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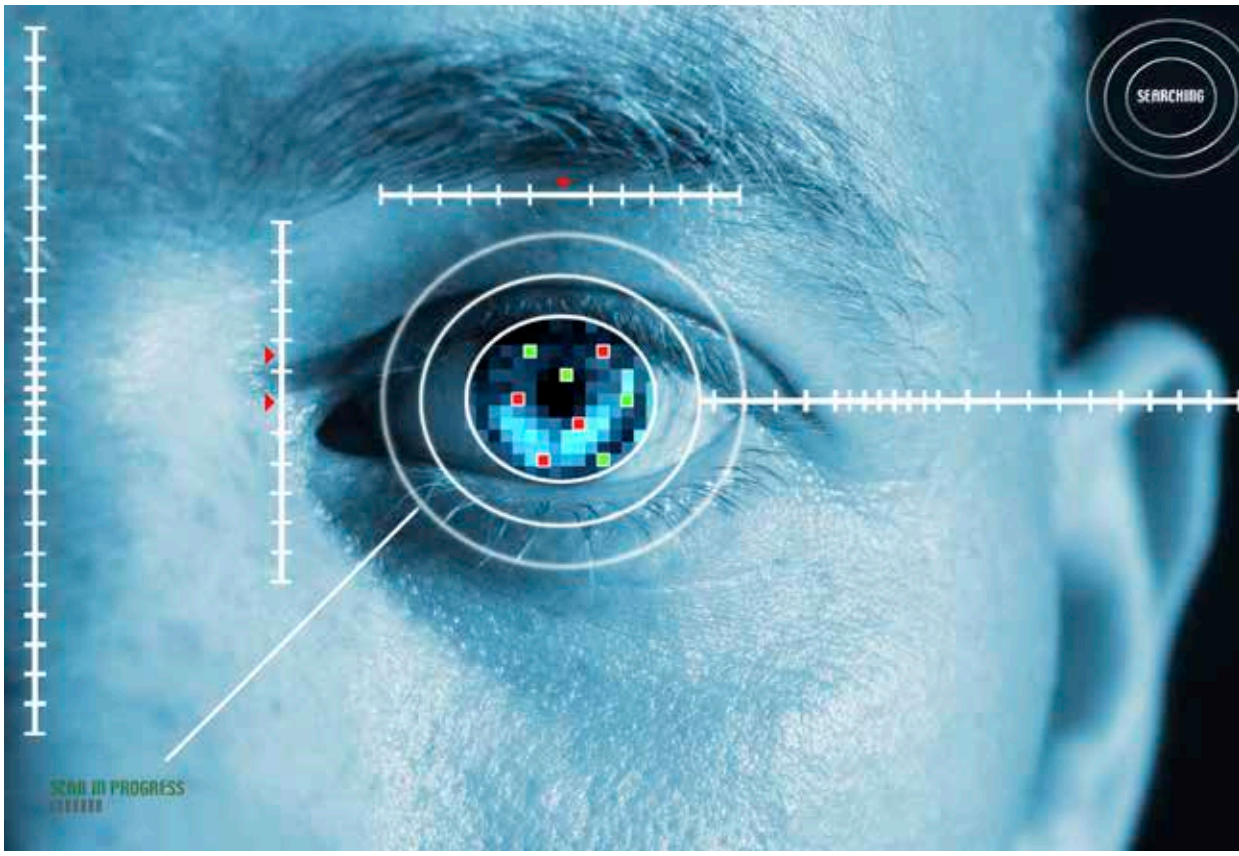
Augmented government
Transforming government services through augmented reality



A GovLab Study

About GovLab

GovLab is a think tank in the Federal practice of Deloitte Consulting LLP that focuses on innovation in the public sector. It works closely with senior government executives and thought leaders from across the globe. GovLab Fellows conduct research into key issues and emerging ideas shaping the public, private, and non-profit sectors. Through exploration and analysis of government's most pressing challenges, GovLab seeks to develop innovative yet practical ways that governments can transform the way they deliver their services and prepare for the challenges ahead.

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Introduction

On September 27, 1998, football fans who tuned in to watch the game between the Baltimore Ravens and the Cincinnati Bengals witnessed much more than a 31–24 Bengal win. That Sunday, ESPN introduced a technological innovation that would forever change the way fans watch sports: a thin yellow line overlaid onto live video representing the distance required for a first down.

This system — called "1st and Ten" — gave television viewers access to information not available to fans in the stands, in an intuitive format that needed no explanation and added to their enjoyment of the game. It also represented an early foray into the use of augmented reality (AR) that proved highly popular. An overwhelming majority of viewers — 92 percent — reported wanting to see the system used in future broadcasts.[1]

While sports fans enjoyed 1st and Ten, technology geeks also buzzed with excitement. The graphics system represented an intersection of science fiction and reality, introducing a real-world use of a technology already common in films such as Terminator and Robocop. With 1st and Ten, AR made an early and transformative imprint on commerce and culture.

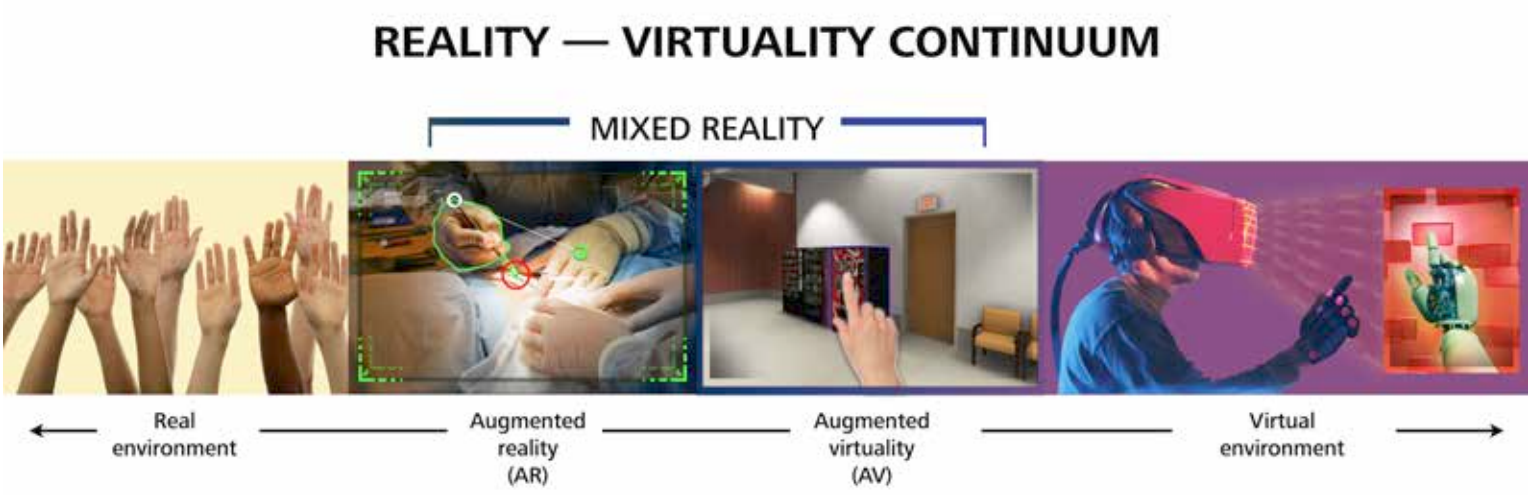
Since then, AR-equipped technologies have continued to evolve, transforming the way we interact with and relate to the world around us. Google's Project Glass has begun to stretch our notion of the possibilities of AR to drive new experiences in our daily lives. With advances in mobile technology and an increasing volume of digital data at our fingertips, AR is positioned to serve as a valuable asset in helping us make complex, real-time decisions more quickly and effectively.

> "These new technologies are changing … humanity's view of itself, giving people the ability to redefine the limitations and capabilities of the species, changing the nature of what it means to be human."
>
> ~Thomas J. Cowper, Staff Inspector, Internal Affairs, NYPD

However, while AR has been applied across a number of industries ranging from retail and navigation, to professional sports, its strategic application to government service delivery is still nascent. *Augmented Government* is the first report to take a broad look at emerging visual AR applications and capabilities, and imagine how they could be used to improve government services. Specifically, this report provides an overview of current applications of AR, and then hypothesizes how these capabilities could be used in tandem to transform operations within three federal agencies. Finally, it provides an overview of some initial questions federal leaders should consider when assessing the benefits of AR to their own agencies.

Defining AR (What is augmented reality?)

AR is the overlay of digital information onto a person's real-world field of vision, aligning both real and virtual objects with one another in a complementary manner.[3] AR exists in a continuum of variations and compositions, as developed by Paul Milgram below.[4]



Unlike virtual reality environments, in which users are immersed in computer simulated surroundings, or augmented virtuality environments, in which a virtual reality environment is enhanced by real objects, AR environments are those in which the real world is augmented by computer-generated data and visuals.

AR has been used commercially for decades to improve outcomes in areas such as manufacturing. In 1990, Boeing developed one of the first manufacturing-oriented AR systems for a wire bundle assembly project, coining the term 'augmented reality' to describe the technology behind the head-mounted digital display that aided aircraft electrical wires assembly.[5] Similarly, DaimlerChrysler has used both virtual and AR systems to design and assemble automotive parts, while BMW has employed visual overlays of data to streamline its welding process. By using video screens on welding guns to avoid misalignment to studs, workers were able to quadruple their speed without any loss of precision.[6]

The U.S. military also was an early adopter of AR. As early as 1992, the Air Force Research Laboratory developed a system called VIRTUAL FIXTURES that is used to extend an operator's sensory-motor facilities and problem solving ability to remote environments.[7] More recently, DARPA (Defiense Advanced Research Projects Agency) invested in the production of a prototype AR contact lens for battlefield use. These lenses transform the design of smaller, less conspicuous military heads up displays (HUDs), equipping human eyes with military grade contact lenses with AR capabilities.[8]

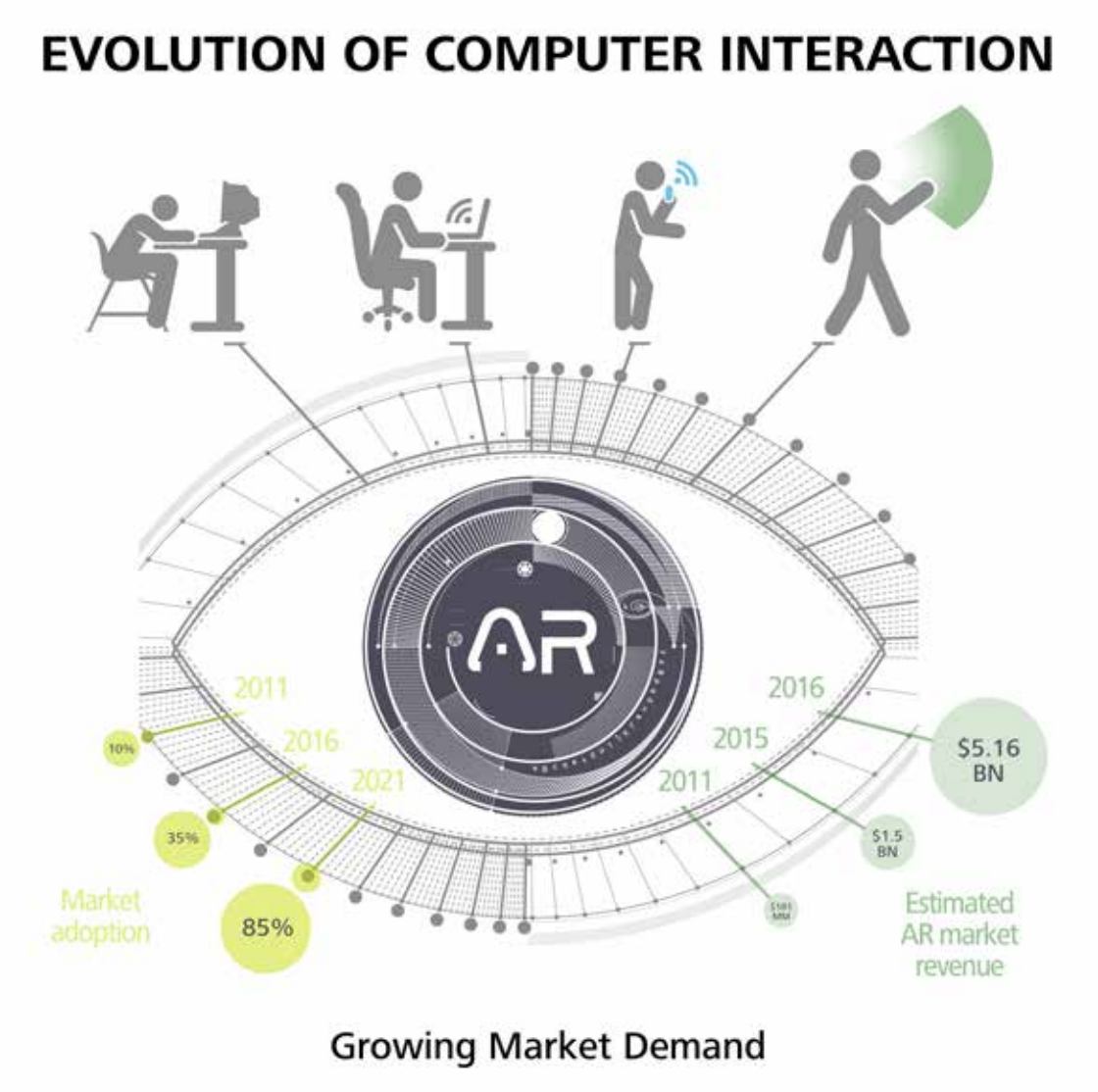
AR today

Early application of AR across industries demonstrated how AR could allow specific activities to be accomplished more efficiently and effectively. However, advances in mobile technology now allow AR to be applied on a more regular basis to everyday challenges. For example, AR applications now exist that can make life easier, from fighting crime to stargazing (Figure 1).

Figure 1: Currently available AR applications[9,10,11,12]

Application	Function
Acrossair AR browser	Select from several layers of geotagged information (photos, tweets, wiki entries) and point your device to overlay information in see-through balloons
SnapShop showroom	Point your device to overlay furniture in a room, to make buying and redecorating decisions easier
Spot crime	Point device at a street location to create a "safe and secure" score based on local crime data
Google sky map	Point device at the sky to identify stars, constellations and planets
iOnRoad AR driving app	Uses front camera, GPS and sensors to monitor driving behavior; displays a warning for following too closely or drifting off the road
RayBan virtual mirror	Uses front and web camera to allow users to shop for and try on the latest products
Klik	Point device to search your social network and identify contacts in your line of sight
Nokia Lumia	Point device at street locations to view rating and location information for restaurants and stores
DoctorMole	Point device at skin for a cursory diagnosis of whether a blemish appears cancerous
Monocle (Yelp)	Point device at stores and restaurants to overlay Yelp ratings onto the real world

The prevalence of AR applications is projected to grow in the coming years as platforms continue to develop. With the amount of digital data growing drastically each year, AR can serve as an increasingly valuable tool in connecting individuals with the information they need to make improved decisions and engage their surroundings in a more meaningful way. Wearable technology platforms — already in development by some of the world's technology leaders — will likely enhance AR's utility as a component of everyday life (see Figure 2). For example, Google's Project Glass will offer users hands-free access to a variety of AR applications.[13]



Forrester Research notes that wearable computing may prompt an AR "platform war" akin to battles between VHS and Beta in the eighties or HD DVD and Blu-Ray at the turn of the millennium, as new AR products converge toward one standard. Analysts now predict that the AR market will grow from roughly $181 million in revenues in 2011 to nearly $5.2 billion by 2016.[14,15] By 2017, more than 2.5 billion mobile augmented reality apps will be downloaded to smartphones and tablets annually; 3.5 times the number of Angry Birds downloads in 2011.[15]

Figure 2: Wearable AR development[16,17,18,19,20]

Developer	Name	Function
Google	Project Glass	Social network, geospatial and commercial data; video and audio communication
Microsoft	Project Fortaleza	Enhanced gesture recognition for Xbox gaming system
Sony		Filed a patent for a goggle-based AR system in June 2012
Olympus	MEG 4.0	Uses Bluetooth connection to smartphone to share information on display
Apple		Has filed several patents including peripheral treatment for head-mounted displays
Layar	Layar	Intel has invested $14 million toward AR-friendly computer chip development
Innovega	iOptik	Multi-focus contact lenses that allow users to focus on near-view augmented images as well as distance field-views

Seeing things differently — The future of AR

Anticipated market growth and trending investments have led *Harvard Business Review* to predict that AR will soon have an impact on everything from advertising, to location services, to healthcare, to relationships, to the very nature of knowledge.[21] Will those clothes fit? Is that my friend over there? Is this an infection? By helping us solve common dilemmas in new, more efficient ways, emerging AR capabilities could change the way we approach and answer a host of everyday questions in the future.

Training and education — How do I do this?

Visual checklists and on-demand instructions can help even skilled professionals reduce errors. Wearable AR devices can allow users to access standardized sets of instructions for a particular task in real time, triggered by environmental factors and overlaid on the user's field of vision.

Checklists have long been shown to assist with memory recall, specifically for mundane but essential tasks that are part of more complex processes. Lists can reduce errors and improve

outcomes in fields ranging from medicine to the hotel industry.[22,23] Similarly, research has shown that overlaying 3D instructions over a real-life process can reduce the error rate for an assembly task by 82 percent, with a particularly strong impact on cumulative errors due to previous assembly mistakes. This functionality can even be activated as needed in times of fatigue or extreme stress. And as a learning tool, AR allows for the benefits of experiential learning without the risks associated with a real scenario.

Data capture and enhancement — How can I improve my senses/memory?

AR allows for improved senses and memory through the capture and enhancement of the user's perspective. By recording video/audio, capturing images and removing elements that obscure the senses, AR technology allows users' eyes to act as cameras, and can enhance the senses in ways not available naturally, such as night vision or the ability to zoom in on far-away objects. Finally, as the technology's ability to automatically capture, identify, analyze and visualize data continues to evolve, the notion of what people pay attention to and commit to memory may change. For example, gardeners who check their plants' health on a daily basis may no longer have to think about it, once equipped with AR goggles programmed to identify indicators of plant malnourishment automatically.

Location and navigation — Where am I? Where is it? How should I get there?

AR uses location-based data for navigation, overlaying digital maps and directions on real-world environments. Through the lens of an AR device, we can receive visual guidance based on GPS technology. Research has shown that such uses can increase the speed and accuracy of search and rescue.[24] When further developed, AR could allow users to keep their eyes on their surroundings without having to shift focus to look a map. In the future, AR wayfinding applications could help a soldier see the terrain in front of him via drone or satellite photos.[25]

Identification — Who are you? What is this?

AR helps us identify objects, locations and people within our field of vision. AR applications, such as those listed in Figure 1, can be used to identify citizens and increase security. Tracking and identification applications could provide real-time queries on assets to show an item's location, current status, shipping date and other useful supply chain information. Current identification methods such as ID cards can be easily forged; AR may be able to reduce this type of fraud by using facial recognition software in tandem with a security database.

Collaboration — How can we help each other?
AR can facilitate collaboration among team members via conferences with distant participants.[26] For example, AR goggles could allow individuals to "see" geographically dispersed participants in a conference as if they were in front of them, and to "tag" items, persons or locations with markers designed to communicate specific information to other individuals that encounter it. Visual "push" notifications and reminders concerning specific tasks could encourage desired behavioral standards. The interaction between what is experienced and what can be shared one day could even allow individuals to experience moments, in a first-person context, from the perspective of others.

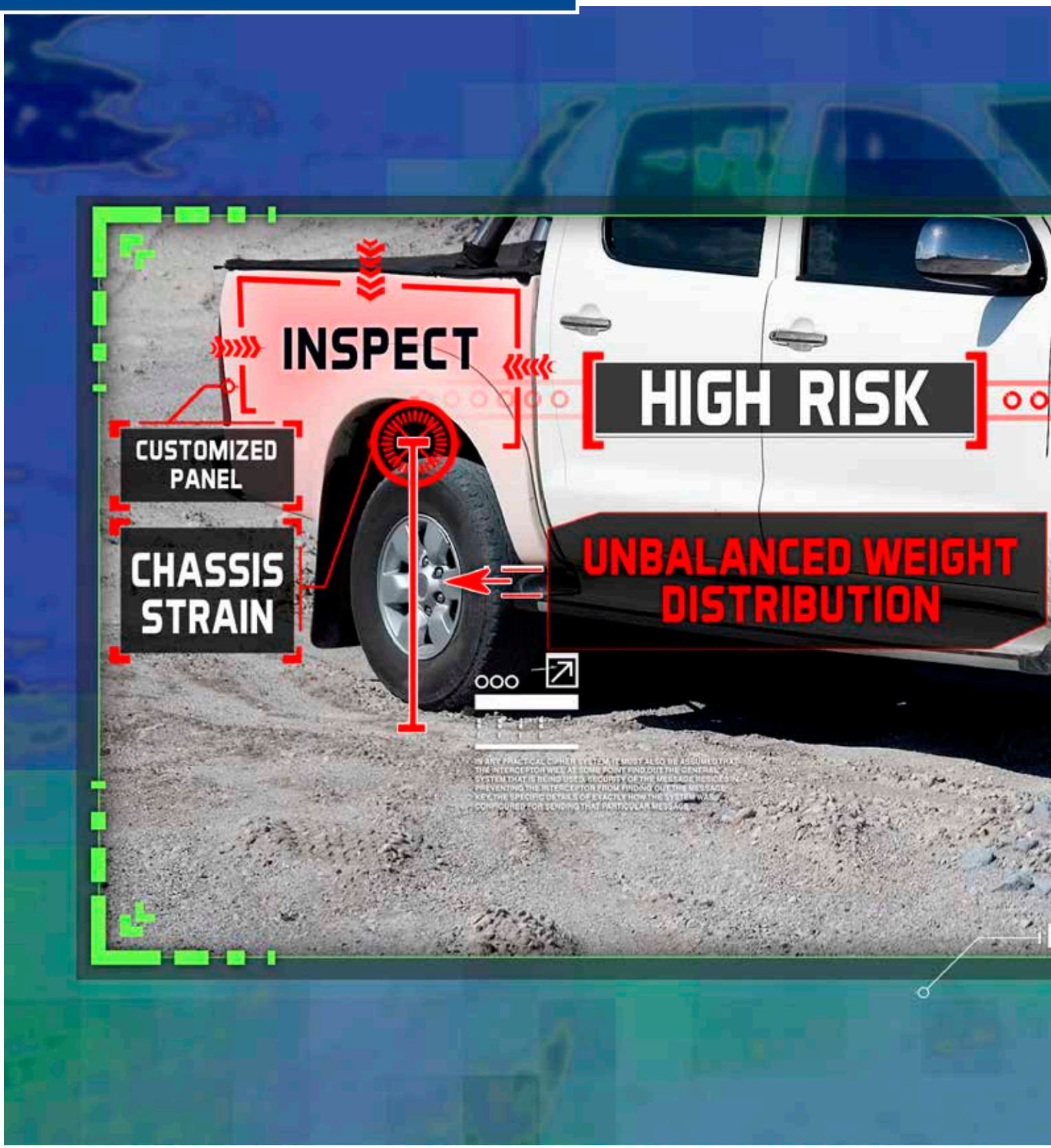
Contextualization — What does it all mean?
AR can provide useful information about a given environment even if we are not actively seeking it. For example, a pop-up advertisement in one's field of vision could indicate that a nearby restaurant fits one's interests. By leveraging information collected on personal and peer preferences, as well as the input of others in our immediate real-time environment, AR can provide context that helps us make more richly informed decisions. This ability creates potential for a "wiki approach" to our daily lives, in which users can tag people, places and things with information to be seen and used by others, leaving notes or other forms of communication for friends or even complete strangers to find.

"We can only see a short distance ahead, but we can see plenty there that needs to be done."

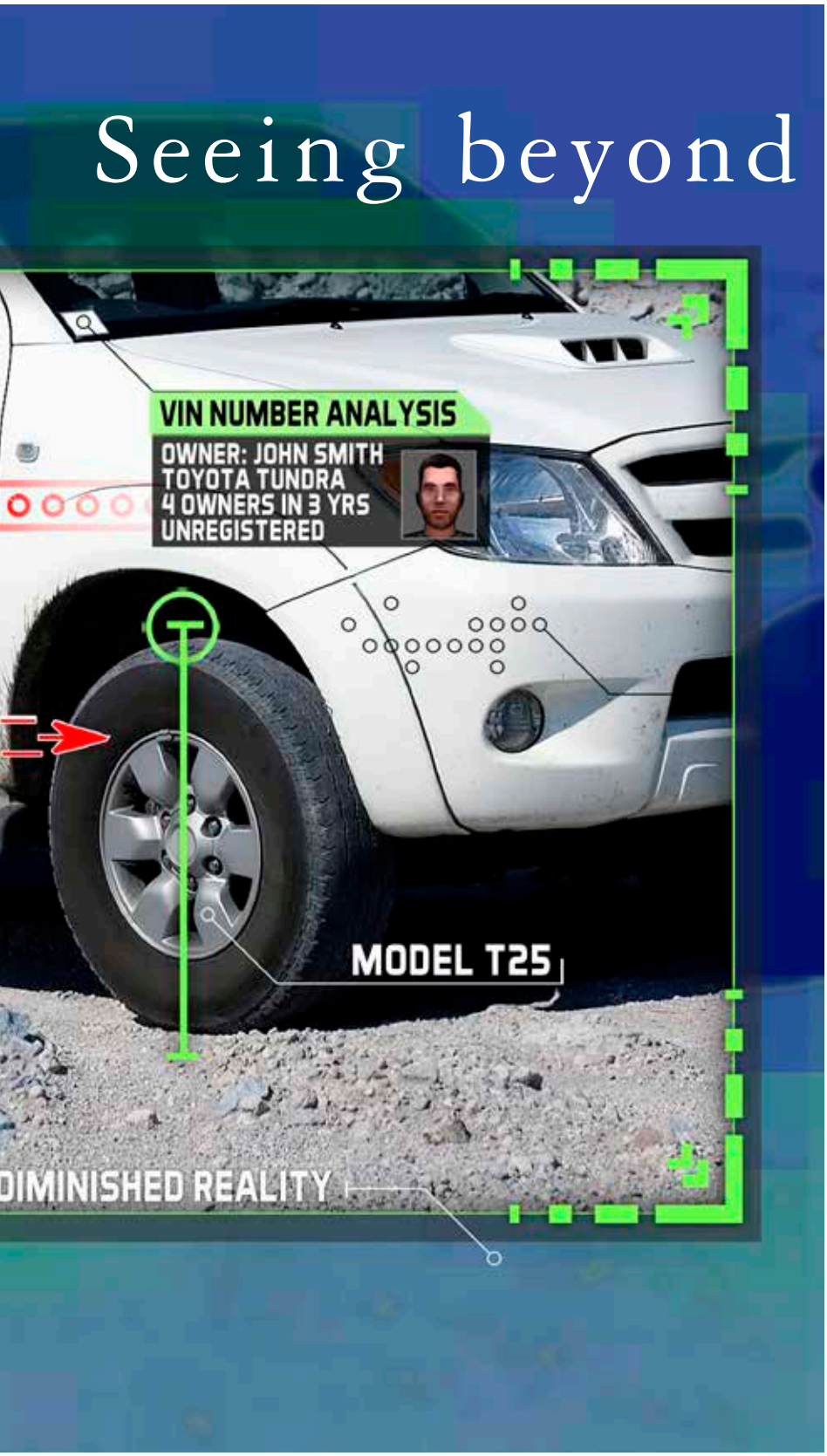
~Alan Turing mathematician, logician, cryptanalyst, and computer scientist

The augmented future of government

These examples of commercial and consumer capabilities represent the beginning of what is possible with the increasing integration of AR into our daily lives. As Millennials and younger generations that have grown up with interactive games and digital media enter the workforce, AR will likely take on an increasingly important role in how companies and governments deliver products and services.
How can governments use this technology to improve the way they meet the needs of citizens? The remainder of this paper explores this question through near-, medium- and long-term case studies.


INSPECT
HIGH RISK
CUSTOMIZED PANEL
CHASSIS STRAIN
UNBALANCED WEIGHT DISTRIBUTION

Seeing beyond borders



Transforming customs and border protection

Interactive training

The rumble of wheels on the concrete floor made Heather look up from her notebook. She angled to get a better look at the three trainers who were rolling a large black case to the front of the classroom. A murmur arose from the 15 Border Patrol agents gathered in the room.

Many of the agents, like Heather, were fresh from the academy, the rest having no more than six months in the field. All digital natives, each of them had shown a natural talent for learning and using new technologies. Now they would serve as the testing group for U.S. Customs and Border Protection's (CBP's) newest tool for keeping the nation's borders safe.

CBP traditionally put potential agents through 19 weeks of training — the longest training period in federal law enforcement — including 200 hours of language training and extensive physical and mental acuity tests.[27] The agency's new augmented reality-based system, *SmartSpecs*, was designed to increase the speed and effectiveness of this training.

Victor Shade, a well-respected senior agent, moved to the front of the class. "Can I have everyone's attention? Today is the official pilot program rollout for the new *SmartSpecs* you've been hearing about. We have a saying here that we do things the right way. Well, these new *SmartSpecs* are going to help us do exactly that."

Using AR to enhance training

As AR continues to evolve, it is poised to drastically transform how training is conducted — particularly in high-risk environments. AR-enabled **Interactive Training** makes it possible to simulate scenarios where trainees can see and interact with virtual environments as if they were real. **Diminished Reality** capabilities, on the other hand, can "remove" data from the trainees' line of site, allowing the variables present in a scenario to change with each iteration so that learners are forced to adapt.

In the scenario described here, a Customs and Border Patrol agent learns how to adapt to changes in her environment by reenacting a scenario with a few changed variables. Due to diminished reality, the agent is no longer able to see her classmates, increasing immersion and reducing distractions.

As Shade spoke, technology specialists distributed a pair of SmartSpecs to each agent in attendance. They were smaller and lighter than Heather had imagined, more similar to the safety glasses worn at a firing range than the bulky night-vision goggles she had imagined. Made of what appeared to be a highly durable plastic, the glasses were completely translucent except for a few small black buttons along the temples.

"What you all hold is what CBP, DHS and industry have been working on for the last couple years so that we can compete with the technology the bad guys use. These will help keep our borders — and you — safe. I know it may seem awkward, but once you see what these will do, you'll realize how much easier and effective your work will be. Go ahead and put your Specs on." As Heather put the glasses on, she immediately saw semi-transparent writing appear on the right periphery of her vision:

AR in action

Agent Heather Flynn 8:08 a.m.
January 21st

A tech geek at heart, Heather remembered when she had first heard years ago that mainstream tech companies were developing AR glasses. She'd even received a pair of her own as a gift a couple years back, though until now she used them only to find well-reviewed restaurants, learn about historical sites on vacation and get visual notices when her favorite stores ran sales.[28] Having grown up on the Texas border, she had seen the damage done by illegal drugs and weapons in local communities. Now her passion for keeping those communities safe and her love for technology seemed to be merging, giving her the tools she needed to learn how to do her job more effectively.

Maybe I should have taken the blue pill

"The primary feature of these glasses is their ability to overlay images that you can see and interact with," said Shade. "We'll be using them to not just tell you, but show you how to execute a checkpoint inspection under a variety of circumstances. Now please follow me."

Shade led the group outside, where a mock border station had been set up for the trainees. "As you know, we recently missed a large shipment of meth entering the U.S. because we didn't follow procedures," he said. "Incidents like this give us a bad name, but more importantly, they put U.S. citizens at risk… and these

were experienced agents! Today we're going to re-enact that day, except this time we're going to get it right. May I please have two volunteers?"

Heather raised her hand immediately, as did Clint Barton, her classmate. "Alright, please step forward to the station. Everyone else, please position yourself behind the fence."

As the class stepped back behind the fence surrounding the training area, Shade looked at the two students standing near the mock checkpoint. With a small smile, he picked up his tablet and initiated the training, selecting a scenario to play out in front of not just the two volunteers, but the rest of the class as well. "Agent Flynn, Agent Barton. You will now experience our agency's first Augmented Training scenario. Heather, you're on point. Please begin."

Crossing the language barrier

Heather looked at Clint, who was biting his lower lip in anticipation. At the word "begin," the Specs she was wearing suddenly tinted light blue, signaling the beginning of the exercise. Then, as the glasses returned to normal clarity, a series of translucent numbers appeared before her eyes.

Scenario starting in: 3… 2… 1…

Heather looked at where the fence and her classmates had stood a moment before, and felt her breath catch in her throat. Somehow, the Specs had "removed" the fence and her classmates from her line of sight, replacing them with what looked to be a very real extension of landscape. Her attention was diverted by what sounded like the rumbling hum of an engine to the west. "Look there," Said Clint, pointing to a small cloud of dust in the distance. The two agents took their positions as an old pickup truck approached the station.

Stopping at the checkpoint, the driver said something in Spanish to Heather. She had grown up in a Spanish-speaking community, but had never become fluent, and was only halfway through a Spanish-language course. The man continued to speak rapidly. Clint looked more confused than she did.

Heather could make out the man's name, and something about papers, but that was about it. Then, as the man repeated his request a third time, an English translation of his words appeared as if by magic in her field of vision.[29]

"I'm Carlos Zataran, I have my papers here. Please let me through."

Clint took the papers and began reviewing them. The signatures on two of the pages, while similar, looked a bit… off. Something felt wrong.

Then, again as if by magic, a list appeared in Heather's line of site, floating over the man's head. Heather went through the steps in her mind, and then in action. *Male crossing the border with no family. That's a warning sign. Ask him a few questions.*

"Sir, is this your first time crossing the border? Here on business?" Carlos Zataran looked at her quizzically. *I must have messed that up*, she thought to herself. Then the Spanish version of what she was trying to say appeared in her line of site.

Señor, es esta su primera vez cruzando la frontera? Vino por negocios?

This is a real-time version of one of those computer-assisted language learning programs. At this rate, I might actually become fluent! After she read the Spanish phrase aloud, the man began a long speech that she could only make out a portion of, but she could tell contained far more information than what she had requested. *Another warning sign.*

Clint returned to her side. "Just ran a search on a similar vehicle," he said. "Two hits came back. One said a similar truck was found two months ago, with no contraband, but a hidden compartment underneath the glove box."

"Sir, please get out of the vehicle."

With reluctance, the driver got out of the car as Clint came over to escort him to a space nearby. As Heather stepped back and looked at the car, another message appeared in her periphery.

Vehicle chassis is two inches lower than standard make. Search all compartments.

Wow — that would have taken a much closer look before!, she thought. Reaching for the location of the secret compartment on the vehicle Clint had matched, Heather banged her fist against the panel of the door and heard a dull, hollow sound. *This must be the same vehicle*. Unscrewing the panel, the two agents looked inside to see what appeared to be several bags of dope. Heather's feeling of impending excitement was interrupted, however, by a red flash in her vision and a loud alarm.[30]

Looking up, the two agents saw the landscape dissolve in front of them, as their classmates and Shade reappeared. "Can anyone here tell me what Ms. Flynn and Mr. Barton did wrong?"

One of the classmates — a slightly annoying know-it-all — raised his hand.

"Clint didn't escort him to a secure holding area," he said. "They were so busy looking at the panel they didn't see their suspect flee." Heather and Clint sighed. "All right, folks, let's try it again," said Shade. "Let's start with the truck arriving."

Augmented steel in the hour of chaos

The car circled around again, and with a push of a button on Shade's tablet, the students once again dissolved from view. Heather and Clint then repeated the steps they'd taken before, and Heather found that the Spanish came easier this time around. But this time, as Carlos stepped out of the car and Clint moved forward to escort him, Heather noticed something was different: fastened to the man's right side was a pistol.

"GUN!" Heather shouted, but too late. The alarm sounded again, and the pistol disappeared from the man's side — a digital prop that had not been a part of the first exercise. Victor and the students appeared again, and the instructor walked them through their mistakes.

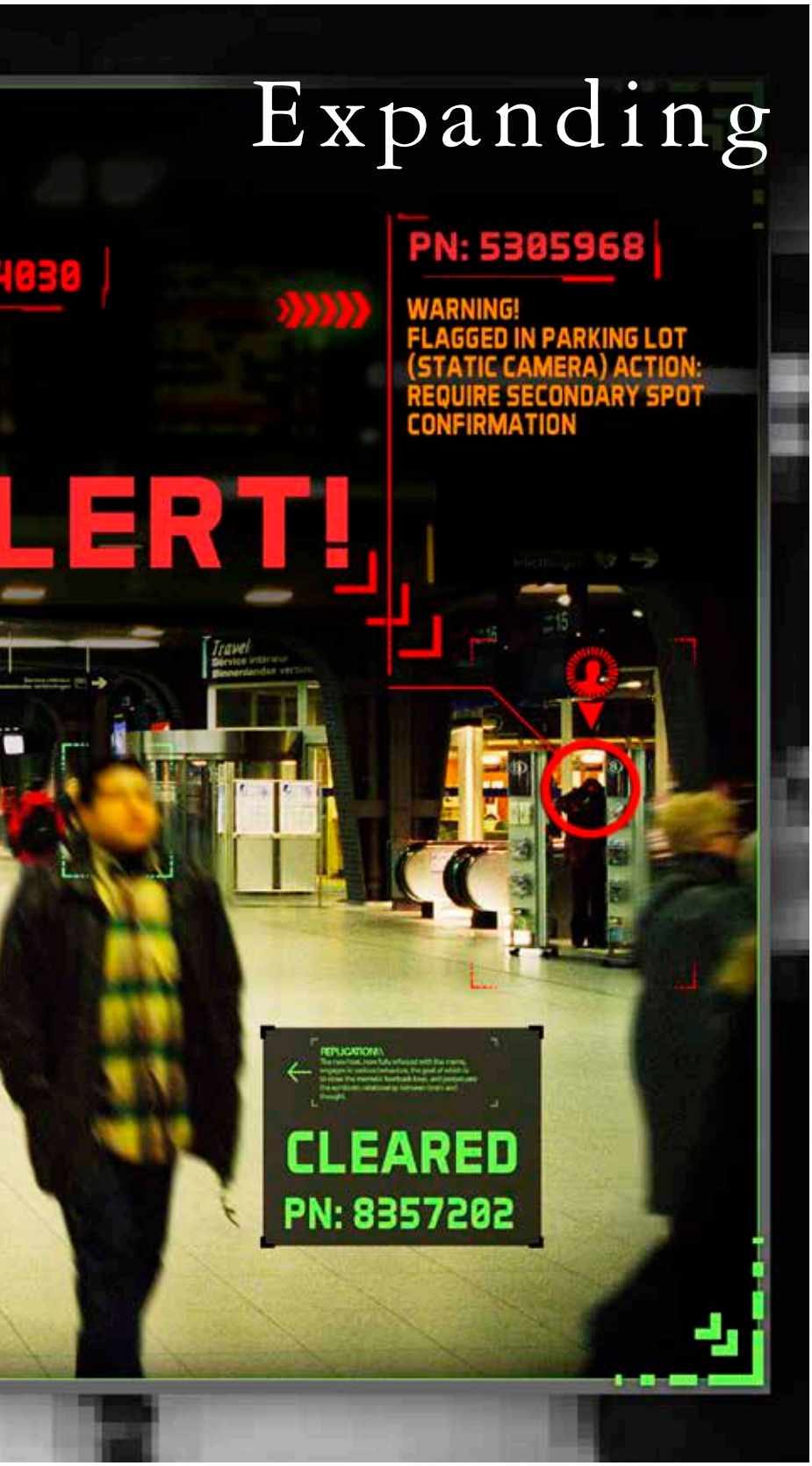
After they ran through the exercise a few more times, another pair took their place. Each time, the training scenario would vary slightly, introducing new variables to test the agents' instincts and procedural knowledge. Heather took a little pleasure in seeing that the know-it-all classmate struggled even more than she had. In the course of just one afternoon, each of the agents had gone through more simulated experiences than they would in a week under the old training system.

"All right, that's a wrap for today," said Shade. "On your way out, each of you will be given an access code to view both what we saw and what you saw as you executed your respective exercises. Study. Don't get it wrong because tomorrow, things will change again!"

Heather's head was spinning. It had been an exhausting but thrilling day. She felt she'd learned so much more than she ever would in a classroom with books. She'd learned by *doing*.


PN: 9472950
PASSENGERS STRIDE: MATCH
KINEMATIC MOVEMENT: 35.46
SPEED: .56
CLEARED
PN: 3959023
CHECK BAG
MATERIALS OF CONCERN FOUND IN BAGGAGE

Expanding perimeters



Envisioning transportation security 4.0

At Dulles airport

"Head this way, ma'am," Juan said. "Ignore the checkpoint and walk straight toward the terminal." The woman smiled and thanked him. As the woman's Passenger Number faded from Juan's field of vision, he looked toward the next passenger.[31]

Transportation Security Officer (TSO) Juan Martinez glanced past the short but slow-moving line of people at the checkpoint on the other side of the screening area. *Why don't they opt in to the program*, he wondered. Since the Transportation Security Administration (TSA) initiated its risk-based screening initiative, many travelers had opted in, drastically reducing average screening traffic. But even though the program allows eligible travelers to circumvent the checkpoint, many were not yet entirely comfortable with providing the required personal information.[32]

Just 10 years before, TSA's identity verification process had been a long exercise, requiring agents to compare each passenger's face to ID and name to boarding pass, thousands of times each day.[33] Now Juan was equipped with augmented reality glasses that changed the process entirely.

Upon enrolling in the new screening program, travelers were assigned a random unique Passenger Number (PN) that correlated to a record of their gait. In the airport, Juan's glasses could analyze passengers' stride, speed and kinematic movement, match the traveler's gait

Reducing error and risk in security screening

In the next decade, AR could play a substantial role in reducing the risk and errors associated with security screening. For example, **Contextual Checklists** overlaid over security officers' vision could standardize operations, while **Facial and Behavioral Recognition** algorithms could be used to decrease the number of false positives in screening, confirm travelers' identities in real time and help identify travelers exhibiting potentially threatening behaviors.

In the scenario described here, screening officers are able to use AR to verify the identity of passengers through kinematic movement, and share and recreate 3D visuals of captured images in real time to deal with a potentially dangerous situation.

to their unique PN and overlay the PN in Juan's field of vision.[34] Juan could then compare that information with PN information from ticket QR codes to verify each traveler's identity. The process, combined with advanced explosive trace detection (ETD) sensors throughout the screening area and an x-ray system moving alongside a moving sidewalk, permitted any traveler without a carry-on to move through to the gate in a matter of seconds.

In a decade, these glasses — known in TSA as AVTs (Augmented Visioning Technology) — had transformed Juan's job, TSA's screening procedures and transportation security.

Ambient security

Flight security at Washington Dulles International Airport once relied on scattered security cameras, a screening checkpoint and the human eye.[35] With advancements in video analytics made by casinos and social media sites, however, AR-supported screening eventually became a viable choice for TSA.

Now Juan and every other TSO equipped with AVTs could function as a source for video capture and analysis.[36] Additional cameras positioned throughout the airport recognized the behavioral, gestural and kinematic characteristics of passengers. Screening began the moment a traveler exited the Metro's silver line or stepped out of a car, and continued through boarding at the terminal.[37]

Based on the techniques that made behavioral detection officers (BDOs) effective in the past, a threat recognition algorithm now ran on live video to identify behaviors suggesting potential threats. AVTs equipped with socio-meters monitored and analyzed passenger patterns, notifying BDOs in the field when detecting a potential threat.[38] These advancements had greatly expanded the capability of individual TSOs, acting as a force multiplier for TSA's behavioral detection program.

For passengers who still chose the longer screening line, AVTs could use data available from check-in to provide a customized checklist of screening procedures based on each traveler's profile. This effort alone reduced screening errors by 80 percent, a huge improvement over the old method that relied on TSOs' ability to recall 600 pages of screening protocols.

Screening 3.0

The thick glass doors hummed shut as Jill Manus walked into TSA's Dulles video analytics office. The Master TSO moved toward an impressive bank of computing equipment, its translucent touchscreen wall bustling with moving images. As she sipped her morning coffee, Jill took in the dozens of video feeds before her.

Just then, a video feed from the airport parking lot flashed yellow with a warning icon hovering over a person in parking lot D. Jill pointed towards the image for two seconds, highlighting it and increasing its brightness, and began to zoom in. With a wave of her hand, Jill dragged the video image to the center of the wall.[39]

Jill could make out a young male pacing anxiously around the back of a Toyota. As she shifted the camera for a better look at the man, a warning message appeared over the image marking the man for further attention if he entered the airport.[40] Jill pressed an icon labeled "Secondary SPOT Confirmation." The man would now appear with a yellow hue on all security officers' AVTs, indicating a need for further screening.

Recognizing the threat

Jordi Summers, a manager in TSA's Screening of Passengers by Observation Techniques (SPOT) program, was walking through the ticketing area when a traveler with a yellow AVT warning message entered the building. As the target approached the United Airlines ticket counter, Summers continued down the concourse, paying attention to the information overlaid on the traveler through his AVTs:

> **Warning… Flagged in parking lot (Static Camera) action: Require secondary SPOT confirmation**

The message dissolved as Summers focused on the target's movement, paying keen attention to his posture. The target clearly avoided eye contact with the ticketing agent, exhibiting fear and distrust, matching the threshold for advanced interrogation. AVT indications also flagged the behavior. Summers blinked his eyes rapidly three times, confirming the initial suspicion through his AVTs. The target now appeared red in his vision. After checking luggage, the target walked quickly around the corner of the ticketing area and out of Summers' line of sight.

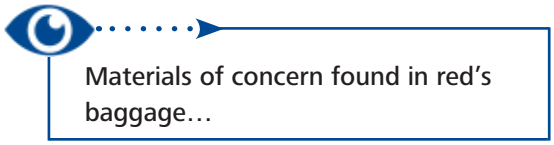
Back in the video office, Jill pointed and dragged Summers' live AVT video to a folder labeled "Advanced Checked Baggage Screening." She then pulled up the target's image from the parking lot video and selected "Historical Facial Recognition Analysis." In addition to the current video stream, three more emerged on the screen with a time stamp from two weeks earlier. The first showed the same man getting out of a white curbside van with a colleague. The second two videos showed two men walking past the checkpoint several times and sitting at a coffee shop. Jill pushed a message to Summers' and Martinez's AVTs:

> **Locate red target… Indications of prior surveillance… Engage immediately upon sight**

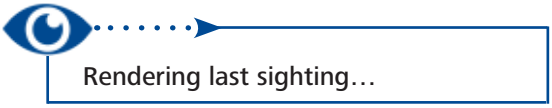
As she scanned the wall for videos of the target, no trace of red appeared.[41]

Door to a brighter future

After seeing Jill's message, Summers went on the move.



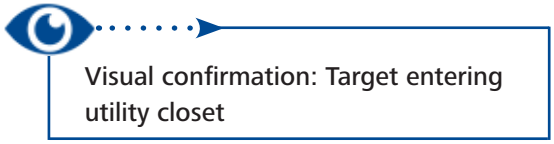
A message appeared in his periphery.



It had been only a minute since Summers had seen the target, yet he was nowhere in sight. Juan at the expedited checkpoint had not seen the target either. "*Where could he…*?" Then a navigational compass appeared in Summers' visual periphery, pointing to the dining area.

As he rounded the corner, Summers stood eye to eye with a translucent image of Griffin walking down the hallway.

The image and text dissolved. Juan then arrived at the corner to join Summers. "Have you seen him?" Suddenly, a door on the far wall flashed bright green. The two men looked as their AVT compasses turned aiming directly at the door.

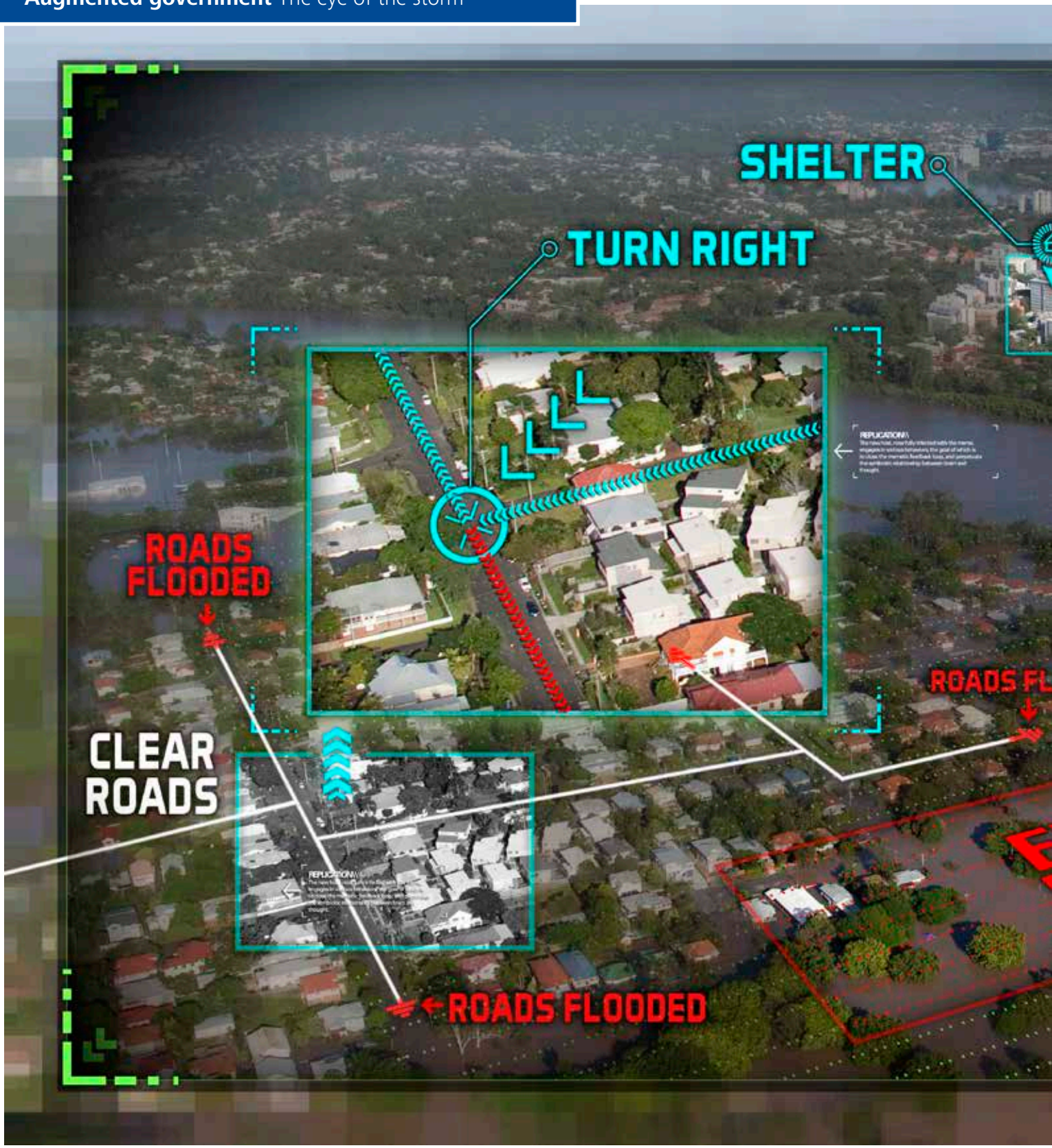


Breaking the tradeoff

This scenario is a fictional retelling of a real TSA incident, illustrating the potential abilities of augmented reality in airport security. In February 2009, Kevin Brown was arrested after trying to check luggage containing bomb-making materials on to a flight at Orlando National Airport.

A manager in TSA's SPOT program identified Brown as a potential threat, leading to the inspection of his luggage and the discovery of bomb-making tools and instructions.[42] In that incident, however, passengers were cleared from the ticketing area and flights departing Orlando were delayed up to two hours. In the future, emerging AR technologies may assist security personnel in identifying threats earlier and in a more timely manner, avoiding such lengthy disruptions. The augmented reality capabilities described here exist today, and are already challenging the traditional tradeoff between extensive security measures and improved customer experiences.

In the near future, government security organizations should consider how AR can be used as a platform to incorporate video analytics, facial and gesture recognition software and remote visual collaboration, and what strategic, organizational and financial resources might be required to do so. AR is poised to transform security operations, extending security perimeters from the checkpoint to the parking lot and beyond.


SHELTER
TURN RIGHT
ROADS FLOODED
CLEAR ROADS
ROADS FLOODED
ROADS FLOODED

The eye of the storm

Augmented emergency management

The calm before the storm

The wind howled as sheets of water cascaded against the glass door. Belle Monroe flipped through different news sites, tracking the incoming storm. Like Hurricane Katrina, 22 years earlier, Hurricane Silva had intensified as it passed through the Gulf of Mexico, growing from a Category 2 to 5 in just 12 hours. Silva was now approaching the coast near Mobile.

Belle's mind flashed to childhood memories of Katrina: her home flooded, her family evacuated to Alabama. Ultimately, they had begun a new life in Mobile, and Belle was now the mother of two little girls who saw the impending storm as an excuse to miss school rather than a threat. But Belle knew better. The storm's rapid growth, and her decision not to evacuate when the first warnings were issued, had put her family in danger. Now all she could do was brace for the worst and pray their safety.

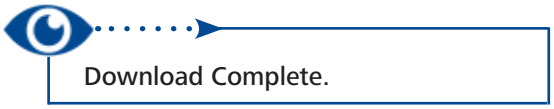
Belle's attention was diverted by small green text noting an incoming message from her eyeglasses. Though most people now wore AR contact lenses, Belle preferred the tactile comfort of her frames. Even if they weren't high fashion, they came equipped with all the "smart" features that had become standard in Visual Enhancement Devices (VEDs) produced in the last five years.[43]

Enhancing search and rescue through geospatial AR application

In the future, AR could allow agencies to use **3D Mapping** and **Wayfinding** capabilities to enhance search and rescue efforts. Examples of this include virtual compasses that show the direction of a target location, displays that direct the user to an objective and three-dimensional mapping of the surrounding environment.

For example, in the scenario described here, the search team uses overhead cameras to create a map of the disaster area and visualize a safe route to disaster victims within minutes through the use of AR.

Focusing her vision on the icon, Belle opened a small prompt window offering to install the latest update to her Federal Emergency Management Agency (FEMA) app. As she confirmed, a progress bar appeared in her field of vision, indicating that an update had been pushed to all smart devices registered to citizens in the storm's path.



Belle hoped the app would perform as advertised.

Introducing eagle vision

Eagle Vision was part of FEMA's new "Eye of the Storm" campaign, an effort to leverage the capabilities that had become common in smart devices during the last decade. FEMA designed its augmented reality app to provide citizens in emergency zones with information including visualizations related to disaster severity, location, path and damage. The app provided personalized service throughout the entire duration of each emergency, from preparation through rescue and recovery. Eagle Vision also included an active "safety score" determined by user location and preparedness.[44]

The wind reverberated throughout the house. Belle watched the faces of her two daughters as their excitement turned into fear. The house seemed to sway a bit as a clap of thunder echoed outside. A digital map appeared at the right side of Belle's vision, outlining her house and the surrounding neighborhood as well as green FEMA-approved "safety zones" that would provide sanctuary from the incoming storm. She could see the edge of the hurricane was approaching —

and fast. A small translucent safety gauge appeared in her peripheral vision alerting her that the area she was in was outside the safety zone. A small pop-up warning notified Belle that her roof was unlikely to survive the storm.

Wishing they had evacuated when they had a chance, Belle turned to her eight- and 10-year-old daughters, who now looked a great deal more frightened. The wind howled louder. Belle felt her pulse quicken as the lights flickered and her daughters ran to her side. An icon loading bar appeared in the upper left corner of her lens, and disappeared in seconds to reveal "Sammy the Eagle," FEMA's virtual guide for the app. Belle pressed the Sixth Sense button on her frames and turned to the wall. In Sixth Sense mode, her glasses projected augmented data on the wall, where the whole family could see it.[45]

On the wall, Sammy provided a step-by-step list of instructions for the family as they prepared for the storm to arrive. Belle had taken most of these steps ahead of time, though it was helpful to reconsider their survival kit and water and food supply. Sammy tracked essential items in the house, and mapped their location for potential rescuers.

The rain and wind grew heavier. Debris battered the house, and the din of thunder was constant. Then with a flash of light, everything went dark.

Winds of change

"Shhhh, it's alright," Belle assured her daughters. Rebecca, the 10-year-old, was handling the power outage fairly well, though Tori had begun to cry. She could hear the sound of tiles flying off of the roof, and suddenly, a window blew in.

Once again, her glasses projected Sammy the Eagle on the wall, a helpful distraction for her daughter. Sammy displayed a 3D map providing the safest route to a relief center about half a mile from the house. Icons of nearby neighbors let Belle know who might help the family reach safety.

As Sammy issued a final warning about traveling in the inclement weather, Belle took her children's hands. "Sammy is going to direct us to safety. Don't let go of me. Do you understand?" Both girls nodded, as Belle turned off Sixth Sense mode and Sammy appeared on her lens once again. As the storm momentarily subsided, Belle and her two daughters headed out into the the eye of the storm.

Enhancing search and rescue

Eyes in the sky

As helicopter blades hummed above him, Jack Arnold looked down on the devastation wrought on Mobile. In 15 years with FEMA's Urban Search and Rescue (US&R) Division he had seen more than a few storms, but his heart still went out to the families who hadn't gotten out before Silva hit.

The hard winds and rain had passed, and Arnold's team didn't want to waste time in getting supplies and medicine to the storm's victims. Looking down, his augmented protected goggles (APGs) toggled between his regular vision and 3D blueprints of city buildings and structures below. With his APGs, Jack could see "through" the flood and rubble, and track the escape paths recommended to citizens via Eagle Vision.

"Are you seeing this, Paul?" Jack asked, sharing his field of vision with headquarters.

"Copy. Stay on that route. It was the most frequently recommended route during the peak of the storm. We're sending out a second team on the other routes." As Jack flew over city blocks, his APGs overlaid video feeds from rescue workers' fields of vision on the ground. Location data related to each Eagle Vision user's last known position were provided as well, so that the rescue team could look for injured travelers and tag areas as "clear" if no survivors were found.

"Jack, look over to the east," said HQ. "The ground team we sent in dropped a pin on an area 560 meters from your current location that they couldn't reach due to debris."

"We're on it."

A red icon appeared in Jack's field of vision, indicating the building that had been geo-pinned. As the helicopter descended, the icon changed to take shape in the form of a school as it had stood before the storm. The difference was stark.

"Jack, we're going to drop you 200 meters south of the structure," said the pilot. A pin appeared in his vision to show where he would be placed. "We'll circle overhead and gather data for your APG to use with pathfinding."

Above the flooded streets, Jack and fellow US&R member Rick Sullinger lowered ropes and dropped to the ground. The water was up to Jack's thighs. The school in front of them was exactly the kind of place a family might use to take cover from the storm. Jack's thoughts were interrupted by the helicopter pilot on his radio. "Alright guys, that's three trips around the building. See if you've got a path."

"Give me a route," Sullinger said aloud. Their APGs overlaid an optimal path to the building using data gathered from the helicopter's cameras and prior records of the building. The APGs also created images of various forms of wreckage, rubble and other potential risks along the route, to help keep the two rescuers safe as they made their way into the school to check for survivors.

"Alright, let's be careful," said Jack. "Follow my lead."

As the pair approached the outer wall of what looked to be the school's gymnasium, a red warning appeared before Jack's field of vision.

Hazardous material detected: Toxicity high, flammable

This was new to Jack. He'd been trained on the new APG chemical detection capability, but this was the first time he'd used it in the field. New icons floated before him — Next Steps, Chemical Info and Source Location. Jack selected the last option with an eye movement. Immediately, a translucent shade of red came over his field of vision, becoming progressively darker to indicate the direction and source of the leak. Jack's eyes were drawn to a blinking red warning light highlighting a pile of rubble between the two rescue workers and the structure's door.

His APGs indicated the estimated distance to source: 20 yards. "Please advise," he said to the APG's voice recognition software. The red warning was replaced with blue.

Drop location pin to direct local city assistance. Avoid radius of 30 yards.[46]

Jack made a gesture to drop a virtual 'Hazard Pin' on the location. Now that the use of APGs was standard protocol for coordinated emergency response, all first responders would be aware of the hazardous leak. Navigating around the hazard, they finally reached the gymnasium's door. Jack pushed the door open and looked into the darkness.

A faint light could be seen. In the dark, both men could see the silhouettes of a group huddled in the darkness around what appeared to be a lone working lantern. Looking around, the APGs seemed to detect no additional threats, so Jack called out into the darkness.

"Hello? My name is Jack Arnold, and this is my partner Rick. We're emergency workers with FEMA, and we're here to help you."

There was a rustling sound, a muffled cry, and slowly a group of eight people made their way forward. Turning off his night vision and holding up a lantern, Jack looked them over. A teenaged couple. An elderly woman. Another couple in their 40s. And one young mother, with her two daughters clutched by her side.

What's next?

Preparing your organization for augmented reality

These vignettes illustrate just a few of the ways that augmented reality can be used to improve the efficiency and effectiveness of government operations in real-time and mobile environments. At present, however, agencies vary widely in their readiness to implement AR capabilities.

So how would a forward-thinking government executive go about assessing this readiness? Here are five specific questions you can ask to determine how your organization can use AR, and what you can do to prepare for its application.

Key questions for federal leaders

Who in my organization requires real-time data for decision-making?

Situations in which workers must consider a large amount of data in a short period of time are often high-impact and high-stress. AR technologies can provide workers with information from multiple data sets in real time, in an easily visualized and understood manner. It is therefore important to consider which individuals are operating under such conditions. For example, employees operating at a security checkpoint — where a mistake or failure to consider vital data could prove disastrous — would likely benefit more from AR technology than desk-bound office workers. Similarly, employees in environments requiring real-time visual collaboration could realize benefits from AR that isolated individuals might not.

What are the technology and data requirements?

The effectiveness and viability of AR technology depends on an organization's data and technology infrastructure. For example, real-time data visualization on AR-equipped smartphones, tablets or goggles is only possible with the necessary analytic capabilities and data. Furthermore, most AR devices rely on some means of connecting to data in a timely manner, making access to wireless networks a prerequisite. On the software side, the organization should make sure that it has the analytics, data visualization and data translation capabilities needed to select and create visualizations for the right data efficiently and accurately.

What are the human resource requirements?

Even in an organization with the required technology and data infrastructure, the effectiveness of AR will likely depend upon its employees' willingness and ability to use it. Government executives should consider factors such as their employees' affinity for new technologies and their comfort level with mobile devices. Furthermore, AR will require training that provides an overview of how AR will be used and its benefits. By reducing the time needed to process environmental data, AR technologies could allow employees to focus more attention on other aspects of their jobs. Executives should consider how the roles and expectations of their workers will shift after the implementation of AR.

What are the risks associated with using AR in my organization?

With any new technology adoption, organizations should consider the risks associated with the widespread implementation. For example, AR's use of wireless networks means that organiza-

tions should consider whether they can maintain a secure wireless network and protect sensitive information. Similarly, the data-capture capabilities inherent in AR applications create obvious privacy concerns for employees and the public alike.

If employees do become dependent on AR's real-time data visualization capabilities, it is important to consider whether a network disruption could impede decision-making at mission-critical moments. Mitigation strategies for such issues should be in place prior to AR adoption.

Finally, it is important to consider the health risks associated with heavy use of augmented reality, as the technology is still young. While the effect should be no more harmful than requiring an office employee to view a screen for eight hours a day, the potential for health risks should be fully tested.

What impact will AR have on my organization's mission-critical activities?
For many organizations, developing a holistic mobility strategy is still a priority. As organizations move forward in planning how to manage information across an ecosystem of mobile apps, web, cloud, video and hardware, understanding how AR will fit in should be a major priority. Will AR have a complementary effect on the existing system? What should the timing be for implementing AR capabilities, and where will the funding come from? What specific areas or offices within the organization could reduce time or cost by applying specific AR functions?

For federal agencies in particular, such questions should be examined now, to prepare for the use of AR in the near future, as its capabilities and uses continue to evolve.

The future is now

Augmented reality is expected to play an increasingly important role in peoples' lives. Evolving from science fiction dreams to our present reality — AR has now become an everyday tool to help engage the world around us. This is particularly true in situations where decisions need to be made using data in real-time. Governments should consider the best way to take advantage of AR's capabilities to strategically improve the way in which they deliver services to citizens in moments that matter most.

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