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POWERING UP MEDTECH'S MODALITIES: TOP TRENDS AND DESIGN CONSIDERATIONS

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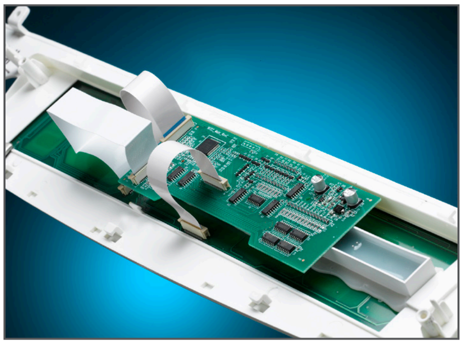

A flat cable design such as Molex's PremoFlex can be folded and bent for wearable applications with space restrictions.

We are living in a digitally integrated and connected world. Evidenced by the use of smartphones, smartwatches and other smart devices, there is no ending this trend. This holds true across many industries and applications, but is especially prevalent within MedTech devices – a market that's predicted to reach $432.6 billion by 2025.[1]

With the emergence of connected health, medical devices such as wearables are being powered by sensors at an increasing rate, driven in a large part by the impact of the COVID-19 global pandemic and healthcare providers' growing investment in remote monitoring.[2] There's not only an uptick in the adoption of wearable medical technologies, but in devices that are miniaturized, AI-optimized and incorporate 3D printing.[1]

Medical device manufacturers are challenged with significantly smaller and lighter weight devices, yet still need to arm them with maximum power and minimum latency. More than ever, they must consider the ever-shrinking real estate of next-generation medical devices across diagnostic, therapeutic and patient monitoring modalities while keeping patient comfort, convenience and ease of use as a priority.

EMERGING TECHNOLOGY ADVANCES IN CONNECTED DEVICE MODALITIES

Diagnostics, therapeutics and medical monitoring modalities have set the stage for connected wearable medical devices. Let's take a look at the emerging technology advances within each of these three key connected device modalities, and then explore the top design considerations that device manufacturers need to integrate moving forward.d.

Diagnostics – Continuous and Proactive

A patient's medical journey begins with an accurate diagnosis, as it informs subsequent health care decisions. Common diagnostic modalities include angiography, ultrasonography, conventional radiography, computed tomography (CT) scan, bone scan and magnetic resonance imaging (MRI). All of these modes call for large, complex and expensive systems that require a patient to enter a medical facility with results that can often take several days to receive and with a greater error rate within a hospital setting versus where a patient typically resides.2

Medical diagnostic technology is evolving from reactive treatments to prevention and proactive diagnosis of diseases and disorders. As the health care system shifts from a fee-for-service to a managed-provider model, there's a greater focus on the quality vs. quantity of care. Furthermore, patients themselves desire more control and insight into their own health management. Next-generation medical diagnostics is a key enabler for these transformations.However, for diagnostics to play a more significant role in the health care process, it must first become more continuous. This movement toward "continuous diagnostics" is made possible by the same innovations that have enabled smartphones and wearable devices. From apps that can replace a stethoscope or monitor the gait of Parkinson's patients, to add-on devices that continuously monitor blood glucose levels (CGM), technology is proving to be indispensable in revolutionizing medical diagnostics.

In addition to implantable sensors made of biocompatible materials, breakthroughs in manufacturing processes now allow for inexpensive and even disposable sensors. Nearly as thin as a sticker, they affix to a patient's skin for continuous monitoring of biosignals through electroencephalograms (EEGs), electrocardiograms (ECGs), pulse oximetry and galvanic skin response. Data from these sensors can be transmitted using very low power technologies such as near field communications (NFC) to a receiver that a patient can attach to their clothing or wear as a smartwatch. From there, data can be relayed to a physician's portal or directly to the cloud using more powerful wireless technologies such as Bluetooth or WiFi.

Diagnostic devices — along with new types of flexible sensors, energy-harvesting hardware and artificial intelligence — are coalescing into the foundation that will make continuous medical diagnostics a reality. This trend will soon allow patients to monitor their health 24/7 with the same

[1] https://www.prnewswire.com/news-releases/the-medical-device-market-is-expected-to-reach-an-estimated-432-6-billion-by-2025--and-it-is-forecast-to-grow-at-a-cagr-of-4-1-from-2020-to-2025--300980092.html

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precision and detail as has historically been possible only with expensive, hospital-grade equipment.

Therapeutics – Treatment on Demand

The acceptance of home-use medical monitoring technology is driving the expansion of these devices to also provide therapeutic relief, shifting therapy from the clinic setting to the on-patient ecosystem.

Fig. 1 - Diagnostics, therapeutics, and medical monitoring modalities have set the stage for connected wearable medical devices.

Thanks to smartphones, inexpensive yet consumer-friendly hardware and advances in next-generation software algorithms, therapies can now be delivered automatically without medical professional intervention. With the advent of the "connected health" movement, patients of the future will be able to receive therapies automatically wherever and whenever they need relief. The blending of therapeutic and monitoring modalities will give patients back time to live their lives on their own terms instead of living their lives around their treatments.

Therapeutics encompass a vast array of technologies and methodologies. Some therapeutic modalities of note include electrical stimulation, such as transcutaneous electrical nerve stimulation, interferential current and deep brain stimulation (DBS), which is essentially a "brain pacemaker" for the treatment of Parkinson's and even Alzheimer's patients.

Several cutting-edge advancements are evolving. For example, thermal therapies such as thermotherapy and cryotherapy are useful in treating soft tissue and musculoskeletal injuries. Drug delivery systems are expected to greatly expand beyond decades-old tech such as insulin pumps and nebulizers. As an example, for those suffering from sleep apnea, CPAP (continuous positive airway pressure) machines have long been the prescribed therapy. Such cumbersome machinery, though, is giving way to implantable technologies, thanks to advances in technology miniaturization and materials science. These same advances will yield new implantable treatments for next-generation pacemakers and neuromodulation therapies. Rounding out the list are therapies based on ultrasound, lasers and even robotic hardware for use in surgeries, physical therapy and at-home senior care.

Telemetry from patient monitoring and therapeutic devices will be transmitted back to their healthcare providers in real time via their smartphone or other wireless connection. Doctors will then remotely tweak each patient's therapy regimen as needed. Finally, more therapies will become non-invasive as well. Percutaneous (the delivery of active ingredients through absorption by the skin), natural-orifice delivery and minimally invasive radiotherapy technologies are primed to make this a reality.

Medical Monitoring – All-in-One Devices

Once a patient is accurately diagnosed and therapeutic treatment is prescribed, medical monitoring is crucial to understand how the body is responding to therapies, maintain adherence and to mitigate the effects of a disease or other physical ailment.

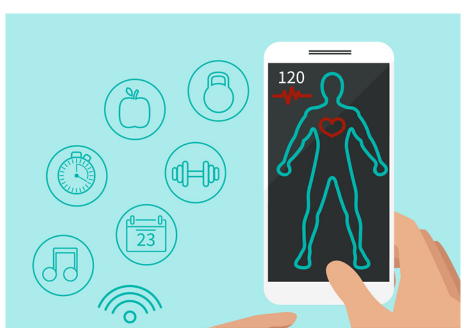

Fig. 2 - Newer EKG capabilities of wellness tracking devices allow wearers to detect atrial fibrillation.

From the early days of a mechanical pedometer to a digital smartwatch, today's technologies have begun to integrate more functionality into one device and are of particular value to high-risk patient populations who suffer chronic conditions. For example, wearable ECG monitors and blood pressure monitors also can now track an individual's vitals, storing as many as 100 readings at a time. More sensitive monitoring systems such as a patch that's worn by a patient can gather extensive vitals including heart rate, temperature and more. Glucose monitoring technology now enables diabetic patients to monitor their blood sugar levels wherever and whenever they need to do so. Newer EKG capabilities of wellness tracking devices allow wearers to detect atrial fibrillation, yielding data that could be a matter of life or death for those with a history of heart problems.

The advancement of biosensor technology unleashes patients from bulky devices by being cableless, wireless and incredibly lightweight – all in a low-cost, easy-to-use and disposable form factor. Flexible circuitry, low-power sensors and printed antennas allow convenient and comfortable medical monitoring hardware to be affixed to or even implanted in a patient. The monitoring hardware can even leverage a smartphone or other wireless Internet access as a gateway to cloud-based services where data from a patient's health monitoring device can be stored.

[2] *https://www.ncbi.nlm.nih.gov/books/NBK338586/*

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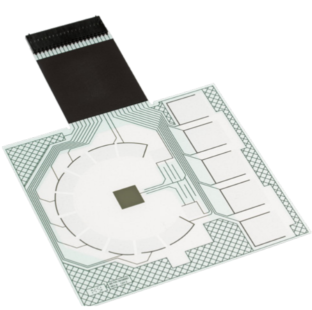
TOP 3 DESIGN CONSIDERATIONS FOR MEDICAL DEVICES

New developments in medical device technology that support diagnostic, therapeutic and medical monitoring modalities are clearly poised to be game-changers for the connected health ecosystem.

Medical device manufacturers will be increasingly tasked with designing low-profile devices that are flexible, light and comfortable while transmitting real-time data between patients and healthcare providers. In order to address obstacles that may hinder transmission of life-saving data, designers must consider optimizing space for components amid the increasing miniaturization of devices. They must address how to power those devices with limited printed circuit board capacity while simultaneously boosting signal integrity. Here are three top design considerations to take into account:



Clear conductive sensors such as the Molex PEDOT offer flexibility and translucent circuits, enabling keypad backlighting on curved surfaces for capacitive user interface panels.

1. ***Component and space optimization.*** When monitoring patient data outside of a hospital setting, on-patient wearables should be more compact compared to large, bulky medical devices. Because these wearables are smaller, tinier components are necessary to maintain power delivery and allow for enabling technologies such as sensors to be integrated into the device. Given the reduced footprint, designers must consider optimizing space as board real estate becomes more constrained. Given newer micro-connectors that are currently on the market as well as others that can be customized, designers are able to address these space limitations. Another way to bypass the modularity of space constraints is by utilizing flexible circuitry to allow for miniaturized components for increased functionality of the device.
2. ***Flexible circuitry integration.*** Devices are becoming more feature-rich, despite their shrinking size and footprint. The complex electronic systems needed for a medical device's functionality also need to accommodate added components that link a patient-friendly interface with a real-time data connection to the healthcare provider. Such technologies include circuitry to the patient's body to capture deeper and better monitoring results. One option device for designers to consider are flexible printed circuits (FPCs) and associated cables and connectors. This proves to be a great advantage because their light, flexible and smaller design meets the stringent criteria for wearable medical devices. In addition, antennas can be printed onto the substrate of a flexible circuit to transmit vital signals or biometrics in a non-invasive, continuous and inexpensive manner.
3. ***Maximum power and high signal integrity.*** Medical device designers should consider low-profile wire-to-board and flex-to-board options when powering medical devices. As the purpose for enabling medical monitoring devices is to relay patient data quickly to a healthcare provider, power and signal are of utmost importance to ensure seamless delivery. Power-to-board solutions can enable a device's functionality by carrying currents of up to 15 amps. Board connections are now being offered with higher circuit counts of 60, 80 and 100 circuits, which is becoming more popular as data is transmitted between connection points in a small form factor. High-performing board-to-board and FPC connectors with multiple grounding points help to ensure the highest level of signal reliability within the connectors, thus allowing for up-to-the-minute information and data relays.

CONCLUSION

MedTech devices have become smaller over this last decade, and the advancements in connected technology are just beginning. Healthcare providers are always looking to support their patients in a non-invasive manner with minimal downtime and maximum comfort, and medical device manufacturers are, too. They are making these goals a reality by engineering new devices that are not only small and lightweight, but also smart, safe and reliable. There's more to come in this space, and design considerations will continue to be pushed towards continuous innovation and improvement.

To learn more

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