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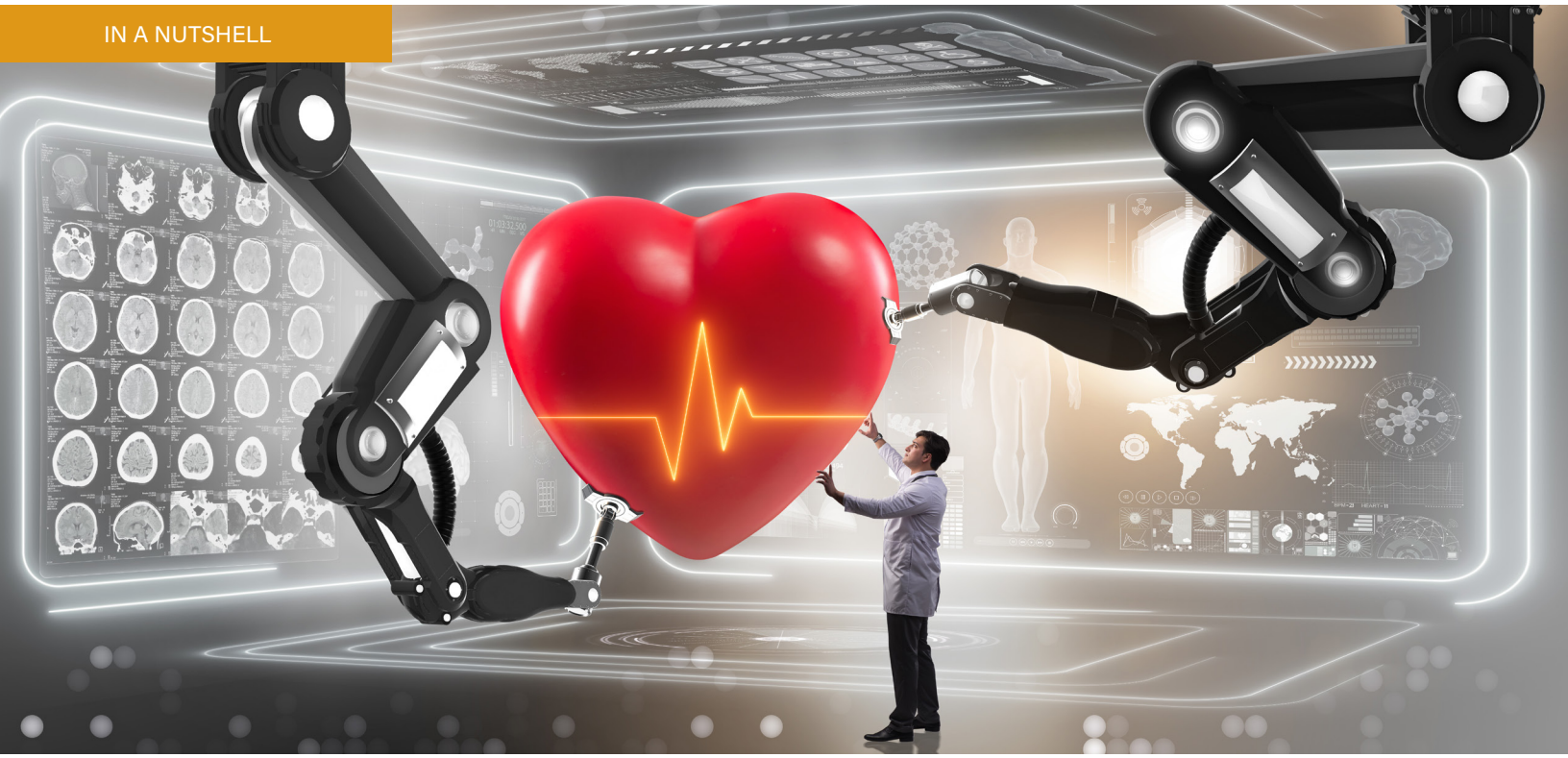

The Health Benefits of Robotics

When people think of robotics, they often think about warehouses or manufacturing lines, where robots automate multiple processes. But robotics has the potential to reshape the way healthcare is delivered in a variety of applications and locales. While we're a long way from a robot replacing a physician, there are many opportunities to provide automation in the healthcare arena that can reduce costs, improve quality of care, and free up healthcare workers' time to focus more on patient care.

Opportunities

Possibilities abound in areas including:

1. Surgical robots

Reducing human error and providing a more precise set of tools for the most complicated surgeries, the market for surgical robots is expected to be one of the fastest growing markets for healthcare related robots. Companies such as: Intuitive Surgical (an Acorn customer), Medrobotics, Verb Surgical, Hansen Medical, MEDTECH, Titan Medical, Microbot Medical, Accuray, and others are offering or developing a variety of specialized robots to assist in the surgical suite.

2. Exoskeletons

One of the more exciting areas of development are robotic devices, such as Exoskeletons, than can assist people with disabilities become more mobile and live more normal lives. This not only reduces the cost of care, but can dramatically improve the quality of life for the patients. Companies involved in Exoskeleton development include Ekso Bionics (an Acorn customer), Barrett Medical, Cyberdyne, Hocoma, Rewalk Robotics, and Reha Technology.

3. Telepresence robots

Providing healthcare to remote and rural areas of the world is one of the more global challenges. According to the World Health Organization (WHO), there is a worldwide

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shortage of around 4.3 million physicians, nurses, and other healthcare workers. Robots that provide telemedical devices that allow a physician to remotely interact, diagnose, and recommend treatment to patients will become more prevalent in clinics around the world. Companies in this space include: InTouch Health, iRobot, and Vecna Technologies.

4. Robotics for medication management

Automating the delivery of drugs, medications/supplies in a hospital/nursing home setting can free up workers time, allowing them focus more on the patient vs. paperwork, etc. Companies involved in this area include: Aethon, Innovation Associates, Omnicell (an Acorn client), Vecna Technologies.

Two important development tips

No matter what the application, there are a few principles to keep in mind when designing robotics-based systems:

1. Design for manufacturability: Emphasis on *"design for"*

The implementation of a design for manufacturability (DFM) approach to design can have a significant impact on the overall development cost as well as the timeline for getting a design through production. Keeping sight of the end goal (ie., a manufacturable product that meets performance and financial goals) from the start can ensure higher quality and lower overall cost. While DFM analysis and implementation can be done after the design is "completed," it is far from the optimum approach.

For post-design DFM, you've already invested time and money creating the current version. Any changes you make for the parts of the design that are creating potential DFM issues must be analyzed in the context of the impact of those changes on the larger system. Changes will also need to be verified and tested to determine if there is any impact on performance, quality, reliability, etc. DFM done at this stage also means there are now two different versions of the product to document, manufacture and potentially seek FDA approval for.

Lastly, DFM done post-design is usually very constrained. There are tooling modification limits and previous "baked-in" design concepts which would require a complete redesign to correct. The product is often perpetually compromised and won't ever have been as cost effective as one designed with manufacturing in mind. The later in the design cycle all of this is done, the more costly the changes are. It's crucial to consider DFM from the start!

2. Design for adoptability: Use models

Having clear, well defined use models is critical to the success of any product development effort. Let's start with the environment: Where will the robot be used? We can break use down into several broad categories:

- The first is an isolated, (somewhat) fixed environment. This is an environment where a robot is more or less stationary or only moves within a confined space that is likely to be protected such that direct physical contact with people is not the norm. Think of production lines, automated prescription filling robots, or robotic systems that operate inside something.
- The second is a somewhat defined environment. This environment may still be somewhat fixed, but the robot has some flexibility in terms of movement and tasks. It may be autonomous, semi-autonomous or remote controlled and will likely be operating near or directly with people. Robots in this category include warehouse "pick and place" robots, hospital supply delivery robots, floor cleaning robots.

Robots for healthcare applications have the potential to significantly impact the quality and cost of healthcare.

- Lastly is an unstructured environment. This environment changes significantly, requiring the robot (and/or its operator) to be able to "see/understand" its environment and adapt accordingly. Underwater robots, security robots that patrol and autonomous vehicles are examples of robots that fall into these categories.

The next set of questions revolve around who will be setting up and using the robot? What is their expected skills level? How difficult will it be to set up the robot? How often will the set-up need to occur? How do you debug/adjust the robot's behavior? These are important to understand in terms of ease of use and proper integration of the robot into its operating environment.

The level of autonomy (if any) is another complex area that needs to be clearly defined. If the robot is semi-autonomous, when and how does the user interact and intervene? What level of "decision making" will be the responsibility of the robot vs. not? What are the limitations of the decision-making capability? For example, suppose a pick and place robot drops an item. Should it try to retrieve it? How many times should it try before it asks for assistance?

For successful adoption, what is expected from the user/operator of the robot? What changes will be necessary (and acceptable) by customers who wish to adopt this robot to their work? What kind of management/support is needed for the ongoing operation of the robot, and who will provide that support? Will the robot have its own "health" or status monitoring capabilities? Who will it report to in case of difficulty? How will the issue be handled?

The work done in defining the use models/cases will have significant impact on the design—and indeed can help control costs. The more they are defined up front, the smoother the design process will be.

Robots for healthcare applications have the potential to significantly impact the quality and cost of healthcare. Designing these systems with use cases and manufacturability in mind will improve their chances of success in the marketplace.

About Acorn

Founded in 1993, Acorn Product Development is based in Silicon Valley with additional design centers in Atlanta, Boston, and DongGuan, China. We provide comprehensive product engineering services—from turnkey product development, subassembly development, and engineering analysis to materials cost analysis and manufacturing cost reduction—for leading companies around the globe.

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