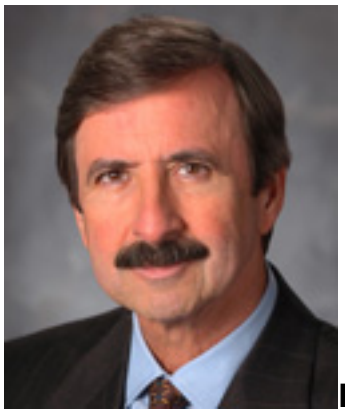
# The Roundtable - MEMS & Nanotechnology

**Beyond smart phones and tablets, what type of device or application do you feel will emerge next to drive the demand for MEMS?**



**Roger Grace, President, Roger Grace Associates**, **www.rgrace.com**

I trust that we are all familiar with the recent notoriety of large volume MEMS applications in mobile phones and tablets. However, based on recent research, I believe that there are many other high volume application opportunities that are quickly emerging for MEMS. I would like to take this opportunity to discuss wireless autonomous sensor networks (WASNs) and more specifically "smart buildings". A European Commission definition states Smart Buildings to be "buildings empowered by information and communication technologies in the context of the merging Ubiquitous Computing and the Internet of Things: the generalization in incrementing buildings with sensors, actuators, micro-chips, micro- and nano-embedded systems will allow to collect, filter and produce more and more information locally, to be further consolidated and managed globally according to business functions and services”.  What is pertinent to this article is the subject of sensors and micro/nano chips. The US Census has reported that there are more than 160 million households in the US. Other statistics state that there are more than 1.7 billion households globally. There also exists millions of commercial buildings worldwide. Most provide heating (and possibly cooling) functions to their inhabitants. They also need to provide a number of additional functionalities including security, safety and convenience. Thus, we have a very large available market for this application.

The key to the delivery of these functionalities is a WAN and at its core is the sensor node. The sensor node can have a number of various sensors including pressure, temperature, humidity, and air quality as well as light level and presence in its front end. MEMS are uniquely suited to supporting these functions based on their low cost, small size, robustness and production maturity. The “fusion” of these sensors with low power signal conditioning ASICs with embedded microcontrollers, high efficiency batteries and a networked back-end communication chip completes the node. I have named this approach "MEMS-based systems solutions" and have authored an article in a recent ECN on this subject.  All of these sensor inputs are

delivered to the host computer in the building whose job it is to optimize the environment of the building while minimizing the energy used to accomplish the task. The good news is that all of the elements of the system are current production realities available through many manufacturers and all that is needed is systems engineering to create the solution.

As a final note...Nest Labs of Palo Alto California (www.nest.com) has introduced in October 2011 their “Nest Learning Thermostat” and appears to have implemented my advice. This $249 device as described in their promotional materials uses six (MEMS?)sensors along with embedded microprocessors that learn from your behavior, preferences and surroundings to create a heating and cooling schedule keeping you comfortable when you are at home and conserving energy when you are away. This will go on top of my 2012 Holiday Gift list...what about you?

For more information, Roger Grace will organize and chair an all-day MEMS session at the Sensors Tech Forum in Anaheim California on October 1, 2012 where this application as well as other high volume MEMS applications and technologies will be addressed. www.sensorstechforum.com [1].

**Karen Lightman, managing director, MEMS Industry Group,** www.memsindustrygroup.org **[2]**

While consumer electronics and mobile handsets are driving the adoption of MEMS in high-volume markets, automotive, displays, and biomedical/quality of life (QoL) applications are gaining market share—and mindshare—in the MEMS industry.

Airbag crash sensors and tire pressure monitoring systems (TPMS) are already at the high-volume mark for cars. In the emerging application category, we are seeing intelligent automotive sensing systems that are moving safety to an entirely new level. These systems can tell if a child is in the street—and can enable the car to avoid impact. MEMS can ensure that a driver is not inebriated before getting behind the wheel, and driver-assist programs—which park and even drive cars for you—might sound like they are straight out of “The Jetsons,” but will likely be commercially available within the next few years.

Optical MEMS technology is improving the user experience with e-reader, tablet and smartphone displays. And MEMS-based pico-projector modules are ‘morphing’ smartphones into portable projectors. Manufacturers like Samsung are embedding these devices into some of their high-end phones, freeing consumers from small-

screen viewing of videos, mobile TV and other multimedia content.

Whole new classes of biomedical devices—from miniature insulin pumps to organ and tissue replacement systems—are leveraging MEMS' intelligent sensing. MEMS-based QoL applications span personalized drug-delivery systems and video games used for physical and mental rehabilitation to implantable brain-computer interface devices that allow quadriplegic patients to control robotic limbs.

These are just a handful of examples of MEMS improving the user's experience and QoL through diverse applications.

 **Piyush Sevalia, VP, Marketing, SiTime Corp.,** www.sitime.com **[3]**

Today, sensor products based on MEMS technology are being used in many consumer and life-saving automotive applications. MEMS technology has now become a crucial part of the semiconductor industry as it drives wafer and assembly volumes. Newer applications will increase the usage of MEMS devices. But – most people outside the semiconductor and automotive industry don't know that their life depends on "MEMS technology" in a car collision.

There is a large, 20 billion unit (annual) industry that is already transitioning to MEMS technology – timing products that consist of resonators, oscillators and clock generators. These timing components are the heartbeat of all electronics, so every electronic device today has 1 – 30 units of these components. A clock on a white-goods appliance uses a 32 kHz resonator, in addition to other timing references for the microcontroller. A mobile phone uses a temperature compensated oscillator – a device which offers excellent clock stability over temperature – as is required by the application.

For the past 30 years, electronics has used quartz as its core timing technology. In fact, watches made the term "quartz" popular – everyone had an accurate timepiece on their hands. While quartz has worked very well, Silicon based MEMS technology offers significant benefits over quartz, such as more features, higher performance, more resilience at a lower cost and a shorter lead time. MEMS timing components also offer another unique advantage – they can be cost-effectively integrated inside packages – completely eliminating all external clocks – which is a massive benefit for the semiconductor industry that thrives on integration. These

benefits have been recognized by large electronics companies, who have increased their usage of MEMS timing components.

20 Billion Units of MEMS timing products being used in every imaginable application – it's enough to make MEMS a household word.

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