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Integrating unmanned aircraft systems into airport operations: From buy-in to public safety

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Abstract

Savannah/Hilton Head International Airport (SAV) is in the middle of its project to integrate unmanned aircraft system (UAS) technologies into its regular airport and airfield operations. The integration includes applications for inspection, maintenance, monitoring and facility management, including support for its Part 139 inspection protocols. As the project moves from Phase I to Phase II, lead members of the implementation team from Woolpert discuss the year of consultation that led into the first phase, lessons learned so far, how those lessons are being carried into the next phase, and how additional phases will be added as the project progresses, adapting and expanding to the changing needs of the airport, the technology, the rules and trajectory of the industry. The paper also evaluates' how the industry is evolving, how the Federal Aviation Administration (FAA) is attempting to safeguard the private and commercial proliferation of UASs, and how recent drone sightings near airports play a role in developing standards for implementations such as this one at SAV.

Keywords

UAS, drones, airport operations, FAA, aviation, asset management

INTRODUCTION

A year ago, the US Department of Transportation reported that the number of unmanned aircraft systems (UASs) registered with the Federal Aviation Administration (FAA) had eclipsed one million.[1] In July 2018, the FAA reported there were just over 100,000 Part 107 licensed pilots.[2] Also, in 2018 the FAA projected the small-model hobbyist UAS fleet would reach 2.4 million units and the commercial, small non-model UAS fleet would grow to 451,800 by 2022.[3] Their incorporation into operations at multiple businesses will continue to affect industries across the globe, as technology continues to improve and its applications expand.

Airports are one of the industries ripe to benefit from the evolution of UAS technology, increasing availability of credentialed operators and pilots and the continual advancements in regulations and restrictions worldwide. As the UAS industry progresses and the number of systems and pilots grow, a duality has formed surrounding UASs and airports. Many airfields have begun to utilise UASs in their operations, taking advantage of the efficiency and quality of the data produced by these systems. At the same time, individual UAS incidents have caused multiple disruptions in the National Airspace System (NAS) creating industry and political pressure to further research and invest in UAS detection systems.

The time is now for airports to familiarise themselves with the constructive application of UASs for airport operations, understand the tool in that setting and separate it from its association with airspace disruptions. The first step for airports, airplanes and UASs to cohabitate is for airports to embrace the wave of capability from UASs coming directly at them and learn to accept, incorporate and integrate these tools into airport operations.

INTEGRATION CASE STUDY

In December 2015, Woolpert established a partnership with the Savannah/Hilton Head International Airport (SAV) to integrate UAS technologies into their airport and airfield operations. SAV has become an aviation industry leader by being one of the first commercial service airports to formally integrate drone technologies into its regular operational programmes. UAS integration at SAV includes applications for inspection, maintenance, monitoring and facility management, including support for its Part 139 inspection protocols.

Due to the groundbreaking nature and large scope of the project, a year of extensive consulting preceded SAV's phased implementation. Woolpert, a firm well-versed in aviation and UASs, recognised the need for further technology and regulation evolution as well as a slow-paced, methodical implementation approach. The approach allowed SAV to build internal support and ensure safe and effective drone operation in the highly complex environment of an active airfield.

The integration was designed to follow a 'crawl, walk, run' approach, with each phase building on the framework laid in the previous phase or phases. The approach enables the team to identify and mitigate potential risks of using UASs near manned aircraft through a palatable and appropriate cadence of integration. At the outset of 2019 the project has completed Phase I and transitioned into Phase II, or the 'walk' phase. Additional phases will be added as the project progresses, adapting and expanding to the changing needs of the airport, the technology, the rules and trajectory of the industry.

The initial applications integrated at SAV during Phase I included the use of UASs for daytime perimeter surveillance and wildlife management operations, as well as other UAS capabilities demonstrations. Advanced integration will include planning for irregular and unscheduled UAS operations, disaster response/recovery operations, nighttime surveillance and airfield asset management, among other tasks that are traditionally supported only by manned operations.

This project is an example of how airports around the world are engaging consultants and experimenting safely with the adoption of this dynamic tool to improve daily airport operations. Lessons learned from this ongoing project — from training to application to customer perception to safety — and others like it will benefit the industry as it innovates for the future.

FIRST, SOME BACKGROUND

Woolpert has worked with SAV in multiple aviation engineering and asset management capacities for years, establishing a baseline trust and comfort level that helped set the stage for this project. Additionally, SAV is aware that the firm is heavily involved in the UAS market and has been since the technology's commercial debut. The firm purchased its first UAS in 2013, and in 2014 it became the first surveying and mapping firm to be approved by the FAA to fly UASs commercially in designated airspaces through its Section 333 exemption. Subsequently, Woolpert has invested in numerous UAS platforms, including vertical take-off and landing (VTOL) and fixed-wing, and has developed a deep bench of 18 FAA Part 107 certified pilots, with payloads of true-colour (RGB), thermal, lidar and multispectral sensors.

When contracted for this integration, the Woolpert team's first task was to review SAV's existing Airport Layout Plan, security plans and airfield/flight operations to establish a baseline Concept of Operations (CONOPS) for UAS perimeter surveillance and wildlife management, the objective of the first phase. The CONOPS includes flight operation areas, checklists and procedures, risk mitigations, areas of interest (AOIs) for mission focus areas, data management and security, and communication and regulatory protocols with air traffic control (ATC). The team viewed internal SAV stakeholders as its most valuable tool. The team worked with key SAV airfield operation, security, first responder and engineering personnel to develop the CONOPS that would include appropriate safety management systems (SMS) style risk matrices; proposed controls to avoid Federal Aviation Regulation (FAR) Part 77 surfaces and other critical operational assets; flight mission communication procedures; and pre-, post- and in-flight operation procedures for both experienced and inexperienced pilots. Clear, effective, consistent and timely communication before, throughout and after each flight mission was critical to the success of the plan.

The next consulting task involved obtaining FAA certifications, permits, authorisations, letters of authorisation (LOAs) and other applicable documents to support UAS operations in restricted airspaces. To keep costs contained and minimise the impact to SAV personnel and operations, Woolpert utilised existing permissions and LOAs at Springfield-Beckley Municipal Airport (SGH) for initial testing and prototype operations, mimicking drafted mission parameters, protocols and UAS platforms. SGH is close to Dayton, Ohio, which is Woolpert's global headquarters. Conducting these tests at an uncontrolled airport provided invaluable experience for operating UAS flights in the Class C environment of SAV.

Once the UAS technologies passed the initial testing phase in Ohio, follow-up demonstration flights were scheduled at SAV as part of the third consulting task. These demonstrations tested the prescribed ATC communications, safety protocols and UAS procedures. System selection was conducted by means of a thorough review of their ability to perform the scenarios outlined in the CONOPS. Required airframe-specific documentation was produced to assist SAV in maintaining safe and legal UAS operations, with the team working closely with SAV, SAV ATC and the FAA UAS Integration Office to codevelop and adapt best practices for operations within the airport environment.

PHASE I: INITIAL IMPLEMENTATION

Phase I of the implementation, which took place from April 2017 to January 2018, focused on the adoption of UASs to address wildlife management/hazard mitigation and daytime perimeter surveillance. These areas of operation were selected based on a priority list of applications developed to test the integration of this technology at an airport. Phase I successfully demonstrated that UASs can be used safely on an airfield with well-developed safety and communication plans coordinated between all stakeholders.

In previous projects with SAV, Woolpert had performed aeronautical surveys and base mapping for the airport and implemented a computerised maintenance management software (CMMS), Cityworks Asset Management System (AMS), for airfield maintenance and management. The CMMS implementation went live in December 2017, and is being used by SAV Operations and Maintenance. The next phase of work is designed to integrate the management of SAV UAS flight operations and associated data and imagery into its capabilities.

The imagery data collected via UAS flights can be analysed to identify pavement or marking issues. The remotely collected data can flow directly into the Cityworks workstream to be used to document issues and create work orders with accurate coordinates and valuable supporting imagery. This additional capability provides an opportunity to minimise the frequency of visits and duration that workers spend in safety-critical areas and creates valuable geodata as part of the airport's system of records.

The need for this capability was apparent during Phase I, when the operations team used a UAS to identify a downed tree that had broken through the perimeter fence located on the swampy north end of the airport. The location was extremely difficult to access on foot or by watercraft, but the UAS was able to collect information safely and quickly, instantly providing the location and including real-time imagery of the breach. With the addition of Cityworks, this remote problem immediately became a work order, initiating action and solution.

TAKING LESSONS LEARNED INTO PHASE II

The goal of Phase II is to expand UAS flight operations into the airport operating area (AOA), an area of the airport that was restricted in Phase I. Completion of this phase is intended to further validate the benefits of UASs to safely support additional airport missions that enhance the productivity and safety of SAV staff and operators, while simultaneously establishing the policies and procedures for SAV to ultimately operate UASs proprietarily.

For example, specific to Airport Emergency Operations Centers (EOCs), the benefit of UASs in safety- or security-related emergency situations is the ability to rapidly deploy ahead of first responders and be integrated into emergency processes and plans. UASs and the array of sensor payload options can enhance and bolster response time by improving situational awareness, tracking moving targets and adding persistent surveillance of an incident. Added benefits of utilising UAS technology in the emergency situation environment are expected to expand as artificial intelligence (AI) solution and capabilities continually migrate into the industry. As UASs become an additional layer of capability at the airport, the data collected or fed from the UAS sensors will greatly enhance the ability for AI applications to perform more reliable and predictive analyses to navigate emergency situations or identify threats. Eventually, AI will play a role in the operations of UASs in emergency and security situations, where the UAS control system will utilise the real-time sensor data to make decisions on flight path, sensor angles and be able to notify the operations team of additional risks.

Phase II of the SAV implementation includes additional operations of UASs for situations such as irregular operations, disaster response/recovery operations, nighttime surveillance, airfield asset management, airfield safety inspections, construction observation operations, traffic monitoring, airport security and other tasks that are not traditionally supported by aerial operations — manned or unmanned.

This phase will involve increased ATC coordination and additional flight permissions to operate UASs safely on movement areas and in the Class C controlled airspace over SAV. Direct coordination will be established with the FAA SAV ATC tower (ATCT) manager to establish the necessary communication protocols and procedures, ensuring there is a specific memorandum of agreement (MOA) between the SAV ATCT and SAV. Prior to demonstration flights at SAV, Woolpert will obtain the necessary ATCT and FAA approval to conduct UAS flights on the airfield utilising its own equipment. The firm is acting as SAV's agent, preparing documentation and submittals to the FAA for airspace authorisations, waivers and, if required by FAA or local agencies, other documentation to successfully obtain approvals. All flight missions are being prepared, overseen and under the command of a Woolpert FAA Part 107 pilot-in-command (PIC).

These planned enhancements will incorporate the greater challenges of expanding flight operations close to active runways, integrate with existing emergency/disaster response teams and assist operations at night and beyond visual line of sight (BVLOS). Additional collaboration is expected to be required with local stakeholders, including airport engineering and facility departments, the Crash Fire and Rescue Department, Gulfstream, security and police.

Next, flight management, data management and security routines will be developed. The use of UASs results in large amounts of data being collected, requiring advanced data processing, storage capacity, accessibility considerations, analysis and visualisation, and IT security controls. Woolpert's geospatial data management expertise and other airport security functionalities using UASs play a large role in the successful and secure integration of live and postflight data into SAV's security monitoring systems.

In this phase, SAV's existing IT systems and applications will be reviewed to identify key performance and controls needed to achieve mission requirements of SAV. This will involve coordination with the SAV security operations team to review current security systems coverage — closed-caption television (CCTV), motion sensors, etc. — security management tools and IT systems associated with the airport's security operations.

The existing Cityworks software will be used to develop applications, interface and establish workflows to assist SAV in planning, managing and reporting on UAS operations. As the analysis of the current IT infrastructure at SAV is being completed, the impacts of including UAS mission data and visualisation capabilities will be defined and recommendations will be reported. Woolpert will work with SAV to script an IT implementation plan to support the UAS programme.

Also, human factors will be studied by calculating the impact of the UAS operations workload and flight operations on the SAV airport operations staff. Introducing alternative solutions, such as incorporating UASs into an existing airfield inspection routine, can be disruptive and challenging. Therefore, there will be interviews with airport operations staff to establish a baseline understanding of tasks, responsibilities and intended outcomes of those duties and tasks. Establishing the applicability of UAS technology is a small subsection of implementation; understanding and quantifying the impacts of UASs to a well-established series of processes is crucial because it will enable airport management to make informed decisions on investment and implementation over time.

A workload assessment report will be generated comparing the current workload and functions of the SAV operations team to the workload and functions when UASs are introduced into the process. The potential unanticipated or unintended impact to other airport operations staff also will be monitored. The FAA likely will conduct similar human-factor studies to gauge impact on ATCT, while the human-factor analysis at SAV will focus on airport operations and staff.

This phase also will involve ensuring and assisting staff education and refining the systems, sensors, processes and data management techniques most appropriate to airport needs. Utilising the MOA, mission planning, flight logs and data storage techniques, classroom-style field instruction and skill enhancement sessions will be conducted to illustrate how to complete successful UAS flights.

The sessions provided by Woolpert will not be designed to prepare pilots to acquire a Part 107 license, but rather will focus on SAV-specific missions from planning to data management. Key components in these sessions will include fundamentals on UAS platform and sensor technology; pre-mission planning and communications; flight operations, including communications, safety, roles and responsibilities, and lessons learned; post-mission tasks, including communication, equipment and data storage, and minor maintenance; and data management, processing and dissemination.

The safe operation of UASs is critical; however, the objective of utilising UASs is not to simply fly but to harness the value of the data and insight collected using UASs. Therefore, during classroom instruction, the firm will demonstrate the data processing, manipulation and output production of the imagery data collected for dissemination to appropriate SAV departments and/or other necessary organisations.

Upon completion of Phase II flights, Woolpert will conduct detailed interviews with key staff members to determine the business case for each mission in terms of the amount of labour saved, risks reduced and the enhanced delivery of services achieved as compared to traditional methods. Additionally, a cost-benefit analysis will be conducted. This is a crucial step to ensure airports make sound business decisions moving forward and those involved identify tangible benefits to present to airport leadership. A final meeting with FAA headquarters to present the results of the project also will be completed at the end of the project.

A critical component to the analysis will be the conclusion regarding the different mission types attempted as part of the project and their viability to support exiting operations. Beyond the workload analysis, technical review of the data by Woolpert will provide data and draw conclusions on the practicality and efficiency of incorporating UAS applications to the outlined mission objectives. Civil, structural, water and transportation engineering experts will be consulted and will contribute to the analysis.

Upon completion of this phase, SAV will determine whether it will acquire UAS technology and self-perform future UAS operations or the most effective utilisation of UAS technology will be accomplished via contractor support. In the event SAV wants to proceed with purchasing and self-performance, a third phase could be added to assist with technology acquisition, additional training and integration support.

EVOLVING TECHNOLOGY

Each advancement in UASs exponentially propels the industry forward and changes the playing field for all involved. As this technology continues to evolve, the FAA diligently sprints to meet demand. At the same time, as the industry continues to navigate this evolution, firms developing and employing UASs fall primarily into two groups: one that pushes beyond the rules and develops technology that will eventually be accepted by the FAA and the other that works to do everything it can within the current guidelines, waiting for its opportunity to leap. Eventually these paths will converge, creating more partnerships that can tackle bigger problems.

There are currently two primary challenges for airports as they relate to UASs in the NAS: (1) the safe integration of UASs into everyday operations, whether through a consultant or trained airport staff, and (2) managing those outside of the airport who attempt to use UASs in their airspace.

Currently, there are FAA regulations in place for the operation of small UASs weighing less than 24.9 kilograms (55 pounds), while those that weigh more require an exemption under Section 333, and now Part 107. Once those rules progress, airports will need more space, more facilities, runways, communications, etc., all need taken into consideration when integrating at an airport.

The field is wide open to innovations that can change the direction of the UAS industry, and these extend to the aviation industry and to the integration of UAS operations at airports. Many of the risks and challenges UAS operators face in regards to flying within the performance-based standards outlined in FAA Part 107 are spurring innovation and technology developments beyond the UAS airframes. Airport operators deploying UASs or permitting operations in controlled airspace need to be aware of these advancements to decrease the risk of collision and/or property damage.

Some of these UAS innovations focus on solutions to support safely 'downing' a UAS in mid-flight, such as utilising parachutes and other means to arrest apparatuses and allow them to fall to the ground without harming people, property or the UAS. In the airport environment, this technology can be used to safely land a UAS in case of system failure or if a UAS needs to be swiftly removed from airspace to avoid collision.

A variety of lighting augmentation solutions also have been on the market for many years, and advancements in light-emitting diode (LED) and battery technology and miniaturisation become available each year. Lighting and signal solutions will promote increased application of UASs and provide additional layers of visibility and situation awareness of a UAS in flight, minimising the issue of the human eye not being able to track a UAS from longer distances.

Sense and avoid, detect and avoid, and detect and deter technologies are another large area of UAS investment and innovation. The industry is taking advantage of technology developments from military-related applications in drone detection systems, translating those technologies into commercially available solutions. There are many types of solutions being developed for ground-based sensors as well as UAS-mounted technology for a UAS pilot to detect and avoid objects and aircraft. UAS manufactures are integrating lidar sensors, ADS-B and other forms of technology to their platform configurations, continually advancing their performance capabilities, while enhancing safety and collision avoidance. Independent innovators have developed UASs with an optical sensor on board, giving them the ability to detect subtle changes in the airspace environment in real time. This allows the UAS operator to detect airplanes, helicopters, birds and other UASs in the air, while in flight.

Counter-UAS (cUAS) capabilities are another area of continual advancement, both technically and politically, in the United States. Airports likely will find these evolving solutions relevant to future investment and deployment as this technology emerges.

Airport operators must be aware of these advancements and how they will impact their ability to protect airspace and provide situational awareness, allowing them to better track and control UASs without disrupting airplane, helicopter and other UAS flights. Another large effort is advancing the UAS traffic management (UTM) systems by federal agencies and commercial businesses around the globe. The notional concept of UTM was first tackled by National

Aeronautics and Space Administration (NASA), and in a relatively short period of time, the technology and standards for deployment of UTM have advanced to address a variety of applications and coverage areas.

UTM systems and sense and avoid technologies also are being developed and are highlighted by the work being done on the Ohio Department of Transportation's US 33 Smart Mobility Corridor research. Woolpert is participating on the project team being led by Ohio State University to establish a UTM to monitor and control air traffic, manned and unmanned, along a 45-mile stretch of state highway. The purpose of this project is to deploy new UTM technologies to permit the mixture of aircraft types along the busy roadway corridor. Projects such as these are what spawn the next layer of technological advances.

These traffic monitoring advancements and applications are of interest to airports because they look at not only how to detect and integrate inside and outside the fence but how a mixed fleet of aircraft can coexist in one layer of airspace. SAV is assessing the multitude of advancements driving towards successfully integrating UASs into an airport environment, supporting processes like Part 139 inspections and documentation and asset management.

There is recognition across consultants, airports, the FAA and among the ATC community that the risks of UASs are slowing down the integration progress, but the technology is not. In fact, in many cases it is the risk that is driving new technology. Watching the first wave of full-scale integrations like that of SAV and seeing the technology in action opens the door to further innovations. There is focus on risks, but attention is also being paid to what opportunity each advancement is creating.

GETTING AIRPORTS ON BOARD WITH UNMANNED AIRCRAFT SYSTEMS

Airports are similar to small cities in their varying needs, applications, operations, risks, etc. And just like a city, it is crucial to identify champions of new technologies to ease integration. From an airport's perspective, those champions should include ATC, consultants, managers, engineers, etc. Airport operators are going to have varying levels of concern with rising UAS numbers, and the impact to a large hub is going to be different from a rural commuter airport. But as technology and awareness continue to grow and champions are kept abreast of these changes, they will better prepare airports to be active partners in UAS integration. UAS planning and data services will continue to improve airport scheduling of UAS operations, detection and tracking systems will remove blind spots of airport operations to all UASs in flight, and education supported by accountability will promote safer and more conscious UAS pilot decision-making.

UASs provide airports with another powerful tool in their arsenal; however, like other tools, it is not always the end-all-be-all solution. When airports become more accommodating and knowledgeable of UASs, it becomes a layer and capability to usually well-established existing routines and processes. Similar to investments airports need to make in advanced tools and technology, UASs and their payloads have limitations to their capability and efficiency depending on the application. But as technology advances for UAS sensor and platforms, as well as secondary systems UASs are supporting, the safety and efficiencies of deploying UASs as a tool will advance.

Beyond adding and enhancing capabilities at an airport, a distinct differentiator of UASs compared to many other technology investments at airports is the cost. The return on investment is outstanding in terms of value of improvements from UAS technology, because airports need to invest thousands of dollars instead of hundreds of thousands of dollars. UASs also are expendable and replaceable, unlike other airport systems.

As exemplified by SAV, the applications and integration of UASs into the airport environment is not a recommendation from an airport master plan, rather from exposure and results of emerging technology reviews. UASs are deployable to support a wide-variety of airport business functions; the specific application and speed at which integration occurs must be considered on a case-by-case basis. There is an old saying in the US: 'You've seen one airport, you've seen one airport.' This saying is extensible to the deployment of UASs at airports around the globe, each facility must understand the technology and resulting values to determine prioritisation of where and when UAS operations are introduced. Security, facility management, wildlife management, field and facility inspections and emergency response (first responders) are outstanding areas of integration, but the priorities for each airport must be determined through understanding localised issues, stakeholder engagements and regulatory constraints.

Recent experiences involving UAS technology and risks have validated the aviation industry's call for increased public awareness. At London's Gatwick Airport in December,[4] drone sightings reported by dozens of customers led to the disruption of hundreds of flights at Britain's second busiest airport. In January, departures at Heathrow were grounded due to a drone sighting,[5] and later that month, flights in and out of New Jersey's Newark International Airport were disrupted after pilots reported drones flying near Teterboro Airport.[6] This illustrates the dire need not only for continued safety but for continued education on the topic.

Conducting public outreach that addresses misconceptions and related fears about adding UASs into the flow of air traffic, both internally and externally, should be prioritised from the beginning of the integration programme. Similar to communications from state and federal organisations on the dangers of operating a vehicle safely near a railroad crossing, communications from airports and the aviation industry are crucial to improving UAS operations safely in the vicinity of airports. The beneficiary of these efforts is the airport and the flying public.

Integration of information systems, policy and best practices always have been better served by conducting valuable stakeholder engagements with end users and organisational leaders. Integration of UASs into well-orchestrated and standardised processes at an airport yields no difference. The engagement with stakeholders early during planning and design phases of UAS integration is vitally important to compile risks and applications that provide facility-unique context for CONOPS, operational standards (SOPs), technology investment, sensors and payloads, and communications. Key stakeholders at the airport may include airport/airfield operators, security team, first responders, engineering and facility management — and the largest, most critical stakeholder: ATC.

Regardless of whether an airport is considering utilising UASs as part of its operations, all airports should be talking about UASs and their effect on the airspace. Interaction, both early and often with ATC, closes the loop on the three main components of UAS operations at an airport: the airport, ATC and the UAS operator.

The SAV integration has been successful in large part because the ATC knew UASs were coming, had a grasp of the process and understood Part 107 regulations. This allowed the ATC to envision how the project would be conducted before the consultant entered the scene. Given the appropriate scope and tools, ATC at any airport can understand the opportunities UASs present. When they consider the risks specific to their sites, they can present these to their consultants and increase UAS education and safety for each project.

UNMANNED AIRCRAFT SYSTEM SAFETY AND AWARENESS MOVING FORWARD

There has been debate about who is responsible for UAS education, whether it's the job of the airports, FAA, consultants or public/government officials. The FAA is providing a great deal of information to assist with these efforts, but it's not feasible to expect the FAA to reach and instruct each person who is utilising UASs. Airports are charged with protecting their airport and airspace, so this site-specific education falls on them. When UASs invade their airspace, airports and consultants need to collaborate. Risks should be examined to understand how to protect the safety of the NAS, leading to policy changes, safety protocols and rules specific to each circumstance and location.

This process and framework are the same around the world. In Europe, Canada, China and any mature airspace system, there are governing regulations, license requirements, pilot requirements, education requirements, etc. The rules may vary, but the risks and the technology are the same around the world.

How to inform the public about the presence of drones should be discussed to not only help protect the safety of airports and airspace but also discourage widespread alarm if passengers report the presence of a drone — especially one that may just be doing its job to support airport operations. The airport community must continue to push for more safety communication and outreach to not only avoid inducing panic and delaying operations but, more importantly, avoid any potential incident in these environments that could lead to tragedy and/or a disruption in the advancement of this highly beneficial technology.

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