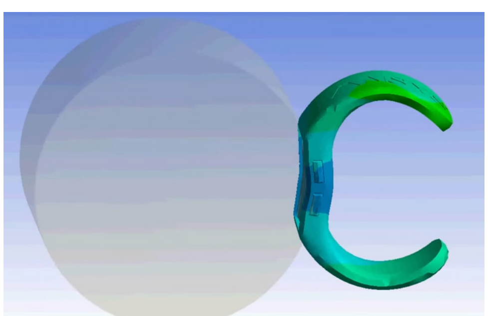
Engineering the Internet of Things: Wearables and Medical Devices

Because the world population is aging, chronic diseases are on the rise and healthcare costs are reaching unsustainable heights, it is essential to detect pathologies early. The Internet of Things (IoT) is now poised to transform the healthcare industry by providing wireless connectivity and sensing. Body-worn electronics and implanted devices, equipped with tiny sensors that continuously monitor vital parameters and securely report anomalies to appropriate physicians, will improve patients' quality of life while delivering timely medical help.

Medical IoT is making medicine participatory, personalized, predictive and preventive (P4 Medicine). Medical device and high-tech companies are joining forces to satisfy an exponentially growing demand that might reach 20 billion medical connected devices by 2020. Successful medical device and pharmaceutical companies are using engineering simulation to develop systems that ensure high reliability, provide data privacy and achieve regulatory compliance quickly.



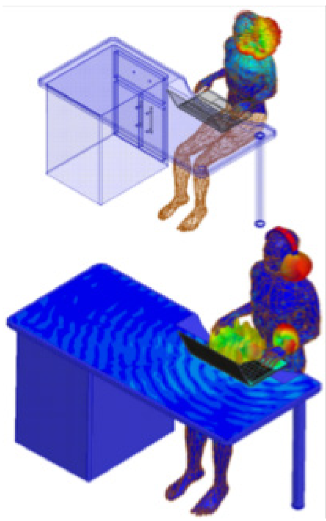
Testing body-worn devices for harsh environments, including impact

The Value of Simulation and Five Core Engineering Challenges

Simulation-driven product development is a well-established methodology across most industry sectors. Traditional build-and-test methods are being eclipsed by high-fidelity simulations. Across the industries, best-in-class companies are adopting simulation-based approaches early in their product design cycle to address the five major IoT challenges: (1) , size, weight, power and cooling; (2) sensing and connectivity; (3) reliability and safety; (4) integration; and (5) durability. The first three of these are especially important for the healthcare industry:

1. Size, Weight, Power and Cooling (SWaP-C)

Smaller, lighter, more energy-efficient, and cooler wearables or implanted devices are necessary for patient comfort and reliability. Adding IoT technologies, such as pervasive connectivity and a higher density of electronic components just makes this challenge more difficult. "Manufacturers are adding wireless technology and other features while hearing aids are becoming smaller than ever," said Casey Murray, Senior Radio Frequency Design Engineer of Starkey Hearing Technologies, in an article in ANSYS Advantage magazine. Designers address these design challenges by using ANSYS solutions to simulate a wide range of design alternatives that take into account the actual geometry of the antenna, components within the hearing aid, and the user's body. Murray concludes: "Simulation saves months of testing time and tens of thousands of dollars in resources for each design project."



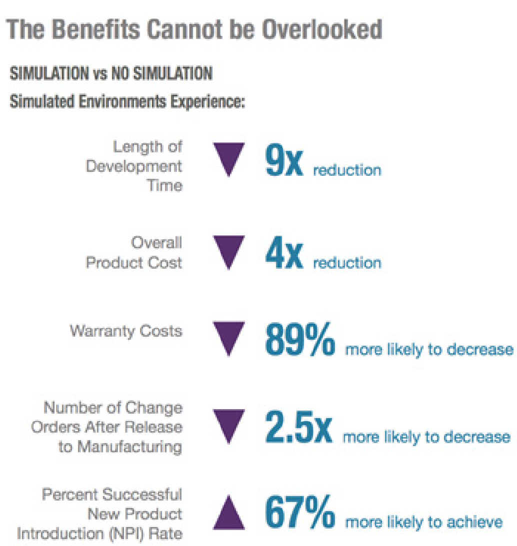
Ineracting wearables and implantable devices can exceed patient safety conditions.

2. Sensing and Connectivity

Smart connected products can sense their environment, communicate with other electronics, and enable decisions and outcomes. For example, an implanted or body-worn device needs to properly interpret measured parameters and come to a preliminary diagnosis. In potentially serious health situations, devices need to immediately warn the patient and give him/her urgent recommendations while contacting the medical staff to take quick actions. Such communications requirements mean that designers need to pay added attention to reducing electromagnetic interference, as well as signal and power integrity.

3. Reliability and Safety

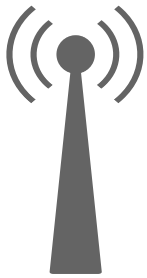
Considering that future patients may have a greater number of body-worn or implanted medical devices as these technologies evolve, there is a serious risk that emitted energy, if not properly controlled, might exceed the specific absorption rate (SAR) and impact the patient's health. Many medical products will be in safety-critical environments and will need to meet relevant reliability and safety standards. "Often it is simply impossible for us to perform experimental tests — as is the case with medical devices" said Chris VanHoof, Director at Imec, a nanoelectronics research company in Belgium, explaining the need for simulation solutions. "ANSYS also handles variability well, which is important to our medical device investigations, as there is a lot of variability in the human body," VanHoof concluded in an ANSYS Advantage magazine article.



ANSYS: The Value of a Consolidated Simulation Platform

The increased difficulty of overcoming the core engineering challenges created by the complexities of making products IoT-ready is highlighting weaknesses in existing design processes. Independent research has shown that successful development of these products requires an increase in communication and collaboration between functional engineering teams. Without this, product delays, reliability issues, and cost overruns are likely. A product made without collaboration can lead to integration issues, especially when subsystems are built and over-designed because each team added their own safety margins.

Companies with a strong culture of collaboration are leapfrogging their competition through the use of engineering simulation. Best-in-class companies use a consolidated simulation platform to analyze component and system-level behavior, as well as subsystem interactions, before physical prototyping. Designers at these companies are able to quickly explore the performance of numerous design alternatives. This allows them to optimize the design for cost, quality or performance. The metrics below highlight just some of the benefits of a simulation-based design approach executed on a consolidated platform that enables cross-functional engineering interaction.



Antenna Design and Placement

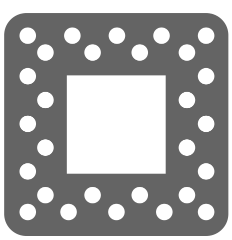
The performance of wireless systems can be very different in the real world when compared with the prototype testing environment of an anechoic chamber. Using advanced computer-based models, engineers can perform a near-field analysis to mitigate the effects of the entire environment, including the human body, on the performance of multiple antennas and wireless devices. This approach provides greater insight, improves accuracy and increases reliability.

As an example, engineers at Synapse Product Development — a leader in wearable electronics — have used ANSYS tools to increase antenna range by a factor of five, while reducing their overall design cycle by 25 percent.

Power Management

For life supporting implanted devices, running out of battery power is not an option. Excessively frequent battery recharging must also be avoided, as it can also be a tricky and sometimes risky task. Wireless power transfer, low power IC design, and even local energy harvesting are the foundations on which many IoT devices will be built. Safety is always a key consideration: Standards and regulatory agencies limit the amount of electromagnetic energy that can be delivered to living tissue.

ANSYS simulation tools, including human body models, can be used to design and analyze a variety of power delivery systems and their impact on the human body. As an example, neurostimulators that are placed under the patient's skin deliver mild electrical signals to provide pain relief by blocking pain messages before they reach the brain. As described in an ANSYS Advantage article, Medtronic was able to avoid costs and delays in developing its neurostimulators by using ANSYS Maxwell to simulate the operation



Embedded Software

Although healthcare is clearly lagging behind aeronautic and automotive applications in this area, there is no doubt that future connected medical devices will include software containing millions of lines of code to properly interpret the large amounts of continuously acquired data and to deduce relevant diagnoses. Because many of these products and systems will be safety critical — defibrillators, for example — the control software must operate flawlessly.

ANSYS has created a model-based embedded software development and simulation environment with a built-in automatic code generator that significantly accelerates the pace of embedded software development projects.

ANSYS: Your Trusted Partner

Whatever your industry or product focus, the IoT is poised to impact your business in significant and often unexpected ways. At ANSYS, we've developed an expanded range of capabilities, including electronic and embedded software modeling, to help you thrive in the IoT era.

Engineers designing the Internet of Things technologies face considerable challenges, including SWAP-C, sensing and connectivity, safety and reliability, integration, and durability. Platform-based engineering simulation, supported by seven applications — antenna design and placement, chip-package-system design, sensors and MEMS design, power management, embedded code generation, harsh environment design, and virtual system prototyping — is crucial to maximizing the IoT opportunities for your organization.

Read our white paper titled "Engineering the Internet of Things" to learn more about how ANSYS simulation solutions can help you develop products for the IoT.

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