The Role of Regulation in Access to Civilian Airspace: Paths Forward for Unmanned Aerial Systems

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Outline

- Motivation
- Regulatory Framework: Conventionally Piloted Aircraft
- Current UAS Regulation: Sample International Perspective
- Path Forward: Operations Oriented Approach
- Summary Thoughts
Projected UAS growth in Commercial Market [1]

# UAS Sales by Sector [2]
Barriers

- Lack of Assurance Arguments for Commercial Off The Shelf Components (COTS) in safety critical roles
- Lack of Component (e.g., sensors, actuators) Quality Assurance Data
- Lack of airspace/operator rules
  - Different mission (e.g., loiter)
  - Different performance envelope
  - Different equipment (see vs. sense)
- Lack of Operator/Ground Crew Standards
- Security and Privacy Issues
- Lack of Explicit Consideration for UAS in Regulatory Framework
REGULATORY FRAMEWORK: CONVENTIONALLY PILOTED AIRCRAFT
Regulatory Framework

- Regulation of aircraft in civilian airspace occurs through the application of (legally codified) rules – e.g., 1998 CASR, 14CFR, EC No 216/2008, ICAO…

- Guidance for compliance is detailed in supplementary documentation (Soft Law) – Advisory Circulars (AC), Acceptable Means of Compliance and Guidance Materials (AMC-GM), etc.

- Standards Documents referenced in AC/AMC-GM provide detailed processes for showing acceptable means of compliance – e.g., DO-178C/ED-12C, DO-264/ED-78a etc.
Regulatory Framework: Certification

- We use the general concept of a CAA for this section to avoid restricting the discussion to any particular country’s regulatory approach.
- A National Civil Aviation Authority (CAA) regulates access to civilian airspace (e.g., FAA, CASA, CAA etc.).
- One key aspect of regulation is certification:
  - Airworthiness Certification
  - Crew Certification
  - Instructions for Continuing Airworthiness
  - Air Operator Certification
- Air Traffic Management (ATM), Air Navigation Service Provider (ANSP), Ground Infrastructure, and Aerodromes are regulated internally by the CAA.
Airworthiness Certification

Airworthiness: Aircraft’s fitness for flight operations, in all possible environments and foreseeable circumstances for which aircraft or device has been designed. [3]

• Type Certificate (TC)
  • Properly designed and meets required standards /regulations

• Production Certificate (PC)
  • Properly manufactured to type design

• Airworthiness Certificate
  • Required for each tail number to gain access to the airspace
Crew Certification

- Pilot Certification
  - Levels: student, sport, recreational, commercial etc.
  - Category Rating: airplane, rotorcraft, glider, etc.
  - Class and Type Rating: As required for category.
  - Ratings can also be obtained wrt equipment: instrument vs. visual, single vs. multi-engine etc.

- Aircrew: Supplementary Flight Crew, Cabin Crew etc.

- Ground Crew: Maintenance Technician, Flight Dispatcher, etc.
Continuing Airworthiness

- Applies to aircraft, engine, propeller or part
  - Complies with airworthiness requirements
  - Remains in condition for safe operation of aircraft

- Based on initial type certification, maintenance and operational regulatory approvals → Instructions for Continuing Airworthiness (ICA). For example:
  - Operator’s approved maintenance data
  - Conformance to original Type Design
  - Record keeping and reporting…
Air Operator Certificate

- Air Operator Certificate establishes requirements and procedures for commercial operation of aircraft
  - Details type of equipment, where and when you will operate, crew training requirements etc.
  - Development of operations and maintenance manuals
  - Includes business plan, system safety process, and reporting procedures
- Directly influences continuing airworthiness
Perspectives (I)

- CPA Framework may not be suitable as-is for UAS:
  - Model of operation for UAS may differ from CPA (& cost)
  - Vehicle and ground infrastructure must be considered for airworthiness, including communications links
  - UAS Airframe manufacturers do not have airworthiness responsibility for fielded platform
  - UAS operators require different skills than conventional pilots
  - Air Operators/Service Providers may take larger role in gaining and maintaining airworthiness of platform based on services offered
CURRENT UAS REGULATION: SAMPLE INTERNATIONAL PERSPECTIVE
Australia [4]

- Civil Aviation Safety Regulation (CASR) Part 101 was first operational regulation for UAS released in 2002; deals with Remotely Piloted Aircraft Systems (RPAS)
  - Currently being updated with ACs, Notice of Proposed Rulemaking

- UAS in controlled airspace are treated as IFR flights, must be equipped with SSR and a collision avoidance or forward vision system, and have filed flight plan with contingencies

- Operation BVLOS, BRLOS requires abort/termination procedures to be filed with ATC authority

- RPAS operator must have ground training applicable for IFR rating
Canada [5]

- Establishes 2 classes: under 2 kg, between 2-35 kg with max airspeed <87kts
  - Requires VLOS, prohibits use of visual observers to extend LOS, and relay stations to extend RLOS
  - Operate below 300 ft in class G airspace, and 5 nmi from aerodrome/urban area, minimum clearance of 500 ft with all obstacles/persons
  - Pilot must be 18, and completed pilot ground school

- All other UAS must certify as CPA do, though individual exemptions may be sought
European Union [6]

- EASA regulates UAS and RPAS ≥ 150 kg used for civil applications, all other UAS regulated by member nation CAAs
  - “Airworthiness Certification of Unmanned Aircraft Systems (UAS)”

- Concept of Operation for Drones
  - Three categories: Open, Specific and Certified
  - Open does not require authorization for flight, but must stay within defined boundaries
  - Specific requires risk assessment to gain Operations Authorization with specific limitations
  - Certified requires airworthiness certification
EU UAS under 150 kg

- UK [7] divides into two categories, ≤20 kg, and >20&<150.
  - Under 20kg, no airworthiness approval or registration for VLOS RPAS, below 400 ft, in class G airspace, or within 50 ft of people.

- Germany [8] prohibits operation of any UAS over 25 kg, or beyond LOS, or above 100 m
  - Commercial operation of a UAS or UAS over 5 kg requires license
  - UAS under 5 kg can receive limited permit for operations up to 100 m, within LOS for repeated use, but not over crowds

- France [9] has two decrees governing UAS use:
  - Aircraft Decree classifies UAS into 7 categories, C(mass, function)
  - Airspace Decree outlines 4 operational scenarios
  - (Category, Operational scenario) pairs determines level of oversight
Japan [10]

- Commercial use of unmanned helicopters for agriculture in Japan since 1980s
- Japan Agricultural Aviation Association sets standard (Ministry of Agriculture, Forestry and Fisheries)
  - Pilot Training
  - Aircraft Registration
- Operators must have valid Maintenance Operator License, and be registered, as well as meet structures, flight performance and maintenance standards
- Aviation Regulations only require that any UAS fly below 150 m and 9 km away from airports

- 2 Part 21.25 Restricted category type certificates to Puma and ScanEagle for Arctic Operations
- Section 333 of FAA Modernization and Reform Act allows case-by-case exemption
  - FAA will grant COA for flights at or below 200ft to 333 exemption holders for weight <55 lbs, VFR, VLOS and stay fixed distance from airport → Can operate anywhere except over urban areas and restricted airspace
- Proposed small UAS rule for <55 lbs, max airspeed 100 mph, max altitude 500ft, VLOS, no overflight of persons
  - Allowed with permission in B,C,D,E airspace
  - Visual observers may be used, but not First Person Camera View
Perspectives (II)

- Other than in Australia, little formal regulation exists specifically to grant access to UAS larger than ‘small’ weight class
- Commercial UAS (even small) are often not granted access (except in Japan) and face regulatory burdens which may be disproportionate (enormous added cost)
- Beyond VLOS/RLOS operations are rarely enabled
PATH FORWARD:
OPERATIONS ORIENTED APPROACH
Motivation for Approach

- Wish to enable airspace access for class of commercial applications whose vehicle platform is not ‘small’, and/or who may wish to operate BVLOS
- Several commercial application domains have been identified:
  - Precision Agriculture, Inspection/Surveillance, Mapping/Surveying
- Each of these applications may present a restricted set of operational hazards whose mitigation may be sufficient to form a type certification basis
- This will enable a ‘starting’ certification basis for (Operational Concept, Platform) pair.
Define Concept of Operations [12]

- Clearly define:
  - Operational Scenarios
  - Operational Environment
  - Assumptions
  - Functional Performance
  - Anticipated Safety Considerations

- Also Relevant: economic considerations
Vehicle Selection [13]

- Relevant Vehicle characteristics
  - e.g., range, endurance, speed

- Relevant Safety Concerns
  - Autorotative capability, etc.

- Economic Considerations
Hazard Analysis

- For the clearly defined Conops, an Operational Hazard Assessment (in conjunction with the selected vehicle) will yield relevant hazards
  - Evaluate wrt severity

- Vehicle specific hazards (that are evinced in operational context) are then aggregated
  - Controllability, maneuverability, etc.

- In the context of operational and environmental assumptions, this forms the set of hazards to be mitigated (airworthiness, operational, training…)
  - Ground Station, Operator, Communication Links, etc.
Develop Type Certification Basis

- Can develop regulation for each hazard that will result in desired level of mitigation
  - Can use available regulation for conventional hazards
  - Can modify available regulation to fit similar hazards in new context
  - Develop regulation for aspects of vehicle/operation that is novel
    - e.g., Communications Link, Containment Area
Assured Containment Concept [14]

- Containment system independent of the UA autopilot and avionics

- Redundant means of enforcing the containment boundaries
  - Doesn’t use vehicle’s sensors, actuators or computational platform

- No single failure in UAS autopilot results in an automatic failure of the containment system
  - limit the UA’s physical location in the presence of such failures.

- Extensible through:
  - Vehicle Types, Operational Environments, Application Domains
Perspectives (III)

- Enabling access to airspace for a wide class of vehicles and applications will require either:
  - Case by case evaluation or
  - Reuse of assurance concepts to form a common certification basis across vehicles and operational concepts or

- Cost outlay required to meet possibly unduly burdensome standards will act to drive which approach is taken
Summary Thoughts

- Enabling UAS access into the airspace must be done in an Efficient (time and cost), Safe and Secure, as well as Non-disruptive manner in order to ensure the economic benefit of this enabling technology is fully realized.

- Regulatory impediments remain the largest barrier to UAS access of airspace.

- Use of operationally driven type certification bases may provide relief while maintaining safety, and begin to build a foundation for certification over classes of operations and vehicles.
Questions?

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Visit the DP-14 in the NASA Integrating UAS into the NAS Booth at AUVSI
References


References


