

HORIZONS

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The Massachusetts Air and Space Museum inspires new generations to explore, experience, and pursue interests and opportunities in science and technology

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DRONES



Time marches along with remarkable consistency, ushering in revolutionary advances in technology and methodology as it does. Among the revolutionary technological changes is the development and pervasive implementation of drones, or UAVs (unmanned aerial vehicles). What was once a small niche market limited to the nerdier elements of society, drones have evolved more rapidly into a giant industry than did the aviation industry itself after Wilbur or Or-

ville Wright started building the first commercially-available airplanes. Once the exclusive domain of the military, drones are now commercially available through the internet, and at most toy and hobby stores.



Drones come in all shapes and all sizes. Some are designed to fly overhead and peer into people's lives with high-resolution cameras. Others are equipped with infrared sensors for evaluating agricultural changes or seismic shifts in the land-

scape. Still others explore the ocean's depths, in search of a greater understanding of the 71% of this planet that is submerged under water. Even submersible drones are actually *flown* by operators.

Just as aviation altered the course of history when it emerged on the scene in 1903, the advent of drones is destined to do the same. Because of the potential impact these new technologies pose, it behooves mankind to get ahead of the methodology that will be employed throughout this evolution. While the Federal Aviation Administration (FAA) has regulatory authority in the use of drones at certain altitudes above ground level (AGL), below that altitude it is virtually powerless. There is a plethora of factors that will bear on the eventual regulations that will attempt to control drone usage, especially in and around cities.

To better understand this newly emerging phenomenon, we must first define what constitutes a drone. The UAV moniker hardly encompasses all drones. Instead, maybe they should be called *unmanned remotely operated vehicles* (UROV), because that is what most of them truly are. By this definition, every man-made, unmanned satellite since Sputnik that has been launched into space is a drone. Today, the conventional operation of drones is commonly handled remotely via radio within line-of-sight. But, for the anticipated boom in com-



mercial drone use coming in the next decade, these flying robots will probably need to rely more upon global positioning system (GPS) and preprogrammed ground coordinates for both departures and landings. The operator will merely initiate the flight, and the drone will do the rest.

Among the most sinister of drones are those deployed by both military and terrorist operatives; carrying intelligence-gathering equipment and weaponry to remote locations and inflicting casualties without risk of harm for those doing the inflicting. Such drones are highly sophisticated machines that necessitate dedicated operators, much the way conventional aircraft require pilots.

The military also employs drone swarms that confuse and confound enemies by flooding the battlefield with dozens of independent drones that fly in formation, concealing the armed drones among them. These swarms spring upon an enemy like a swarm of bees or locusts. They are a frightful sight.

Surveillance drones can be aloft for days at a time, controlled by multiple operators on the ground and refueled conventionally by aerial tankers. They fly at altitudes where they are nearly impossible to spot from the ground; collecting both photographic data and advanced telemetric information about enemy troop movements. Other military drones are hunter-killers, armed



with lethal weapons that allow an operator to attack and take out targets while not even being in close proximity to the battlefield. While military drones have grown in both size and capability, they'll likely not be the aspect of the drone industry that is rife for the greatest expansion.

these supplies can be quickly dispatched to the remote doctor via one of their drones. These lightweight aircraft travel over washed out roads and missing bridges and deliver the required supplies via parachute. The drone then returns to its base where it is recovered and readied for the next assignment. *Zipline's* drones are saving lives now.



Commercialized drones are destined to be where the largest growth will occur over the next ten years. Package delivery by commercial giants like Amazon offer door-step delivery alternatives that will make the US Postal Service, FedEx and UPS almost obsolete. Carrying the equation to its logical conclusion, it is feasible that a customer will be able to place an order via computer, the order will be electronically processed and sent to distribution where a drone will be assigned to assemble and pick up the order and fly it directly to the customer, all without human interaction within the company.

One American company is breaking ground in drone use in new and emerging countries around the world, providing a unique delivery system of critically-needed supplies. *Zipline* is a California-based company currently operating in central African nations where modern roads and infrastructure are only dreams. Doctors serving in remote areas have the tools and the know-how to treat critically-ill patients, but often lack supplies of blood, plasma, or drugs. *Zipline* operates close to medical warehouses where

***Zipline's* Remote Delivery Drones in Rwanda**

In Dubai, United Arab Emirates, requirements for flight have been relaxed to permit the use of drones as air-taxis. Implementation of this revolutionary means of transportation is on the not-too-distant horizon. Quad and hex-copter designs will accommodate one or two adult passengers who merely get into the vehicle, fasten their safety belts and push the start button. The drone will be preprogrammed to fly to and from specific locations throughout the city. Simple, and there's no need to tip the cabbie!

The bigger consideration for planners and developers is precisely where all these robots will fly. For decades, specific altitude ranges have been assigned for aircraft flying overhead. Adding two new layers of aircraft – delivery drones and air-taxi drones – will require an entire reordering of airspace in order to keep everything from bumping into each other. Presumably, air-taxi drones will fly closest to the ground, zooming over ground traffic as they deliver their passenger(s) quicker than anything below them. The next altitude range would be reserved for commercial package delivery. The problem that immediately

leaps to mind is when all these package delivery drones need to descend to deliver their packages, how often will they collide with air-taxi drones delivering people that are in their path? For that matter, how often will they collide with each other? Look out below!

Advanced traffic collision avoidance systems (TCAS) will be needed more than ever with the commercialization of lower airspace. For that matter, TCAS will be fundamental for the package drones due to the sheer volume of competitive drones that will occupy their assigned portion of the sky. Drones that do not rely upon a remote operator pose the best option because they can be assigned to fly to specific locations without being overridden by a human operator who reacts incorrectly to given conditions.

As is true with all aviation, one of the greatest obstacles to safe flight is weather. While some drones have the artificial intelligence to compensate easily for heavy wind gusts and other weather variables, many may still fall victim to the ever-changing whims of Mother Nature. However, it is anticipated that robot craft will be better equipped to more readily



compensate for situational changes than are human pilots because the one human element they don't have is emotion. Whether this ability to think without emotion will be able to handle the complex mission ahead of it remains to be seen.

Drones are an industry because of the sheer number of manufacturers involved in producing them. But there are ancillary business interests involved that support this

new emerging industry. Insurance companies now offer drone policies for both property damage coverage for the craft and liability coverage for anyone else adversely affected by the drone flight. There are also schools that will teach you how to properly fly drones and that grant flight certifications that meet recognized standards, just like FAA-recognized flight schools for pilots.

Whether for personal amusement, commercial ventures, or for national defense purposes, drones

are merely flying (or submerged) robots that are either remotely controlled by a limited number of people, or preprogrammed to fly a specific course. The key to understanding drones is keeping in mind that they are pure



robots. And, like most robots, they are increasingly eliminating the need for “manpower” in whatever field of endeavor you might consider. Mechanization of the air, without the benefit of pilot and crew, offers many benefits that come from eliminating the requirement for life-support systems for people. The only oxygen needed is the amount required to run the motor, provided the motor isn’t electric.



Soon, package delivery by drones will be commonplace. Your Christmas, anniversary and birthdays gifts will arrive gift-wrapped by your friendly drone carrier. Even pizza delivery by drone will be more efficient than the kid in the beat-up Honda with an illuminated sign on the roof.



But a warning accompanies this quantum leap in technology; a warning that tells man that he has yet

to design any system that is not subject to failure at some point. Machines wear out over time, other technologies may interfere with ongoing operations, and signals may get crossed up. Each time man has built the perfect machine, he is astonished to find that he didn’t think of every variable that should have been incorporated into the original design. When he fails to think of everything, disaster follows. For those who must endure the emergence of the drone industry, let us hope that the designers and planners have done their homework and that the cluttered sky where the clouds once smelled of gasoline will still be visible through the cloud of drones that are coming our way. ✦

PAN AM Celebrates the *Boeing 707* And the Dawn of the Jet Age

Featured speaker at the annual gala on Long Island will be Frank Abagnale, about whom the movie “*Catch Me if you Can*” with Tom Hanks is based. On hand will be scores of the people who made all the magic during the golden age of passenger flight. There will even be cooking demonstrations that will whip up delicious dishes such as Cherries Jubilee.

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Boeing will be Kendall Square Initiative's first major tenant

New research presence will serve to advance innovation in the aerospace industry and shape East Campus gateway.

Steve Bradt—MIT News Office
August 1, 2018

[Boeing](#), the world's largest aerospace company, will soon become part of the MIT/Kendall Square innovation fabric. The company has agreed to lease approximately 100,000 square feet at MIT's building to be developed at 314 Main St., in the heart of Kendall Square in Cambridge.

The agreement makes Boeing the first major tenant to commit to MIT's [Kendall Square Initiative](#), which includes six sites slated for housing, retail, research and development, office, academic, and open space uses. The building at 314 Main St. ("Site 5" on the map-next page) is located between the MBTA Red Line station and the Kendall Hotel. Boeing is expected to occupy its new space by the end of 2020.

"Our focus on advancing the Kendall Square innovation ecosystem includes a deep and historic understanding of what we call the 'power of proximity' to address pressing global challenges," MIT Executive Vice President and Treasurer Israel Ruiz says. "MIT's president, L. Rafael Reif, has made clear his objective of reducing the time it takes to move ideas from the classroom and lab out to the market. The power of proximity is a dynamic that propels this concept forward: Just as pharmaceutical, biotech, and tech sector scientists in Kendall Square work closely with their nearby MIT colleagues, Boeing and MIT researchers will be able to strengthen their collaborative ties to further chart the course of the aerospace industry."

Boeing was founded in 1916 — the same year that MIT moved to Cambridge — and marked its recent [centennial](#) in a spirit similar to the Institute's 100-year celebration in 2016, with special events, community activities, and commemorations. That period also represents a century-long research relationship



Building 5 concept (Courtesy Weiss/Manfredi)

between Boeing and MIT that has helped to advance the global aerospace industry.

Some of Boeing's founding leaders, as well as engineers, executives, Boeing Technical Fellows, and student interns, are MIT alumni.

Earlier this year, Boeing announced that it will serve as the lead donor for MIT's \$18 million project to replace its 80-year-old Wright Brothers Wind Tunnel. This [pledge](#) will help to create, at MIT, the world's most advanced academic wind tunnel.

In 2017, Boeing acquired MIT spinout [Aurora Flight Sciences](#), which develops advanced aerospace platforms and autonomous systems. Its primary research and development center is located at 90 Broadway in Kendall Square. In the new facility at 314 Main St., Boeing will establish the Aerospace and Autonomy Center, which will focus on advancing enabling technologies for autonomous aircraft.

"Boeing is leading the development of new autonomous vehicles and future transportation systems

that will bring flight closer to home,” says Greg Hyslop, Boeing chief technology officer. “By investing in this new research facility, we are creating a hub where our engineers can collaborate with other Boeing engineers and research partners around the world and leverage the Cambridge innovation ecosystem.”

“It’s fitting that Boeing will join the Kendall/MIT innovation family,” MIT Provost Martin Schmidt says.

“Our research interests have been intertwined for over 100 years, and we’ve worked together to advance world-changing aerospace technologies and systems. MIT’s Department of Aeronautics and Astronautics is the oldest program of its kind in the United States, and excels at its mission of developing new air transporta-

tion concepts, autonomous systems, and small satellites through an intensive focus on cutting-edge education and research. Boeing’s presence will create an unprecedented opportunity for new synergies in this industry.”

The current appearance of the 314 Main St. site belies its future active presence in Kendall Square. The building’s foundation and basement level — which will house loading infrastructure, storage and mechanical space, and bicycle parking — is currently in construction. Adjacent to those functions is an underground parking garage, a network of newly placed utilities, and water and sewer infrastructure. Vertical construction of the building should begin in September.

At 250 feet high, the new 17-floor building will accommodate additional commercial tenants, as well as the MIT Museum, which will occupy over 57,000 square feet on the building’s ground, second, and third floors. The ground floor is designed to feature retail and restaurant uses, including the entrance to the new

home for the MIT Press Bookstore.

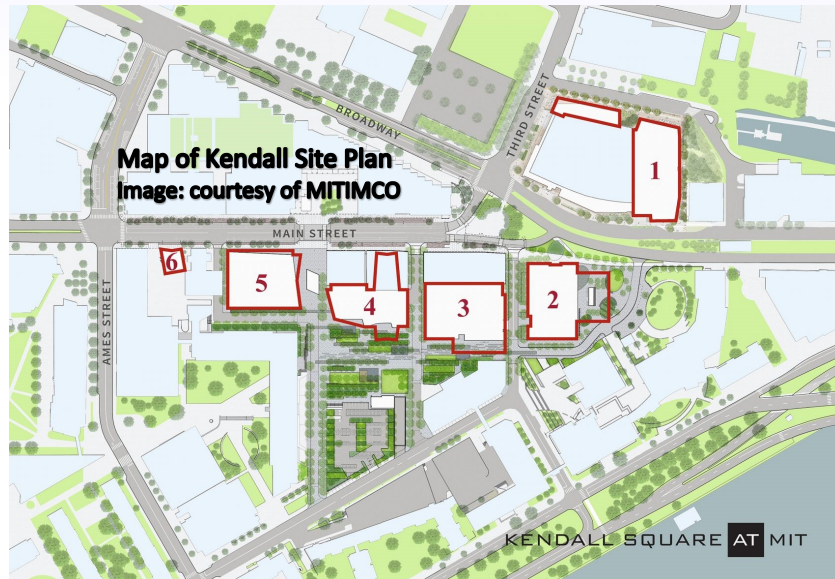
“Boeing will be a great addition to the Kendall Square innovation ecosystem, “ says Steve Marsh, managing director of MIT’s real estate group. “Boeing has chosen to locate at the new gateway to MIT’s campus being developed above the Kendall MBTA station. This is as close to MIT’s campus as industry innovators can physically get, and that helps promote important collaborations.”

On the other side of the MBTA station, MIT’s new graduate residence hall (“Site 4” on the map above) is already going up. The Institute decided to lead with that 450-unit facility in response to community interest in expanding on-campus housing inventory for graduate students. That building will also serve to

shape the East Campus gateway by creating new homes for MIT’s Admissions Office, an innovation and entrepreneurship hub, a childcare center, active retail concepts, and the MIT Forum, which will provide shared space for community programming.

Tying these buildings together will be an outdoor space well over two acres. The area will feature a combination of hard and soft landscape treatments accompanied by art installations, interactive science experiments, inventions, and other engaging and surprising elements showcasing MIT’s innovative and welcoming spirit. The Institute has recently hired Jessie Schlosser Smith as its new director of open space programming; she is already beginning to collaborate with faculty, students, staff, and members of the Cambridge community to envision memorable programming for the outdoor spaces.

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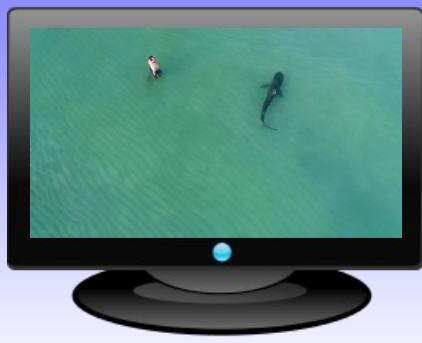
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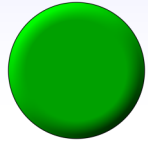
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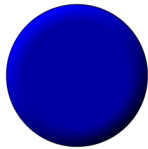
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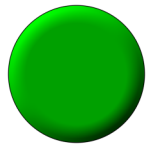
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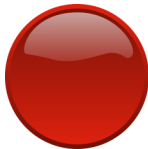
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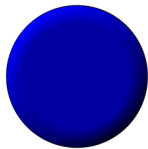
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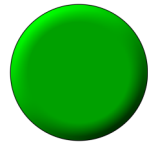
Coyote Drones



Crop Dusting with Drones



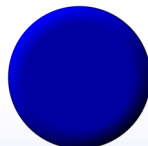
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