GIVING A VOICE TO GENIUS

By Howard High

It is 1997. What started as a brief dinner encounter with Gordon Moore and others from Intel, a fateful evening has grown into a 20 year relationship between Intel and Stephen Hawking that has battled to keep Hawking's technology ahead of his declining physical capabilities.

Is there ever a time when Gordon Moore isn't the smartest guy in the room? It may have been the case at a small dinner party in 1997 tucked away in the back of Santa Clara's Marriott Hotel. Stephen Nachtsheim and his wife Jami Dover, along with Moore and others from Intel, had been invited to attend a smaller gathering in advance of a presentation by Stephen Hawking.

"I don't remember exactly what the event was, but I had the opportunity to talk with Hawking directly. I remember his wife pointing out that it was great I talked directly to Hawking since most people had a habit of talking to her even when he was sitting right there. I was surprised that it was pretty easy to communicate with him," recalled Nachtsheim.

At that time Hawking was using a desktop computer connected to large batteries bolted to the back of his wheelchair. His computer, while Windows OS-based, featured a DOS-quality screen, a speaker to act as his voice, and a device he could move with his hand. It was primitive and slow, but proved to be a useful tool for him.

Hawking has motor neurone disease related to amyotrophic lateral sclerosis (ALS) that limits how his neurons provide motor functions to his muscles. Ultimately ALS leads to paralysis. Hawking was diagnosed in 1963 and, at the age of 21, given just a few years to live. Hawking surpassed such doomsday predictions and continued to feed himself and get into and out of bed unaided for another decade. But as the years passed, his muscular motor skills deteriorated and in 1985 he caught pneumonia on a trip to Geneva that required a tracheotomy so he could breathe which resulted in him losing his ability to speak.

"Although I cannot move and I have to speak through a computer, in my mind I am free."
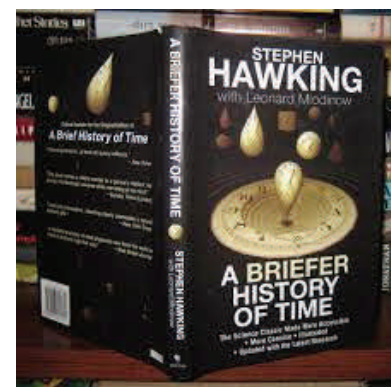
-Stephen Hawking

These disabilities didn't stop Hawking from making remarkable contributions to science. Hawking was the first to set forth a theory of cosmology explained by a union of the general theory of relativity and quantum mechanics. He is a vigorous supporter of the many-worlds interpretation of quantum mechanics.

In 1974, Hawking became a celebrity within the scientific world when he showed that black holes aren't the information vacuums that scientists had thought they were. He demonstrated that matter, in the form of radiation, can escape the gravitational force of a collapsed star. "Hawking radiation" was born. The announcement sent shock waves of excitement through the scientific world, and put Hawking on a path that's been marked by awards, notoriety and distinguished titles.
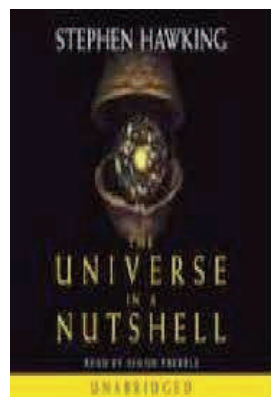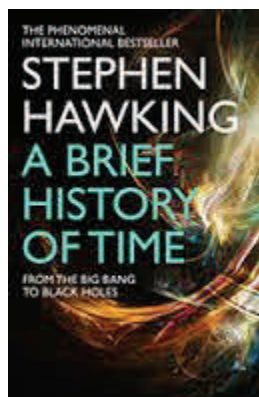
In 1988, Hawking catapulted to international prominence with the publication of *A Brief History of Time*. The short, informative book became an account of cosmology for the masses. The work was an instant success, spending more than four years atop the London Sunday Times' best-seller list. Since its publication, it has sold millions of copies worldwide and been translated into more than 40 languages. But it also wasn't as easy to understand as some had hoped. So in 2001, Hawking followed up his book with *The Universe in a Nutshell*, which offered a more illustrated guide to cosmology's big theories. Four years later, he authored the even more accessible *A Briefer History of Time*. In 2014, a feature film -- *The Theory of Everything* -- was made about Hawking's relationship with his first wife, his diagnosis of motor neurone disease, and his success in physics.

THE COMPUTER

But in 1997, after that fateful evening with Gordon, Stephen and others from Intel began a long lasting relationship that has battled to keep Hawking's technology ahead of his declining physical capabilities. "As GM of the Mobile and Handheld group (MHPG) at the time, it was pretty obvious that we could construct a system that would be way better than what he had. I went over to Gordon and suggested that we do so. He enthusiastically agreed, so I went back to Hawking and asked him if he would be OK with that and he wholeheartedly agreed." recalled Nachtsheim.

The challenge fell on the shoulders of Dan Lenehan and his team responsible for the Systems portion of MHPG. "Our target was to get Hawking the latest mobile system using the Pentium processor. Toshiba gave us some notebook motherboards to be the center piece of this custom build," Nachtsheim said.

Hawking's original system ran under DOS. Windows took over the world, he was forced to try and run his voice synthesisng software (EZ Keys) in a "DOS box." As Lenehan recalls, processor interrupt performance became critical because EZ Keys would scan through recently used words and phrases allowing Hawking to select these words by squeezing a switch in his hand. This made his text creation much faster. "The processor in his old computer (an AMD 486) didn't have enough performance to allow him to select his intended choice consistently. The scanning became jerky and he was missing his intended target frequently," noted Lenehan.

Professor Hawking is using new software to speak, but has opted to keep the same voice.

"We also had mechanical and electrical constraints driven by his wheelchair. We built a chassis in the same form factor as his original computer to house the Toshiba boards and we selected a DC-DC power converter to switch power from the wheelchair's 12V car battery to the Toshiba DC input voltage," Lenehan said

Manny Pitta took charge of building the chassis and the system. A couple of the key challenges were that it had to run the software that Hawking was used to, and Intel wanted it to be upgradeable. "We explored upgrading the software and speech synthesizer but he was not interested in making a switch," Manny remembered. It turned out that he was proficient using EZ Keys and was reluctant to learn a new system. The same applied to Hawking's speech synthesizer. By 1997, advances in technology had led to the availability of software that sounded more human. However, it was the sound of the original synthesizer that had become recognized as Hawking's, and he didn't want to lose "his voice" for a second time.

Manny recalled that when he visited Hawking at Cal Tech to finalize specifications for the Mobile Pentium upgrade, he had a chance to speak with him and remembered the physicist's sense of humor. "We marveled over the fact that even with these severe limitations on his ability to interact with people, he was able to project his personality outward," he noted. "I recall that during the Cal Tech trip, someone mentioned that it was time for afternoon tea. In an instant, I saw the back of Professor Hawking's wheelchair as he raced out of the office to join in on the festivities," Manny recollected.

Once the new computer system was ready, Manny traveled to Hawking's office in Cambridge to do the installation.

It took about six months to design, build, install and test the new system. By the time it was all done, the news system ended up being about a 10x improvement over Hawking's existing system and with much longer battery life.

Later Chris Moore (no relationship to Gordon), working under Matt Fruin, took on the responsibility of maintaining and upgrading Professor Hawking's computer.

When MHPG brought out the Mobile Pentium Processor a little later, Chris upgraded the system to take advantage of the latest technology. That effort has continued over the many years with many different Intel engineers striving to keep Hawking's system current to Moore's Law. Intel tends to upgrade Hawking's computer every couple of years.

Regarding his computer, Hawking has recently posted:

"Since 1997, my computer-based communication system has been sponsored and provided by Intel® Corporation. A tablet computer mounted on the arm of my wheelchair is powered by my wheelchair batteries, although the tablets internal battery will keep the computer running if necessary.

My main interface to the computer is through a program called EZ Keys, written by Words Plus Inc. This provides a software keyboard on the screen. A cursor automatically scans across this keyboard by row or by column. I can select a character by moving my cheek to stop the cursor. My cheek movement is detected by an infrared switch that is mounted on my spectacles. This switch is my only interface with the computer. EZ Keys includes a word prediction algorithm, so I usually only have to type the first couple of characters before I can select the whole word. When I have built up a sentence, I can send it to my speech synthesizer. I use a separate hardware synthesizer, made by Speech+. It is the best I have heard, although it gives me an accent that has been described variously as Scandinavian, American or Scottish.

Through EZ Keys I can also control the mouse in Windows. This allows me to operate my whole computer. I can check my email using the Eudora email client, surf the internet using Firefox, or write lectures using Notepad. My latest computer from Intel, based on an Intel® Core™ i7 Processor and Intel® Solid-State Drive 520 Series, also contains a webcam which I use with Skype to keep in touch with my friends. I can express a lot through my facial expressions to those who know me well.

I can also give lectures. I write the lecture beforehand and save it on disk. I can then send it to the speech synthesizer a sentence at a time using the Equalizer software written by Words Plus. It works quite well and I can try out the lecture and polish it before I give it.

I keep looking into new assistive technologies, and recently Intel® have sponsored a team of its engineers to design a new facial recognition system aimed at improving my communication speed. They also have some new ideas regarding my software interface and it will be interesting to see the results of this. It looks quite promising. I have also experimented with Brain Controlled Interfaces to communicate with my computer however as yet these don't work as consistently as my cheek operated switch."

Stephen Hawking

achievement

That initial Intel team won an Intel Achievement Award for its efforts to equip Stephen Hawking with the tools he needed to continue contributing his greatness to the world. What started as a brief dinner encounter in 1997 has grown into a 20 year relationship between Intel and Hawking. This initial group's groundbreaking work equipped one of the most important scientific minds of our generation with some of the world's most advanced computer technology. This allowed Hawking to carry on with his important work uncovering how our universe operates as Intel has continued to give a voice to his genius.

"Remember to look up at the stars and not down at your feet. Try to make sense of what you see and wonder about what makes the universe exist. Be curious. And however difficult life may seem, there is always something you can do and succeed at. It matters that you don't just give up."

-Stephen Hawking