



ShoreTel Ergonomic Phones Whitepaper

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Ergonomic Phone Design

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You expect your cell phone to be well designed. You expect your MP3 player to be great. You want a stylish, ergonomically correct office chair. You demand great design from the kitchen utensils and power tools you use at home. But when it comes to your office phone, you've had to settle for absolute mediocrity.

Business professionals spend many hours on the phone each day, whether collaborating with coworkers and partners or interacting with customers and suppliers. Call-center workers literally spend all day on the phone. But despite the long hours, many of these professionals use the equivalent of a \$10 cordless screwdriver when they should be using professional-grade DeWalt power tool. Employees are the most expensive asset in any company, and making them more productive is key to delivering business value.

Although the telephone is indisputably the most essential business communications tool, the importance of great office telephone design has largely been ignored since Bell Labs invented the touchtone phone more than 50 years ago. A well-designed office phone is an instrument of real business value. A great phone must sound great, but it also needs to be easy to use and aesthetically pleasing to view.

Bringing Ergonomics to Phones

Good ergonomic design adapts the device to the user and makes the device easier to use. Ergonomics is the science of designing products, machines and systems to maximize the safety, comfort and efficiency of the people who use them. In ergonomics, designers draw on many principles, including industrial engineering, psychology, human measurement, and biomechanics to adapt the design of products and workplaces to people's sizes and shapes and their physical strengths and limitations. Armed with a complete picture of how people interact with their environment, ergonomists develop the best possible design for products and systems. One of the primary goals of ergonomics is to prevent workplace illnesses and accidents. Ergonomists also seek to increase worker efficiency and productivity when designing workspaces.

The modern discipline of ergonomics can be dated back to 1949 at an interdisciplinary meeting of those interested in human work problems in the British Navy. Today, the science of ergonomics is used widely—in everything from the creation of consumer products goods like toothbrushes and razors, computer products like displays and keyboards, automobile interiors, and manufacturing assembly lines. Even the design of the graphical user interface, with its icons and drop-down menus, did much to make once-cryptic computers usable by virtually anyone.

ShoreTel Embraces a Human Centered Design

ShoreTel has been focused on great design from the founding of the company. ShoreTel Personal Call Manager™ is widely recognized in the industry as easy to use because of its intuitive user interface. ShoreTel's IP phone, which can be considered a physical manifestation of Personal Call Manager, delivers the ultimate in ergonomic and aesthetics design including superior audio quality. ShoreTel's IP phones builds on our leadership as a design and technology innovator.

"When we introduced IP phones, we took it as an opportunity to create a higher quality phone," said Tom van Overbeek, who was a major driver of the IP phones' ergonomic design as ShoreTel's past CEO and a current member of the Board of Directors. "The design philosophy behind ShoreTel's IP phones is simple: Your office phone should be a joy to use."

Creating a phone that is a joy to use means pleasing the senses of hearing, sight and touch. A ShorePhone looks different than the usual boring black office phone. Make a call or answer a call, and you'll notice that the phone feels great. When you hear the audio clarity, you'll be nothing short of astounded.

Designing a great sounding, affordable phone that was a pleasure to use meant revisiting some vintage ideas and throwing out some preconceived notions. “We designed an office phone that has the best possible sound quality,” said Ed Basart, Chief Technology Officer at ShoreTel. “No one had ever tried to do that before.”



“We started by looking backward,” said Curt Anderson, Founder of Compass Product Designs, the industrial design firm instrumental in the design of the ShoreTel IP phones. One inspiration was the Bell “500” desk phone, which was created in 1949 and became the gold standard for easy-to-use phones around the world.

Another inspiration came from professional cycling. The handlebars of a racing cycle are designed to be held in multiple positions to minimize rider fatigue after long hours on the bike. Business professionals similarly spend grueling hours on the phone.



ShoreTel also looked to the sleek design of the Audi dashboard, which puts all the controls within the easy reach of the driver. Similarly, ShoreTel put all of the controls for the telephone within each reach and sight.

ShoreTel was one of the first in the industry to implement a hi-fidelity, wideband audio codec, in its IP phones, which has created the first improvement in telephone sound quality in 75 years. ShoreTel worked with MWM Acoustics, a world-renown acoustical engineering firm, to custom design the microphones and speakers used in the speakerphone and the handset for exceptional sound quality from a desk phone.

Designed for Sound

While some other IP PBXs have lesser sound quality than traditional TDM PBXs, the packet-based nature of IP telephony is actually an opportunity to deliver better than toll-quality sound. The rich sound of ShoreTel phones results from hi-fidelity audio and innovative design. ShoreTel phones deliver seven octaves of range, whereas most phones deliver only three octaves. Hi-fidelity sound simply sounds better, is easier to understand and is less tiring on the listener. Better sound translates into productivity gains – shorter calls with fewer errors or higher sales because salespeople are more clearly understood.

Hi-fidelity audio, also known as wideband audio, is possible once IP telephony is freed from the narrowband audio used on the public switched telephone network (PSTN). Wideband audio, which is specified in TIA-920, provides bandwidth from 50 Hz to 7,000 Hz, which more than doubles today’s 300 Hz to 3,400 Hz narrowband standard. Because a wideband codec samples speech at twice the 64-bit rate of conventional PSTN calls, the sound quality is more natural.

Narrowband was locked in during the transformation of the PSTN from analog to digital in the 1980s and the adoption of the G.711 codec. The lower frequency limit of narrowband was set at a practical level to avoid noise in the external environment, such as 60 Hz from power lines and other electrical gear. The upper limit comes from the Nyquist Theorem which says that a sine wave can be reconstructed from sampled data at a maximum of half the sample rate. In our case here, the sample rate is 8 KHz, the Nyquist limit is 4 KHz, and because of the limits in the algorithm, errors begin to creep in at 3,400 Hz, which is the set upper limit on most systems.

Overall, two-thirds of the frequencies in which the human ear is most sensitive and 80 percent of the frequencies in which speech occurs are beyond the capabilities of the public telephone network. Contrast narrowband telephone performance to FM radio and television, which span 30 Hz to 15 kHz, CD audio covers 20 Hz to 20 kHz, professional and audiophile audio 20 Hz to above 22 kHz, and AM radio extending up to 5 kHz.

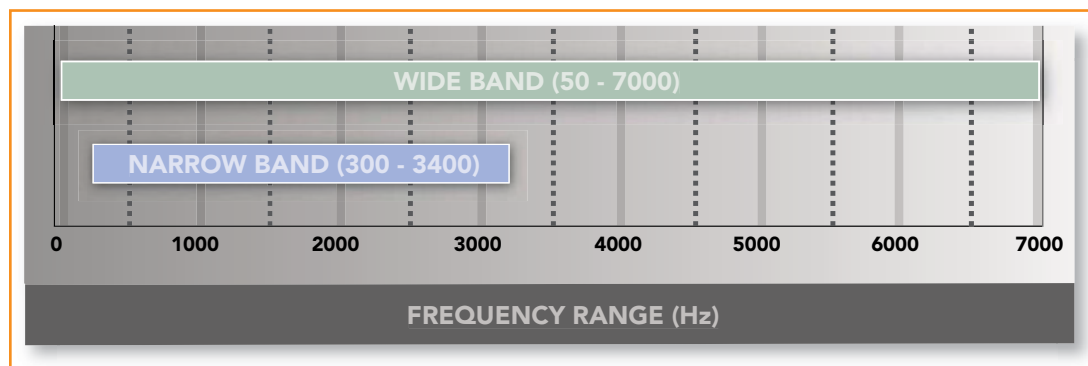


Figure 1: Wideband audio technology provides bandwidth from 50Hz to 7,000 Hz, which more than doubles today's 300 Hz to 3,400 Hz standards. The wideband codec samples the speech at twice the rate of conventional narrowband PSTN calls, which results in superior speech quality.

With wideband audio, the increased range on the low end (50-300 Hz) makes conversations sound less tinny (think of more "bass" on your stereo). The increase on the upper range contributes to the naturalness of the speaker's voice (think of more "treble" on your stereo). In musical terms, adding 150-300 Hz gives one additional octave, and 75-150 Hz adds a second octave at the low end. According to a Polycom whitepaper by Jeff Rodman ("The Effect of Bandwidth on Speech Intelligibility, January 2003), much of the intelligibility of human speech comes from the vowels, which have a fundamental frequency of 100 Hz. In user testing, the intelligibility improves from an accuracy of 75 percent at 3300 kHz bandwidth to over 95 percent at 7 kHz bandwidth. Users will no longer have to spell out words ("S" as in "Sam," "a" as in "apple,") to be understood.

Measurements show that the intelligibility of speech decreases with decreasing bandwidth. A sentence composed of ten words, each with 90 percent reliability, has only a 35 percent probability of being understood clearly. In normal speech, words come out at a rate of 120 words per minute. Consequently, 3.3 kHz speech produces about 40 ambiguities per minute, where 7 kHz speech will produce fewer than four, or close to the accuracy of live, open-air speech.

The expansion of global business has increased the importance of accurate telephone communications among workers who have different native languages or dialects. Understanding accented speech can be much more difficult than native speech, both because of the presence of an accent, and because grammar, pronunciation and even word selections are much different than the listener expects. The importance of the physical parameters of speech communications rises, because listeners cannot always deduce an unclear word from its grammatical context.

ShoreTel's use of wideband audio in the ShorePhone IP phone is just one ingredient in delivering great sound. ShoreTel also optimized the speakerphone design so you won't sound like you're on a speakerphone at all. Users get the convenience of a speakerphone with the sound quality of a handset. A ShorePhone can be used in a small and mid-sized conference rooms without worrying about the tinny echo that plagues conventional speakerphones.

ShoreTel and MWM Acoustics designed the handset and speakerphone microphones and handset speakers to meet ShoreTel's requirements for hi-fidelity sound. The custom high-gain speakerphone microphone delivers outstanding sound pickup. The speakerphone has full-duplex operation, so the audio flows continuously between both ends. Not all conventional speakerphones do this, and as a result, conversations often sound clipped. The high-volume output on the speakerphone meets ADA compliance for the hearing impaired.

The innovative placement of the microphone in the ShorePhone also drives hi-fidelity sound. The speaker-phone microphone is located away from the speaker for maximum sound isolation. The microphone points downward and the phone is slightly lifted by the base, giving it a 360-degree pickup range.

The speaker grill has more than twice the standard number of holes, which quite simply lets the sound out. As any audiophile knows, good speakers allow for plenty of air and a large, round enclosed speaker cavity on the underside of the phone creates this volume.



Figure 2: The phone includes a high-gain, custom-designed speakerphone microphone for loud, clear sound.



Figure 3: The speaker grill communicates the large “speaker engine” under the hood.

The ShoreTel handset has a high-gain microphone for exceptional sound quality. The handset meets ADA compliance for the hearing impaired, as it is a non-magnet speaker that’s compatible with hearing aides and delivers high-output volume.

The ShoreTel phones are standards-based and support G.729 and G.711 codecs as well as the wideband codec.

Designed for Sight

A beautiful phone is as much a part of office décor as a mahogany desk or ergonomic executive chair. ShoreTel designed ShorePhones to encourage interaction. The phones are aesthetically pleasing, with elegant, sweeping lines.

ShorePhones come in black and silver to match your office style, whether more traditional or style-conscious. The IP 560 executive and IP 560g gigabit phones are beautiful silver or black aluminum. The IP 230 office worker, IP 212 key system, and IP 110 public area phones are black or silver plastic with a special texture that mimics aluminum.



Figure 3: ShoreTel IP phones are designed to be aesthetically pleasing. They come in silver or black to match your office style.

The phone base has a gentle concave sweep, which places the keypad more horizontally for ease of dialing—like a laptop—while the display remains on a vertical angle so it’s easier to see. Workplace studies show that people find it easier to read displays when they are placed lower and angled upward toward their faces, just like reading the morning newspaper. The ShorePhone resolves the classic conflict of traditional desk phones—you can see the phone display or you can use the keypad, but you can’t see the display and use the keypad at the same time. With the ShorePhones, users don’t have to fiddle with a swiveling display to see who they’re dialing.

The audio controls for the speaker, headset and mute provide clear, quick access. Users can easily switch between a handset, headset and speaker without inadvertently disconnecting the call. With bright indicators of whether a person is on speaker, a headset or muted, visitors walking into an office can see at a glance whether the person is on the phone. This eliminates the most frequent office conversation-starter: “Are you on the phone?”

The volume control, headset and speaker buttons are clearly labeled with internationally recognized symbols. Volume for the handset, speaker, and headset and ringer are independently controlled and automatically remembered.

The display on the ShorePhone is large and easy to see— which is particularly important as the average age of the workforce is increasing. The IP 560 executive and IP 560g gigabit phones have bright, backlit displays for exceptionally easy reading. The IP 230, IP 212 and IP 110 phones have high-contrast displays, which are easy to see. “Cell phones typically have bright displays, but ShoreTel pioneered putting a nice, bright display on office phones,” said Basart. “We designed the display so you can see it easily and without any glare.”



Figure 4: It’s easy to switch between a handset, headset and speaker. Plus, bright indicator lights make it easy to see if a person is on the phone.

The message-waiting light is large and bright. It’s visible from 360 degrees because it’s located at the top right corner of the phone. A user can see if a message is waiting even if the phone is turned away from him or her. The line buttons are color-lit so they are easy to use.



Figure 5: A large, bright message waiting light makes it easy to see if a message is waiting even if the phone is turned away from the user.

Designed for Touch

A phone should feel comfortable and be easy to use. ShoreTel placed a major focus on designing the handset to maximize productivity while minimizing user fatigue and shoulder and neck pain. ShoreTel tested 35 competitive handsets to understand people's behaviors and preferences when using the phone, and evaluated hundreds of models for its own phone design in its user testing efforts to determine the ideal design.

The ShoreTel handset feels balanced in a user's hands. A handset that's too light feels flimsy and cheap. A handset that is too heavy can feel awkward and lead to fatigue. ShoreTel designed the handset with an ideal, balanced weight of 180 grams. The handset is weighted toward the earpiece, so a user can easily pick up the phone and rotate it to his or her ear in a fluid motion—not unlike swinging a hammer.

The ShoreTel handset has a smooth rubber grip that feels great in your hand. The material is similar to the covering used on ergonomic hand tools or kitchen utensils. Many phones are plastic and slippery, which makes for sweaty hands on long conference calls.

ShoreTel designed the handset to be held in multiple ways. Business professionals spend hours on the phone and how a person holds a handset depends on personal preferences and other tasks he or she performs simultaneously, like typing or using the telephone keypad. The handset has a slim waist, so users can easily grip it around the middle, pick it up in different ways, or hold it by the mouthpiece. Other vendors' handsets are designed like two-by-four blocks with hard angles that do not match the hand's natural curvature.



Figure 7: The handset can be held across the saddle, with the handset matching the curves of the hand.



Figure 8: A user may hold the handset with an index finger on the back, so there is a finger notch.



Figure 9: The mouthpiece has rounded corners so a user may comfortably hold the handset around the mouthpiece.



Figure 10: A user may hold a handset with a thumb on the back, using the finger notch.

It's easy to pick up a ShorePhone, because there's plenty of room created by the curvature of the handset against the inverse curvature of the phone base. The handset fits neatly into the hand. Picking up a conventional bar-shaped phone can be clumsy because there isn't enough space between the handset and the base. (How many times have you accidentally hung up on a caller because you knocked the phone while trying to pick it up?)

Figure 11: When you pick up the handset, you'll find the handset conforms to the shape of your hand.

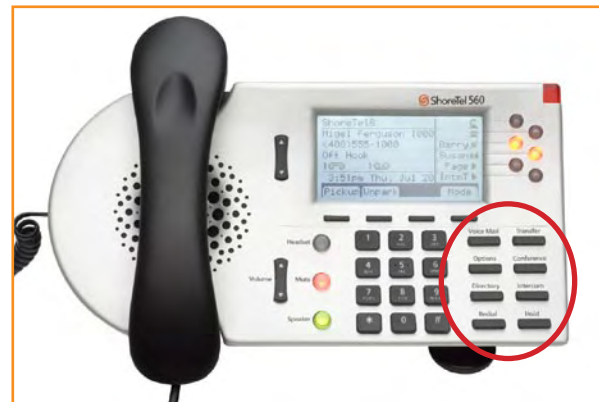


ShoreTel designed the earpiece for comfort when pressed against the ear. It's easy to transfer and rest the headset against your shoulder, which minimizes tension in the neck.

The keypad buttons on a ShorePhone have a progressive feel. They provide enough resistance so they feel like they're being used without being clunky. Tactile feedback is critical for visually impaired people, and the ShoreTel phones meet the American Disabilities Act (ADA) requirements (see sidebar). The buttons have a mild texture so fingers hit and stay on the button, which makes it easier to dial without looking directly at the keypad. Indents on the "5" key also help guide the visually impaired. Audio controls are symbolic and easy to understand at a glance.

The ShoreTel phones have fixed-feature keys for consistent, easy access to the most common operations, including transfer, conference, intercom, hold, voice mail, options, directory and redial. Phones that rely too heavily on soft keys can be difficult to use, since common features can be hard to find or can change position. The feature keys are labeled in English, which minimizes training for new users. At the same time, the keys are grouped together so you can easily add an overlay with symbols for international use.

Figure 12: ShoreTel has grouped together the feature keys for the most common features for consistent, easy access. This includes transfer, conference, intercom, hold, voicemail, options, directory and redial.



- **Soft keys** on the ShoreTel phones provide context-sensitive operations, making even complex operations easy.
- The **directory** key leverages the QuickDialer on the Personal Call Manager, which provides smart filtering that allows a user to just type one digit per letter. Users can instantly locate and call another person by entering just the first few characters of a name on the keypad, and the phone automatically displays all of the matches. To reach a user named “Rich,” you simply press 7 once (R), 4 once (I), 2 once (C), and you start seeing all of the matches for RIC... You do not have to press 7 three times, 4 three times and 2 three times like with other poorly designed systems. Plus, the directory is always up to date with all people on the system, because new users are dynamically added to the directory.
- The **redial** key on the phone is more than just redial. If a user hits the redial key once, a complete call history of inbound, outbound and missed calls appears. Then the user selects the desired number, and hits the key again to automatically redial.
- The **options** key allows quick management of user’s personal options, including call handling and ring-tone selection.
- The **voice mail** key provides quick, one touch access to voice mail.
- The idle display quickly communicates the name, date, time, extension, DID, number of missed calls, number of voicemail, agent state and call handling mode. The call display indicates the status of call including the status, caller ID and call timer.



Figure 13: Soft keys provide context-sensitive operations, making the phone easy to use.

Designed to be Easy to Manage

Not only are ShorePhones a joy to use, and systems administrators will find that managing the phones as well as the ShoreTel phone system is easy and efficient—even when the organization has many locations.

Installing a ShoreTel IP phone system is plug-and-play. A non-technical person can simply plug in a new phone, and the phone automatically gets an IP address, subnet mask, and gateway plus the accurate time from a time server as well as the latest software from the ShoreTel management server. There’s no need to manually “flash” the telephone for a software update as with other vendors’ phones.

When the ShoreTel phone comes up as “available,” a person simply walks up to the phone, logs in to voicemail, then assigns their extension to the phone. This simple process makes deployment fast, easy—automatic. The keys are self-labeled, so the buttons are always accurate and eliminate the tedious manual labeling of key caps.

An administrator can use ShoreWare™ Director to easily deploy software updates to the phones in any office from a central location. As new software releases become available, an administrator can automatically update all of the phones via a network download, further reducing administrative costs.

Administrators can clean up the clutter of wires under users’ desks. All models of phones—even the IP 110 lobby phone—have an embedded Ethernet switch, so only one wire to the desktop is needed. Plus, all phones support standard power over Ethernet (PoE).

A Wide Range of Phones

ShoreTel has a wide range of phones to meet organizations' varying requirements for functionality and price.

The phone of choice for telephony-intensive professionals and executives is the IP 560. It has six line appearances, four soft keys, a full duplex speakerphone, a large backlit screen, and a headset jack. The aluminum cover, which comes in silver or black, is both beautiful and cool to the touch. The IP 560g is functionally equivalent, but has a 10/100/1000 Ethernet switch for users with gigabit speed requirements to the desktop like designers, architects and media creators.

The IP 230 is designed for knowledge worker who relies on the telephone as well as ACD agents and supervisors. This phone has three line appearances, eight function keys, four soft keys, a high contrast display, a full duplex speakerphone, and a headset jack.

The IP 212k is ideal for users with shared call handling responsibility in key system environments like retail stores, branch offices and small offices. The IP 212k has 12 line appearances, eight feature keys, two soft keys, a high contrast display, a full duplex speakerphone delivering headset-level audio performance, and an integrated headset jack.

The single line IP 110 phone is well suited for open areas including lobbies, classrooms and dorm rooms. The IP 110 has six feature keys for common operations, a line display for caller ID, date and time, as well as a speaker for one-way intercom.

As a leader in IP phone systems, ShoreTel continues its innovation in phone design. "We make continuous improvements to our phones," said Basart. "We focus on what people want and have created a full line phones that are easy to use, look great and provide superior sound."

ShoreTel Compliance with the American Disabilities Act

The ShoreTel system complies with the American Disabilities Act (ADA) of 1990 and the associated regulations issued by the Federal agencies that define guidelines for accessibility to places of public accommodation and commercial facilities by individuals with disabilities. These guidelines include requirements for telephones and telephone systems.

All models of the ShorePhone are ADA compliant, meeting the “ADA Standard for Accessible Design” (Pt. 36, Appendix A, Section 4.31, Telephones) and the 508 provision for TDD/TTYs.

The ShoreTel phone system complies with the specific items:

- **Volume Control** – Telephones should have volume controls that provide a gain adjustable up to a minimum of 20 dB. The telephones should provide at least one intermediate step of 12 dB for incremental volume control.
Complies – The ShorePhone telephone meets the volume requirements.
- **Automatic Volume Reset** – The telephone should automatically reset the volume to the default level after every use.
Complies – The ShorePhone telephone meets the volume reset requirements.
- **Hearing Aid Compatibility** – The telephone should have a means for effective magnetic wireless coupling to hearing technologies shall be provided.
Complies - The ShorePhone handset has been designed not to interfere with the magnets found in hearing aides.
- **Minimized Interference** – Interference to hearing technologies, including hearing aids, cochlear implants, and assistive listening devices, shall be reduced to the lowest possible level that allows a user of hearing technologies to use the telephone.
Complies - The ShorePhone handset has been designed not to interfere with the magnets found in hearing aides.
- **Support for TDD/TTYs** – Products that transmit or conduct information or communication, shall pass through cross-manufacturer, non-proprietary, industry-standard codes, translation protocols, formats or other information necessary to provide the information or communication in a usable format. Technologies which use encoding, signal compression, format transformation, or similar techniques shall not remove information needed for access or shall restore it upon delivery.
Complies - The ShoreTel system supports standard analog telephone ports that connect with TDD and TTY devices. (See ShoreTel Application Notes 106 and 107)
- **Controls and Keys** – Controls and keys shall be tactilely discernible without activating the controls or keys. These controls and keys shall be operable with one hand and shall not require tight grasping, pinching or twisting of the wrist. The force required to activate controls and keys shall be 5 lbs. maximum. If key repeat is supported, the delay before repeat shall be adjustable to at least 2 seconds. The status of all controls or keys should be visually discernible, and discernible either through touch or sound.
Complies—The ShoreTel system has controls and keys that are tactilely discernible that are operable with one hand. ShoreTel does not support key repeat. The status of controls and keys are visually discernible, and discernible through touch or sound.
- **The cord from the telephone to the handset shall be at least 29 inches (735 mm) long.**
Complies—The cord extends beyond 29 inches.
- **A wall-mounted object should not protrude into the walkway more than four inches to ensure visually impaired individuals do not run into them.**
Complies—When wall-mounting phones in walkways, halls or aisles, the ShoreTel phone should be inset into the wall by at least one inch. Otherwise, the phone and the wall mount bracket will protrude 4 ½ inches.

Resources and References

Listen to the quality differences between wideband and narrowband audio.
<http://www.mwmacoustics.com/html/wideband/mwm-wideband.html>

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"TIA-920 – Transmission Requirements for Wideband Digital Wireline Telephones," Telecommunications Industry Association, 2002.

About the Authors

Richard Winslow has been with ShoreTel since 1997 and was the Senior Director of Product Management for much of the product including the ShoreGear voice switches, ShoreWare Director and ShorePhone telephones. Prior to ShoreTel Richard worked at Nortel. Richard holds a Bachelor's degree in electrical engineering from San Jose State University. Richard recently joined the ShoreTel channel sales team working with major accounts.

Ed Basart is the Chief Technology Officer and co-founder of ShoreTel. He is responsible for the long-range direction of ShoreTel product research and development which includes the award winning ShoreTel phones. In addition to ShoreTel, Ed also co-founded two other well-known companies: Network Computing Devices, where he was vice president of engineering, and Ridge Computers, where he served as vice president of software. He began his career as a software engineer at Hewlett Packard. The Iowa native holds a Bachelor's degree from Iowa State University and an M.S. in electrical engineering from Stanford University.

Tom Van Overbeek is former President of ShoreTel and remains on the Board of Directors helping guide the company during his retirement. Tom was instrumental in specification and design of the original line of ShoreTel phones leveraging his passion for ergonomics.



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