A Publication of Anuva

The Future

Of Wearable Technologies

STEP BY STEP GUIDE TO WEARABLE DEVICE TECHNOLOGY

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CHAPTER ONE

The Future of Wearable Technologies

MedTech Devices

In the late 1980s, LifeAlert's "HELP! I've fallen and I can't get up!" became one of the most well-known infomercial catchphrases. The company's device, worn by elderly patients, provided a simple way to contact emergency assistance with the click of a single button after the user fell and could not reach a telephone.

Over the past 30 years, advances in microelectronics, sensor technology, and most importantly the Internet have greatly advanced wearable technology past a single-button device. According to Business Insider, the wearable device market is expected to grow to more than $12 billion by 2018 with medical, health, and fitness devices leading the way. Wrist-worn products such as Fitbit and Nike FuelBand have already shipped millions of devices. Although wrist-worn devices are the most popular, whether they are fitness/health bracelets or smart watches, other form factors such as smart glasses and even smart earbuds are also a large emerging market.

Why are wearable devices the future of medical technology?

Current microelectronic and wireless technologies allow these devices to measure a multitude of important metrics in a small, lightweight form factor and communicate this data transparently to a cell phone or other Internet-connected device. The two largest technology drivers for wearable devices have been MEMS (Microelectromechanical systems) sensors and Bluetooth Low Energy.

- One can think of **MEMS sensors** as pedometers on steroids. These sensors cannot only track how many steps you take per day but how fast and in which direction you are moving. Even precise movement such as weightlifting exercises or movement during sleep can be tracked with this technology.

- **Bluetooth Low Energy** is a technology that allows all the data your wearable device collects to be easily transmitted to your smartphone and subsequently uploaded to the Internet. Additionally, as obesity rates and healthcare costs continue to rise globally, Internet-connected medical devices are facilitating the gamification of health and fitness to improve health and reduce costs.

Movement tracking is just the beginning of what current medical and health wearable devices can accomplish. In more advanced devices, metrics such as heart rate, blood pressure, EKG/EEG, and even glucose levels can be tracked. These measurements are especially useful in professional healthcare settings, such as hospitals or nursing homes, where patients must currently be tethered to large expensive devices.

With virtually endless possibilities for wearable device applications in the health and medical sectors, the market is wide open for new products. Find out more about “The Future of Medical Technologies: Wearable Devices” in the following chapters of Anuva’s ebook.

Clockwise from upper left: Fitbit Fitness Tracker, Apple Watch, Bragi Smart Headphones, Google Glass

> With virtually endless possibilities for wearable device applications in the health and medical sectors, the market is wide open for new products.
>
> ***- Anuva***

Do you have a great wearable device idea?

Contact Anuva to BRING ON IMPOSSIBLE! Our years of expertise in designing and manufacturing medical devices will transform your idea into a reality!

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The 3-Step Guide to Drafting Product Specs

Improving Device Design Efficiency

You have a great idea for a wearable device, the resources to start designing, and now you have to communicate this idea to your team. This step requires writing a list of product specifications, which appears to be a simple task, but you may quickly find that the devil is in the details. How do you know you're covering everything the engineers need without adding too much detail too early in the process?

In this chapter, we will provide a simple guide for drafting a list of product specifications that will improve your design efficiency and product outcome.

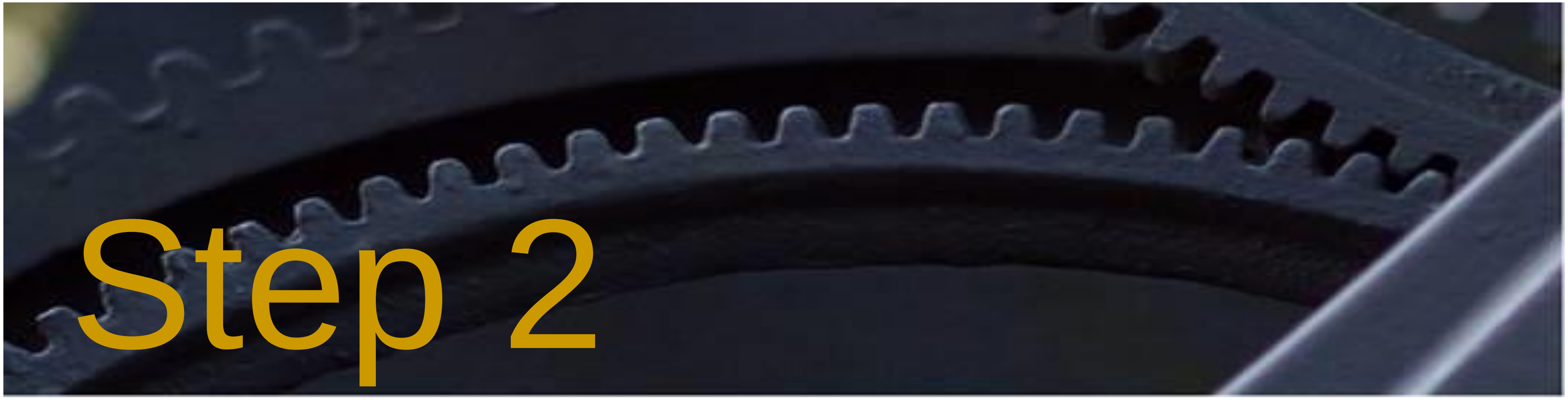
Getting Started:
Back to the Basics

Before you even think about drafting a specifications list, you should step back to the basics. A fully developed foundation for your product, known as a "needs statement" in engineering jargon, is the perfect way to get going. Here is the best way to write a fail-proof needs statement:

1. **Define the problem** – In order to develop a needs statement, the problem must be understood. Start with writing down the problem to be solved with no mention of the solution.

2. **Translate the problem to a need** – Write a needs statement that aims to directly reflect the goal of solving your stated problem. This will clarify your project scope.

3. **Verify that the need is solution independent** – Do not include any specifics of the product design that would limit the solution to a particular technology, etc. Focus only on addressing the problem to be solved in your statement. This will prevent you from jumping too far ahead and allow the engineers some creative liberties.

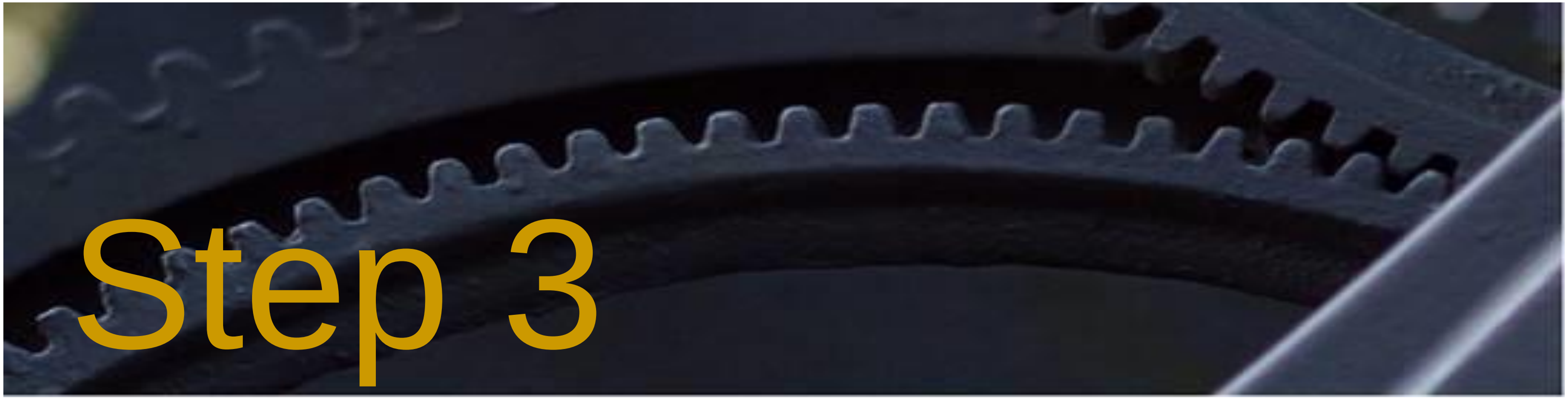


List Your Target Specs:
Be Specific

Now it's time to start asking yourself any and every question about your product and write down the detail that answers each question. Keep the specifications short, concise, and clear, and make sure that you are only creating a list of "what's," not "how's." For example, you should answer questions such as "What kind of patient will be using my wearable device?" and not "How is it going to look?" Make sure to also provide an acceptable range (measurements, etc.) for all listed features so that you have a means for comparison at the end of the design process.

When you are finished writing the list, here are some good questions to ask yourself about each specification to make sure you are on the right track. If the specification does not have an answer to each one of the following, then it might be reaching too far ahead and should be removed from the target list.

1. **Is the feature specific and clear?**
2. **Is the feature measurable?**
3. **Is the feature attainable?**
4. **Does the specification address your need?**
5. **Is the feature reasonable given your timeline for the design process and budget?**



Finalize Your List: Be Realistic

Now it's time to consult the engineers to make your final list of specifications. You should have a meeting to review your specifications and get answers from a technical perspective about what is possible versus overkill, what could work better, and what might be missing from your list. At the end of the meeting, your team should have enough information to draft a few concepts for refinement.

In your meeting, here are some good questions to ask the engineers:

1. **What safety requirements do you foresee accompanying the design?**
2. **What regulations might be involved and how would you classify the device?**
3. **What is an estimated development timeline based on the complexity of your device?**

In turn, here are some questions to be prepared to answer:

1. **What are your target timelines?**
2. **What is your estimated budget?**
3. **What is the size of the intended market? Do you have an estimated scale of production?**
4. **What other products and patents on the market are you familiar with that might be associated with your device?**
5. **What in your specifications show your device is unique and important?**

While developing product specifications may seem like a grueling task, you will find that the better the specifications are the more satisfied you will be with the end product. It is important to provide the development team their own creative liberties within the boundaries of the product scope you have laid out in the specifications. These specifications will be the guide for your engineers, ensuring that the product you envision will come to fruition.

What Are Your Wireless Options for Wearable Devices?

Weighing the Pros & Cons

As smart phones become more prevalent, they become the benchmark for user interfaces with other devices — including medical and health tech wearable devices. Everyone now expects to be able to connect to the Internet or at least connect a device to their phone. Today, we can connect headphones wirelessly to our music players, synchronize a watch with a cloud service, and upload data from a heart-rate monitor to a smart phone. All these applications rely on some form of wireless communication. Wireless communications may be roughly broken up into three categories based on their range and the amount of data they can handle.

- **Wi-Fi** typically represents the longest range and the highest data rates.
- **Bluetooth** is a mid range and mid data rate system.
- Short-range solutions are represented by **Radio Frequency Identification (RFID)** and **Near Field Communications (NFC).**

Each of these systems has advantages and disadvantages when being considered for wearable devices.

Wi-Fi

When people think of Internet connectivity, they are usually referring to Wi-Fi. It offers the highest security levels, the highest data rates, and the longest operating range of these technologies. These advantages come at a cost. The larger range comes at the expense of requiring higher power transmitters, which can adversely affect battery size and life. Wi-Fi antennas are optimized for the expected operating range. These antennas may be as small as 2mm x 5mm for very short operating ranges or may be antennas that are tens of centimeters long for longer ranges.

Wi-Fi solutions are generally the most complex of the group and often require external host controllers along with a dedicated radio controller to provide the device functionality. Complete modules are available as certified devices with FCC approvals. Examples of devices that might use Wi-Fi include wearable video cameras that upload high-definition video or video headset glasses that download high-definition video.

Bluetooth

If a device needs to connect to a smart phone, Bluetooth is the most popular way to go. Devices that use Bluetooth include wireless headsets, keyboards and mice, speakers and hands-free operation in most new cars. Integrated system-on-chip devices are available from several vendors. These incorporate a microprocessor, memory, power management and radios into a single package. Most devices offer development systems in which the functions of the device may be incorporated into the system-on-chip. This minimizes the total number of chips needed to provide a complete wireless solution. As with Wi-Fi, these modules are available as certified devices with FCC approvals easing overall system integration.

Bluetooth Low Energy (BLE) is a special form of Bluetooth. BLE allows the transmitters to remain in the idle mode for longer periods, thus using significantly less power over time, allowing for smaller batteries or longer run times. Antennas for Bluetooth can be as small as 2mm x 5mm. A typical system-on-chip solution may be four to six times smaller than a Wi-Fi solution. Costs for a Bluetooth solution also tend to run between four to six times less than Wi-Fi solutions. Examples of wearable devices that might use Bluetooth include a wrist bracelet body monitor, an audio headset, or an insulin pump.

RFID/NFC

Today, Radio Frequency Identification (RFID) is typically used in inventory control tags, implantable pet ID tags, and access control systems. For RFID, the operating range of these devices is dependent on the antenna size. Larger antennas, on the order of several centimeters in diameter, can yield operating ranges of up to 100 meters. Near Field Communication (NFC) is a specialized subset of Radio Frequency Identification (RFID). NFC is gaining popularity as a means to implement electronic wallets. In order to enhance security, NFC limits its operating range to 10 cm. RFID technology is more mature than NFC, but it is not available in typical smart phones.

NFC and RFID chips are available to provide all the radio functions as well as the processing needed to decode the signals in wearable technology devices. Some systems provide the development environment to allow host functions to be performed by the chip. These chips are comparable in size to Bluetooth chips, however, the antenna size often makes the overall system size significantly larger. Cost is comparable to Bluetooth systems.

RFID technology is more mature than NFC,
but it is not available in typical smart phones.

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Deciding on the proper technology to meet your wearable device's needs?

This can be a daunting task. If you need assistance, contact Anuva! Our years of expertise in designing and manufacturing medical devices can transform your idea into reality!

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A Resource Guide to Wearable Device Sensors

Your Options

In chapter three, we covered the many wireless communication options available for wearable devices. With these wireless options available, one must be able to provide useful data for transmission. This chapter will explore an array of sensors commonly used in wearable devices for both commercial and medical purposes.

These sensors are split into two main categories:

- **Motion-tracking sensors**
- **Bodily function sensors**

Motion tracking

Microelectromechanical Systems (MEMS) Devices

MEMS devices utilize modern semiconductor fabrication processes to build devices that measure real-world forces. These devices contain structures on the scale of micrometers that are created so they can move within the device. Taking advantage of Newton's three laws of motion, these moving structures can be used to detect the direction and magnitude of the device's acceleration. Additionally, using specific materials to produce these structures can make them very sensitive to magnetic fields, which allow the device to provide measurements that indicate its orientation.

- **Accelerometers** – The most common MEMS sensor, accelerometers are capable of sensing gravity as well as linear accelerations. MEMS devices can be used for a variety of wearables that measure motion, ranging from walking (a modern-day pedometer) to monitoring sleep patterns to detecting seizures. Accelerometers used in wearable devices are generally specified by the maximum acceleration the device can measure. Common values for this maximum acceleration range from 2g to 16g.

- **Gyro** – In a similar way that an accelerometer can measure linear accelerations, a gyro can measure rotational accelerations. The rotational measurements alone are generally not as useful as the measurements obtained from an accelerometer, but when used in conjunction with an accelerometer, each device can correct minor errors in the other. With these corrections, a more precise description of the user or patient's movements can be determined. Accelerometers used in wearable devices are typically specified by the maximum rotational acceleration the device can measure. Common values for this maximum acceleration range from 250 deg/s to 2000 deg/s.

Microelectromechanical Systems (MEMS) Devices

▸ **Magnetometer –** A magnetometer measures magnetic fields, primarily the magnetic field of the earth. In other words, a magnetometer is the 21st-century version of the compass. While accelerometers and gyros sense movement in 3D, these measurements are generally in relation to an unknown starting point. A magnetometer can be used to fix these relative movements to the coordinate system of the earth, helpful in detecting the absolute orientation of a user or patient to monitor movements such as when an elderly person has fallen.

These MEMS sensors can be as small as 2mm x 2mm x 1mm individually or all three can be integrated into a single package as small as 3mm x 3mm x 1mm. In addition, the power consumption of these devices varies depending on the data acquisition speed but can be as low as only a few micro-amps. These specifications make the sensors very suitable for including in small wearable devices in which weight and power consumption are a high priority.

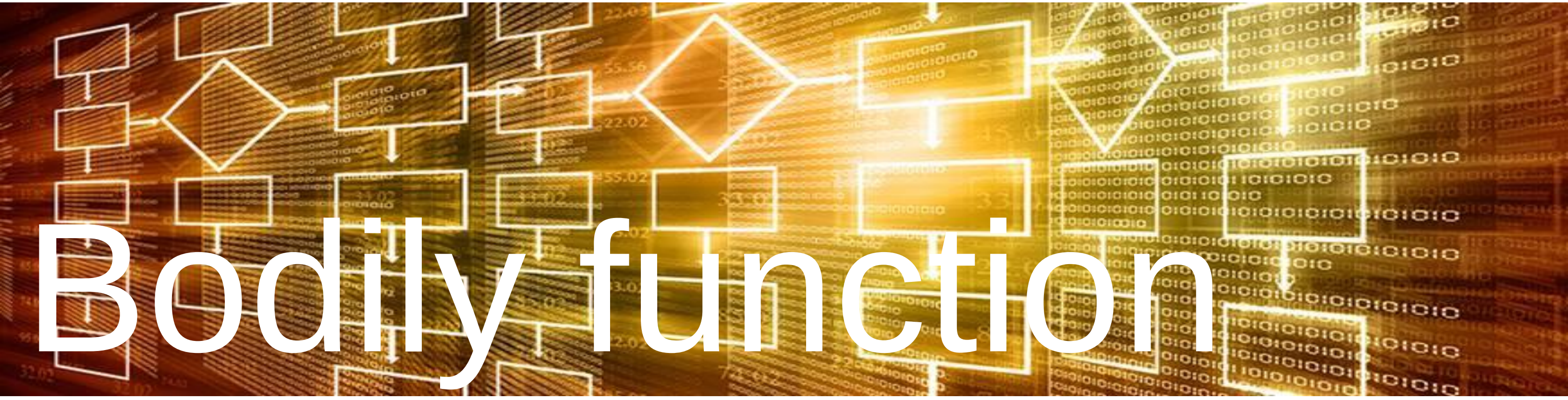
Motion tracking

Global Positioning System (GPS)

GPS is a satellite navigation system that provides location and time information in any location where the receiver has an unobstructed line of sight of four or more GPS satellites. The receiver gathers signals from different satellites, calculates the distance to these satellites, and uses this information to deduce its location.

- GPS sensors in phones are commonly used for navigation.
- GPS sensors in fitness devices can track the distance an athlete runs.
- GPS sensors in devices worn by patients can provide their location in an emergency.

The only concern that needs to be addressed while using a GPS receiver in a wearable device is the power consumed because battery power conservation is critical in devices that monitor safety and detect medical disorders.

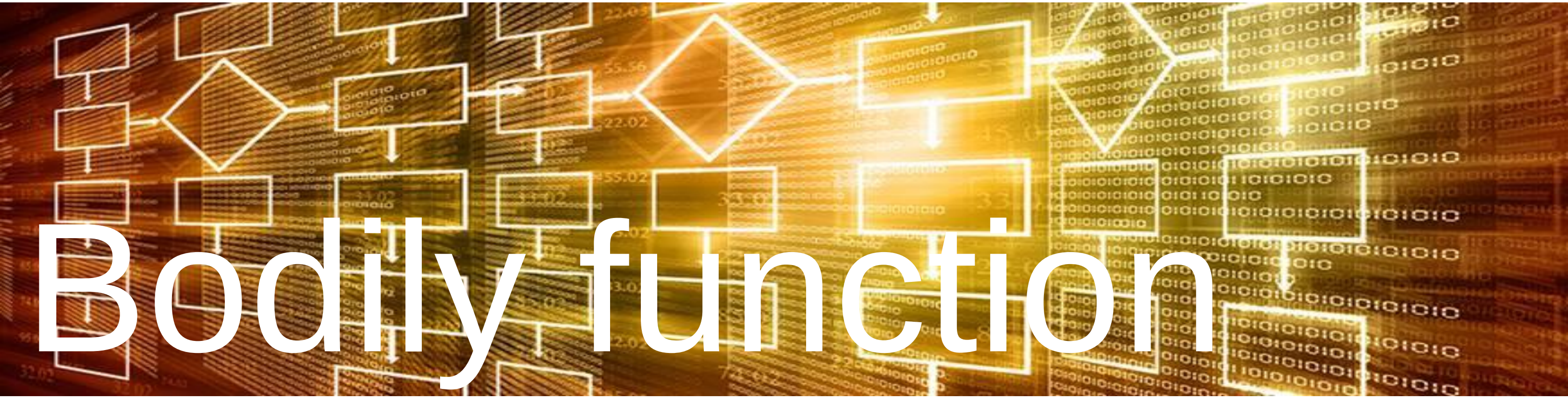


Bodily function

Heart Rate Sensors

Tracking a user's heart rate is an essential feature in most of the fitness-related wearable devices. An effective heart rate-sensing technology that can be used in wearable devices measures the electrical activity of the heart. Bio potential signals such as ECG can be measured using a capacitive-sensing method in which the skin and the electrode attached to it form the two layers of a capacitor. The major challenge in using electrodes is the motion artifact introduced under movement. This can be prevented by improving the conductivity between the skin and electrodes. Chest strap heart rate monitors make use of skin electrodes to record the heart rate and transmit it to a receiver. Chest straps have given way to biometric shirts and jackets, which have electrodes woven inside the fabric.

Pulse oximetry is another non-invasive method used in wearable devices to measure a user's O2 saturation, heart rate, and blood pressure. It involves a light source, usually LEDs, emitting light into the tissue and a photo detector to collect light reflected or transmitted from the skin. The amount of light absorbed by the hemoglobin in the blood allows the device to detect the O2 saturation levels, while the blood volume changes in the blood vessel reflect the heart rate and blood pressure. These optical sensors are used in smart watches, fitness bracelets, and earphones to monitor the heart rate of a user.



Bodily function

Temperature Sensors

Another sensor that can be easy integrated into many wearable devices is a temperature sensor. Used in a variety of situations, temperature sensors can provide early warning for heat-stroke in athletes.

A second interesting application is the use a woman's basal body temperature, or the lowest temperature the body reaches during sleep, as an indication of fertility. A wearable device capable of routinely tracking body temperature is much more accurate than previously used manual tracking methods.

Most wearable devices do not require all of these sensors in a single product.

> Battery power conservation is critical in devices that monitor safety and detect medical disorders.
>
> ***- Anuva***

Want to select the right sensors for your application?

Contact Anuva! We have years of expertise integrating a variety of sensors into products and can help you get the best performance for your device.

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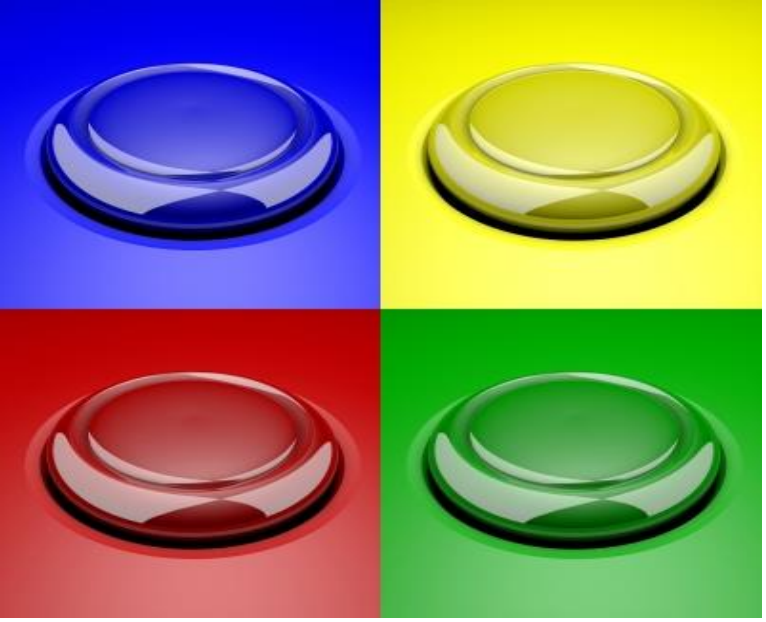
Choosing a User Interface

What Engineers Need to Consider

In chapter four, we outlined the different types of sensors that can be used in wearable devices. Chapter five will explore the different kinds of user interfaces (UIs) for wearable devices and assess each based on criteria such as:

- **Power management**
- **Security**
- **Functionality**



Physical Buttons
Pushbuttons/Membrane Switches

Pushbuttons and membrane switches are the simplest UI option for wearable devices. Physical buttons have many advantages over more sophisticated UIs. From a power-consumption perspective – which, as shown in previous chapters, is a paramount concern for wearables — physical buttons consume virtually no power (on the order of microamps). With respect to security, there are two concerns:

- Accidental depression of buttons
- The device's security against water intrusion

To prevent accidental depression of any physical buttons, a wearable device designer must be careful to consider where the device will be worn, where the buttons will be placed on the device, and how much force is required to activate a button. Depending on the application, the device may need to be water resistant or water proof.

This type of requirement will require that the buttons do not create any areas where water can enter the device. Many IP67-certified buttons that will prevent water intrusion are commonly available but will increase the cost of the device. Additionally, simple pushbuttons and membrane switches can be a perfect solution in cases where there will be infrequent interaction with a device, such as an insulin pump that only needs to be controlled a handful of times a day.

Capacitive Buttons

A second and more recent development in physical buttons is the capacitive touch button. Capacitive buttons or sensors are able to detect the capacitance of a user's skin or any other conductive device, such as a capacitive stylus. These types of buttons have a few distinct advantages over pushbuttons.

1. The circuits required to sense a user's skin can be placed behind solid materials such as plastic or glass. This decreases the cost of manufacturing a waterproof device because only the enclosure must be designed to be waterproof when using this type of user interface.

2. Because capacitive buttons are only sensitive to certain materials or surfaces, the chance of accidental activation is minimized. Although additional circuitry is required to interface with capacitive sensor buttons, the current integrated circuits available to perform the sensing are very power-efficient and there is only a small penalty to using this technology over pushbuttons or membrane switches. Since these buttons can be placed behind solid enclosures, the physical appearance may also be customized much easier and cheaper than purchasing customized pushbuttons.

LEDs

Another inexpensive and popular option for wearable UIs is LED indicators. LED indicators come in an array of colors and sizes that can suit almost any application.

- LEDs can be mounted behind transparent buttons to indicate the current state of a button or the status of the wearable device.

- Newer RGB (red, green, blue) LEDs even allow the color to be changed dynamically, which lets you display multiple different types of information using a single LED.

Although LEDs can use a significant amount of energy (5 to 20milliamps per LED), they still utilized much less power than an LCD screen. To minimize power consumption, designers and engineers can also consider blinking, strobing, or pulsing the LED indicator to reduce the amount of time the LED is on.

"RGB LEDs allow the color to be changed dynamically, letting you display multiple different types of information.

- Anuva

Touchscreens

Touchscreens have been considered as one of the most interactive and intuitive user interfaces and hence are used in smartphones and tablets. When choosing a UI for a wearable device, the focus should be on functionality and consumer experience.

- Touchscreens can be used in wearable devices such as smart watches, which require more user interaction than mere data collection from sensors.

- They allow users to easily navigate through information.

A major hurdle in using touchscreens as the UI is that they consume a lot of power, limiting the battery life of the wearable device. Designers need to implement intelligent power management techniques to make sure that the wearable devices do not need to recharge often.

Touchscreens as opposed to simple LCD display screens allow user input and hence can pose a security threat in devices especially those used for health monitoring. Care should be taken to add a layer of security to ensure safety of the user.

Smartphones

While designing UIs, it is important to not replicate the smartphone/tablet experience. Instead of having a miniature app on the wearable device, engineers can use the smartphone itself to control the device sensors.

- Wearables must have low power consumption because they always remain on.

- The wearable device can then become an extension of the smartphone, allowing it to take care of all the functionalities that consume higher power.

These wearables need to be connected to the smartphone using some wireless option. Bluetooth provides a secure, low-cost, and low-energy solution for the connectivity between the wearable and the smartphone.

6

Form & Function

Must-Ask Questions When Designing Wearables

As a kid growing up in the ‘80s, many of us had lawn-mowing businesses and cut the grass for homeowners on our streets **–** all while wearing Sony Walkman portable cassette players. In that Walkman was a cassette filled with songs often dubbed off the radio. (Back then, we didn’t have the luxury of making a “grass-cutting mix” MP3 playlist.) That Walkman and the calculator watch were the first wearable tech devices.

Today, one wonders how much time and effort was devoted to developing the form factor of those devices and to the consequences of those design decisions specific to wearables.

Wearable technology has come a long way since the days of clunky cassette players, thanks in part to the advancement of technology miniaturization and a new design paradigm in which form is given as much attention as function. There are several factors that an engineer must consider when approaching the design of a wearable device, which will be addressed in this chapter.

How will the device be used?

When we set out to design a device at Anuva, before anything is sketched, calculated, or modeled, we spend a good deal of time envisioning how the user is going to interact with the device. For example, is the device something the user just straps on and doesn't interact with until he or she takes it off at the end of the day? Or, is it something the user is going to be looking at or interacting with every 10 minutes? Are users going to be wearing it all day or for just a short period of time during, say, a workout? There are a host of questions that need to be answered related to how the user will interact with the device before a successful development process can begin.

The device-interaction requirements for a product such as the Samsung Galaxy Gear Smartwatch are much different than for a fitness tracker like the Fitbit Flex. A clear understanding of the device's intended function is required in order to determine the simplest and best way for that device to be designed to perform that function. We have found that brainstorming sessions, including different types of potential users within the device's target demographic, help determine the best path forward for user interface design. A room full of mechanical engineers may result in a device that is easy to design and manufacture, but some other nuances of an ideal design may be overlooked.

Often in discussions with clients in the early stages of a product's development, their wish list for device functionality isn't realistic for the small enclosure size that a wearable device usually requires. We quickly get into a "fitting 10 pounds of stuff into a 5-pound bag" situation. It is helpful to do an exercise to calculate how much space each function of the device will take up to determine what is realistic. Looking back at the previous chapters of this ebook, you can see a host of different technologies that appear in wearable tech devices. But even though many of these components are small, the space required to implement them adds up quickly as functionality is added. When enclosure space is severely limited, the need for a clear understanding of the device's core functionality and a realistic discussion are paramount to determine what is necessary to perform a function. If a device needs to be able to fit on your wrist or clip to your jacket lapel, follow the KISS principle. Don't add GPS, Wi-Fi, Bluetooth, and a touchscreen if the device's core functionality doesn't require that.

What environment will the device be used in?

In addition to determining how the user will interact with the device, thought must also be given to where the user will be interacting with the device. The ingress protection requirements for a scuba diving computer are different than your Beats by Dre Studio Headphones. The device's level of protection against water or dust ingress will fundamentally alter how the device is designed and assembled.

▸ **For devices designed to be used in dry, non-sweaty environments**, screws holding together two sides of a plastic enclosure could easily fit the bill. It's relatively inexpensive to implement this design strategy, but it does not give much protection from the elements.

▸ **If the device is to be sweat-proof or waterproof**, then other design strategies must be implemented, such as through the use gaskets or thermal or ultrasonic welding (for plastic enclosures). Electronics may also need to be conformally coated. Ingress protection requirements can even drive the overall shape of the enclosure, because different sealing technologies have different design restraints. However, just because you can design a device to be waterproof, that doesn't necessarily mean you should make that claim.

Designers must always assume that users will misuse a device; and if they are able to compromise any of those ingress protection features designed into the device, it will eventually happen. This could lead to unhappy users or even potentially dangerous situations, so again a clear understanding of the intended device function must be considered when determining the path to design completion.

What type of enclosure material should you select?

▸ **Will the device be used extensively outdoors?** If so, any plastics need to be UV resistant or you risk discoloring or degradation of material properties.

▸ **Is the device going to be used in the pool?** Then it needs to be able to resist the litany of chemicals that are present in pool water.

▸ **Will the device contain electronics?** Then your enclosure material must be flame retardant.

Recently, the battery in a Samsung phone caught fire while underneath a girl's pillow in Texas. The battery was allegedly an off-brand replacement and not the original OEM-approved equipment, but this shows the potential for user misuse that designers must account for.

In the medical device world, all plastic enclosures must be made from self-extinguishing material. This is even more important with wearable devices that could be in contact with the user's skin, potentially causing a burn injury if the device caught fire. Biocompatibility must also be considered when choosing a material for a device enclosure, especially if there will be prolonged contact with the user's skin. Many medical plastics are certified as biocompatible via ISO10993, which is helpful guidance, but these certifications do not preclude the need for material testing. For instance, Fitbit recalled the Fitbit Force product earlier this year due to reports of mild to severe skin irritation. The enclosure used surgical-grade stainless steel and other "materials commonly used in consumer products," yet the issue was prevalent enough for Fitbit to discontinue the product and conduct an expensive product recall.

The lesson: Be as informed as possible when it comes to how and where the device could potential be used (or misused) and account for all these factors in the design and testing process.

Can form & function live in harmony?

The old engineering axiom is that form follows function, which was probably the case with the Sony Walkman cassette player design. The designers were able to fit a bunch of 1970’s technology into an enclosure that could be body worn, and they ended up with brick with a clip on it. Not to criticize Sony designers and engineers – the original Walkman is an amazing example of efficient use of space, and its designers did what they could using the tools available – but in today’s competitive wearable tech market, form matters just as much as function.

When it comes to wearable devices, the comfort of the product can be just as important to the user as the device’s function. A device can perform its function perfectly, but if it isn’t comfortable to wear, it isn’t going to be used for very long. This is also where material selection comes into play. The tactile feel of the elastomeric strap that holds a device around your wrist depends just as much upon the material that the designer chooses as the shape of the design itself. Also, it helps to gain insight from other successful products on the market. Although they may not share your device’s function, they could encompass a similar form.

Determining what it is about the form of those devices that makes them successful can help drive your design decisions. Device form is also a large factor in what sells a product. A potential user’s first impression of any device is often when he or she sees a picture of it or views it in its packaging. Getting input from a quality industrial designer who understands the specific design challenges of wearable devices is important in developing a product that not only is functional and comfortable, but also stands out in the marketplace against its competitors. Even in today’s world of miniaturized electronics, without proper artistic design input, you still may end up with a brick with a clip on it. It will just be a smaller brick.

Need assistance determining the appropriate form for your device?

Connect with our team at Anuva! We have many years of expertise designing and developing products.

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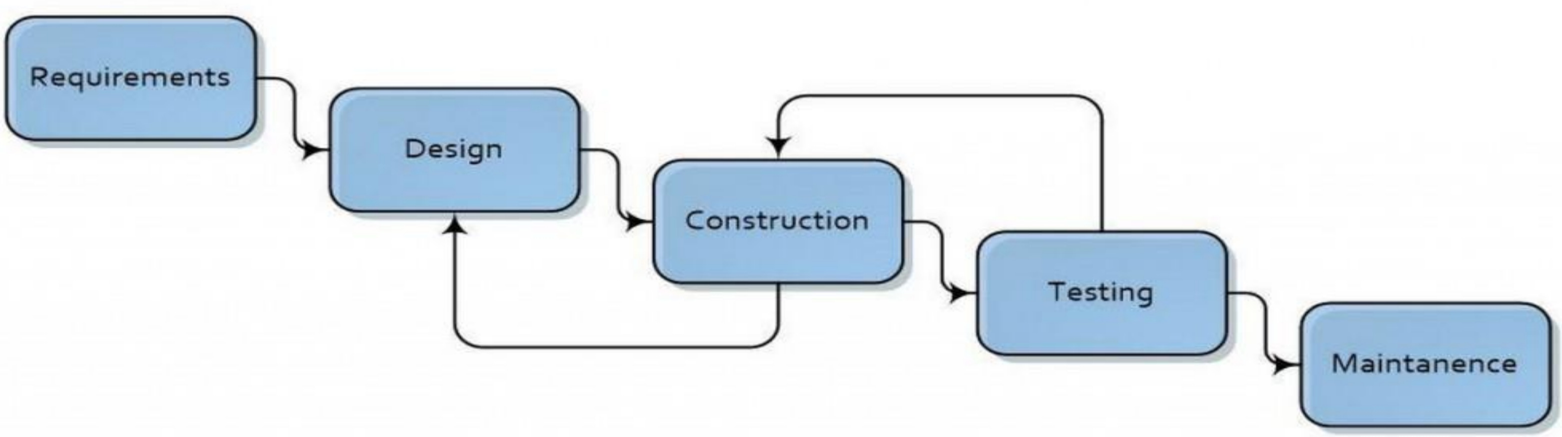
CHAPTER SEVEN

Embed the “Smarts” Into Your Wearables: Software Development

5 Stages

Now that you're this far into our ebook, one can safely assume that your idea for a wearable medical device of the future is honing in on a promising prototype design. Your team has a grasp on the purpose, the necessary sensors, user interface, and form factor to move forward. Moreover, your stakeholders may be even more enthusiastic after learning of the expected 32.7 percent growth rate in smart wearable technologies, according to the "Global Consumer Smart Wearable Technology Market 2014-2018" report.

The one remaining challenge on your plate: How to actually get the necessary "smarts" into your wearable technology. Across the spectrum of complexity of functions that your wearable performs, it's likely that your product will need an embedded controller with software to facilitate functionality. Fortunately, the process of developing your software is not all that different from other development processes and follows the same basic five stages.



Software Requirements

Determining the requirements for your software is the most important step in designing it. Engineers need to take time to deconstruct your wearable concept to the basic, absolute functions that the software must perform in order for the device to perform its job.

Establish the relative importance of each of these basic requirements to have an idea of what should be prioritized. Exhaustive, well-honed requirements will yield the specifications for your software. Good software specifications at this stage will not only minimize the number of iterative cycles your team will have to perform, but will also provide a clear understanding of what the core of the product is as you move forward toward a final product.

Stage 2

Embedded Design

Once the specifications are in place, it is time to actually flesh out the design of your software. Here is where you will want to consider the nature of the data the software application will be handling. Start with the timing requirements: **How often do you need to access or process your sensor data? How time-sensitive are these processes?**

Software processes with strict timing requirements, such as generating an accurate PID control signal at 50 Hz, will need to be architected very differently than more flexible application processes, such as turning on an LED or catching a button press.

During this stage, also consider the volatility of the data your embedded system will handle. For example, if you have a temperature sensor that provides a stable ambient temperature, you can probably afford having to skip reading the sensor in order to perform a more time-sensitive task. This is in contrast to receiving a critical message from an IC that cannot be requested again.

Putting together all the above information will help your team form a concrete idea of how you need to architect your software.

- Will a big main loop with a flexible and variable execution time serve your purposes?
- How many interrupts will the system have to process, and which interrupts should it prioritize?
- Should the system leverage a real-time OS with a scheduler?

It's at this stage that all of these questions can be answered. It's also at this stage that you want to pick the appropriate development tools for the job. Ensure that you have versioning control tools, bug-tracking tools, and any additional equipment in place before proceeding forward.

Stages 3 & 4

Construction & Testing

These are the execution stages. It is imperative here to proverbially “dot your i’s and cross your t’s.” Make sure that the development team has a software-coding policy and comment policy in place to ensure that everyone can quickly understand what each component of the software does and how it may affect what they are currently work on. Testing seems to be emphasized at the very end of the software-development process and, hence, usually gets assigned the least amount of time. However, testing should not be taken for granted because this is the step that makes sure the product is bug free. Before you begin testing, have a clear understanding of why you are testing. It can either be just to ensure that the product is bug free or to test the safety of the product or to improve performance. Your timeline and depth of testing depends on the reason why you wish to test the product. The most common testing procedures include:

▸ **Unit Testing –** Unit testing involves taking the smallest piece of testable software, isolating it from the rest of the code, and making sure it behaves exactly the way it is supposed to. This type of testing can be done early on in the development cycle and it allows for an easier integration of the code.

▸ **Integration Testing** – In this phase, units that have been tested individually are combined into a single component and the interface between them is tested. Test cases are created with the purpose to ensure that all the components of the program interact with each other correctly.

▸ **Regression Testing** – Regression testing should be done when you make changes to the source code. The changes may be in order to modify a feature or to fix a bug. In either case, you need to make sure that resolving one bug has not introduced a new one. This can be done by rerunning the existing functional and unit test cases.

▸ **Validation** – It is the process of evaluating the software at the end of the development process to determine whether it satisfies all the requirements and specifications. In other words, it answers: “Are we building the right product?”

Stage 5

Support & Maintenance

Once the wearable device is tested and ready for release, it is deployed to the intended users. When the product is in the market, support in the form of training is needed in the initial period. Support is also required to evaluate and fix bugs detected in the product.

Apart from bug fixing, support and maintenance of software, allow for enhancements in the functionality of the product. This stage is critical for improving the quality and usability of the product. Bug-tracking tools come in handy during this stage because they provide an organized way to resolve and prioritize issues.

> When the product is in the market,
> support in the form of training is needed initially.
>
> ***- Anuva***

What Should Your Wearable Wear?

Choosing Materials for Medical Device Enclosure

This chapter will discuss material selection, one of the most difficult decisions to make about your wearable device design. There are a large amount of basic plastics and metals to choose from. But the list becomes downright intimidating when you consider:

- **Additives**
- **Alloys**
- **Blends**

If you are searching for some guidance or are preemptively curious about how to make such a decision, the following three areas help break it down.

The User

First and foremost, you need to detail your user.

Who will be wearing your device? If you have a gender- or age-specific user, this will affect the size, shape, and weight of the device material. If you decide that your device is intended to be worn by young children, for instance, then you can imagine a material that is lightweight and brightly colored. This definition, however, also tells you that the device material should be durable or easily and inexpensively replaced to accommodate the typical carelessness of a young child. Even though the user definition here is general, it has enormously reduced your possible choices.

What will the device come in contact with on the user? Will it be worn on someone's belt loop, or does it apply straight to the skin and need to be biocompatible?

How long or for how many uses should you expect your device to function? Whether you decide you need a disposable device or an indestructible one, you can eliminate an entire class of materials with this question.

What type of exposure will the device get in the users' environment? Where will they be wearing it? Think about how it will need to withstand temperature changes, humidity, radiation, and potential hazards (fire, water, etc.). Along with effects of exposure, consider the effect your wearable device will have on the surrounding environment: Will it need to be sterilized or cleaned, and how often?

These problems can be often addressed with material additives, but should still be well-defined early in the decision-making process.

The Production

Now that you have found some clarity by defining your user, take a step backward and think about how this device might be manufactured to fit your needs. This is where you should heavily consider the cost of the material through two specifications.

1. You will need to provide an intended scale of production (do you anticipate needing 100 units or 100,000?).

2. You will need to define if your device or any components of your device are intended to be reusable.

The material you choose will limit the possible production methods you can use, so these two factors will help you find the most appropriate manufacturing process for your needs and, thus, an applicable material that falls in line with this process.

Keep in mind that the type of material and the type of manufacturing process you can use are interdependent, but both rely directly on your scale of production. You should use this production scale to narrow down the possibilities, and then weigh the costs and benefits of each option until you find what is best for your device.

Worst-Case Scenario

Now that you've answered all the basic questions, you can probably pick out a handful of appropriate materials that could work. But that's not enough – you need a perfect fit! You want to guarantee the safety of your users while they wear your device, which means it has to be tested for changes in what you might call the "worst-case scenario."

Here is where it will be most helpful to have a regulation-loving team of engineers on your side. The testing requirements will vary depending on your application, so it is important to map out early in the development which tests your device will need to pass. When these are decided on, you have everything you need to pick the perfect material.

Often, there will still be more than one material that is suitable for your application, even after mapping out all of the areas listed in this chapter. If this is the case, one further step you can take to choosing the best material out of the bunch is by using a tool called a Pugh Chart.

Pugh Chart

1. Start with your material choices listed across the top and your criteria for comparison (the answers you came up with above) listed down the side. In front of the material choices, make a column for baseline values and weighted values for each criteria. (See figure below.)

	Baseline	Weight	Material	1	2	3	4
Criteria							
1							
2							
3							

2. Next to each of your criteria listed, add a baseline value to define your scale (should be the same for all criteria) and then score each according to its importance to you and the device function in the weight column. (See figure below.)

	Baseline	Weight	Material	1	2	3	4
Criteria							
1	0	2					
2	0	4					
3	0	3					

3. For each material that meets your criteria, mark with a +1. For each material that takes away from your criteria, mark with a -1. For each material that neither accomplished nor diminishes your criteria, mark with a zero.

	Baseline	Weight	Material	1	2	3	4
Criteria							
1	0	2		+1	+1	0	-1
2	0	4		-1	+1	+1	0
3	0	3		0	-1	0	+1

4. Multiply the weight value across the materials.

	Baseline	Weight	Material	1	2	3	4
Criteria							
1	0	2		+2	+2	0	-2
2	0	4		-4	+4	+4	0
3	0	3		0	-3	0	+3

5. Add each material column and whichever has the highest sum is your winner!

	Baseline	Weight	Material	1	2	3	4
Criteria							
1	0	2		+2	+2	**0**	-2
2	0	4		-4	+4	**+4**	0
3	0	3		0	-3	**0**	+3
Total				-2	+3	**+4**	+1

Need help selecting the appropriate materials for your wearable device?

Reach out to Anuva! Our team of experts have years of experience designing and developing products..

CONTACT US

Selecting Biocompatible Wearable Tech Materials

A Crash Course

What is the best part about wearable technology products?

You can wear them while they work! This also indicates, however, that your wearable device must be made of an appropriate material to be worn safely. Rather than panicking and diving head first into a regulatory whirlpool, let us provide a crash course in how to choose materials that are safe and headed for approval.

When we are talking about being able to wear a device safely, we are talking about biocompatibility. Biocompatibility indicates that a material will perform appropriately without inducing a reaction in a living tissue or cell. In other words, regulating materials for biocompatibility is what allows you to confidently wear a Band-Aid without breaking out in peculiar patches of hives.

Standards

Each medical device on the market today that is designed to come in contact with human tissue is regulated primarily by the International Organization for Standardization (ISO) for biocompatibility, almost exclusively through the 10993-1 standard. The best way to approach choosing a biocompatible material for a wearable technology, and to rest assured when you need your next Band-Aid, is to use this standard.

Contact lenses were one of the first examples of wearable devices with documented biocompatibility concerns. This dates all the way back to Leonardo Da Vinci!

Standards come hand in hand with classifications, so we first need to ask two simple questions:

1. **How much does the product touch?**

2. **How long does it touch?**

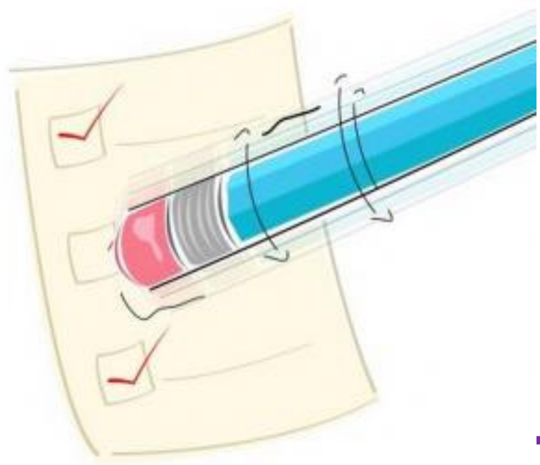
Categories

To give you a little more detail, you are deciding here just how invasive the device is so you can narrow down the types of tissues it will contact directly. The device can fall under one of three categories according to the answers to the two questions on the previous page. Your wearable device will fall under the first or second category, which are described here:

Category I: The device contacts only external body tissues, which includes skin, mucous membranes, or injured surfaces. Some examples of materials that are currently used for this type of contact are PVC, Polystyrene, and Polyethylene.

Category II: The device contacts internal tissues from the outside, such as a needle, and will come in contact with internal and external tissues including blood, bone, and dentin as well as skin and mucous membranes. This category can be divided further according to the allotted time of contact. If the device is in contact with the listed tissues for a short term, some materials that may be appropriate include Silicone, Polyurethane, and Teflon. Material better suited for longer-term contact is Nylon, Polypropylene, and Polyester.

Category III: The device is totally implantable and thus only contacts internal tissues, such as muscle/fat tissue, bone, and blood. Some materials that are currently used for this type of contact are PMMA, PET, and hydrogels.



The Checklist

Now that we have a solid starting point with your device classification, we can look at the nine major players in passing biocompatibility tests (according to the 10993-1). Make sure to consider each of these carefully when choosing your material.

1. **Cytotoxicity** – Does the material cause a negative effect on body cells, such as cell death or inhibition of cell growth?
2. **Sensitization** – Does the material cause a level of discomfort on contact?
3. **Irritation** – Does the material cause visible irritation, including redness, itchiness, or swelling of the surrounding skin or membrane?
4. **Intracutaneous Reactivity** – Does the material cause a localized reaction from the surrounding tissues?
5. **Acute Systemic Toxicity** – Does the material cause an immune response from the surrounding tissues or body systems upon application?
6. **Subacute/Sub-chronic Toxicity** – Does the material cause an immune response from the surrounding tissues or body systems for an extended period of time?
7. **Genotoxicity** – Does the material cause any gene mutation changes?
8. **Implantation** – Does the material cause any pathological effects on living tissues, such as inducing an internal immune response?
9. **Hemocompatibility** – Does the material have any effect on blood or alter blood components?

Note: You may be exempt from a few of these, depending on your application. If you are not, however, you should look for a vendor, or ensure your engineering team finds a vendor, who has been approved for biocompatibility testing according to your needs. Whether it is in raw resin form or a completely finished product, testing is the same for all forms of a material. Therefore, it is essential to make sure that the vendor provides a certificate of biocompatibility regardless of the stage of development you are in when you purchase the material. If you are still unsure about the quality of a material, you can always ask the vendor or your engineering company to provide the risk-management procedures. This will show you how recent their certifications and regulatory procedures are. Whether your design is wearable for portability, aesthetics, or convenience, when it comes to designing this kind of device it's important that it should be safe.

CHAPTER TEN

Connecting a Wearable Device to the Cloud

Frequently Asked Questions

When designing a wearable device, you might want to seriously consider connecting to a cloud service.

- **Why?**
- **What exactly is the cloud?**
- **What benefits does the service provide?**

Chapter 10 of this ebook will answer those questions.

What is the cloud?

The "cloud" is a term that encompasses a network, servers on the network, and programs on servers that store, retrieve, and process data.

Why would you want to connect a wearable medical device to the cloud?

There are three main reasons:

Data backup – The cloud is a great place to back things up, because wearable devices have limited storage and often unreliable flash memory. Plus, the device could get lost, damaged, or stolen.

Data processing – In the cloud, you have almost unlimited computing power for analyzing data. This will reduce the power consumption of the wearable device.

Data sharing – Data is usually shared over the Internet. If the data is already in the cloud, then sharing it becomes quick and easy.

Consider a smart device (e.g. a watch) that records the user's heart rate and stores the data periodically to the cloud server. Once the data has been uploaded, the server could use the heart rate to calculate the number of calories expended. Later, the user could log on to a web site to see a graph of his or her calories expended over time, and even share that caloric data with others.

What type of hardware is required to set up a custom cloud service?

No hardware is typically required. Cloud server virtual machines can be set up in a few hours using Amazon Web Services or Rackspace. The virtual machine can be managed over the Internet.

What software is required?

Following is a list:

Operating system – A server runs an operating system much like a personal PC, with the exception of the graphical user interface, which is usually not installed. Typical operating systems for servers include Windows Server 2012 R2, Ubuntu Server (Linux), CentOS (Linux), and RedHat (Linux).

Database – Most cloud services need a database to store data. Popular databases include Microsoft SQL (if you are running Windows Server OS), MySQL, and Oracle.

HTTP server – Cloud services need software that can communicate to a wearable device over the network. Some popular choices include Apache and Windows IIS.

Scripts – Custom scripts are needed to interpret HTTP requests, query the database, and process data. There are many scripting languages that can be used for this purpose, but some of the most common languages are PHP, Perl, and Ruby.

Cloud services add tremendous functionality to wearable devices, transforming them from boring sensors into “Internet-connected things” that allow data to be processed and shared.

Do you have other questions related to wearable tech connectivity?

At Anuva, we have expertise in developing cloud systems for wearable devices. Contact us and we would be glad to provide solutions.

CONTACT US

CHAPTER ELEVEN

Does Your Wearable Device Need a Smartphone Application?

“There’s an app for that”

This is a ubiquitous statement nowadays. Does the wearable device that you are developing *really* need a smartphone application?

Yes…is the correct answer for the majority of wearable devices.

No…is the response in some cases.

In this chapter of “The Future of Wearable Technologies” ebook, we will explain the reasons why a wearable device might – or might not – need a smartphone application.

Why you need an app…

Reason 1

A smartphone application might be needed in order to connect the device to the "cloud," a term encompassing a network, servers on the network, and programs on servers that store, retrieve, and process data. Why might you want to connect to the cloud? The reasons are threefold:

- **Data backup**
- **Data processing**
- **Data sharing**

The cloud is a great place to back things up, because wearable devices have limited storage and often unreliable flash memory. Plus, the device could get lost, damaged, or stolen. The cloud is great for data processing because processing in the cloud reduces the load on the device's embedded microprocessor. This saves power and might reduce the performance requirements of the microprocessor. Finally, data that is already in the cloud can be shared quickly and easily by many users.

Reason 2

Another need for developing a smartphone application for your wearable is so that the application can replace the display on the device. Doing so will save you development time, because you do not have to create the hardware and software to support a custom display. Also, eliminating the display on the device will save you money on material costs. This might allow you to hit a lower price point to effectively market the product.

Why you *don't* need an app…

Reason 1

The wireless transmissions of data from device to smartphone can create a security risk. Even though data can be encrypted, computer hackers sometimes find ways to breach the system. Devices that have been hacked recently include pacemakers and insulin pumps. As a general rule, life-sustaining medical devices need extra scrutiny for security vulnerabilities. This can increase the cost to develop smartphone applications for these devices. For devices that do not contain life-sustaining or other sensitive data, security is less of a concern.

Reason 2

The smartphone app lacks the necessary processing power. If this is the case, a PC application or server daemon could be used in place of a smartphone app. An example use of a PC application or server daemon would be the simultaneous collection of data from many different wearable devices with data processing done in real time. In this instance, the smartphone simply is not powerful enough to collect all the data and process it, and a more power machine would be needed.

Reason 3

The final reason not to develop a smartphone application for your wearable is because it can be expensive to create and maintain the software. If the device will be mass marketed, you'll need to develop both an application for iPhone *and* for Android. There are technologies that allow for the reuse of code between iPhone and Android applications, but these technologies are notoriously unreliable and produce substandard code. Therefore, you will have to develop and maintain two separate source code repositories. This makes it costly to develop smartphone software.

Although smartphone applications can complement wearable devices very well – serving as the user interface and connecting to the cloud – it's important to note that they add significant complexity and cost.

Need to determine if a smartphone app is needed for your wearable?

At Anuva, we have in-depth knowledge in both software and hardware engineering. Let's connect!

CONTACT US

Make Your Manufacturing, Post-Manufacturing & Support Pledge

“Begin with the end in mind”

This phrase very much applies to New Product Implementations (NPI).

Decisions and promises made early in any product-development process can greatly affect manufacturing and post-manufacturing support and costs. All of our previous chapters in this wearables device ebook have led up to the point in time in which the product has to actually be produced, shipped, and supported.

As soon as the basic elements of the product have been defined, such as the printed circuit board size and type and the enclosure type, you need to get your manufacturing partner involved.

Even before involving your manufacturing partner, some extremely important design cost considerations must be defined:

- **What can I sell this device for?**

- **How much margin do I need to cover my operational costs and make an acceptable profit?**

The difference between these two is your Cost of Goods Sold, or COGS. The target COGS must be a design requirement that is routinely reviewed by the design team. (Of course, you must also make sure that you understand your operational costs as well.)

Another set of critical aspects to keep in mind are the lead times for components, tooling, and process development. This is especially important if there are design elements that are “pushing the envelope” relative to component technology (which often leads to limited availability and long lead times) and the processes required to manufacture the product.

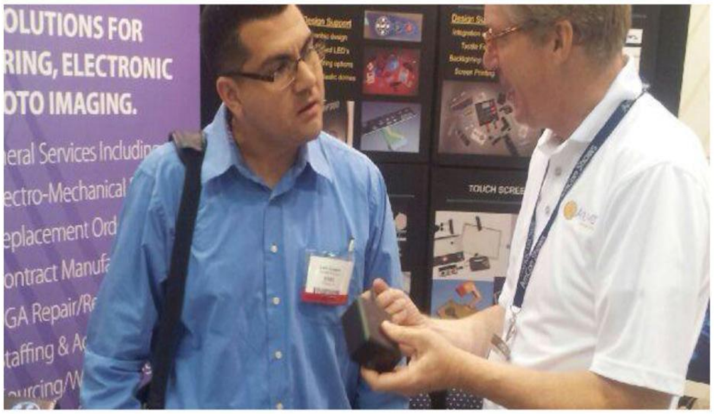
If you take nothing else from this ebook chapter, at least make this pledge:

"I, (state your name), promise to NOT give potential customers a unit price or delivery commitment until I fully understand both."

Another benefit to having your manufacturing partners involved early on is so that they can provide valuable design input that will help keep material and labor costs minimized while maximizing quality.

US manufacturing is a very real option for all but the most labor-intensive products, especially when one considers the many downsides to offshore manufacturing. To name a few:

- **Lower quality**
- **Longer lead times**
- **Increased shipping costs**
- **Impacts to cash flow because of having to pre-pay**



Finally, once you ship your first product, you have created an entirely new set of challenges – you now have to support your customers!

Questions to ask include:

- **If the product is updatable, how is this done?**

- **If the customer is having a problem, how does he or she contact you – via your website? Phone?**

- **If the product needs to be returned, what process will be used?**

- **Will the product be repaired or replaced? By whom?**

Fortunately, all of these challenges can be handled by the Anuva family of companies. It is quite conceivable that you can become a “virtual manufacturer” and never actually have to touch the product yourself.

Does My App Need to Be FDA Regulated?

In today's changing world of technology…

…things have gotten more complicated with the use of apps for wearable devices.

There are apps on the iPhone and Android platforms for almost everything, from tracking your run to telling you when the washing machine door is open. Some apps are now being considered medical devices and need to be regulated by the FDA.

Should your app be regulated by the FDA?

The first thing to determine is **“What is the app’s intended use?”**

Simply put, the intended use is what you claim your app (or medical device) will be used for. This is also known as a “label claim.” Let’s take the many monitoring /fitness apps on the market.

‣ If you’ve created an app that monitors someone’s heart rate, it could fall under FDA regulation (depending on what you do with the recorded heart rate).

‣ If the heart rate is just being used by the person to help aid his or her fitness goals, then the app would not be considered a medical device.

‣ But, if the app maker claims the heart rate is accurate and the information is sent to a doctor to aid in medical treatment, then it would be considered a medical device and may require FDA approval.

Another example: a wearable medical device that can deliver drugs into your body. Does the app simply contain the medical device product information for easy access? Or can the user control the medication delivery through the app?

The way the app is to be used in conjunction with the medical device, as well as the data transferred between them, is what needs to be considered. The device could be delivering a life-saving medication into your body and the delivery must be accurate whether it comes from the device or the app. That is why an app of this type will likely fall under FDA regulation.

Once it is determined that the app will fall under FDA control, **several steps need to be taken in order to get your app to market:**

▸ The app and development process will need to be well documented that follows the FDA Good Manufacturing Practice (GMP) quality management rules.

▸ All of the software will need to be thoroughly tested, possibly to the lowest level of software control.

▸ It may also need to undergo performance testing to validate the functionality of the device over many uses and across multiple devices.

The answer to "Will my app be regulated?" is not always straightforward. The FDA has even issued an entire guidance document on this hot topic to help companies determine if their app will be regulated or not. To gain further clarification on medical device mobile medical applications, **please click on this FDA link.**

It is important to think about FDA regulations early in the development process so you can design your wearable device and app with these requirements in mind.

> The answer to 'Will my app be regulated?' is not always straightforward.
>
> ***- Anuva***

CHAPTER FOURTEEN

How to Create Your Own iOS App

A Guide to iOS App Development for Wearables

Apple is clearly a leading company in creating both mobile devices and the apps that those devices use. Its large market share means that…

- Most companies or clients will want their app feature in Apple’s App Store
- Developers need to learn to build apps for Apple devices

Tools You Will Need

To build apps for Apple, you need a Macintosh computer. The primary programs used to build Apple apps only run on the OS X operating system, which is the primary operating system for Macs. There are some third-party tools that allow development on PCs, but those are not endorsed by Apple.

To develop an app, download the current version of Xcode onto your Mac. It’s available in the Apple App Store for free. You’ll need to make sure your Mac’s operating system is compatible with the current version of Xcode. Xcode allows you to create a user interface by dragging and dropping elements onto the screen, and it allows you to create the rules and logic that power your app by writing code. Xcode also allows you to test your app to make sure it works the way you want it to.

Apple uses two primary programming languages:

- **Objective-C**
- **Swift**

Swift is the latest version, and its syntax is more like plain English and is easier to use.

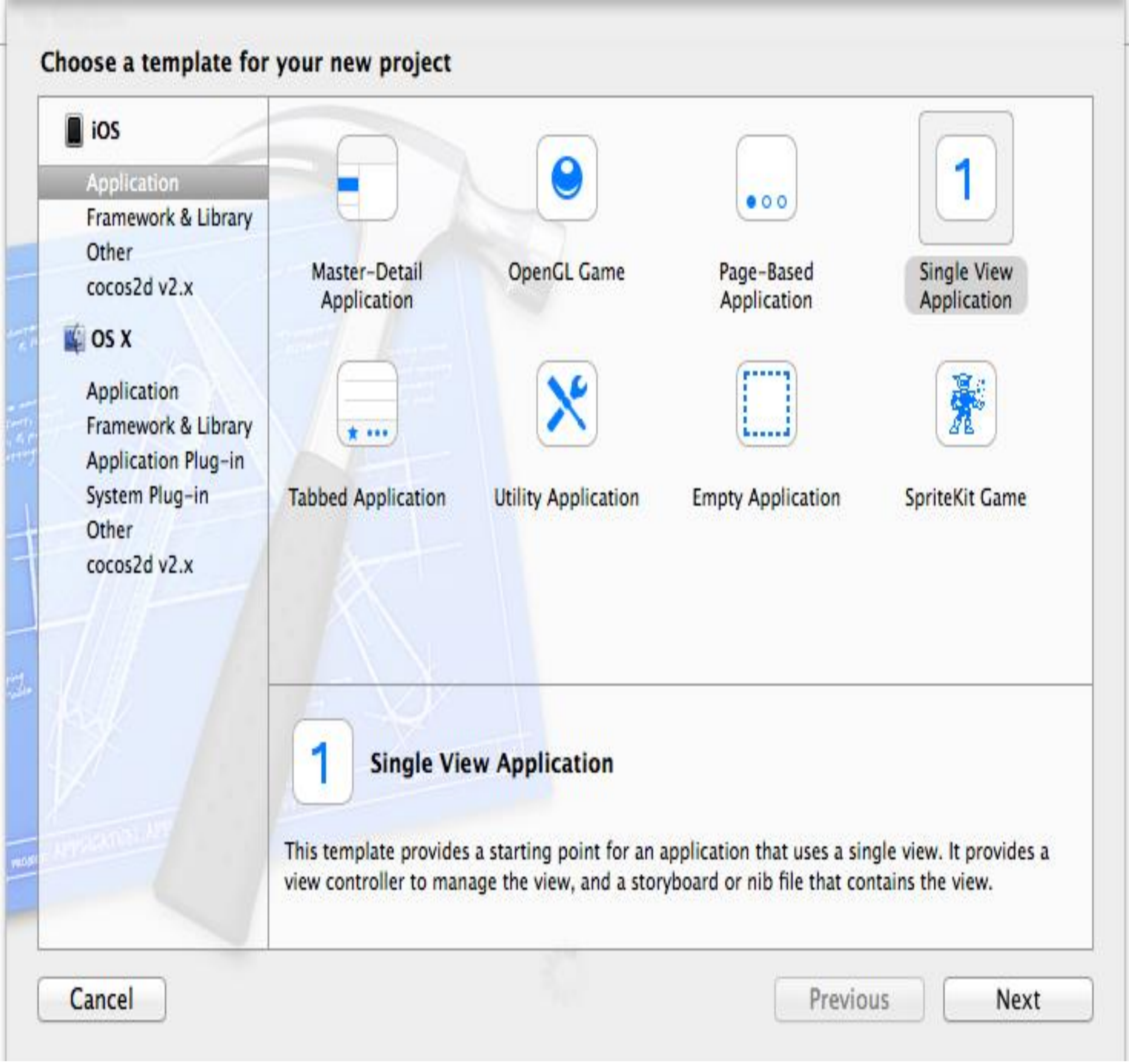
To place an app in the App Store, you’ll need an Apple Developer membership. Memberships require an annual fee (currently $99), and allow you to publish as many apps as you want into the App Store and lets others download and install your app. Your membership gives you access to Apple’s Provisioning Portal, where you will upload your certificates and create profiles that control on what devices your app can be installed, and iTunes Connect, where you will create the catalog listing for your app, upload and publish your app. iTunes Connect will also allow you to check the statistics of your app, such as downloads, earnings, in-app purchases, and more.

Creating Your App

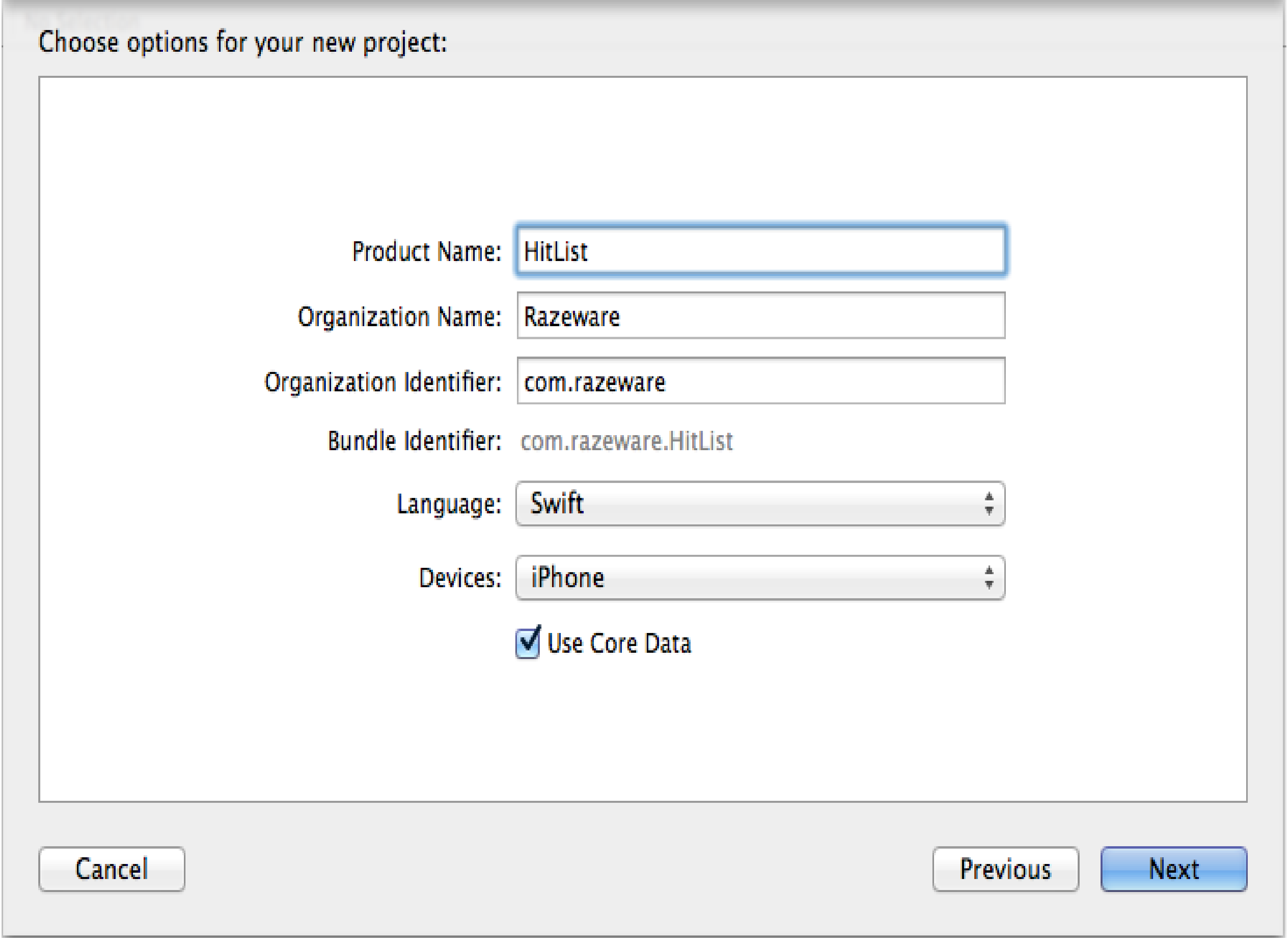
Before you start, you need to know where you want to go. Start by clearly outlining the purpose of your app. Understand what problem you're trying to solve or what service you want to provide. Think about your user interface: What content will your app present, and how will users interact with it? It can be helpful to sketch out your app by creating a storyboard that shows how your app will work. Xcode includes a powerful Storyboard feature that allows you to create a prototype where you set up screens with images and objects. The screens can be connected by segues which include transition effects and navigation.

To familiarize yourself with Xcode, you can start by building a very simple app. This app will display a message on the screen of an iPhone. Follow these steps:

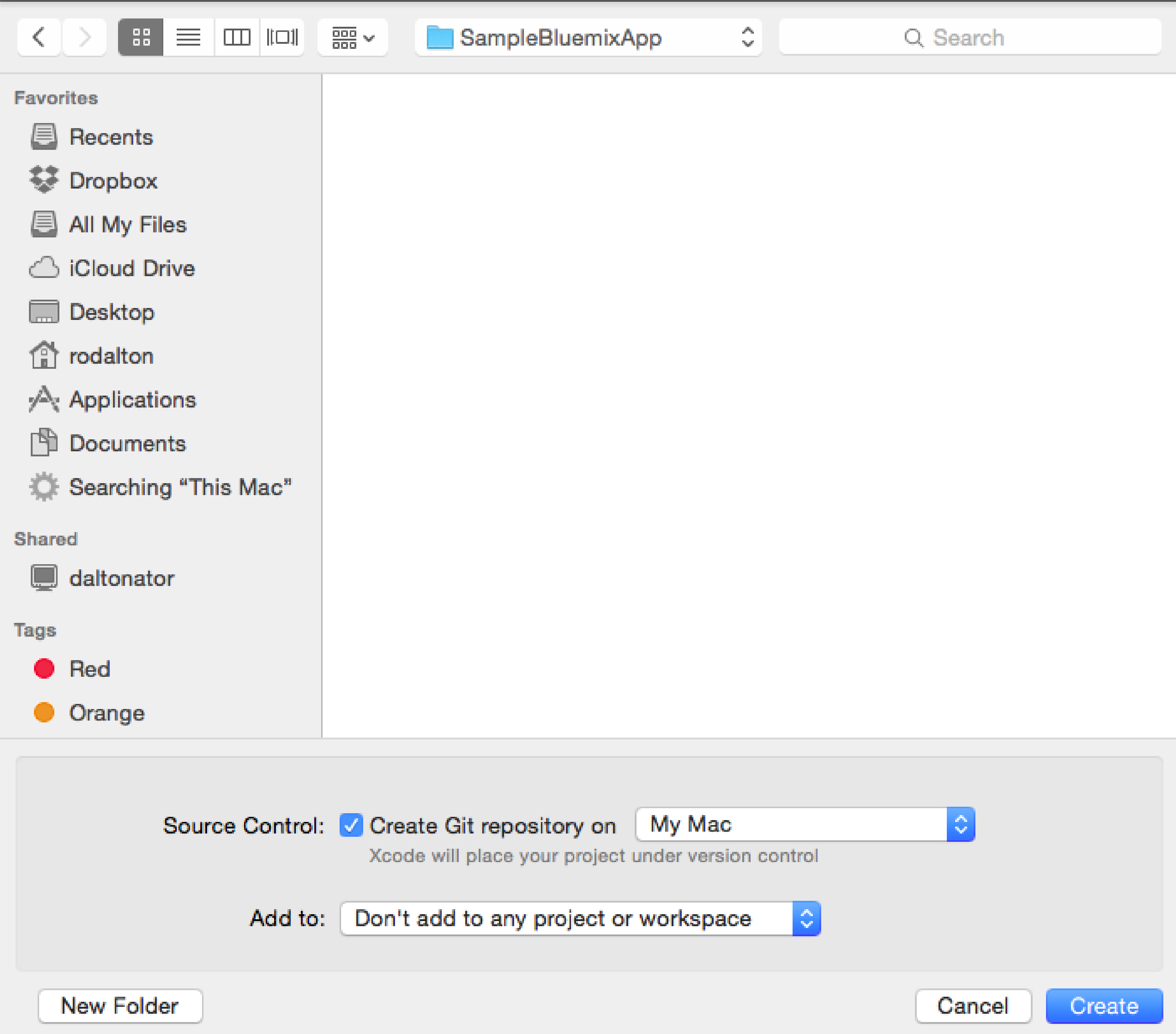
- Start Xcode and select "Create a New Xcode Project" from the splash screen.



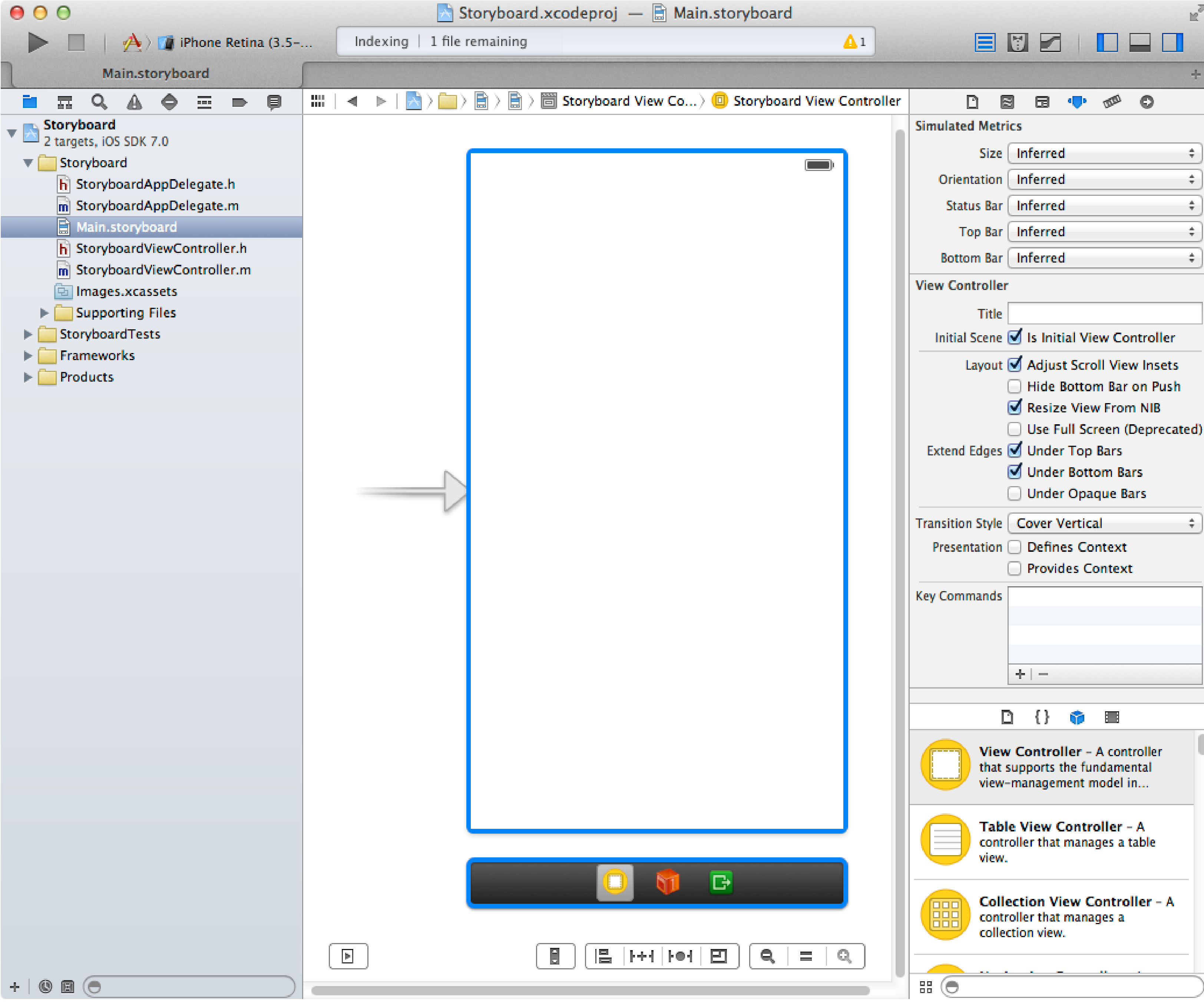
- Make sure you're in the Application section under iOS and choose "Single View Application" and click "Next."



- In the next screen, you'll need to provide several pieces of information.
- Enter a product name for your app. In this example, we'll use a phrase commonly used by new programmers, and enter "Hello World."
- Enter your organization name, or your own name, whichever is applicable.
- Enter an organization identifier, which is typically [your organization name].com
- For this example, choose Swift as the language.
- For this example, choose iPhone as your device.
- For this example, make sure "Use Core Data" is unchecked.
- Click "Next."

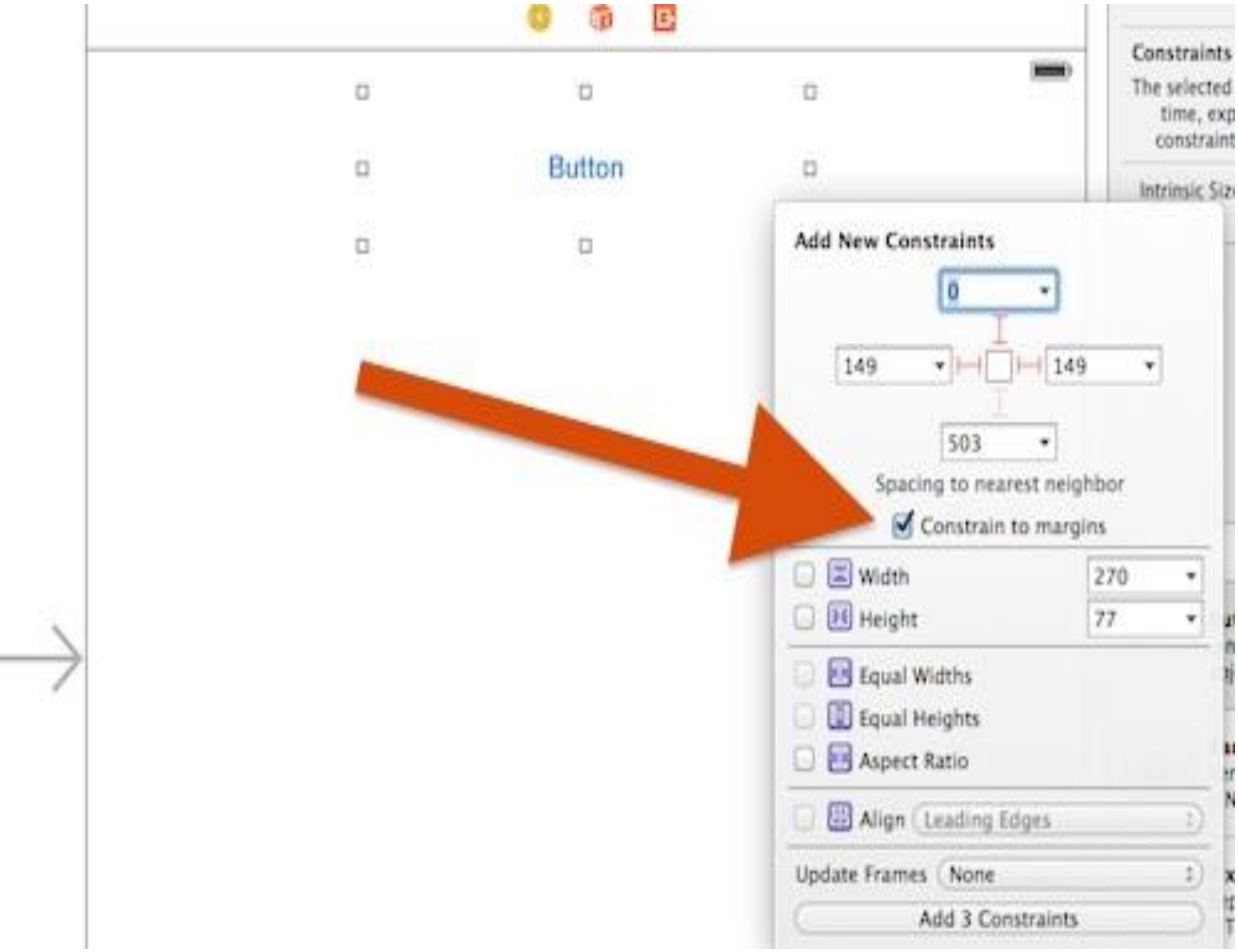


▸ Make sure the “Create Cit Repository” box is unchecked, and save the file anywhere you wish. Click “Create.”



▸ A new file will be created. In the panel on the left, you'll see a file menu labeled "Hello World." Expand the screen to see your project configuration settings.

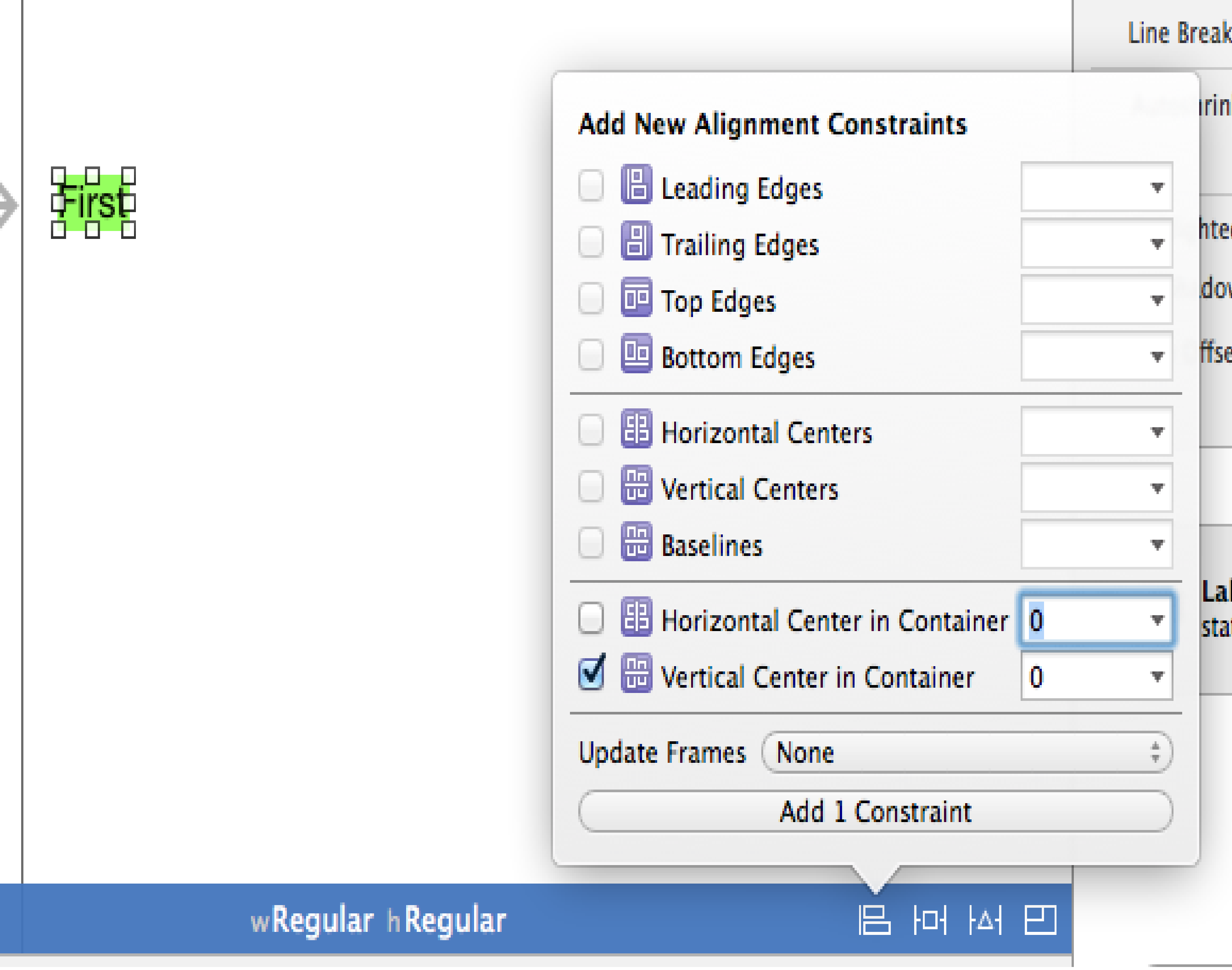
▸ Click Main.storyboard, and your screen will become a view for your application. Remember, this is a single-screen application. The arrow on the screen indicates your starting point. More complex apps have multiple screens and views, and the arrow shows which one you're currently working on.



‣ In the Library pane in the lower right-hand corner, you'll find lists or grid views of elements you can add to your screen. Enter "Label" in the search box, and when it appears in the library, click it and drag it to the screen.

‣ Double-click the text of the label, and type in "Hello, World."

‣ Click on the label, and then at the bottom of the screen, choose the Align icon. A menu will appear, titled "Add New Alignment Constraints."

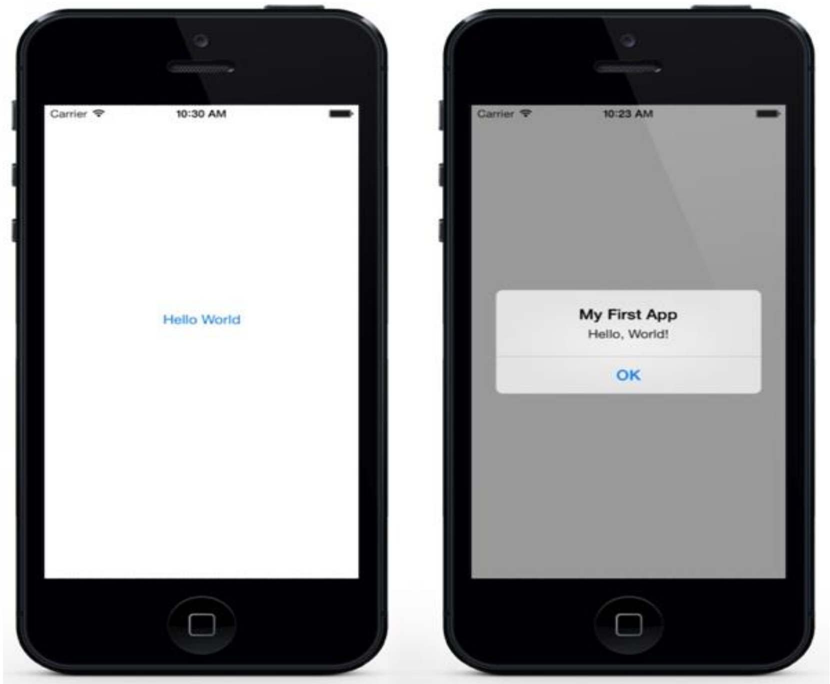


‣ Choose "Horizontal Center in Container" and choose "Vertical Center in Container."

This will center your label on the screen. Click "Add 2 Constraints." Gridlines will appear on the screen, showing where the label will be positioned.

▸ Click the “Run” icon (a triangle pointing right) in the upper left-hand corner of your screen.

▸ A simulator of an iPhone screen will appear, with the phrase “Hello, World” in the center of the screen on a white background.



Congratulations, you’ve created an iOS app!

Need further assistance in your quest for developing an iOS app?

Anuva specializes in helping to transform ideas into real-world applications, and our team of engineers and business development staff are available to answer your questions.

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What's Your Wearable Device IQ?

Take Our Quiz

Got a great idea for a wearable medical, health, or fitness device?

Want to tap into the booming “weartech” market that’s expected to hit $12 billion by 2018?

To help you better understand the basics of wearable device design and development, Anuva created the following multiple-choice quiz based on the information provided in the previous ebook chapters. Once you’ve completed the quiz, you can find the correct answers on the last page of this chapter.

Good luck!

1. Which motion-tracking sensor can be used in Microelectromechanical Systems, or MEMS, devices?

a) Accelerometer
b) Gyro
c) Magnetometer
d) All of the above

2. Which wearable device wireless option represents the longest range and the highest data rates?

a) Bluetooth
b) RFID/NFC
c) Wi-Fi
d) None of the above

3. What is the most common software-development testing procedure?

a) Unit
b) Integration
c) Regression
d) Validation
e) All of the above

4. Why would you want to connect a wearable medical device to the cloud?

a) Because it's required by the FDA
b) For data backup, data processing, and data sharing
c) To increase the power consumption of the device
d) You should never connect a wearable device to the cloud

5. Which biocompatibility test (according to the 10993-1) determines whether a device's material causes a level of discomfort on contact?

a) Cytotoxicity
b) Sensitization
c) Irritation
d) Genotoxicity

6. What is the simplest user interface option when designing a wearable device?

a)Pushbuttons and membrane switches
b) Capacitive buttons
c) LED indicators
d) Touchscreens

7. The wearable device market is expected to reach how much by the end of this year?

a) $12 Million
b) $5 Billion
c) $20 Billion
d) $12 Billion

8. When working with the engineering team to create a final list of wearable device product specifications, what question should you be prepared to answer?

a) What are your target timelines?
b) What is your estimated budget?
c) What other products and patents on the market are you familiar with that might be associated with your device?
d) All of the above

9. Among the various wireless options for wearable devices, which one needs to connect to a smart phone and is the most popular?

a) Bluetooth
b) Wi-Fi
c) RFID
d) None of the above

10. When connecting a wearable device to the cloud, what software is required to run a custom service?

a) Operating system
b) Database
c) HTTP Server
d) Scripts
e) All of the above

11. Which biocompatibility test (according to the 10993-1) determines if the device's material causes an immune response from the surrounding tissues or body systems upon application?

a) Hemocompatibility
b) Intracutaneous Reactivity
c) Acute Systemic Toxicity
d) Subacute/Sub-chronic Toxicity

12. When don't you need a smartphone application for a wearable device?

a) When you want to connect the device to the cloud
b) When the application can replace the display on the device
c) When the wireless transmissions of data from device to smartphone can create a security risk
d) None of the above

Here Are the Correct Answers:

1. d: All of the above
2. c: Wi-Fi
3. e: All of the above
4. b: For data backup, data processing, and data sharing
5. b: Sensitization
6. a: Pushbuttons and membrane switches
7. b: $5 Billion
8. d: All of the above
9. a: Bluetooth
10. e: All of the above
11. c: Acute Systemic Toxicity
12. c: When the wireless transmissions of data from device to smartphone can create a security risk

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This concludes our wearables ebook. Look for our upcoming online series focused on future technologies.

Seeking a premier turnkey engineering, manufacturing, and logistics company that specializes in design to distribution partnerships? Contact our team of experts to
BRING ON IMPOSSIBLE!

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