It's your data, it's from your body, you own it. You can contribute the information. With the World Economic Forum, we're working to establish data ownership rights. Making health data more valuable than it is now. The bottom line is we're moving into a domain where we can begin to figure out, for the first time, what leads to healthy behaviors and unhealthy behaviors.

The Quantified Self movement is a wonderful example of people spontaneously beginning to collect this data, using it to achieve a great deal about people's state of health.

For instance, I don't know how much the people I work with sleep. But my colleagues Sandy Pentland and his team have been doing a lot of work on sleep. And they know exactly what time people go to bed, what time they wake up, how often they get up during the night, how long they sleep, and so forth.

The question is, what do we do with this information? How do we make sense of sensors?

Sensors and sensor networks are all over. They already sit on our desks and beds, helping in monitoring our sleep and heart function. The real potential is to bring sensors into our homes. Sensors will sit on our bodies, in our homes, in our clothes, in our dwellings, wherever. Sandy says this is going to be a lot more interesting is the Quantified Self branch, where your pacemaker reports back to your doctor.

Sensors and sensor networks are a new technology. They already sit on our desks and beds, helping in monitoring our sleep and heart function. The real potential is to bring sensors into our homes. Sensors will sit on our bodies, in our homes, in our clothes, in our dwellings, wherever. Sandy says this is going to be a lot more interesting is the Quantified Self branch, where your pacemaker reports back to your doctor.

For instance, I don't know how much the people I work with sleep. But my colleagues Sandy Pentland and his team have been doing a lot of work on sleep. And they know exactly what time people go to bed, what time they wake up, how long they sleep, and so forth. The question is, what do we do with this information? How do we make sense of sensors?

Sensors and sensor networks are all over. They already sit on our desks and beds, helping in monitoring our sleep and heart function. The real potential is to bring sensors into our homes. Sensors will sit on our bodies, in our homes, in our clothes, in our dwellings, wherever. Sandy says this is going to be a lot more interesting is the Quantified Self branch, where your pacemaker reports back to your doctor.

Sensors and sensor networks are all over. They already sit on our desks and beds, helping in monitoring our sleep and heart function. The real potential is to bring sensors into our homes. Sensors will sit on our bodies, in our homes, in our clothes, in our dwellings, wherever. Sandy says this is going to be a lot more interesting is the Quantified Self branch, where your pacemaker reports back to your doctor.

Sandy: If we recognize that, we can set up networks so that they are more interested in recruiting people. We're much more creatures of habit, and change has to do with social reinforcement far more than it has to do with health benefits. There may be health benefits, but they may not be strong enough to lead people to change. We need to think about what a healthy or a sick network looks like.

Vivian: What are some of the trends around tracking people's diets?

Sandy: Well, there's a shocking projection that 400 million people will have diabetes. Understanding how people adopt unhealthy behaviors and unhealthy lifestyles is very important. We think that it's going to be really useful to be able to accurately detect when people were coming down with the disease.

Sandy: If we recognize that, we can set up networks so that they are more interested in recruiting people. We're much more creatures of habit, and change has to do with social reinforcement far more than it has to do with health benefits. There may be health benefits, but they may not be strong enough to lead people to change. We need to think about what a healthy or a sick network looks like.

Vivian: What are some of the trends around tracking people's diets?

Sandy: Well, there's a shocking projection that 400 million people will have diabetes. Understanding how people adopt unhealthy behaviors and unhealthy lifestyles is very important. We think that it's going to be really useful to be able to accurately detect when people were coming down with the disease.

Sandy: If we recognize that, we can set up networks so that they are more interested in recruiting people. We're much more creatures of habit, and change has to do with social reinforcement far more than it has to do with health benefits. There may be health benefits, but they may not be strong enough to lead people to change. We need to think about what a healthy or a sick network looks like.
Sandy: Well, there’s a shocking projection that 400 million wearable sensors will be on people by 2014. Most of those sensors will be aimed at very specific medical problems. But humans evolved as a social species. We have an amazing ability to assess other people and their health. Before you make any explicitly medical measurement, you can tell a great deal about people’s state of health. I talked about this in my book, Honest Signals. When you listen to people’s voices, for example, people can usually tell when other people are depressed. We’ve built sensors that screen effectively for depression by changes in voice tone and pitch. Some of my students started a company to build some of these tools that look at behavior and signaling, called Cogito Health.

Vivian: What are the things on a larger scale that you could use for diagnosis or screening of disease?

Sandy: People are inherently social, and we display our stress, our distress, through our behavior. We did a study with MIT students where, using cell phones, we could accurately detect when people were coming down with the flu, when they were stressed or depressed, just by how their pattern of activity and communication changed. It’s common sense, but we’ve never made it something that’s really a system. Now we can. Another spin-off company, Sense Networks, has used this kind of knowledge to screen for diabetes risk. If your behavior is similar to people who have diabetes, then your odds of diabetes are much higher. Understanding how people adopt these patterns of behavior and how we can change them is really core to our whole health system. People are not rational decision makers. We’re much more creatures of habit, and the habits are copied from the people around us. So behavior change has to do with social reinforcement far more than it has to do with information or argument.

If we recognize that, we can set up networks so that they reinforce healthy behaviors and not unhealthy behaviors. If you map out the networks of who listens to who, you can find small sets of people that are key to setting new ideas loose within the community. And if you reach them, they’re the ones that are the biggest change agents.

For instance, I don’t know how much the people I work with sleep. We’re going to give a small group of them Zeo sleep-tracking devices and look for patterns. Do sleep disorders correlate with events in the outside world? If you sleep less, does that mean you become less social? Less active? More stressed? We’ll combine the mobile phone monitoring, the Zeo data, and lifestyle questionnaires—it’s the combination of all these different sources of information that’s powerful.

Vivian: How do you see this evolving in terms of ubiquity in people’s lives over the next 10 years?

Sandy: I see two branches. One branch is the medical branch, where your pacemaker reports back to your doctor. That will happen and it’ll have important effects. But one I think is going to be a lot more interesting is the Quantified Self side, where people get to know more about their lives, their patterns, how they compare to other people, and how those relate to outcomes.

One concern is we need ways to look at people’s information and combine it that are safe and benefit the people that are contributing the information. With the World Economic Forum, we’re working to establish data ownership rights. It’s your data, it’s from your body, you own it. You can choose to share it and you can set up safe ways to do that, but you should share it when you get something out of it.

Vivian: What are some unintended consequences you might foresee?

Sandy: If we don’t put the right policies and structures in place, then the bad guys become more powerful. Would you really want to live in Zimbabwe if the government knew everything about you? Maybe not. It’s a new power, with pluses and minuses. We have to figure out how to use it wisely.

Vivian: Might we use sensors and sensor networks to compare ourselves to our neighborhood? What does this mean for creating healthy living environments or healthy neighborhoods?

Sandy: Researchers have looked at patterns of communication and mobility within neighborhoods, and drawn amazingly strong correlations with sociometric outcomes. There do seem to be information ghettos where people don’t communicate with the outside world very much. The bottom line is we’re moving into a domain where we have enough data and enough people living different ways that we can begin to figure out, for the first time, what leads to good neighborhoods and bad neighborhoods, good personal lives, good families, and good health.
Future technologies that will likely impact healthcare will be based on the next wave of technologies. These are wireless, miniaturized, and affordable sensors that can be used in multiple areas of patient care. As sensor prices drop, demand increases in various sectors, including healthcare.

### Sensor Technologies in Healthcare

**Advancements in Sensor Technology**

- **Wireless Sensors**
  - Bluetooth, WiFi, and other wireless technologies enable the transmission of data from sensors to a central location, allowing real-time monitoring.

- **Miniaturized Sensors**
  - These sensors are small and can be implanted in the body, providing continuous monitoring of various physiological parameters.

- **Affordable Sensors**
  - As sensor prices drop, the cost of healthcare technology continues to decline, making it more accessible to patients.

**Examples of Sensor Applications**

- **Healthcare Monitoring**
  - Wearable devices for monitoring heart rate, blood pressure, and other vital signs.
  - Smart homes for seniors with sensors to detect falls and changes in behavior.

- **Environmental Monitoring**
  - Sensors in cities to monitor pollution levels, noise, and temperature.

**Pain Management**

- Researchers are developing wireless pain sensors that can be implanted in the body, providing real-time feedback to prescribers.

**Remote Monitoring**

- Telemedicine platforms that use sensor technology to monitor patients remotely, improving access to care.

**Conclusion**

Sensor technology is rapidly advancing, enabling the development of new tools and devices that can improve healthcare outcomes and reduce costs. As sensor technology continues to evolve, we can expect to see more innovations in healthcare and other sectors.
Sensing technologies will be crucial in the fight against diabetes. In the early 1960s, diabetes management was limited to frequent blood glucose monitoring using hand-held meters. However, in 2006, Medtronic received FDA approval for the MiniMed system, which allowed for continuous glucose monitoring. This system is composed of a sensor, transmitter, and receiver, allowing patients to monitor their glucose levels in real-time. Since then, numerous continuous glucose monitoring devices have been developed, making blood glucose monitoring more convenient and effective.

Sensor technology has also played a significant role in diabetes management. For example, a sensor could be injected under the skin and connected to a transmitter and receiver. This would allow for real-time monitoring of blood glucose levels, providing patients with a more accurate picture of their glucose levels throughout the day. Continuous glucose monitoring devices have been shown to improve glycemic control and reduce the frequency of hypoglycemia and hyperglycemia episodes.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.

Sensor technology has also been used to develop technology that can detect and monitor specific health conditions. For instance, blood glucose sensors can be used to detect and monitor the emission of certain organic compounds that are characteristic of specific health conditions. These sensors can be used to develop cancer-sensing devices that can detect cancer at an early stage, allowing for more effective treatment.
...and to demand change. In doing so, we can help ourselves to these health risks, and to demand change. In doing so, we can help...
Senso-biometrics, an emerging technology in the medical sector, has the potential to revolutionize healthcare. By enabling medical professionals and patients to monitor health conditions and detect diseases in real-time, this technology could improve diagnosis, treatment, and patient outcomes.

Medical sensors are devices that can be implanted or attached to the body via sensors and transmitters. They are capable of collecting data from various sources, including internal body signals, external environmental factors, and remote monitoring devices. This data is then transmitted to a server for analysis.

Medical sensors can be categorized into different types based on their function and application. They include:

- **Internal sensors**: These sensors are implanted into the body and are designed to collect data from internal sources such as blood, tissues, or organs. They can monitor vital signs, detect diseases, or measure specific parameters.

- **External sensors**: These sensors are placed outside the body and are designed to collect data from external sources such as the environment, physical activity, or remote monitoring devices. They can monitor environmental factors, physical activity, or patient behavior.

- **Remote monitoring devices**: These devices are connected to the body and are designed to collect data from remote locations. They can monitor patient health, collect data for research, or provide real-time data to healthcare providers.

Medical sensors are used in various applications, including:

- **Diagnosis**: Medical sensors are used to diagnose diseases and detect abnormalities. For example, glucose sensors are used in diabetes management to monitor blood glucose levels.

- **Monitoring**: Medical sensors are used to monitor patient health and track vitals. For example, ECG sensors are used to monitor heart health.

- **Treatment**: Medical sensors are used to manage and deliver therapies. For example, insulin pumps are used to deliver insulin to patients with diabetes.

- **Research**: Medical sensors are used in research to collect data and test hypotheses. For example, researchers use sensors to monitor environmental conditions or track patient behavior.

Medical sensors are designed to be small, portable, and wearable. They are typically powered by batteries and are connected to smartphones or computers via wireless technology. They are becoming increasingly popular due to their convenience, ease of use, and ability to collect real-time data.

Medical sensors are expected to play a significant role in the healthcare industry by empowering healthcare providers with real-time data and enabling personalized healthcare. They are expected to improve patient outcomes, reduce healthcare costs, and enhance the patient experience.

Medical sensors are also expected to have a positive impact on the environment. For example, sensors can be used to monitor environmental conditions and detect pollution. This data can be used to inform policy makers and encourage sustainable practices.

Medical sensors are expected to be a major source of revenue for the healthcare industry. According to a recent report, the global medical sensor market is expected to reach $35 billion by 2025, growing at a compound annual growth rate of 9.8%.

Medical sensors are expected to revolutionize healthcare and play a significant role in the future of medicine. They are expected to improve patient outcomes, reduce healthcare costs, and enhance the patient experience. Medical sensors are expected to become an integral part of the healthcare ecosystem and play a significant role in the future of medicine.

Medical sensors are expected to be a major source of revenue for the healthcare industry. According to a recent report, the global medical sensor market is expected to reach $35 billion by 2025, growing at a compound annual growth rate of 9.8%.

Medical sensors are expected to revolutionize healthcare and play a significant role in the future of medicine. They are expected to improve patient outcomes, reduce healthcare costs, and enhance the patient experience. Medical sensors are expected to become an integral part of the healthcare ecosystem and play a significant role in the future of medicine.

Medical sensors are expected to be a major source of revenue for the healthcare industry. According to a recent report, the global medical sensor market is expected to reach $35 billion by 2025, growing at a compound annual growth rate of 9.8%.

Medical sensors are expected to revolutionize healthcare and play a significant role in the future of medicine. They are expected to improve patient outcomes, reduce healthcare costs, and enhance the patient experience. Medical sensors are expected to become an integral part of the healthcare ecosystem and play a significant role in the future of medicine.
Vivian: We wanted to talk to you about the work that I’m doing on sensors in health and how we might use it.

Meaningful data vs. too much data
Although sensors and sensor networks are becoming smaller and more pervasive, it is not enough to simply have their technology in our daily lives. We still need to integrate sensor networks into the workplace, school, and home environments. It’s not enough to generate data without having the right context to interpret that data in the right way.

The management of data should allow for sensor technology optimization, making it possible for health data to be shared globally. It is important for organizations and communities to share data in a meaningful way. Every sensor network creates data, but you should only share the data when it is meaningful and useful for people in the community.

The Quantified Self movement is a wonderful example of people spontaneously beginning to collect this type of data. Regular monitoring of the social health of a patient is becoming more important. People are inherently social, and we display our habits and behavior change within the network.

The habits are copied from the people around us. So behavior decision makers. We’re much more creatures of habit, and it is important to understand how habits can be influenced.

People are not rational decision makers. What do we have to do to make it easier for people to change their habits?

The habits are copied from the people around us. So behavior decision makers. We’re much more creatures of habit, and it is important to understand how habits can be influenced.

People are not rational decision makers. What do we have to do to make it easier for people to change their habits?

The habits are copied from the people around us. So behavior decision makers. We’re much more creatures of habit, and it is important to understand how habits can be influenced.

People are not rational decision makers. What do we have to do to make it easier for people to change their habits?

The habits are copied from the people around us. So behavior decision makers. We’re much more creatures of habit, and it is important to understand how habits can be influenced.

People are not rational decision makers. What do we have to do to make it easier for people to change their habits?

The habits are copied from the people around us. So behavior decision makers. We’re much more creatures of habit, and it is important to understand how habits can be influenced.

People are not rational decision makers. What do we have to do to make it easier for people to change their habits?

The habits are copied from the people around us. So behavior decision makers. We’re much more creatures of habit, and it is important to understand how habits can be influenced.

People are not rational decision makers. What do we have to do to make it easier for people to change their habits?

The habits are copied from the people around us. So behavior decision makers. We’re much more creatures of habit, and it is important to understand how habits can be influenced.

People are not rational decision makers. What do we have to do to make it easier for people to change their habits?