did occasionally feel the heat and a burning feeling on his lap and “proximal thigh”. Two days later he had blisters that burst and developed into infected wounds. [2]

Infertility !!!

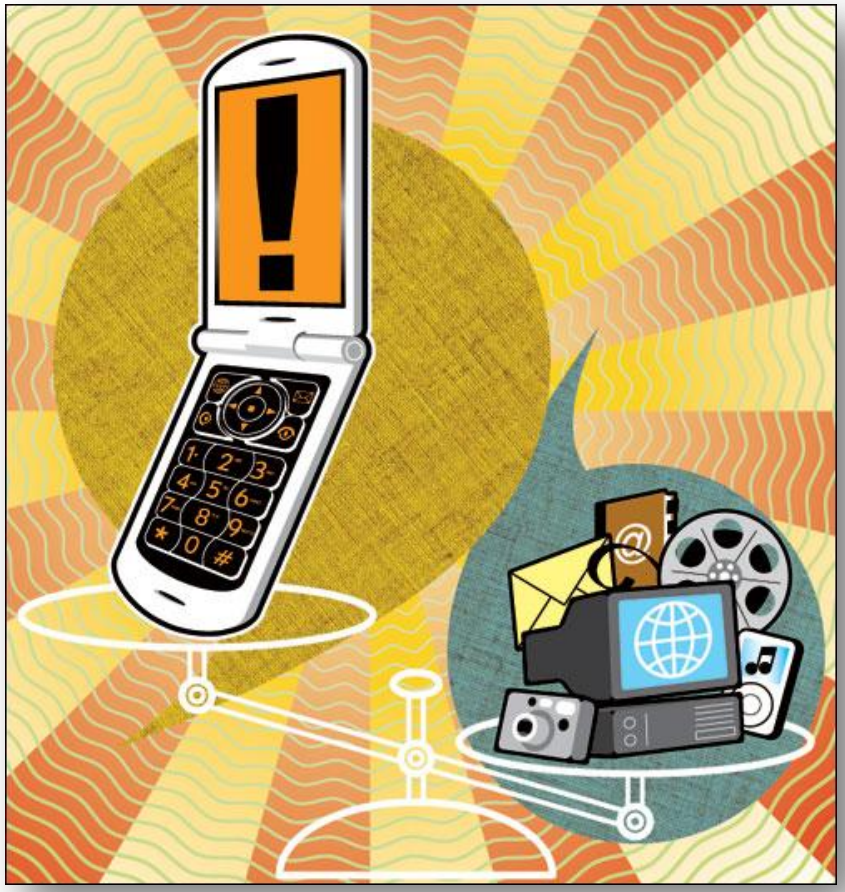
- In addition to a hot laptop being uncomfortable to use, if you are a man, it may reduce your fertility. [3] The researchers concluded that working with a laptop positioned on the thighs causes significant elevation of skin temperature in the groin as a result of heat exposure and posture-related effects. Long-term exposure to repetitive hot laptop use in the lap may have a negative impact upon fertility, specifically in teenage boys and young men.

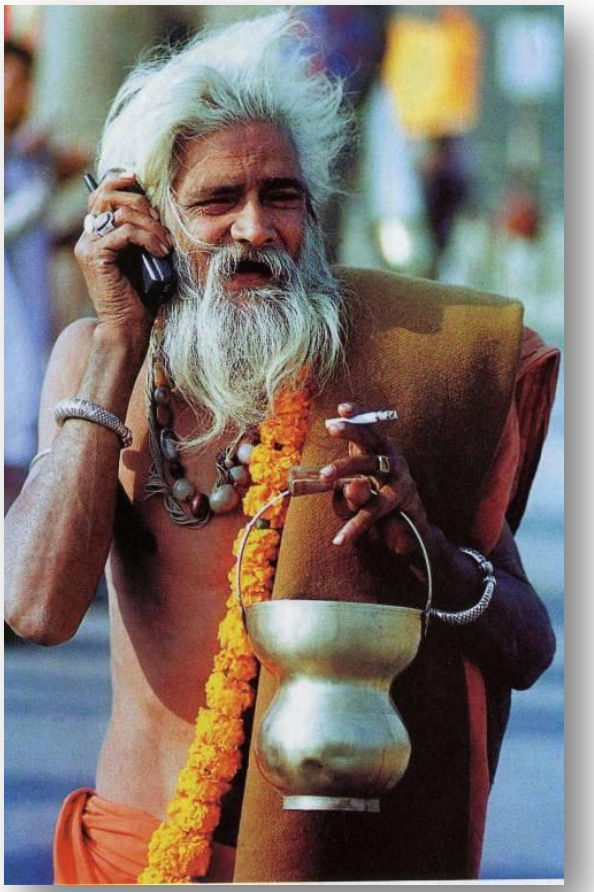
1)Consumer Reports, March 2003 , Laptop Computer Test- "Portable power" pp 44-47. 2) Ostenson, C. G. (2002). "Lap burn due to laptop computer." Lancet 360(9346): 1704. 3) Sheynkin ,Y., Jung, M., Yoo, P., Schulsinger, D. and Komaroff, E. (2005) Increase in scrotal temperature in laptop computer users, Hum Reprod., 20 (2) 452-5.
Pasted from <http://ergo.human.cornell.edu/hotlaptops.html>

Consumer Electronics Use Environment…

- Cost sensitive, function rich, lightweight, green and fashion accessory
- Pervasive in daily life – TAKE IT EVERYWHERE !!
- Extension of INDIVIDUAL'S persona – COOL! Image is everything!
- Interaction with environment – game controllers with multiple accelerometers
- Few people will buy a consumer electronic device based on its RELIABILITY but almost everyone will expect a reliable product
  - Use conditions are diverse and more damaging to product

The World Goes Mobile…





Source: NY Times

Consumer Electronics Have Become Ubiquitous…

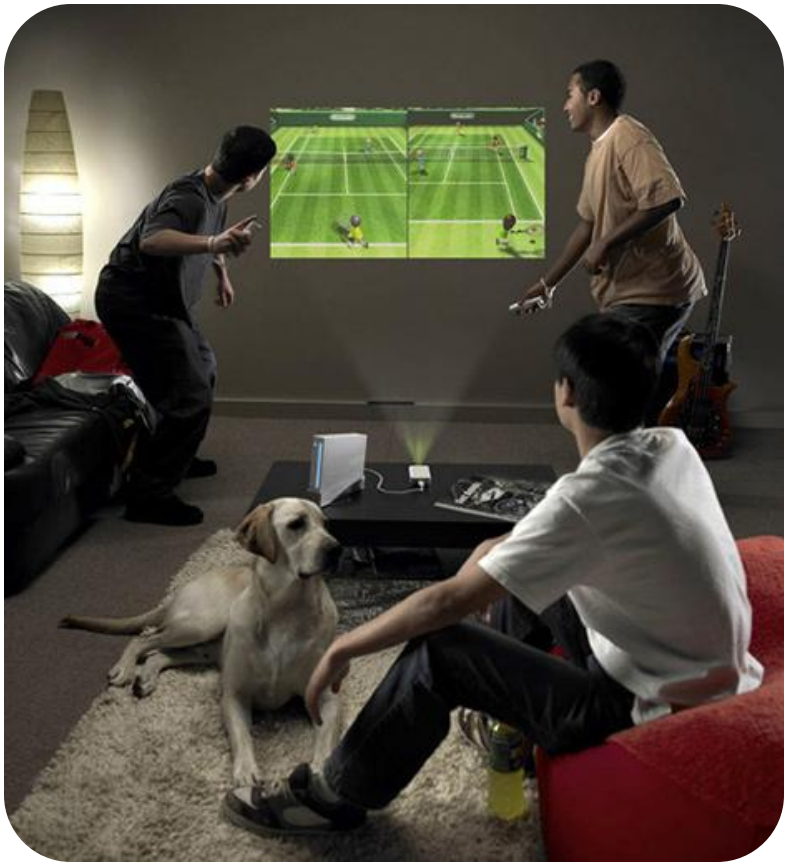
…and that is a challenge for Si, packaging, thermal and reliability engineers

Spectrum of Users and Usage Environment

- People of all ages enjoy gaming because of the immersive user experience.
- New uses will be found in the pursuit of entertainment.

Users Will Find New Ways to Use Products

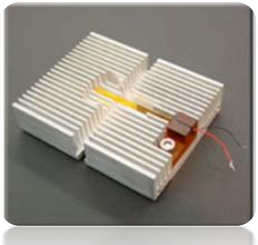
TI DLP Pico Projector™



Miniaturization is a Key Driver

2008 **2010**

System: Digital Projection



Subsytem: Heatsink/fan

Flexible and Portable Electronics

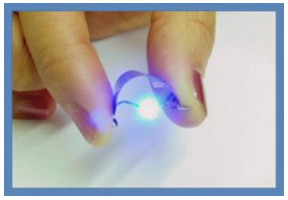
- Flexible and non-intrusive
- Reliability environment is varied and not fully understood – washable electronics anyone?
- Heavy premium on processing power but also heavy penalty for power consumption and thermal dissipation
- Usability is key – user input devices, NED and virtual displays, privacy issues
- Severe restriction and penalty for thermal dissipation as heat sources (Si) migrate closer to skin

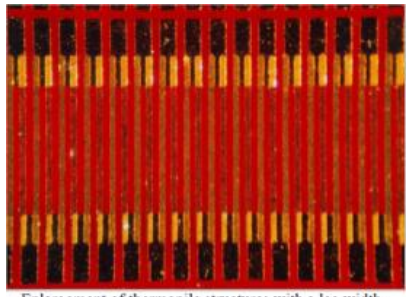
Wearable Computing

Thermo Life ™

- Thermal considerations
  - Human body is complex system with about 80 W of dissipation at rest – complex regulation modes (storage, radiation, conduction and evaporation)
  - "Comfort" only in narrow range
  - Temp next to skin cannot exceed 40 to 45°C
- Power generation from human body - Thermoelectric (Thermo Life, Seiko Thermic, etc.)
  - 3V power at 5°K delta

Skin Temp. °C	*State*
45	tissue damage
43-41	threshold of burning pain
41-39	threshold of transient pain
39-35	hot
37-35	initial sense of warm
34-33	neutral
33-15	increasing cold
15-5	intolerably cold





Enlargement of thermopile structures with a leg width of 50 microns

Seiko Thermic™

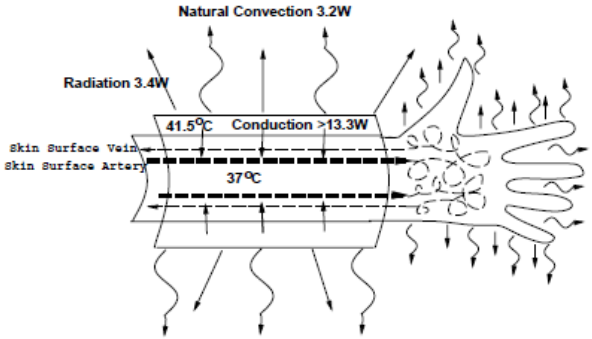


Figure 4. Forearm computer heat dissipation.

Yes, Portable Electronics Have Issues Too

- Heat flux density is high
- Temperature of outside limited to 45C – close to user's skin
- Small volume
- Premium on power for Active cooling
- Thermal design power going up – usage driven, device integration

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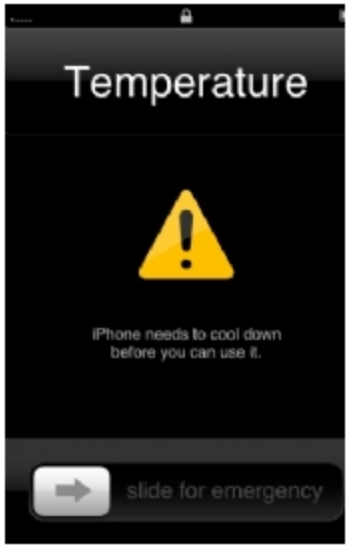
Apple Admits iPhone Overheating Issues -- Sort of

Daniel Ionescu

Jul 2, 2009 5:51 am



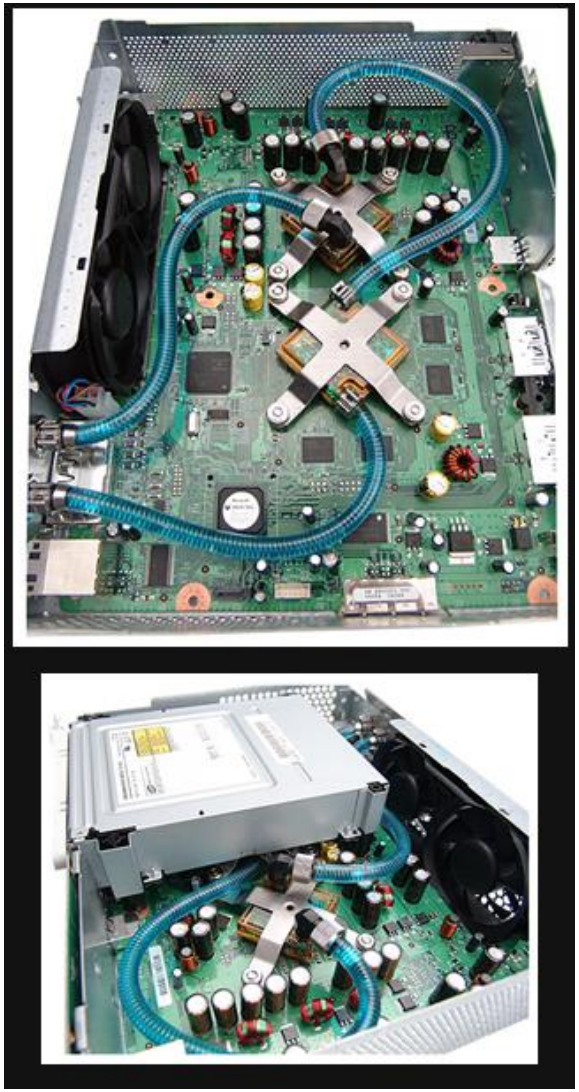
Apple has issued a warning on its support pages regarding iPhone 3G and iPhone 3GS overheating, marking the first time the company has officially acknowledged the problem. Reports that the iPhone 3GS is having overheating problems have surfaced last week, merely days after the devices was launched.

Over the last few days, many iPhone 3GS users have been reporting that

Thermal Challenges in Consumer Electronics

- Miniaturization (both at package and system) drives high heat flux
- 3D (TSV and POP) – doubling heat density degrades performance by 30% !
- Power required for active cooling is at premium in portable electronics
- Cost constraints are severe along with volume, weight and acoustic constraints
- Lack of clear thermal management technology roadmap forces inefficient, short-term product-centric solutions
- Thermal solutions need to survive shock, drop impact, bending, humidity and chemical exposure

Microsoft Xbox 360
3rd Party Thermal Management



http://www.thebitbag.com/2007/07/25/liquid-cooling-for-the-xbox-360/

Sony Playstation 3 Thermal Management

Thermal priority is clear from the size of the fan and heat pipes.

http://www.mechanicaldesignforum.com/forum/viewtopic.php?f=15&t=2515

Future

- Develop power efficient computing power and architecture
- Plan for thermal/noise management at product inception rather than after ID
- Put effort in developing mid and long term technology roadmaps to enable efficient product development
- New materials and processes