Unmanned Aircraft Systems (UAS) Integration into the NAS
or…
Fun, Fun, Fun 'Till Daddy Took the Quad-copter Away

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Intro thoughts:

To Fly. To free ourselves from our grounded state and enjoy the benefits of these insightful perspectives, has always seemed like a worthy goal.

To get to higher ground, climb a tree for a better view, stand on a rooftop! There is always advantages with elevation! And, it is enjoyable! Not long ago, there was nothing of man's making present in the air overhead.

Early manned flight was Balloon flight, useful in peace and war for the intelligence gathered from this improved view of the surroundings.

Gliders experiments were done by an intrepid few, but these experiments with fixed wings usually fell short of understanding and applying a system to control the path of flight. Technology and innovation came together with the Wright Bros in 1903. The time was right for this heavier-than-air, self powered, controllable, piloted craft. The aero-plane and air travel was born.

Rapid development of the airplane ensued. Public uses such as US Mail as well as military needs drove these advances. Progress in airframe design, power plant reliability, and pilot experience was far ahead of any organized body's handle on regulations, testing and certification. The research and development race was on. There were many operational failures and casualties in this helter-skelter trial-and-error climate.

How sturdy were these airplanes? Where were all these airplanes kept? Who could fly them? What were the standards and expectations from one airport to another? Was there Traffic Control for all these things flying around? What about communication between the ground and air? Signaling from one airplane to another? What were emergency procedures? Were folks on the ground safe from the airplanes overhead?

Commercial aviation grew to satisfy the wanderlust and/or business needs of those who wanted to get something or somebody somewhere in a relatively fast, efficient, unique way. A flight on a Fokker Trimotor passenger plane from Key West to Havana was $50 in the mid 1920s. Rattan chairs for the passengers were bolted to the floor.

A functional airplane needed:
- a competent, experienced, well-trained pilot;
- a structurally sound and operationally forgiving airframe for safety
- payload capacity
- navigational abilities;
- a place to land and take off
- Communications
- and air traffic management

• support personnel and facilities

Aircraft operation is inherently dangerous. There are certain risks of crashing into the ground, crashing into some other airplane in the air, of getting lost, or not being able to accomplish the expected mission/tasks. Some flying missions are riskier than others.

A benchmark for the dangers of early aircraft operations, Charles Lindbergh was noteworthy for his ability to survive flying's dangers despite formidable challenges with all the aspects of airplane operation.

As an example of the unpredictability of flying at that time, he had the national record for the number of times he had parachuted out of planes prior to his Sprit of St. Louis trans-Atlantic flight. In the two and half years before his Atlantic air crossing, he parachuted to safety four times in harrowing emergency situations, once as an Army student pilot, again as a test pilot, and twice as a contract pilot for the U.S. Air Mail Service. These episodes earning him the name "Lucky Lindy." He was then the record holder of the "Caterpillar Club" (parachute=silk) Not many were in his league of talent or luck.

Commercial air travel is now amazingly much safer than car travel. Air freight is incredibly fast and efficient.

Even now, though, there are jobs to be done where the risks and costs are very high for the airplane, pilot and crew. There are the tasks that are too boring to be a good allocation of material or personnel resources. There are airborne needs where is no existing aircraft system (plane, pilot, ground control, communication) capable of doing the job.

As necessity is the mother of invention, it has been clear for some time that there are unique roles for an Unmanned Aircraft System. An unmanned aircraft system (UAS) has no pilot on board. It has special aircraft and procedural requirements and many potential applications.

What are these vehicles? How have they been used? Who makes the rules? What are the operational regulations? What will the future of unmanned aircraft use look like?

A brief review of the history of "drone" development is helpful in understanding some of the special features of Unmanned Aircraft Systems, and how they are unique.

FUNDAMENTALS OF UAS OPERATIONS

1) History of Unmanned Aircraft

- Flight controls - Wright Bros understanding and fashioning a working wing-warping system allowed the first controlled flight

- **pic wright flyer**

- "Radio" (Tesla's full spectrum spark-gap transmitter) - addressing the idea of "remotely piloted aircraft" command and control

- 1918 First unmanned aircraft - US Military "aerial torpedo"
  - **need pic aerial torpedo**

- Target drones - as targets, to aid development of antiaircraft weaponry

- WWII Attack drones - little real success/dangerous; V1 Buzz Bomb
  - **pic V1**

- Cold War - reconnaissance/ signal-gathering aircraft
  - **pic drone**

- Autonomous operation -The ultimate goal. introduction of computer and early GPS enabled drones of the 60s and 70s

- Intelligence gathering drones - Capability rose from target drone to signal transmission, then to actual image transmission

- 1982 conflict Israel-Syria - battle-tested information-gathering and targeting data
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- 1990s Desert Storm - notable improvements in GPS and Sattelite link technology.
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- 1990s to 9/11/2001 there was only slow progress of UASs.
  - Advances again were mostly in the area of computing and GPS accuracy improvements. There emerged resistance for further development from manned aircraft pilots.
  - After 9/11, UAS the pace of UAS development quickened. There were approx 2000 drones operational by 2010 .There was clear advantages of low risk, practicality, cost savings, with the ability to carry out dangerous/boring roles.

- Future: The ultimate direction is toward fully Autonomous UAS, being totally independent of outside signals.
  - **image Navy UAV stealth**

So, Unmanned Aircraft are now beginning to prove their worth. The success of these military reconnaissance operations was noted by various *nonmilitary* groups, and systems were developed that would allow the unmanned aircraft to perform civilian missions currently being performed by manned aircraft.

2) UAS Elements - Unique Requirements of UA<u>System</u>

- A*ircraft -* Unmanned or remotely piloted
- *Command and Control Element* (C2)
    - Ground Control -
        - human control center - large or hand held;
            - pilot duties and sensor operation duties
    - Autopilot with varying levels of autonomy, which is the ability to execute a preprogrammed mission with no operator intervention
        - low autonomy- needs remote control, some stabilization by its autopilot
        - high autonomy- onboard autopilot controls all: takeoff ->landing

- *Communications Data Link* - is how the C2 info is sent and received to and from the autopilot:
    - Line of Sight (LOS) operations - radio frequency link
    - Beyond line of sight (BLOS) operations are via satellite or relay vehicle (vulnerable to Communication integrity loss, jamming, frequency-hopping)

- *Launch and Recovery* Element.
    - Small VTOL=simple, not needing a runway, allowing rapid deployment;
    - Large fixed wing=complex and personnel/labor intensive.

Payload - Allows the mission function.

Sensor payloads: navigation; C2; remote sensing/imaging; surveillance/reconn.;data collection (air samples, temp, etc)
Things to drop/deliver; weapons, packages, beer

Human Element - the most important element of UASs. The list includes; Pilot, sensor operator, ground crew support. With the development of increase automation technology in UAS operations, the human element will become a smaller component.

3) Operation of a UAS - How does UAS Operation differ from a manned aircraft?

"Manned aircraft have clear and rigid standards to which they must be built and certified. These regulations provide assurances to those who fly in them, and to those over which they fly. They provide assurance also that the aircraft is worthy and will remain intact and safely perform the flight profile for which it is certified."

UASs have had little government regulation.

The *See and Avoid* (SAA) requirements are the most challenging barriers to the ability of unmanned or remotely piloted aircraft to fly in unrestricted airspace. Secure, stable *communication* with the aircraft is a necessary part of the SAA function of an unmanned system.

Collision avoidance is possible when *each pilot* is able to see and avoid each other. When conditions are too poor for visual guidance, instrument flight rules (IFR) are in effect. During IFR flight, collision avoidance is provided by the FAA through Air Traffic Control measures. With *no pilot onboard a UA, the ability to see and avoid other manned aircraft is compromised!*

The terms *well clear* and *see and avoid* directs the pilot of the aircraft to never get so close to another aircraft as to “create a collision hazard”, to have “situational awareness” and be on the constant lookout for other aircraft, whether in VFR or IFR environments.

This capability can *not be present* in *existing* UAVs unless there is some sensor or visualization system on board that can serve as an acceptable substitute to a manned aircraft SAA capabilities. The *FAA’s stated goa*l or standard for a certified sense-and-avoid system is a “target level of safety” equivalent to one fatality per 1 billion flight hours (system wide)...which is the standard for commercial aviation.

4) *Deployment of Unmanned Aircraft Systems: UAS Uses*

Unmanned aircraft only exist if they offer *advantage* compared with manned aircraft. The military terms the roles most suited for UASs as those that are *dirty, or dull, dangerous (DDD)*. Civilian roles can be categorized similarly.

UA flight operations vary widely, depending on the size of the aircraft and the jobs for which they are designed
The Global Hawk is a very large aircraft, with a 130 foot wingspan, jet engine, operates at over 60,000 feet, can cruise at over 300 knots, with an endurance of 36 hours**.** It can cary a payload of 3000 lbs, and has a range of 12,000 miles, and can fly over any area of the world. It is nearly the size of a Boeing 737, and obviously needing a runway.
(**need Global Hawk pic)**
The smallest UASs are the VTOL nano-drones now can be held and launched from the palm of your hand, with the ground control-pilot and sensor-operator crew of one.
(**pic nano UAV, and Phantom 2 with camera)**

UAV systems Air Vehicle types:

- High Altitude Long Endurance (HALE) - >15000m; >24 hr; reconn, surveillance, attack roles. Air Force from fixed bases
- Medium Alt. Long Endurance (MALE) - 5-1500m; 24 hr; same roles as HALE
- TUAV - Tactical UAV or Medium range; 100-300 km. smaller. naval and land forces
- Close Range UAV - mobile army/naval groups; diverse civilian purposes; up to 100km; reonn, targeting; security; civilian monitoring tasks
- MUAV/Mini UAV - Hand launched, under 20kg.; VTOL capability in some
- Micro UAV or MAV - wingspan < 150mm, urban environment; slow, hovering flight/perch capability

show pic wall-walker, formation flight

- NAV - Nano Air Vehicles - seed-sized, used in swarms, ultra short range surveillance; radar confusion

show nano

Military Roles

In recent years, there has been substantial press covering the *military*'s use of drones in the Middle East, especially the Pakistan/Afghanistan boarder areas. These are the large, long-range aircraft such as the Predator or Global Hawk.

They are large, expensive HALE and MALE aircraft, carrying very sophisticated payloads, and are controlled by a complex, secure, remote communications center, with long-range communications via satellite.

In addition to these missions of Long-Range Reconnaissance and/or Strike, military roles for the Navy, Army, and Air Force include many tasks of surveillance, reconnaissance, port and fisheries protection, artillery ranging, NBC (nuclear, biological, chemical) contamination monitoring, IED detection and destruction, and urban surveillance. These military applications are in unique settings, and with a unique operational envelope (safety, etc.) compared with non-military settings. Lessons learned from these experiences are valuable insights for the non-military community contemplating UAS civilian and public operations.

U.S. REGULATORY STSTEM: HISTORY UP TO 2013

The introduction of new technology or procedures into the National Airspace System (NAS) requires many steps before the FAA can allow changes, including a comprehensive safety analysis, which may then lead to the rule-making process.

History of US Aviation Regulation

1. 1915 Pres. Wilson created the National Advisory Committee on Aeronautics to oversee *"problems"* of flight.

i. issues of the number of crashes
ii. the lack of a harmonized or common system of air navigation
iii. Needed regulations addressing safety, and some order to the commercial aspects of aviation
iv. need for a regulated civil airport network
v. the need for a civil aviation infrastructure to support the growth of the growth and stability of the industry, both non-military and military

2. 1918 U.S. Postal Service air operations begin

3**. 1958 Federal Aviation Administration (FAA) was created** -

This was in response to a series of fatal accidents and midair collisions involving commercial aircraft

The FAA is a part of the Dept. of Transportation and has Congressional authority to *regulate* under the Commerce Clause of the U.S. Constitution.

"*The U.S. government therefore has the **exclusive power to regulate the airspace** of the United States. A citizen of the United States has a public right of transit through the navigable airspace. Among other powers the statute confers upon the administrator of* *the FAA is the **mandate to develop plans and policy for the use** of the navigable airspace and **assign by regulation or order** the use of the airspace necessary to ensure the **safety of aircraft and the efficient use** of airspace. The Administrator may modify or **revoke a regulation**, order, or guidance document when required in the public interest. The administrator shall prescribe **air traffic regulations** on the flight of aircraft (including regulations on safe altitudes) for **navigation**, protecting, and identifying aircraft; **protecting individuals and property on the ground;** using the navigable airspace efficiently; and **preventing collision** between aircraft, between aircraft and land or water vehicles, and between aircraft and airborne objects. Pursuant to its rule-making authority, the FAA has set forth the **standards of the operation** of aircraft in the sovereign airspace of the U.S. These **Federal Aviation Regulations (FARs) are the rules of the road** for certification of all **civil aircraft,** airmen, and airspace; certification and operations for air carriers and operators for compensation **or hire**; air **traffic** and general operating rules' and **schools** and other certificated agencies, **airports**, and navigational facilities."*

So..the FAA makes rules and regulates aircraft, airmen, some employees of airlines and commercial operations, airports….everything in and concerning the National Airspace.

These efforts are supported by *codes*, *regulations* and *standards* set by engineering and manufacturing organizations.

The terms unmanned aircraft, or UAS, or remotely piloted aircraft, were and *are not in the FARs* or any other federal regulation or statute. And yet….Aircraft def.- "a device intended to be used for flight in the air"

Tools of the FAA

i) policy statements

ii)Airworthiness directives -which are issued in response to a safety or technical problem. These must be corrected prior to continued operations.

iii) *Advisory Circular* - used to advise the aviation community of issues pertaining to the regulations, but are not binding upon the public (rare exceptions)

There have been several landmark FAA Regulations shaping and in response to the growth of interest and needs of Unmanned Aircraft Systems.

1981 - ***FAA issued AC 91-57***- This was intended to define what a *model aircraft is*, and create their operational standards.
It states that model aircraft cannot be flown higher than 400 feet above ground, or within 3 miles of an airport; must be flown away from noise sensitive areas, such as schools, hospitals, and churches.
The purpose of these restrictions was to eliminate collision possibility with manned aircraft and to protect the population from injury caused by a crash of the model aircraft.

This Advisory Circular encouraged voluntary compliance with safety standards for operation. *This Document* remains as the operative standard for model aircraft operations within certain designated areas and under the authority of the Academy of Model Aeronautics (AMA).

2005 - **FAA issued UAS Policy Statement** in response to dramatic increases in interest in UAS operations in both the public and private sectors. The intent was to provide guidance to be used by the FAA to *determine if unmanned aircraft systems may be allowed to conduct flight operations in the U.S. NAS*

Remember that Until the mid 1990s the use of UASs were primarily for *military* operations. Prior to the mid '90s nearly all *civilian* "unmanned aircraft" were model aircraft.

The 2005 Policy Statement clarified that, with existing technology, if UAS operators were strictly held to the "see and avoid" "right of way" rules of existing FARs there would be *no* UAS flights in civil airspace.

So, this FAA UAS Policy gave developers and operators **two choices** for Operating

1) For a ***Public Operator*** - a *Certificate of Operation (COA)* must be obtained
    1) Public operator is any governmental institution. e.g. police, firefighting, biological resource management, state universities, the military, and the Dept. of Homeland Security.
    2) Permits operations of specific aircraft, in a defined block of airspace and includes special provisions unique to the proposed operation
2) For a ***Civil Operator*** - The *Special Airworthiness/Experimental Certificate*
    1) Includes all operators not under the public category
        1) e.g. individual citizens, private companies and organizations, and private educational institutions.
    2) Experimental certificate regulations preclude carrying people or property for compensation or hire, but do allow operations for research and development, flight and sales demonstrations and crew training.
    3) Specific for operators, procedures, and pilots.
3) ***Model Aircraft Operators*** were specifically not included in this policy creation, Model Aircraft operators were again requested to comply with AC 91-57 as the operational guide.

Recognizing that there was a gap in these guidelines, and with increasingly available UAV technology, some commercial for-hire UAS operators began operating small-ish UAVs with cameras and other sensing equipment, without having applied for a COA or a special airworthiness certificate.

They would make a claim that they can fly their small UAS under 400 feet without communication with the FAA or running the risk of FAR infringement, on the grounds that they are "<u>models"</u>

The FAA in 2007 issued a clarification of the 2 specific UAS operational allowances. *Specifically disallowed were those operations of a commercial nature,* without a COA, but *supposedly* under the guidelines of AC 91-57.

If the definition of *Aircraft* is interpreted to include unmanned aircraft, with no exceptions for models, then the FAA may regulate anything and anyone that operates or pilots an aircraft in the navigable airspace.

((*Navigable Airspace* is defined as: at and above the minimum proscribed flight altitudes including airspace needed for safe takeoff and landing. The 400 ft altitude limit for model aircraft in AC 91-57 may have been in observance of this 500 ft minimum safe altitude for manned aircraft.))

((Minimum safe altitudes are 1000 ft above ground in a congested area, with lateral separation of 2000 ft. In sparsely populated areas or over open water, 500 ft above ground, and no closer than 500 ft from any person, vessel, vehicle or structure.)))
graphic National Airspace

2008 -
FAA created a ***Small Unmanned Aircraft System (sUAS)*** **Aviation Rule Making Committee (ARC)**

The Government Accountability Office (GAO) reported that the U.S. must develop a clear and common understanding of what is required to safely and *routinely operate UAS in the NAS.*

This committee of government, manufacturer, operators, and academia folks created formal recommendations regarding sUAS, presented to the FAA in 2009. Air Traffic committees also submitted a summary of risks and safety management recommendations.

This effort was designed to eventually lead to the published *Notice of Proposed Rulemaking (NPRM)***,** the first set of rules by the FAA, dealing *specifically with small unmanned aircraft systems. (more on this below…)*

Current and Future Regulations of Unmanned Aircraft

Market forces have been creating greater opportunities for developers and entrepreneurs to invest capital in these UASs to make them more capable, and easier to use.

The many potential civil commercial users, especially of these small UASs, have been putting pressure on the FAA to take the lead on UAS rule making, and to come up with a regulatory structure for the evolution of airspace use

2013

In response, the FAA has unveiled major documents regarding UASs this past November:

1) ***UAS comprehensive Plan*** mandated by the 2012 FAA Modernization and Reform Act, delivered to Congress from the DoT Joint Planning and Development Office

2) ***Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap,*** *by the FAA* **(***the first annual)*

also released in Nov. ‘13
3) *the* ***Notice of Final Privacy Requirements for UAS Test Sites***

UAS COMPREHENSIVE PLAN - JPDO

Is a result of the combined efforts of representatives from the Next Generation Air Transportation System (NextGen) partner agencies:
Dept. of Transportation
Dept of Defence
Dept of Commerce
Dept Homeland Security
NASA
FAA
Industry representatives

Introduction

“UAS are to be integrated in an already shaped and automated NAS and Air Traffic Control (ATC) environment that was originally developed for manned aircraft.”

“UAS provide a wide variety of operational, societal, and economic benefits to its diverse group of users.
…the market for government and commercial use
of UAS is expected to grow, with small UAS having the greatest growth potential.
“As the demand for UAS increases,there are growing concerns regarding how UAS will impact existing aviation.
Worldwide expenditures on UAS and related research could be potentially as much as $89.1 billion in aggregate over the next decade

Comprehensive Plan outline:

UAS National Goals, Objectives, and Targets

UAS National Goals

1)Routine Public Small UAS VLOS Operations in NAS (without special authorization, i.e. COA) (2015)
2)Routine Civil Small UAS VLOS in NAS (without special authorization; i.e. Special Airworthiness Cert.) (2015)
3)Routine Public UAS Operations in NAS (2015)
4)Routine Civil UAS Operations in the NAS (2020)
5)Define, Determine, and Establish Acceptable Levels of Automation for UAS in NAS (TBD)
6) Foster U.S International Leadership in UAS capabilities and in Standards Development (Ongoing)

UAS National Objectives

1) Establish Applicable Certification and Training Requirements for Pilots/Crew Members, Other UAS Operational Personnel, and Appropriate Air Navigation Service Provider (ANSP) Personnel
2) Approve Applicable Medical Requirements and Standards
3) Establish Applicable Airworthiness Certification Requirements
4) Implement Small UAS Rules for Pilot and Observer
5) Approve the Use of Ground Based Sense and Avoid for UAS
6) Approve the Use of Airborne Sense and Avoid for UAS Ops
7) Develop and Integrate UAS Enabling Technologies within the NAS Infrastructure to Support Appropriate Levels of Automation
8)Approve Integrated Operations for Manned Aircraft and UAS in the NAS

Integration of Civil UAS in the NAS Roadmap (FAA's Integration Roadmap)

UAS Research and Development (R&D) Prioritization
1) Interagency Research Collaboration

Test Ranges

Small UAS Rule

Integrated Approach and the Path Forward

So, the Overall Plan shows *what* must be done, and now the Roadmap is the *"how"* of this integration process…

FAA Roadmap Nov '13 An Exhaustive 66 page document!

"The FAA Roadmap sets a *timeline, and lists methods for integration of UASs into the NAS*….

"Unmanned aircraft offer new ways for *commercial enterprises and public operators* to increase operational efficiency, decrease costs, and enhance safety; and this roadmap will allow us to safely and efficiently integrate them into the NAS.

"…We have made great progress in *accommodating public UAS* operations, such as military and border security operations. The list of potential uses is now rapidly expanding. Challenges remain for the *safe, long-term integration of both public and civil UASs* in the NAS.

“Aviation policies and regulations focus on overall safety being addressed through three primary areas: *equipment*, *personnel, and operations and procedures*. It addresses the challenges in establishing standards and operational regulations for every aspect of the UAS; pilot, crew, airframe,command and control, communications link, sense and avoid capability, lost link autonomy, and environment “

“..The FAA is working with stakeholders - manufacturers, vendors, industry trade associations, technical standards organizations, academic institutions, research and development centers, with input from numerous governmental agencies.

insert chart of what there is to do..from Roadmap

Commercial operations that the FAA lists as present and projected include:

- Security
- disaster response, including search and support to rescuers
- communications and broadcast, including news/sporting event coverage
- cargo transport
- spectral and thermal analysis
- critical infrastructure monitoring, including power facilities, ports, and pipelines
- commercial photography, aerial mapping and charting, and advertising

Public and other Commercial applications to the increasing demand for airspace:

- crop monitoring
- precision surveying
- wildlife monitoring
- ground traffic/boarder monitoring and control
- firefighting support
- police services

It is anticipated that there will be many more applications when known regulations are in place, allowing easier, and less cumbersome access to airspace.

Phases of Integration

The *Roadmap* describes its *timelines* by the description of what needs to be accomplished in the near term (5yrs) as *Accommodation.* The “near term” would then phase out, gradually being replaced by the *Integration* phase, followed by an *Evolution* phase. FAA quotes a trajectory for this process as having “board timelines”.

insert graph showing phases

“Perspective 1: Accommodation

The Roadmap’s main job in this phase is to provide an *initial estimate of timing* and to *list tasks and considerations* toward enabling UAS integration into the NAS for the planning purposes of the UAS community.

“Accommodation” at its beginning, is in large part a continued expansion of the current COA and Airworthiness/Experimental Certificate approach. Operators will still be required to apply to the FAA for individual COAs for each and every application of UASs.
“This requires proven capabilities to enable operations at a constrained level”.

The “Accommodation” phase is summarized as including:
- Evaluation of Safety concerns for UAS operation in the NAS
- Work with industry and Aviation Rule-making Committee (ARC) to review the operational, pilot, and airworthiness regulations.
- Developing standards for technological solutions to operational challenge
- Research, modeling, and simulation for UAS Sense and Avoid, C2, and human factors

During this *Accommodation* phase, progress is expected towards a more uniform vehicle and operations profile. The idea is that during the “Integration” phase, per-use COA or Airworthiness/Exp. Cert. is replaced with *standardized* aircraft and operational licensing.

“Perspective 2: Integration
With the progression to the *Integration Phase,* the plan is to have the balance between COA operations and Regular operations in the NAS shift toward unrestricted access within FAA regulations for Certified pilots and UASs.

Integration will have been successfully established when:
- new operational rules and standards, policies, and procedures have been established for small UAS and other UAS
- Command and Control link standards have been defined
- establish Minimum Performance Specifications
- Certification methodology for each applicant and flight crew training

“Perspective 3: Evolution.

All ***required policy, regulations,*** *procedures, guidance material, technologies, and training are* ***in place and routinely updated*** *to support UAS operations in the NAS*

In this final phase of adoption of the UAS, it is expected that there will be *seamless operations* of certified UAVs and crew members in the evolving NAS.
The FAA will have published Type Standard Orders (TSOs) based on a system level Minimum Operational Performance Standards (MOPS).
Certified Sense and Avoid algorithms will be available for collision avoidance and self-separation that are coordinated with manned collision avoidance systems and the evolving satellite-based NextGen Air Traffic Control systems.

Commentary: Overall Plan and Roadmap

There has been a quick, substantial response to these *Roadmap* and *Overall Plan* documents since their release last November from all parties potentially affected by these announcements.

The issues which are generating the most commentary are those which may imply a much slower course toward development of full integration of all UASs.
Items generating commentary:

- "Removing the pilot for the aircraft creates a series of performance considerations between manned and unmanned aircraft that needs to be *fully researched* and understood to determine acceptability and potential impact on safe operations in the NAS."

-The FAA implies throughout the documents that the UASs will have to grow and mature a great deal to become equivalent to manned aircraft and to comply with essentially the same runes as manned aircraft.

- The Air Traffic Control system will need to absorb flight of unmanned aircraft in an already overcrowded route network system.

- Development of Sense and Avoid (SSA) and Control and Communications (C2) systems with adequate performance are seen as principle challenges. This is a main reason that a *phased* introduction of UAS is anticipated while these core systems are fielded and matured over a lengthy period.

Small UAS (sUAS) Plans and Observations from Nov. 2013 FAA Documents -

So, as we've seen, these documents represent the first look at *how and when* the FAA plans to integrate *UASs* into the national airspace system. Although much of the proposed integration functions of these documents apply to UAVs of all sizes and purposes, many aspects of these plans do also address more specifially.....

Ta Daaa!…a Faster Track for Small Commercial Drones (sUASs).

The FAA's new documents make clear that *large*r commercial drones will be integrated into the national airspace system *very slowly*, over an extended period involving technical testing and rule-making that may span a decade.

In contrast, the timeframe for the express approval of so-called "small" commercial drones ("sUAS"), weighing less than 55 pounds, is of greater interest to the new commercial drone industry.

These small aircraft systems, it seems, will be doing the *majority* of civil and commercial tasks now in mind. *Many* of the most beneficial uses of civilian drone technology can easily be implemented using *technology available today,* at low altitudes, by these existing platforms. The goal is to get the small UASs off and running a soon as possible.

The release of the *Notice of Proposed Rule-Making ("NPRM")* specifically addressing small UASs has been eagerly anticipated.
(These notices are to initiate public comment, over a proscribed period of time, after which a rule announcement is made.)

The Comprehensive Plan indicates that "The NPRM for small UAS is being drafted and is targeted for release in 2014." The Roadmap is a little more specific: "The sUAS NPRM is expected to be released in *early* 2014."

FAA Proposed Regulations: Challenges for small UAS ?

In the Comprehensive Plan and Roadmap documents, there are a few regulatory issues outlined that may be more burdensome than anticipated by developers of the smallest UAS platforms. These regulations and requirements are suggestive of a more complicated process than hoped for.

1. Operator Qualifications

Pilot Certification, including Medical Requirements:

*T*he Roadmap indicates that "..each aircraft is flown by a certified pilot … .. "FAA certification requirements for pilots and crew members for sUAS classes are published as part of a sUAS rule by 2014."

…certification is arguably unnecessary? (for example, a photographer using a hobby-grade radio-controlled multi-rotor to take photographs of real estate at very low altitudes).

2. Operational Restrictions

Constrained Airspace and Performance:

The Roadmap indicates that "Operations of sUAS under new regulations may have *operational*, *airspace*, and *performance constraints*."

The Comprehensive Plan gives a more specific sense of the anticipated initial airspace restrictions for sUAS: The "Initial Capability" will involve "Operations outside of Class B/C airspace and not over populated areas."

An *airspace* restriction, in particular, an altitude ceiling, for early commercial drone use is not a surprise or a bad idea. The reference to "*not over populated* areas" may be a significant obstacle for a many commercial applications, such as cinematography on controlled film sets, crop inspection in semi-rural areas, or the survey of disaster-stricken urban areas.

The reference to "*performance constraints*" and "approved procedures" hints at potential restrictions on the capabilities and applications of sUAS platforms even within the designated airspace.

Line-of-Sight Requirement:

The Roadmap indicates that sUAS may need to be operated within the "visual line-of-sight (LOS) of the flight crew" in order to avoid regulations similar to those applicable to manned aircraft.

If not LOS, then a list of "general requirements and assumptions" for UAS operations may be applied to non-LOS sUAS, including:

- compliance with existing operating rules,
- the need for an airworthiness certificate,
- the requirement to "file and fly an IFR flight plan,"
- the use of an on- board ADS-B (Out) transponder,
- air traffic separation capabilities, and
- pilot communication with ATC using standard phraseology, among others.

The operational value of video and digital telemetry sent back from the aircraft is not addressed.

((((In the Glossary at the back of the Roadmap, the term "Visual Line-of-Sight" is defined as "Unaided (corrective lenses and/or sunglasses exempted) visual contact between a pilot-in-command or a visual observer and a UAS sufficient to maintain safe operational control of the aircraft, know its location, and be able to scan the airspace in which it is operating to see and avoid other air traffic or objects aloft or on the ground.")))

Autonomous Flight Prohibited:

"Autonomous operations are not permitted. The pilot has full control, or override authority to assume control at all times during normal UAS operations."

The FAA has taken a firm stand with respect to autonomous flight for any UAS. Some of the more innovative small multi-rotor designs contemplate the use of autonomous technologies to navigate the environment, for example in a search and rescue operation surrounding a collapsed building. One key technology already implemented in many existing sUAS platforms is the ability to "return to home" via GPS guidance in the event of a control signal loss or other malfunction. (present for example in the dii Phantom quadcopter).

Daytime Flight Only:

The FAA's timeline indicates a goal of "increased night operations for public entities . . . by the 3rd Quarter of 2015."
This suggests a delay for certain commercial applications, such as search-and-rescue, agriculture, or wildlife monitoring, where night operations are advantageous.

C. Mandatory Procedures

Registration and Approval:

The FAA has also indicated that future regulations will address "registration of sUAS [and] approval of sUAS operations." It is not clear from these documents whether the registration and approval mechanism will be minimally burdensome (such as simple identification and operational notice provided on an FAA website) or something more complex resembling the registration of manned aircraft.

Safety Data Reporting and Record-keeping:

The Roadmap indicates that “data collection will expand when . . . new rules and associated safety data reporting requirements are implemented for sUAS.”

These statements all suggest that commercial sUAS operators will be expected to collect safety-related data. This may involve using required sensors on board the drone, and to maintain formal operating records.

Interface with Air Traffic Control:

The Roadmap targets that the FAA will “train air traffic control workforce within six months after sUAS rule enactment” and “sUAS operations are aligned with ATC Handbook … when the sUAS rule is published and effective.”

This suggests that sUAS operation may, in some way, be subject to interaction with air traffic control.

The Path Forward

Government/Public Users First:

The Comprehensive Plan states that with respect to routine sUAS operations,

Public operators will be permitted use of sUAS platforms before civil (private, commercial) operators.

2015 is indicated as the timing goal for both of those “national goals,” How these two steps, described as a sequence, will happen simultaneously is anybody’s guess.

So, the FAA does not allow commercial use of drones, but it is working to develop operational guidelines by the end of 2015. There is official word the project may take longer than expected. The projection is that some 7,500 commercial drones could be aloft within five years of getting widespread access to American airspace, whenever that widespread access process gets working.

An industry-commissioned study last spring predicted more than 70,000 jobs would develop in the first three years after access is granted.

…..to be discussed if time allows…..

Model Aircraft

The most recent news from the FAA is the announcement of the plans of cooperation between the FAA’s UAS Integration Office with the Academy for Model Aeronautics (the *other* AMA). The FAA’s recognizes and likes the AMA’s existing detailed safety procedures concerning model operations.

The FA also recognizes that AMA as being a ready resource for all AMA members and nonmember model enthusiasts. The AMA will be the focal point for the aero-modeling community, the hobby industry, and a conduit for the FAA to communicate relevant and timely safety information. The cooperative plan will maintain a comprehensive safety program for its members, including the guidelines for emerging technologies of the model UASs.

By jointly working together, the FAA and the AMA agreement complies with the existing congressional directives of the FAA staying clear from directly regulating model aircraft. These aircraft are already operated/regulated within the guidelines of the national organization, the AMA.

Privacy Considerations

Privacy Framework:

It is unclear how the FAA plans to address *privacy issues* with respect to *small UAS platforms*. The sUAS NPRM is promised by " 2014," the rules anticipated to be in "routine" operation" by 2015.

From the Comprehensive Plan:

"As use of UAS by civil agencies and private industry grows, preserving the privacy, civil rights, and civil liberties of individuals becomes increasingly important."

"**Federal** agencies are mindful that national defense and homeland security measures are to be designed and performed without diminishing the privacy, civil rights, and civil liberties of individuals.

"There are specific laws applicable to **public** agencies that ensure that those agencies follow privacy principles."

Although there is no Federal law that specifically addresses privacy concerns with respect to **civil** UAS operations, many states have laws that protect individuals from invasions of privacy which could be applied to intrusions committed by using a UAS."

It seems that, for now, the FAA may plan to defer to existing state and local invasion-of-privacy or anti-stalking statutes.

Privacy concerns have been raised with respect to the six planned UAS test sites.The plan is to permit the test site operators (who are "public entities" -- generally state or local government agencies) to develop their own privacy policies, with the FTC's Fair Information Practice Principles as an informative guideline.

"The privacy policies developed by the test site operators will help inform the dialogue among policymakers, privacy advocates, and the industry regarding broader questions concerning the use of UAS technologies."

These test sites may not be fully operational for some time, and the privacy-plan evaluations' results will likely not be helpful in formulating a policy for small UASs.

December 2013

***Six UAS Test Ranges* have been chosen by the FAA**

These test site locations were announced Dec. 30, 2013. The goal is to conduct research into the certification and operational requirements necessary to safely integrate UAS into the NAS over the "next several years". In selecting these test sites, from dozens of applicants, the FAA considered geography, climate, location of ground infrastructure, research needs, airspace use, safety, aviation experience and risk. As a group, they are meant to also achieve cross-country geographic an climatic diversity.

The FAA's research goals include:

- System Safety & Data Gathering
- Aircraft Certification
- Command & Control Link Issues
- Control Station Layout & Certification
- Ground & Airborne Sense and Avoid
- Environmental Impacts

"The FAA established requirements for each test site that will help protect privacy." Test site operators will be required to comply with federal, state, and other laws protecting an individual's right to privacy; publicly available privacy policies, and a written plan for data use and retention; and conduct an annual review of piracy practices that allows for public comment. "

University of Alaska - Contains a diverse set of test site range locations in 7 climate zones, including sites in Hawaii and Oregon. Goals are to work on setting standards ford different aircraft categories, monitoring and navigation, and safety.

State of Nevada - Objectives concentrate of operator standards and certification requirements. Also studies will be how Air Traffic Control procedures will evolve with the introduction of UASs into the civil environment and how these aircraft will be integrated with NextGen.

New York's Griffiss International Airport - Griffiss is a decommissioned Air Force base, now the location of the New York Air National Guard's 174th Attack Wing, which flies MQ-9 Reaper drones out of its base and from the airfield at the Army's Fort Drum in northern New York state. Objectives here include research on sense and avoid capabilities for UAS, and the challenge of integrating UAS into the congested, northeast airspace.

North Dakota department of Commerce - Areas of focus here includes developing essential data for UAS airworthiness, and validation of high-reliability link technology. Human factors research will also be a focus.

Texas A&M University - Goals include development of system safety requirements for vehicles and operations, including protocols and procedures for airworthiness testing.

Virginia Tech - Plans to conduct UAS failure mode testing and to evaluate operational and technical risk areas. Included are test site locations in Virginia and New Jersey.

Let's go Fly! 1/13/14