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**SCIENCE, TECHNOLOGY
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Acoustic Gunshot Detection Systems: Community & Policy Considerations

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EXECUTIVE SUMMARY

Acoustic gun detection systems (AGDS) are a law enforcement technology designed to detect gunshot sounds and notify police of the event and location in close to real time. ShotSpotter is the most well-known AGDS in the United States, sold by a company of the same name. In what follows, we analyze ShotSpotter and the company's claims that the system improves safety, reduces crime, and promotes positive relationships between communities and police. We conclude that the technology's accuracy, effectiveness, cost, and systemic biases raise serious concerns. Communities concerned with local law enforcement's purchase and deployment of AGDS can advocate for a variety of policy responses including: a ban, moratorium, community oversight, or technology assessment & deliberative democracy.

BACKGROUND

Understanding the Technology

The main component of AGDS is the acoustic sensor, usually installed on buildings and lampposts. The gunshot identification process begins when the technology detects a sound it identifies as "gun fire" through an algorithm which filters the impulsive noises caught by the sensors, and compares it to a database of gunshots and other similar sounds. The sound is then sent to the company's analysts for review to confirm or reject the sound as "true" gunfire. If they confirm, a separate triangulation algorithm calculates the location based on the timing of the sounds picked up by their sensors, and notifies police of the GPS coordinates.¹ According to ShotSpotter, this process takes less than a minute.²

Understanding the Company

The AGDS technology was developed by a team of scientists in the 1990s, who realized they could use sound waves to detect and map gunshots.³ They started ShotSpotter with a handful of contracts with local police departments in California, until an influx of venture capital in the early 2000s enabled them to expand and market to cities across the U.S. After experimenting with different unsuccessful business models, the company became profitable in the 2010's, in part through diversifying its offerings.⁴ It now provides tools to be used in conjunction with AGDS technology including "CopLink X" for data analytics,

and "ShotSpotter Investigate," a cloud-based case management tool to prepare data from any detected shot for criminal trial.

ShotSpotter, which became publicly traded in 2017, is extremely concerned with its public image. An Associated Press article highlighting the technology's flaws prompted the CEO to reach out directly to law enforcement agencies employing their system, and request they engage with the media for positive publicity.⁵

ShotSpotter's Customers

ShotSpotter sells its technology directly to police departments, framing it as a way to address the gun violence epidemic while building community trust, and as a complement to "precision policing."⁶ Precision policing is a framework that claims to address the divide between law enforcement and communities. It has two



operational components: 1) focused enforcement with target areas determined by the use of data, intelligence, and algorithmic technologies, and 2) community policing and public engagement in target areas, in which law enforcement officials spend time patrolling regular neighborhoods, getting to know residents, and communicating the reason for their presence.⁷ ShotSpotter and other AGDS platforms have grown in popularity alongside other policing and surveillance technologies including facial recognition and pre-trial algorithmic risk assessments.

ASSESSING AGDS

Local law enforcement agencies purchase ShotSpotter for the promised benefits of crime reduction, saving the lives of gunshot victims, and a more efficient police response.⁸ The actual impacts are much less clear, due to problems with accuracy, effectiveness, cost, and systemic bias.

ShotSpotter is Ineffective

ShotSpotter claims it has a 97% accuracy rate, but it ignores false positives, which means this figure does not indicate whether the system can reliably tell the difference between the sound of gunfire and other loud noises like firecrackers, cars backfiring, construction noises, helicopters, and other harmless sounds.⁹ The performance equation Shotspotter uses only counts errors based on failure to identify a verified gunshot, or a mislocated verified gunshot.⁹ ShotSpotter itself states that the technology only detects gunshots in an outdoor area.¹⁰

Meanwhile, the company claims ShotSpotter has only a 0.5% false positive rate, yet independent studies and customer reviews highlight false positives as the number one operational concern.¹¹ ShotSpotter's official statistic obscures the process that they use to identify a



Almost 89% of alerts found no evidence of a gun-related incident

false positive. The company only deems an alert a “false positive” after the following steps:

1. ShotSpotter alerts law enforcement to what it determines is a gunshot.
2. Police are deployed to the location of the alert.
3. Police prove the sound was something else based on evidence. An example would be if the police arrived and saw evidence of fireworks and reported the findings to ShotSpotter, then the alert would be declared a false positive.

In a significant number of cases, neither law enforcement nor Shotspotter are able to verify the source of the noise.⁹ However ShotSpotter excludes these cases from its count of false positives, which leads to misleading and overstated accuracy. A study by the MacArthur Justice Center found that in Chicago, the vast majority of initial police responses to ShotSpotter alerts – 88.7% – found no evidence of incidents involving a gun.¹²

ShotSpotter Reduces Community Engagement and Does Not Reduce Crime

Despite the company's claims to the contrary, there is evidence that AGDS actively reduces police/citizen collaboration. Articles in the International Association of Chiefs of Police's Police Chief Magazine, for example, question ShotSpotter's effectiveness in building community trust.¹³ After implementing an AGDS, the St. Louis Police department had a decrease in civilian reported gunfire calls in the areas covered. Meanwhile, for every 100 calls generated by ShotSpotter, police in St. Louis found evidence of a crime in less than one incident, versus 7.6 incidents for every 100 calls generated by community members. Despite numerous requests for studies proving the efficacy of the technology in reducing crime rates, ShotSpotter claims such studies would be invalid due to complexities in the underlying causes of gun violence.¹³ In interviews with police in departments that use ShotSpotter, one study found that while officers had an overall positive feeling toward ShotSpotter, many believed it was “Ineffective” or at best “Somewhat Effective” in preventing shootings.¹⁴





More than 40,000 false positives over two years

ShotSpotter is Costly and Wastes City Resources

Municipalities purchase ShotSpotter on a subscription basis, usually for a 1–5 year term, with an option to renew when the contract comes to an end. The City of Chicago is one of ShotSpotter's largest customers, paying approximately \$10 million/year for the system.¹⁵ Yet, one study found:

- 89% of ShotSpotter calls in Chicago turned up no gun-related crime, and 86% led to no report of any crime at all.
- Over the course of almost two years, there were more than 40,000 false positive ShotSpotter calls.
- On an average day in Chicago, there are more than 61 ShotSpotter-initiated police calls that turn up no evidence of any crime, let alone gun crime.

These false alarms mean the actual cost of ShotSpotter to the City of Chicago is much higher than \$10M/year due to the unnecessary deployment and use of limited police resources, and likely contributes to higher policing costs in other cities as well. Additionally, cities do not own or necessarily have access to the data that ShotSpotter collects. ShotSpotter charges additional fees to access aggregate data, and may sell data to outside companies or other third parties.

ShotSpotter Reproduces Systemic Biases

Policing technologies such as ShotSpotter often reproduce systemic biases by relying on past data that has been shaped by over policing, biased enforcement patterns, and ongoing disinvestment in marginalized communities. In the case of ShotSpotter, cities are largely deploying it in Black and Latino neighborhoods, producing yet more police involvement in communities that are already overburdened by the criminal legal system. It can also create a circular justification for the continued policing of these same communities, as alerts from ShotSpotter produce (false) data that reinforces the

decision to conduct surveillance in the locations where cities place ShotSpotter. The Office of the Inspector General of the City of Chicago published a report in 2021 which indicated a correlation between the neighborhoods in which ShotSpotter was implemented, and an increase in unrelated “investigatory stops” (stop & frisks).¹⁶

OPTIONS FOR COMMUNITY RESPONSE

Given the problems with accuracy, efficacy, cost, and bias described above, it seems likely that the funds cities allocate to ShotSpotter would be better spent on community investments that are proven to reduce crime, such as after school programs, drug treatment programs, and poverty alleviation.

Communities that are concerned about local law enforcement's purchase and deployment of AGDS can advocate for a variety of policy responses including: a ban, moratorium, community oversight, technology assessment & deliberative democracy.

Banning AGDS

A full ban on the use of AGDS technology is the most straightforward, clearly defined, and effective policy response. In recent years, a number of local jurisdictions have used this approach in response to algorithm-based policing and surveillance technologies. Santa Cruz and New Orleans have banned predictive policing.¹⁷ San Francisco was the first city to ban city use of facial recognition technology, which has now been banned in nearly two dozen other cities.¹⁸ But bans are often narrow and focused on a specific technology. Because surveillance technology is a fast growing market, with frequent releases of new products and new kinds of devices or systems, bans need to be broad enough to include tweaks and adjustments to AGDS products and may need to be updated regularly.

A Short Term Moratorium

A short-term moratorium would be a more temporary approach to limiting the use of AGDS. California implemented a 3-year moratorium for the use of facial recognition technology in police body cameras to allow policymakers time to establish appropriate regulations.¹⁹ A moratorium provides policymakers the opportunity to find balance in the regulatory arena, especially if the community feels an AGDS might be beneficial if implemented with appropriate safeguards. However, there is a risk communities may not be consulted during the moratorium period, and well-financed stakeholders might take control of the regulatory process instead.

Increasing Community Oversight

Communities can also lobby local governments for increased oversight of the purchase and use of technologies related to law enforcement and surveillance. In May 2021, the Detroit City Council passed the Community Input Over Government Surveillance (CIOGS) ordinance, drafted in coordination with the ACLU of Michigan.²⁰ The ordinance requires city-run departments, including the police department, to host public hearings before acquiring any surveillance technology, to create transparency between government and community, as well as requiring the city to establish guidelines and annual reporting on the use of surveillance tech.²¹ Guidelines and annual reporting allow the community to evaluate if the technology is as effective as promised, and the public hearings can provide a platform for the community to express their concerns and share their experiences. However, this type of policy can be solely performative if governments enact them without committing resources to meeting their requirements. Community members may not always know about hearings or have the technical expertise to engage in the conversation, or their voices may simply be disregarded in the decision-making process.

Technology Assessment & Deliberative Democracy

Finally, communities can advocate for greater power over local tech-based decision making, including the use of AI applications in law enforcement, through technology assessment and deliberative democracy. One option might be to establish a program that assesses the social, equitable, ethical, and other impacts of all new technologies being considered for government procurement that informs policymakers about risks and issues involved. This could be applied on a local, state, or federal level.

A well-developed example of this kind of program is the Danish Board of Technology, which selects approximately seven to eight new technologies every year for evaluation.²² Its evaluations inform parliamentary discussion. The Government Accountability Office, which supports the US Congress, has a similar Science, Technology Assessment, and Analytics Team that provides information about trends in emerging technologies.²³ At the local level, many municipalities are creating technology-focused departments to manage the growing turn towards “smart” cities. While this kind of technology assessment can be valuable for identifying issues for public concern, governments must establish clear mechanisms to ensure that these evaluations inform the policymaking process.

Many technology assessment programs bring deliberative democratic approaches into the evaluation process in



order to ensure that community knowledge and expertise informs the consideration of a technology’s benefits and risks. A number of US states including Vermont, Alabama, and Hawaii have established advisory committees to evaluate government purchase and use of artificial intelligence in several domains ranging from police use to employment algorithms. However, there is great variability in the makeup of these committees, which can affect whether they reaffirm or challenge status quo power dynamics. Different committees may value well-organized stakeholders, a representative cross-section of their population, or maintain a focus on technical expertise.²⁴ The make up of committees will ultimately determine the direction of policy decisions. These deliberative democratic efforts can yield thoughtful and nuanced recommendations, while improving community trust in policymaking and respect for community knowledge and expertise. However, residents will often have to lobby to ensure diverse representation and inclusion of historically excluded voices.

The University of Michigan’s Science, Technology, and Public Policy (STPP) program is a research, education, and policy engagement center concerned with cutting-edge questions at the intersection of science, technology, policy, and society. This memo was written as part of STPP’s community partnerships initiative, where we work with organizations that have concerns related to a current or anticipated science or technology issue. If you want us to take a deep dive into the implications of an emerging technology in your community, or if your city is considering implementing ShotSpotter and you want more information, contact us at stpp@umich.edu.

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