Electronic Device Design, Part IV

More medical devices are being designed with electronic components that enhance the overall functionality and/or efficiency of the product. It is interesting to theorize where these electronics may take healthcare. For this month's Perspectives, we received a large number of responses so be sure to check out the other Parts of this feature.

Looking ahead, what technology will educe the biggest breakthroughs in electronic medical devices?

Lou Niederlander
Electrical Engineer, Valtronic Technologies

Semiconductor lasers rely upon a PN junction to generate light. The laser produces a specific wavelength of coherent light.

Lasers can be up to 50% efficient and generate multiple watts of power. Lasers though, are especially sensitive to heat (t›30°C) requiring the removal of any heat generated by the light source.

For a laser outputting five watts of light, 10 watts of power has to be delivered, five watts of which are dissipated as heat, which must be removed. Although an aluminum extrusion heat sink appears to be the simplest solution for heat removal, one finds that the heat sink size and air flow required for cooling are large. The heat sink size begins to dictate the finished product's footprint and the fan noise becomes an issue, for example, when in a medical device is used in an office setting.

To minimize the size and noise difficulties, a copper folded fin heat sink provides a practical alternative. At twice the efficiency of aluminum, the copper folded fin (0.05

in. thick) is also "warped" along the airflow, causing increased air contact with the fins. The copper heat sink efficiency allows a reduction in fan air flow, hence a reduction in noise.

David Krakauer
Product Line Manager, iCoupler Isolation Products, Analog Devices Inc.

New technologies now make it possible to easily isolate the universal serial bus (USB) interface so that it can be added to electronic medical devices while supporting the trend toward more compact, cost-effective, and interconnected devices. Designers have maintained this trend by taking advantage of standard building blocks lessons learned from the computer industry where standard interfaces, such as USB, have created great flexibility in how products are used. USB is a prime example, because it enables people to use a wide range of input (mice, keyboards, etc.), storage (memory sticks, portable drives), output (printers), and other devices (wireless network adapters) to easily interact, stay connected, and share data. Consider the impact of medical devices that integrate all the functionality needed to isolate USB: data can be easily transferred between home medical devices and the hospital by simply plugging the device into a personal computer. Patients using these devices can choose input devices that are best suited to their needs and abilities. Medical professionals can save costs by using standard peripherals instead of more costly and specialized tools.

Chris Van Hoof, Ph.D.
Program Director, IMEC

Further miniaturization of medical implants and adding more on-board intelligence will strongly contribute to the patient's comfort and to more personalized proactive healthcare. For example, the life quality of an epilepsy patient would drastically increase with an implanted brain wave monitoring system that alerts the patient to danger and then automatically administers medicinal drugs to ward off an epileptic attack.

Advanced packaging solutions and integration technology developed in the microelectronics industry can enable a strong miniaturization of today's implants. In the future, they can bring completely new implants with extra features and on-board intelligence at cost-effective production.

To increase the autonomy and unobtrusiveness of medical implants, technological innovation should focus on:

•Small systems that are mechanically bendable or even stretchable; techniques such as chip-in-wire technology, ultra-thin-chip embedding in flexible and/or stretchable packages, and 3D out-of-plane integration are promising to achieve this.

•Improve the biocompatibility of implants to guarantee long-term operation and to reduce adverse reactions.

•Make the implants autonomous by focusing on low power consumption and energy harvesting so that no batteries need to be replaced.

•Wireless communication of measured data to the outside world.

Narasimhan Venkatesh
Chief Wireless Architect, Redpine Signals Inc.

Wireless networking of medical devices will provide opportunities for diagnostics, imaging, surgical, monitoring, and control equipment to share information and collaborate in real time. The availability of universally compatible wireless networking based on the emerging 802.11n standard would enable capabilities that a multitude of proprietary wired or wireless connectivity cannot offer, providing a significant force-multiplier effect. As it is adopted into an increasingly large number of environments, it will allow medical equipment to be connected with minimal setup procedures and maximal flexibility. Standards-based wireless connectivity is not difficult to integrate into new, as well as existing equipment, with devices such as wireless device servers providing a means to connect to a standard LAN network via an existing serial interface. Imagine if data collected from various diagnostic and monitoring equipment in various locations in a medical facility, or even at a patient's home, is instantly available on the same network to concerned medical professionals in any location around the world. The benefits to the medical community, as well as to the patient, would be phenomenal.

Edward Dowski, Jr.
President, OmniVision CDM Optics Inc

OmniVision's CameraCube technology could have a significant impact on the future of endoscope cameras by allowing high-quality sub-millimeter sized cameras at much lower costs. Future medical imaging devices with diameters similar to that of small catheters, for example, could be enabled due to the small size, while visualization could be enabled in numerous medical tools due to the low cost. By combining the sub-wavelength alignment precision with the "art" of replicating precision optics, sub-millimeter size optical systems can be reliably produced in high volumes.

The fabrication architecture involves producing thousands of lenses at a time, in contrast to the single or small number of lenses made in a traditional molding or optical grinding process. This method removes much of the complications from handling very small size lenses. The individual lens elements are then combined with layers that act as the aperture stop and filters, resulting in a large array of optical systems. Integration with system-on-a-chip sensors and processors, illumination and communications can be achieved in the same manner, further reducing assembly costs and complexity.