Activation of Body-Worn Cameras without Responder Manipulation

Operational Field Assessment Report

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FOREWORD

The First Responder Technologies Division (R-Tech) is part of the U.S. Department of Homeland Security (DHS) Science and Technology Directorate's (S&T). R-Tech works closely with the nation's emergency response community to identify and prioritize mission capability gaps, and to facilitate the rapid development of critical solutions to address responders' everyday technology needs.

R-Tech gathers input from local, tribal, territorial, state and federal first responders and engages them in all stages of research and development—from building prototypes to operational testing to transitioning tools that enhance safety and performance in the field—with the goal of advancing technologies that address mission capability gaps in a rapid time frame, and then promoting quick transition of these technologies to the commercial marketplace for use by the nation's first responder community.

As R-Tech projects near completion, the National Urban Security Technology Laboratory (NUSTL) conducts an operational field assessment (OFA) of the technology's capabilities and operational suitability to verify and document that project goals were achieved.

R-Tech's OFA reports are posted on the First Responder Communities of Practice (FRCoP) website — a professional networking, collaboration and communication platform created by DHS S&T to support improved collaboration and information sharing amongst the nation's first responders. This vetted community of members focuses on emergency preparedness, response, recovery and other homeland security issues. To request an account, complete the online form on communities.firstresponder.gov/web/guest/home.

Publically released OFA reports are also available on the DHS S&T First Responder Publications page, www.dhs.gov/science-and-technology/frg-publications.

Visit the R-Tech website, www.dhs.gov/science-and-technology/first-responder-technologies, for additional information on R-Tech and its other projects.

Visit the NUSTL website, www.dhs.gov/science-and-technology/national-urban-security-technology-laboratory, for information on NUSTL programs and projects.

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EXECUTIVE SUMMARY

Most commercial off-the-shelf (COTS) body-worn cameras currently in use by law enforcement personnel must either be manually activated when needed or they are set to continuously record while worn. In the former case, responders may fail to activate their cameras in rapidly developing emergency situations, while in the latter case, large amounts of irrelevant video and audio data are obtained that may nevertheless need to be digitally archived.

Hitron Technologies Inc. (Hitron) developed the body-worn camera prototypes that were assessed during this operational field assessment (OFA) to address these limitations for U.S. Department of Homeland Security (DHS) Science and Technology Directorate's (S&T) First Responder Technologies Division (R-Tech). The prototypes were designed to automatically activate based on trigger signals transmitted wirelessly from any of four critical event sensors: a holster sensor that detects the unlatching of a holster weapon retaining strap, an occupancy sensor that detects responders exiting their vehicles, an audio sensor that detects elevated sound levels and a hemodynamic sensor that detects an increase in the wearer's pulse rate.

Two prototypes, designated 'Type 1' and 'Type 2,' were developed by Hitron. The Type 1 prototype retrofit a manually activated commercial off-the-shelf Axon Flex™ body-worn camera with components to mechanically actuate the camera's record button when triggered by a critical event sensor. The Type 2 camera is a manually-activated body-worn camera that Hitron obtained from an industry partner and reprogrammed to enable automatic activation; it can also be remotely activated via a wireless cellular link to a laptop computer running Hitron-developed camera activation software.

The DHS S&T National Urban Security Technology Laboratory (NUSTL) conducted an OFA of the prototypes and critical event sensors on March 27, 2018, at NUSTL in New York, New York. Four individuals from law enforcement organizations in Arizona, Illinois, New York and Virginia served as evaluators. The evaluators used the prototypes and critical event sensors in different operationally relevant scenarios to assess their suitability for use by law enforcement personnel.

Of the four critical event sensors, the holster sensor received the most positive evaluator response. It worked well as a camera activation device, and the evaluators indicated that any event involving the removal of a weapon from its holster should be recorded. The three other critical event sensors performed less reliably as camera activation devices, and evaluators expressed reservations about their practicality for operational use. The evaluators indicated that the calibration process for the other three sensors needed to be simplified in order for law enforcement personnel to effectively use them in the field. The evaluators approved of the retrofit concept of the Type 1 prototype; however, they found its current design cumbersome to wear. The evaluators approved of the one-piece design of the Type 2 prototype, but suggested that its size and weight be reduced, and that it be provided with recording status indicators, simpler manual controls, and a way to quickly review acquired recordings. The Type 2 prototype's remote activation capability was not successfully demonstrated during the OFA. Some reservations about the general concept of remote activation were expressed, and the evaluators recommended that body-worn cameras with this capability clearly indicate to their wearers that their cameras have been remotely activated.

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1.0 INTRODUCTION

Law enforcement personnel are increasingly equipped with body-worn cameras to document the events they respond to. Most commercial off-the-shelf (COTS) body-worn cameras currently in use must either be manually activated when needed, or they continuously record while worn. In the former case, responders may fail to activate their cameras in rapidly developing emergency situations, while in the latter case, large amounts of irrelevant video and audio data are recorded that may nevertheless need to be digitally maintained.

The body-worn camera prototypes that were assessed during this operational field assessment (OFA) were developed for the U.S. Department of Homeland Security (DHS) Science and Technology Directorate's (S&T) First Responder Technologies Division (R-Tech) by Hitron Technologies Inc. (Hitron) to address these limitations. The prototypes are designed to automatically activate based on trigger signals transmitted wirelessly from different types of critical event sensors.

Hitron developed four different critical event sensors to activate the prototypes: a holster sensor that detects the unlatching of a holster weapon retaining strap, an occupancy sensor that detects responders exiting their vehicles, an audio sensor that detects elevated sound levels and a hemodynamic sensor that detects an increase in the wearer's pulse rate.

Two prototypes, designated 'Type 1' and 'Type 2,' were developed by Hitron. The Type 1 prototype is a COTS Axon-Flex™ body-worn camera widely used by law enforcement organizations that has been fitted with an adaptor developed by Hitron to mechanically actuate the record button on the camera's manual control unit when triggered by a critical event sensor. A fully developed version of the Type 1 prototype would allow law enforcement organizations to retrofit their manually activated body-worn cameras to provide them with an automatic activation capability until they are replaced by body-worn cameras with a native automatic activation capability.[i] Hitron developed the Type 2 prototype by modifying the operating software of a manually activated body-worn camera to enable automatic activation. Both prototypes respond to all four critical event sensors.

On March 27, 2018, the National Urban Security Technology Laboratory (NUSTL) conducted an OFA focusing on the effectiveness and usability of the two prototypes and their associated critical event sensors. The OFA was held at NUSTL, with four law enforcement personnel from police departments in Tempe, Arizona; Chicago, Illinois; Richmond, Virginia and New York, New York, serving as evaluators. The evaluators provided feedback on the functionality, reliability and durability of various camera/sensor combinations when used in operational scenarios.

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[i] In the latter stages of development of the prototypes, two other companies also began to market body-worn cameras with automatic activation capabilities. See links below.

https://www.axon.com/products/signal-vehicle
https://watchguardvideo.com/fully-integrated-car-body-worn-video-system

1.1 Purpose

The purpose of the OFA was to assess the operational suitability of the Type 1 and Type 2 prototypes and critical event sensors for use by law enforcement personnel.

1.2 Objective

The objective of this OFA was to obtain feedback from law enforcement personnel on the Type 1 and Type 2 prototypes and critical event sensors when used in operationally-relevant ways. The OFA was designed to assess:

- Reliability of camera activation by each of the four critical event sensors;
- Reliability of remote camera activation;
- Suitability of camera time-to-activation;
- Quality of recorded video/audio data for incident documentation;
- Field usability (e.g., wearing comfort of the prototypes and critical event sensors);
- Quality of user interface (e.g., manual controls, operating state indicators); and
- Suitability of durability specifications (e.g., operating temperature range, water and dust resistance, battery life).

1.3 Participants

Table 1-1 lists the Activation of Body-Worn Cameras without Responder Manipulation (ABWC) OFA Participants.

Table 1-1 OFA Participants

Role	Organization
Evaluator	Chicago Police Department (Illinois)
Evaluator	New York City Police Department (New York)
Evaluator	Tempe Police Department (Arizona)
Evaluator	Virginia State Police Communications Division
Venue Host and Observers	National Urban Security Technology Laboratory
Program Managers and Support Staff	DHS S&T R-Tech
OFA Test Director and Data Collectors	DHS S&T NUSTL
Technology Developers	Hitron Technologies Inc.
Observers	DHS S&T R-Tech
Photographer/Videographer	DHS S&T Communications, Outreach and Responder Engagement

1.4 Requirements

Table 1-2 summarizes requirements for the Type 1 and Type 2 prototypes and associated critical event sensors and how these requirements were assessed during the OFA. These requirements were drawn from the Broad Agency Announcement 13-012/Call 0004, *Activation of Body-Worn Cameras without Responder Manipulation*, and from requirements communicated to the NUSTL OFA test director by the DHS S&T program manager for the ABWC Project.

Table 1-2 ABWC Requirements Matrix

Capability	Requirement	Test Method
Reliability	Recording mode consistently activates when triggered by each critical event sensor (i.e., holster, sound, occupancy and pulse rate).	Hands-on assessment by evaluators during OFA. Additionally, NUSTL data collectors tracked success rate of camera activation by each critical event sensor.
	Recording mode time-to-activation when triggered by each critical event sensor is sufficiently short to capture all necessary video/audio data.	Hands-on assessment by evaluators during OFA. Evaluators judged whether time-to-activation is sufficient based on review of camera recordings and/or camera activation indicators.
Functionality	Recorded video/audio data is of sufficient quality for incident documentation purposes.	Hands-on assessment by evaluators during OFA: Evaluators judged quality by reviewing camera recordings acquired during OFA.
	Camera and sensor components are comfortable to wear and do not interfere with performance of duties.	Evaluators judged based on size, weight and form factor of components.
	Camera's user interface is intuitive to operate.	Evaluators judged based on experience in operational use scenarios.
	Manual controls (e.g., record on/off) are easily actuated.	Evaluators judged based on experience in operational use scenarios.
	Camera state indicators (e.g., recording mode on/off, battery level indicator) can be clearly read.	Evaluators judged based on experience viewing indicators in operational use scenarios.
	Recorded video/audio data can be easily downloaded and viewed.	Evaluators judged based on their experience exporting recording from cameras.
Durability	Suitably resistant to mechanical shock. Suitably resistant to failure by water/dust infiltration. Suitable operating temperature range. Suitable battery operating time.	Evaluators reviewed specifications provided by Hitron.

1.5 System Description

The Type 1 and Type 2 prototypes can be wirelessly activated by trigger signals transmitted via Bluetooth from four different types of critical event sensors developed by Hitron.

Figure 1-1 Holster Sensor

Left: Sensor, detached from holster. Right: Sensor attached underneath weapon retaining strap.

Photo Courtesy of Hitron Technologies Inc.

The holster sensor (Figure 1-1) transmits an activation signal when it detects the unlatching of the holster's weapon retainer strap. It consists of a magnetic sensor attached to the holster body and a small magnet patch attached to the weapon retaining strap. Unlatching the weapon retaining strap brings the magnet patch in proximity to the magnetic sensor, prompting a camera activation signal to be transmitted.

The vehicle occupancy sensor (Figure 1-2) is based around an infrared distance sensor that measures the distance to the object it is directed towards. The occupancy sensor is mounted in the vehicle passenger compartment with its infrared distance sensor directed towards a vehicle occupant. When the occupant exits the vehicle, the distance measured by the infrared sensor changes, prompting a camera activation signal to be transmitted.

Figure 1-2 Vehicle Occupancy Sensor

Left: Front view of sensor. Right: Mounted in passenger compartment.

Photo Courtesy of Hitron Technologies Inc.

Figure 1-3 Audio Sensor

Photos Courtesy of Hitron Technologies Inc.

The audio sensor (Figure 1-3) transmits a camera activation signal when it detects sound levels above a user-set baseline. It consists of a microphone and Hitron-developed electronics unit. The microphone is mechanically clipped to the wearer's shirt, while the electronics unit is attached to, or carried in, a shirt pocket.

The hemodynamic sensor transmits a camera activation signal when it detects a 12-beat-per-minute increase in its wearer's pulse rate. It consists of a Polar OH1 COTS pulse rate sensor and a Hitron-developed electronics unit (Figure 1-4). The Polar OH1 sensor is worn on an armband; the electronics unit was not provided with an attachment device and so the evaluators had to hold it in their hands or carry it in a pocket during the OFA.

Figure 1-4 Hemodynamic Sensor

Left: Polar OH1 pulse rate sensor. Right: Pulse rate sensor and electronics unit.

Photos Courtesy of Hitron Technologies Inc.

All of the critical event sensors contain internal batteries that can be recharged by connection to a universal serial bus (USB) port.

The Type 1 and Type 2 prototypes are not keyed to specific critical event sensors, i.e., they are designed to be activated when any sensor within a 10-meter range transmits a camera activation signal.

The Type 1 prototype is a widely used COTS Axon Flex body-worn camera system retrofitted with additional components developed by Hitron to enable automatic activation. The Axon Flex body-worn camera system consists of a camera connected by wire to its manually activated control unit. The additional components developed by Hitron are a mechanical actuator connected by a coiled cable to a power supply unit. The camera, manual control unit and Hitron retrofit components are shown in Figure 1-5. The mechanical actuator is designed to press the record button on the Axon Flex manual control unit when triggered by a critical event sensor. The coupled manual control unit and mechanical actuator are worn clipped on the user's belt, while the power supply unit is carried in a pocket as shown in Figure 1-6.

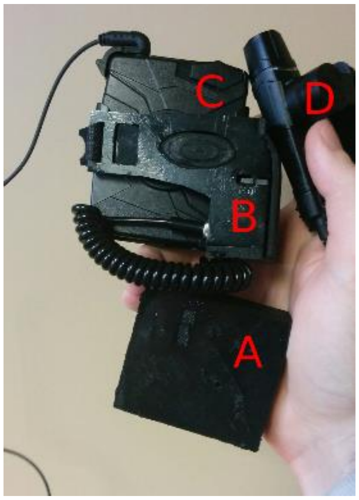

Figure 1-5 Type 1 Prototype Components

Power supply (A), mechanical actuator (B), Axon Flex manual control unit (C) and camera (D).

Photo Courtesy of Hitron Technologies Inc.

The Axon Flex camera system at the core of the Type 1 prototype continually collects video and temporarily stores the most recent 30 seconds of video data in a temporary memory buffer; no audio data is stored in the buffer due to privacy concerns. When the camera's record button is actuated, the audio-free video data stored in the buffer is added to the start of the camera recording.

Figure 1-6 Type 1 Prototype Components as Worn during the OFA

Photo Courtesy of Hitron Technologies Inc.

The Type 2 prototype, as shown in Figure 1-7, is an all-in-one unit, i.e., camera, control electronics and power supply are contained in a single housing that is worn clipped to an item of clothing. It is a manually activated body-worn camera that was reprogrammed by Hitron to enable automatic activation; it has is no temporary video data buffer. It can also be remotely activated via a wireless cellular link to a laptop computer running Hitron-developed camera activation software.

Figure 1-7 Front and Side Views of the Type 2 Prototype

Photos Courtesy of Hitron Technologies Inc.

2.0 OPERATIONAL FIELD ASSESSMENT DESIGN

2.1 Event Design

During the OFA, four evaluators from police departments in Tempe, Arizona; Chicago, Illinois; Richmond, Virginia and New York, New York, participated in operational assessment scenarios to evaluate the operational suitability of the Type 1 and Type 2 prototypes and the four critical event sensors. The test venue was NUSTL, which is located in New York, New York. Presentations, training and debrief sessions were held in NUSTL conference rooms, and assessment scenarios were conducted on the first and ninth floors of NUSTL. NUSTL provided props, including a mock weapon and mannequins that stood in as suspects, and NUSTL staff members acted as victims and witnesses during the assessment scenarios. The holster and all electronic components were provided by Hitron.

The OFA Assessment Plan called for hands-on trials of the Type 1 and Type 2 prototypes and the four critical event sensors by each first responder in five different operational assessment scenarios, summarized in Table 2-1. Both prototypes were to be used in the first four scenarios, while the remote activation scenario was designed specifically for the Type 2 prototype.

Each scenario involved camera activation by a single critical event sensor so that activation of the prototype's camera could be clearly linked to a particular critical event sensor. After the evaluators completed each assessment scenario, they reviewed acquired videos on either a laptop computer or mobile phone application.

The occupancy, audio and hemodynamic sensors needed to be calibrated before use. The evaluators performed these calibrations or observed other evaluators perform them. For the occupancy and audio sensors, calibration was a two-step process involving establishing a baseline level and a threshold level at which the sensor would transmit a camera activation signal. For the hemodynamic sensor, a baseline pulse rate was determined by having each evaluator wear the sensor for 1 minute while seated; the camera activation threshold was pre-set by Hitron to be an increase of 12 beats per minute above the wearer's baseline pulse rate.

Table 2-1 Summary of the Operational Assessment Scenarios

Scenario	Task
Holster Sensor Camera Activation	Evaluator approaches suspect (mannequin), unlatches weapon retention strap on holster and verbalizes several commands.
Occupancy Sensor Camera Activation	Two evaluators exit a vehicle, approach and interview the victim (actor).
Audio Sensor Camera Activation	Evaluator approaches suspect (mannequin) and verbalizes several commands appropriate during apprehension.
Hemodynamic Sensor Camera Activation	Evaluator starts seated, then stands and walks down the corridor, and climbs multiple flights of stairs to detain a suspect (actor).

Scenario	Task
Remote Camera Activation	Upon remote activation of the camera from a 9th floor NUSTL conference room, evaluator returns to conference room from a starting point elsewhere on the 9th floor.

2.2 Scope and Limitations

The OFA consisted of three main components:

Figure 2-1 Hitron Overview Presentation

- **Classroom Presentations and Technology Familiarization:** The OFA began with an introductory session providing the evaluators with overviews of R-Tech, the ABWC OFA Assessment Plan and a site safety briefing. This was followed by an overview of the prototypes and critical event sensors by Hitron (Figure 2-1). The evaluators were then trained on how to use the prototypes during the operational scenarios.
- **Operational Assessment Scenarios:** After the evaluators gained an understanding of the assessment plan and the technology, they performed the operational assessment scenarios described in Table 2-1, which simulated law enforcement tasks.
- **Evaluator Survey and Debrief:** Following the scenarios, the evaluators provided feedback based on their experience using the technology in the operation assessment scenarios. Evaluator feedback included responses to a survey read to them by NUSTL data collectors and participation in a group discussion led by the NUSTL OFA test director. NUSTL data collectors recorded comments made by evaluators regarding the prototypes and critical event sensors, and the overall concept of the technology.

Additionally, evaluators were given the opportunity to provide constant verbal feedback to NUSTL staff members during each portion of the assessment.

This OFA was intended to allow law enforcement personnel to assess the operational suitability of the Type 1 and Type 2 prototypes and the four critical event sensors, including their reliability, functionality and durability; it was not a test of the technical performance of the prototypes and sensors.

2.3 Deviations from the Test Plan

Due to unforeseen technical problems, there were deviations from the original test plan to allow time for Hitron to troubleshoot the issues with the prototypes.

After each evaluator completed the tasks of the first operational scenario, video recordings from the Type 2 prototype were uploaded to a laptop computer; however, the upload took much longer than the schedule allotted for because video recordings stored on this prototype prior to the OFA also had to be uploaded. To make use of this time, a group discussion on the overall concept of the technology was held in a NUSTL conference room while the files were being uploaded. There were also deviations from the original test plan regarding individual scenarios.

Occupancy Sensor Camera Activation: The occupancy sensor did not reliably activate the Type 1 prototype during set up on the morning of the OFA. The occupancy sensor scenario was moved to the afternoon to allow Hitron time to troubleshoot. Hitron was unable to resolve occupancy sensor activation issues with the Type 1 prototype; therefore, the evaluators performed the scenario tasks with only the Type 2 prototype.

Holster Sensor Camera Activation: The holster sensor scenario was moved to the morning session instead of the afternoon as scheduled, while Hitron attempted to troubleshoot the technical difficulties encountered during set up of the occupancy sensor scenario. One evaluator opted not to perform this scenario as the tasks performed went beyond his organizational role.

Hemodynamic Sensor Camera Activation: Due to time constraints, two of the four evaluators did not perform this scenario with the Type 2 prototype.

Remote Activation: A cellular network link between the Type 2 prototype and the Hitron computer running the remote activation software could not be established; therefore, the remote camera activation scenario was not performed. Evaluator feedback was limited to the underlying concept of remote activation of body-worn cameras.

3.0 RESULTS

Figure 2-1 Holster Sensor Scenario

OFA results are reported in the following three sections. Section 3.1 summarizes NUSTL data collector observations on the technological performance of the Type 1 and Type 2 prototypes and four critical event sensors during the assessment scenarios. Evaluator feedback provided in the form of survey responses is presented in Section 3.2. Evaluator feedback in the form of comments provided at various stages of the OFA is presented in Section 3.3.

3.1 Scenario Performance Outcomes

NUSTL data collectors tracked how frequently the critical event sensor succeeded in activating the Type 1 and Type 2 prototypes, assessed whether the prototypes activated quickly enough to fully capture each scenario's events, and captured other relevant information about the performance of the prototypes and critical event sensors. Their observations are summarized below.

Holster Sensor Camera Activation: The holster sensor activated the Type 1 and Type 2 prototypes in 100 percent of the trials performed. Evaluators repeated a verbal command to mark the release of the weapon retainer strap on the holster; the camera recordings did not always begin soon enough to capture these verbal commands.

Occupancy Sensor Camera Activation: During the set-up of this scenario, the Type 1 prototype did not respond to trigger signals produced by the occupancy sensor. Hitron was unable to troubleshoot this problem; therefore, the scenario was only performed with the Type 2 prototype.

Figure 3-2 Occupancy Sensor Scenario

The Type 2 prototype did not consistently perform as intended when used in this scenario. Two evaluators performed four trials, each with one successful activation. Two other evaluators performed one trial after the occupancy sensor was moved from the driver's door to the steering wheel. In both trials, the Type 2 prototype successfully activated; however, in all successful trials, camera activation was not immediate as intended. The cameras began recording during the victim (actor) interview rather than upon exiting the vehicle.

Audio Sensor Camera Activation: During the audio sensor scenario, activation success varied greatly between the Type 1 and Type 2 prototypes. The audio sensor was recalibrated by the first evaluator after his first two unsuccessful trials with the Type 2 prototype. In all following trials, the Type 2 prototype was successfully activated by each evaluator. Ten trials were performed with the Type 1 prototype and only one was successful.

During the only successful trial, the Type 1 prototype components were held in the evaluator's hand, above the waist. At the beginning of each trial, evaluators repeated a verbal command to mark the start of the trial; the camera recordings acquired during the trials did not always capture these verbal commands.

Figure 3-3 Evaluator Wearing Audio Sensor

Hemodynamic Sensor Camera Activation: The hemodynamic (pulse rate) sensor initiated camera recordings in five of the six trials performed by the evaluators; however, there was considerable variation in the time to activation among these trials. In three trials, the camera recordings began after the evaluator climbed two or three flights of stairs. In the other two trials, the camera recordings did not begin until the evaluator was in the hallway after coming back down the stairs.

Remote Camera Activation: The first attempt to remotely activate the Type 2 camera was unsuccessful because a cellular network link between the Type 2 prototype and the Hitron computer operating the remote activation software could not be established. Hitron was unable to resolve this problem; therefore, further remote activation trials were not performed by the evaluators.

Figure 3-4 Hemodynamic Sensor Scenario

Evaluator donning the hemodynamic sensor (left).
Evaluator climbing stairs during the hemodynamic sensor activation scenario (right).

3.2 Survey Responses

The evaluators were asked to rate the features and capabilities of the Type 1 and Type 2 prototypes and the four critical event sensors. The survey consisted of a series of statements (e.g., 'the camera is comfortable to wear') to which the evaluators were asked to choose one of four responses: strongly agree, agree, disagree or strongly disagree.

A summary of evaluator responses about the Type 1 and Type 2 prototypes is shown in Table 3-1; responses for each evaluator are indicated in separate columns labeled 'A' to 'D.' Table 3-2 summarizes evaluator responses to statements about the critical event sensors.

Evaluator assessments of the features and capabilities of the Type 1 and Type 2 prototypes received both positive and negative responses; exceptions were the uniformly positive responses to statements about the quality of acquired video and audio data for both prototypes. Additionally, they consistently agreed that the Type 1 prototype was comfortable to wear. They also agreed that the Type 2 prototype would not interfere with their normal duties and activities as its manual controls were easily activated, and that video recordings could be easily reviewed on the Type 2 prototype.

Consistently negative responses were received on the ease of exporting acquired video recordings from both prototypes, and on the ease of reading the Type 1 prototype's battery level indicator.

The evaluator responses for the critical event sensors were based on their experience using the sensors with both prototypes; however, evaluator D provided different assessments of the holster sensor activation time when used with the Type 1 and Type 2 prototypes, as indicated in Table 3-2. Evaluator assessments of the sensors were mixed on most points; however, they provided consistently negative responses about time-to-camera activation for both the occupancy and hemodynamic sensors.

Table 3-1 Survey Responses for the Type 1 and Type 2 Prototypes

Statement	Type 1				Type 2			
	A	B	C	D	A	B	C	D
The camera is comfortable (e.g., weight, size, placement on uniform)	Agree	Agree	Agree	Agree	Strongly Disagree	Agree	Agree	Strongly Agree
Wearing the camera and sensors *does not* interfere with donning/doffing other equipment	Strongly Disagree	Agree	Disagree	Agree	Disagree	Agree	Strongly Disagree	Strongly Agree
Camera *does not* interfere with the performance of normal duties and activities	Strongly Disagree	Strongly Agree	Strongly Disagree	Agree	--	Strongly Agree	Strongly Agree	Agree
Camera user interface is intuitive	Agree	Strongly Disagree	Strongly Disagree	--	Strongly Disagree	Strongly Disagree	Strongly Disagree	Agree
It is easy to notice/confirm that audio/video was being recorded during the assessment	Strongly Agree	Agree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Agree	Strongly Disagree	Agree
Camera battery level indicator is easily viewed	Strongly Disagree	Disagree	--	--	Strongly Disagree	Disagree	Strongly Disagree	Agree
Manual controls are easily activated	Strongly Agree	Strongly Agree	Disagree	Agree	--	Agree	--	Agree
Recorded audio/video data is easy to download	--	--	Strongly Disagree	--	Disagree	--	Strongly Disagree	
Recorded audio/video is easy to view	Agree	Strongly Agree	Disagree	Agree	Agree	Strongly Agree	--	Agree
Recorded video data is of sufficient quality for incident documentation purposes	Strongly Agree	Strongly Agree	--	Agree	Agree	Strongly Agree	--	Agree
Recorded audio data is of sufficient quality for incident documentation purposes	Strongly Agree	Strongly Agree	Agree	Agree	Agree	Strongly Agree	Strongly Agree	Agree
The mechanical shock resistance is suitable for typical field use by law enforcement	--	Agree	Strongly Disagree	Agree	--	Agree	Strongly Disagree	Agree
The resistance to water/dust infiltration (Ingress Protection Rating) is suitable for typical field use by law enforcement	--	Agree	Strongly Disagree	Disagree	--	Agree	Strongly Disagree	--
The operating temperature range is suitable for typical field use by law enforcement	--	Agree	Strongly Disagree	--	--	Agree	Strongly Disagree	--
The battery operating time is suitable for typical field use by law enforcement	Agree	Agree	Strongly Disagree	Agree	Strongly Disagree	Strongly Disagree	Strongly Disagree	Agree

Key: Strongly Agree; Agree; Disagree; Strongly Disagree; -- = No Response

Table 3-2 Survey Responses for the Critical Event Sensors

Statement	Sensor	Evaluator A	Evaluator B	Evaluator C	Evaluator D
Sensor is comfortable (e.g. weight, size, placement)	Holster	◕	●	○	●
	Audio	◔	●	○	◕
	Hemodynamic	◔	●	●	◔
Sensor would not interfere with the performance of normal duties and activities.	Occupancy	●	●	○	●
	Holster	●	●	○	●
	Audio	◕	●	○	◕
	Hemodynamic	◔	●	●	◕
Sensor activation time is sufficiently short to capture all necessary video/audio data.	Occupancy	--	◔	○	◔
	Holster*	●	◕	○	◕ ◔
	Audio	◕	--	○	◔
	Hemodynamic	○	--	○	○

Key: ● Strongly Agree ◕ Agree ◔ Disagree ○ Strongly Disagree -- = No Response * = Mixed responses

*Evaluator D provided different responses for holster sensor activation time for the two prototypes; both responses are shown. The left symbol is the response for the Type 1 prototype, while the right symbol is for the Type 2 prototype.

3.3 Evaluator Comments

Evaluator comments were collected by NUSTL data collectors in several different ways:

- Each data collector shadowed an evaluator and recorded relevant comments during the hands-on assessment sessions.
- Data collectors took notes as the evaluators discussed the Type 1 and Type 2 prototypes and critical event sensors based upon their experience using them up until that point during a break in the hands-on assessment sessions.

- As the evaluators completed the survey on the prototypes and critical event sensors, the data collectors encouraged them to provide comments elaborating on their responses.
- The debrief session included an open-ended discussion led by the OFA test director eliciting feedback from the evaluators on the operational suitability of the Type 1 and Type 2 prototypes and the four critical event sensors for use by law enforcement organizations. The evaluators were encouraged to offer suggestions on possible improvements to the prototypes and critical event sensors, and to provide feedback on any point that had been missed by the surveys and in the discussion up to that point. Data collectors took notes on evaluator comments made during this discussion.

3.3.1 Type 1 Prototype

The evaluators appreciated the underlying concept of the Type 1 prototype, i.e., that law enforcement organizations would be able to field body-worn cameras with automatic activation capability through a simple retrofit of their existing equipment rather than by purchasing entirely new equipment; however, there was a general consensus that the overall design of the Type 1 prototype was somewhat cumbersome and needed to be streamlined in the final product design. The Type 1 prototype requires users to wear the Axon Flex manual control unit and mechanical actuator on their belts, connected by cable to a power supply carried in a pants pocket. Evaluators noted that their belts were already crowded with equipment, and expressed a preference for eliminating potentially entangling cables wherever possible. They recommended that in a final product design, the manual actuator and power supply be integrated into a single, compact component directly attached to the Axon Flex manual control unit.

3.3.2 Type 2 Prototype

One evaluator commented that he preferred the all-in-one design of the Type 2 prototype to the multicomponent design of the Type 1 prototype. Evaluators suggested that a final version of the Type 2 prototype should have recording indicators that are clearly noticeable to the wearer; the only way to determine if the prototype is recording in its current design is to view the display screen on the back of its housing. One evaluator suggested that the array of manual control buttons on the Type 2 prototype's body was too complicated and should be simplified in a final product design. Several evaluators recommended that a final version of the Type 2 prototype should be smaller and lighter than the current prototype. Evaluators noted that the lags in camera activation during the assessment scenarios were more problematic for the Type 2 prototype than for the Type 1 prototype because the Type 2 prototype lacked the Type 1 prototype's 30-second video buffer.

3.3.3 Holster Sensor

The holster sensor received the most positive feedback of the four critical event sensors. The evaluators all agreed that any event in which a weapon is drawn should be recorded.

Comments and suggestions regarding the holster sensor centered on three points:

Sensor attachment: Evaluators expressed concerns that the hook and loop fastener used to secure the sensor to the holster could be detached from the holster by a car seat or seatbelt. In a related remark, one evaluator stated that the sensor was too large and, for this reason, might be susceptible to detaching.

Variety of holsters in use: Evaluators noted that holsters in use by law enforcement officers vary considerably in design based on weapon type and holster preference. Holster sensors compatible with the wide variety of holsters in use across the country would therefore be desirable. One evaluator noted his department did not use a holster with a retention strap and therefore this sensor as implemented could not work for them as it is sensing the proximity of the retention strap to the sensor.

Integration with other equipment: One evaluator suggested that the holster sensor be capable of triggering both a body-worn camera and a radio alert message to the wearer's command unit.

3.3.4 Occupancy Sensor

Due to technical problems with the Type 1 prototype, the occupancy sensor scenario was only performed with the Type 2 prototype. The Type 2 prototype did not consistently activate when the evaluators exited the vehicle. When camera recordings were initiated, evaluators considered the time lapse between vehicle exit and camera activation to be too long.

Additional comments, summarized below, focused on the general concept of use of the occupancy sensor rather than its performance.

Unnecessary activations: The occupancy sensor is currently designed to initiate camera recordings whenever officers leave their vehicle. The evaluators stated that this would result in the camera recording numerous vehicle exit events unrelated to law enforcement response and therefore not worth recording. Some evaluators believed that in a typical shift, the number of recordings of such events would exceed the number of recordings of events that needed to be recorded, significantly increasing the amount of video data needing to be archived. It was suggested that camera activation should be based on trigger signals emitted by the occupancy sensor in conjunction with a second critical event, such as the activation of the patrol vehicle's emergency lights.

Sensor calibration: Several evaluators considered the current calibration process for this sensor to be impractical for field use. They indicated that the calibration process took too long, and that officers would not want to go through the process of calibrating the sensor at the start of each shift, or might forget to do so. Evaluators suggested that the occupancy sensor should be designed so that it only needed to be calibrated once to function properly.

Interference: One evaluator stated that his organization's vehicles had an inward-facing infrared illuminator that was used in conjunction with an in-vehicle camera used to record transported arrestees; the evaluator's concern was that this infrared illuminator might interfere with proper function of the occupancy sensor.

3.3.5 Audio Sensor

Evaluator comments focused on two aspects of the practical use of the audio sensor in the field:

Sensor calibration: Evaluators expressed concerns about the calibration of the audio sensor. One concern was that a single calibration of the audio sensor would not be appropriate for all sonic environments an officer might encounter; therefore, the audio sensor might trigger the cameras too readily or fail to trigger them when needed (e.g., a calibration performed in a quiet environment might lead to unnecessary activations in an environment with a louder ambient background sound level). They stated it would be inconvenient for officers to recalibrate the audio sensor for different environments and speculated that officers might forget to do so. The consensus was that the calibration procedure should ideally only be performed once per shift. They recommended that Hitron explore whether it might be technically feasible to incorporate a voice recognition component into the sensor so that it would only trigger camera recordings in response to a human voice, perhaps when a predetermined key word is spoken.

Sensor placement. Several evaluators commented that the placement of the audio sensor on the upper chest during the hands-on assessment would not be ideal for operational use, because it could potentially be activated by their service radios, which are typically worn on the chest, or interfere with quick access to the service radio in an emergency.

3.3.6 Hemodynamic Sensor

Evaluator comments on the hemodynamic (pulse rate) sensor focused on several points:

- Several evaluators indicated during the scenario that the hemodynamic sensor did not trigger camera recordings quickly enough to adequately capture the initial stage of the scenario.
- One evaluator raised a concern about the method of recharging the sensor. The sensor must be placed in a holder that is plugged into a USB port. The evaluator was dissatisfied that the charging method for this sensor relied on a specialized item (the holder) that could not be readily replaced if lost or damaged.
- One evaluator stated that law enforcement officers should not wear hemodynamic sensors, because indications of an elevated pulse rate might be used as evidence against them in court.
- Evaluators stated that selecting an appropriate pulse rate triggering threshold that would work for all law enforcement officers might be problematic. Several evaluators suggested that the threshold be set so that camera activation would only occur in response to extreme stress (i.e., activation due to a very large increase in pulse rate).

3.3.7 Remote Activation

The Type 2 prototype remote activation feature did not function on the day of the OFA because a communication link between the Type 2 prototype and the software could not be established. As such, evaluator comments focused on the underlying concept of remote activation, which was to enable a command unit to activate an officer's body-worn camera when there is concern that the officer is in distress. One evaluator stated that many law enforcement officers would not like the remote activation feature, pointing to the fact that police radios can be programmed to allow remote listening, but no agencies he knew of use this feature due to privacy concerns. Evaluators indicated that it would be important for officers to know that their cameras had been remotely activated (i.e., there needed to be clearly audible and visible recording indicators). One evaluator suggested the addition of an acknowledgement feature allowing the officer to indicate to his command unit that camera activation was unnecessary.

3.3.8 Keying Sensors to Cameras

The Type 1 and Type 2 prototypes are currently designed to be activated by any critical event sensor within a range of approximately 10 meters. Evaluators had mixed opinions about this. On the positive side, the activation of multiple cameras would provide several perspectives of the recorded event, which might better document what had occurred. On the other hand, it might inappropriately capture sensitive conversations unrelated to a critical event. Another possible problem noted by the evaluators is that cameras might be inadvertently activated by a non-critical event (e.g., responders exiting a nearby vehicle in a police station parking lot). This issue was raised during the debrief session and Hitron stated that it could addressed by providing law enforcement organizations with the option to key their body-worn cameras to a specific set of sensors.

4.0 CONCLUSIONS

The evaluators unanimously approved of the underlying concept of the Type 1 prototype, i.e., that the manually activated body-worn cameras currently in wide use around the nation could be given an automatic activation capability through a simple retrofit device. They suggested that a final product of this type should be more compact to better integrate with the COTS body-worn camera for which it was designed.

One evaluator expressed a preference for the all-in-one design of the Type 2 prototype to the multicomponent design of the Type 1 prototype. Suggestions for improvements to the Type 2 prototype included providing audio and visual indictors that the camera is recording, simplifying external manual controls, and reducing its size and weight.

The holster sensor received the most positive feedback of the four critical event sensors. The evaluators all agreed that any circumstance involving the removal of a weapon should be recorded, and the sensor itself worked well as an activation device. The evaluators commented that the wide variety of holster designs in use by law enforcement organizations around the nation would need to be considered in developing holster sensors into a final product.

The other three critical event sensor types—occupancy, audio and hemodynamic—performed less reliably than the holster sensor as camera activation devices. Evaluators expressed reservations about their general practicality for field use, particularly whether they would initiate camera recordings under appropriate circumstances. A consistent suggestion for improvement was that the process of calibrating each sensor needed to be simplified.

One evaluator stated that the remote activation feature of the Type 2 prototype might not be well received by law enforcement personnel due to privacy concerns; other evaluators recommended that body-worn cameras with a remote activation feature should have audio and visual indicators that clearly inform the wearer that the camera had been remotely activated.

The Type 1 and Type 2 prototypes and the four critical event sensors are currently designed so that every prototype within range of a critical event sensor will activate when the sensor broadcasts an activation signal. Evaluators expressed mixed opinions about this, depending on whether they believed the benefit of obtaining additional recordings of a particular law enforcement response event outweighed the disadvantage of potentially initiating recordings of sensitive conversations or non-critical events. Hitron indicated during the debrief session that it could provide law enforcement organizations with the option to key cameras to a specific set of critical event sensors in a final product.

5.0 REFERENCES

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