Noisemakers Called to Arms

Cutting-edge sonic equipment offers many military applications.

Henry S. Kenyon, Signal Magazine (afcea.org) | July 2002

The U.S. Army may soon use high-intensity acoustics to disperse crowds, confuse enemy troops and covertly communicate. These experimental devices project highly focused beams of sound that can relay a message audible only to the individual singled out to receive it or can serve as a nonlethal weapon to disorient an adversary.

Long a staple of science fiction and think tanks, sonic weapons may become a reality because of recent developments in commercial audio technologies. Advanced loudspeakers designed to produce a narrow beam of sound are now entering commercial markets and the entertainment industry. New lightweight devices that can be carried like a rifle may one day permit military and law enforcement agencies to employ an alternative to rubber bullets and tear gas during riots and civil unrest. Directed sound that cuts through the noise of a factory floor, loading dock or battlefield also would serve to alert individuals about potentially dangerous situations.

One of the private sector firms assisting the Army's research efforts is the American Technology Corporation (ATC), San Diego. The company's work with the military grew out of its commercial research into directional loudspeaker technology.

A prototype device, called the directed stick radiator (DSR), produces a highly focused and intense beam of sound. ATC President Terry Conrad notes that the DSR is only a small portion of the acoustics work the company is undertaking "to help the military get rid of people without shooting them." Although ATC's commercial acoustics have some of the same basic research concepts as the military applications, Conrad emphasizes that they are two separate technologies.

The company has entered a cooperative research and development agreement with the Army's Tank-automotive and Armaments Command's Armament Research and Development, and Engineering Center (ARDEC) at Picatinny Arsenal, New Jersey. Here, researchers are working to develop acoustic systems for use in nonlethal weapons, psychological warfare and secure communications.

According to Del Kintner, ATC's director of military sales, the current version of the DSR is a crude test device consisting of three to four transducers stacked together to form a column or tube that is three or four feet long and three to four inches in diameter. The device produces a range of sound patterns across frequencies to which humans are sensitive. He notes that in its current configuration, the DSR can make its target extremely uncomfortable. "If you stand in the beam for more than 10 or 12 seconds, you get sick. People turn as green as grass, and you can pulse it in such a way that their ears don't really recover—so they keep getting this uncomfortable effect and they can't brace themselves to get away from it," he explains.

However, not much is known about DSR's and other acoustic devices' lasting effects on humans. One of the goals of the research is to gain a better understanding of what these devices do to individuals. Kintner notes that ARDEC's behavioral scientists will determine safety parameters to mitigate any potential long-term effects such as damage to hearing.

A prototype device for use by the military and law enforcement is being developed through a cooperative effort. ARDEC engineers are conducting target effects analysis of the DSR while General Dynamics' Bath Iron Works advanced technology division, Bath, Maine, will build the first prototype, Kintner says. Additional experiments in acoustic chambers will determine the most effective frequency ranges, modulation schemes and phasing for the device. Researchers also are investigating improved transducers and other technologies to increase performance and better focus the sound beam. He notes that one of the envisioned uses of the device is to incapacitate individuals in a crowd without taking down the entire group.

The final product of the program may not even resemble a stick, Conrad says. "It might be flat; it might be a stick or a sphere. It should not be assumed that it will be in any particular form," he advises.

Although governments have investigated the potential weapons applications of acoustics for the past half-century, none of this work went beyond the research stage. James Croft, ATC's chief technology officer, notes that while some of these devices were successful in a laboratory setting, they were large and weighed up to several tons. The ideal size and weight is something an individual soldier can carry, he says. However, advances in electronics, power systems and materials technology now permit the miniaturization of high-power amplifiers that are efficient enough to operate on batteries.

Previous research focused on using low-frequency sound below the audible hearing range. But the long wavelengths necessary for this approach make it impossible to direct the sound or get an extremely high-power output for the device, Croft observes. "So those attempts have pretty much failed. We have focused on operating in ranges where we can control the sound, both in directionality and intensity, and also where the human ear is very sensitive to it, so the effects are very strong," he explains.

Croft notes that ATC's research has allowed the firm to study a range of transducers and to invent new ways to generate sound for its commercial products. The result is the development of systems that can generate highly intense sound and be highly directional. This combination of new technologies in more practical frequency ranges and increasingly efficient mechanical systems may lead to the development of manportable devices that weigh roughly the same as a rifle, he says.

Aside from weapons, directed acoustics also have applications in secure communications and psychological warfare. Such a device would work as a directional loudspeaker. Messages could be sent to individuals in a crowd without disturbing or alerting others. Additionally, because the message is a tight beam of sound, it cannot be intercepted like a radio broadcast, Conrad says.

ATC's proprietary sound technology also can produce what Conrad describes as a virtual speaker. If the beam is directed at a solid object such as a vehicle, wall or rock, that surface will transmit the sound. He notes that this feature is already being used by the entertainment industry for special effects and outdoor entertainment where statues or pictures can be made to produce sounds.

However, this same principle can be applied to special and psychological operations. Besides making objects produce sounds, the technology could be used to distract enemy troops by

making them believe a squad of soldiers is hiding in a position far from its actual location, Croft explains.

ATC's sound devices have an effective range of more than 100 yards. In a communications application, a listener would hear the same quality of sound beamed to them from a great distance that they would hear standing several feet away from a speaker, Croft says. The intelligibility of the sound is similar because the sound travels in a very tight beam that does not lose energy with distance. Additionally, the quality of the sound remains high because it does not reflect off of any objects to cause secondary sound arrivals, he maintains.

Highly focused sound also has uses in noisy work environments such as loading areas and engineering and hangar decks on naval vessels. Croft cites the example of experiments aboard a U.S. Navy tank-landing ship. Forklifts were loading acetylene bottles in a vehicular passageway aboard the craft. In this very noisy environment, company personnel were able to communicate with a forklift operator. "We took this thing and beamed it right at him, and he looked all around to see where the sound was coming from. Even though the noise level in that place was close to 80 or 90 decibels, the operator heard the sound when it was directed at him," Croft says.

ATC also is working with the U.S. Navy and General Dynamics advanced technology group to test the feasibility of installing directional speakers aboard aircraft carriers. Most of this work is centered in the hangar bay and flight deck, environments where it is difficult to hear messages from the ship's 80-watt loudspeakers. "Because there's so much echo going on there, if you ask a crew member about a message, he'll tell you that he has no idea what that announcement just was. And you know they're losing lives because of it," Kintner says. Based on the success of the demonstrations, the USS Carl Vinson will be equipped with directional speakers, he adds.

The same technology that projects sounds makes it technically feasible to cancel them out. This can now be achieved locally with a device that sends out-of-phase sound waves set to arrive precisely at the source of the noise, Croft explains. For example, an automobile muffler may be replaced with a loudspeaker that cancels the noise from the exhaust pipe. He notes that ATC's sound projection technology permits this principle to be theoretically applied to its sound projectors, allowing noise to be dampened at its source from a distance.

Additional information on American Technology Corporation is available on the World Wide Web at www.atcsd.com.