SOLVE FOR X.

Drones In Logistics

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Outline

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- Drone Characteristics and Challenges
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- Drone Applications in Logistics
- Case Study: Aircraft Assembly
- Conclusions

INTRODUCTION

The Nature of Drones

- Unmanned Aerial Vehicles/System (UAVs/UAS), Remotely Piloted Aircraft (RPAs)
- Range of sizes and configurations
  - Fixed wing, rotocraft (inc. multirotor), Tilt wing/rotor

Drone Enabling Technologies

- Improved microprocessors
- Advances in flight control software and autonomy
- Improved materials and manufacturing
  - Rapid prototyping, composites
- Developments in sense-and-avoid technology
  - Sensors, artificial intelligence
- Networking and communication protocols

Current Drone Landscape

- As of the end of 2016, 40,000+ FAA registrations for commercial drone use
  - BNSF
  - Sempra Energy
  - Amazon.com
  - Disney
  - Intel
- Current global market of commercial applications: >$2B
- 2020 Projection: $127B

DRONE CHARACTERISTICS AND CHALLENGES

General Objective: Move payload from place to place

Technical Capabilities For Logistics

- Movement Strategies (point to point or follow trajectory)
  - Remote control
  - Autonomous flight
- Variety of payloads
  - Cameras (EO/IR)
  - Other sensing equipment (LIDAR, RFID, etc)
  - Network nodes
  - Objects (depending on platform and weight)

Payload Capacity

- Related to design factors
  - Engine/Motor selection
  - Flight mode (e.g. VTOL less efficient than winged flight)
- Payload inextricably related to flight time/duration

Other Technical Factors

- Communications and flight sensors
  - Dropout
- Sense and Avoid
- Battery Technology
- Cybersecurity

Regulatory Considerations

- Outdoor flight regulated by Federal Aviation Administration (FAA)
- Part 107 regulations (June 2016)
  - Line of Sight (LoS) operations
  - Single vehicle per operator
  - Daylight operations only
  - Cannot fly over persons not participating
  - Max 400ft
  - Max 100mph
  - Class G airspace without approval (B,C,D,E need ATC approval)
  - Less than 55lbs, including payload
  - Remote pilot airman certification
  - Drone must be registered
- Most of these are possible to modify with a waiver
- Section 333 exemption

Drone Operations

- Drone-Operator ratio
- Central vs Distributed control
- Personnel and Training
  - Pilots/Operators
  - Maintenance team
  - Other personnel that will interact with UAS
- Safety and emergency operations

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DRONE APPLICATIONS IN LOGISTICS

Point To Point Delivery

- External – customer is end point
- Internal – inter/intra facility
- Payload capacity key factor
- Regulatory approval is a challenge (BLOS, populous areas, interaction with manned aircraft)

Asset/Inventory Tracking

- Utilize high mobility of drones to track assets or resources
  - Example: Mining
  - Use drone to obtain birds-eye view of mine equipment and layout
  - Scan and monitor stockpiles
- Scan and track inventory in vertical warehouses (Eyesee, Dronescan)
- Typically operates in or over company property, which reduces regulatory burdens

Inspection

- Drones can allow for faster, less expensive inspections of infrastructure or large equipment
  - Example: Railway inspection (BNSF)
  - Aerial imagery of wide ranges of rail lines can be captured in a single UAS mission
- Requires inspection team with both drone and subject matter expertise to design flight paths and interpret results
- Drone range/flight time can be an important limitation

CASE STUDY: AIRCRAFT ASSEMBLY

Scenario

- Commercial aircraft assembly line
- Static and dynamic elements to environment
- Current movement of parts/tools via motorized carts along designated paths

Problem

- Size of facility, path restrictions, and height of assembly work reduces efficiency of ground delivery
- Can drones be used as a warehouse delivery option?
- What are the major constraints or concerns in the implementation of such a system?
- Key Requirements: productivity, reliability, safety

Vehicle Selection

- VTOL multi-rotor
  - Advantages
    - Low speed, higher maneuverability, hover capability
    - Low requirement for takeoff/landing area
    - Multi-rotor relatively robust to failures
  - Disadvantages
    - Small payload capacity (<5-10kg)
    - Frequent recharging needed (10-20 min flight time)

Operations

- Delivery directly to personnel difficult to implement and dangerous
- Autonomous flight between stations, based upon mobile device request
- Onboard camera allows for basic obstacle detection
- Single command desk to monitor system (minimal personnel requirement)

Challenges

- Safety to personnel and equipment a major concern
  - Possible to isolate “highways” along the ceiling, but this requires significant infrastructure expense
- Personnel to insert/remove items at drone stations
- Limited payload reduces the usefulness of such a system across all delivery needs

Resolution

- Ultimately, drones represent a tool in the logistics toolbox that has important capabilities and weaknesses
- In this case, there is insufficient justification for the investment in drone tech
- Each situation must be carefully evaluated and planned to ensure appropriate strategic decisions

CONCLUSION

Summary

- Drones are a rapidly growing market that provide multiple opportunities in logistics, manufacturing and supply chain settings
- Drone systems vary considerably in capabilities, requirements, and operational and regulatory considerations
- An appropriate systems engineering plan including CONOPS should be developed as part of the acquisition of drone technology

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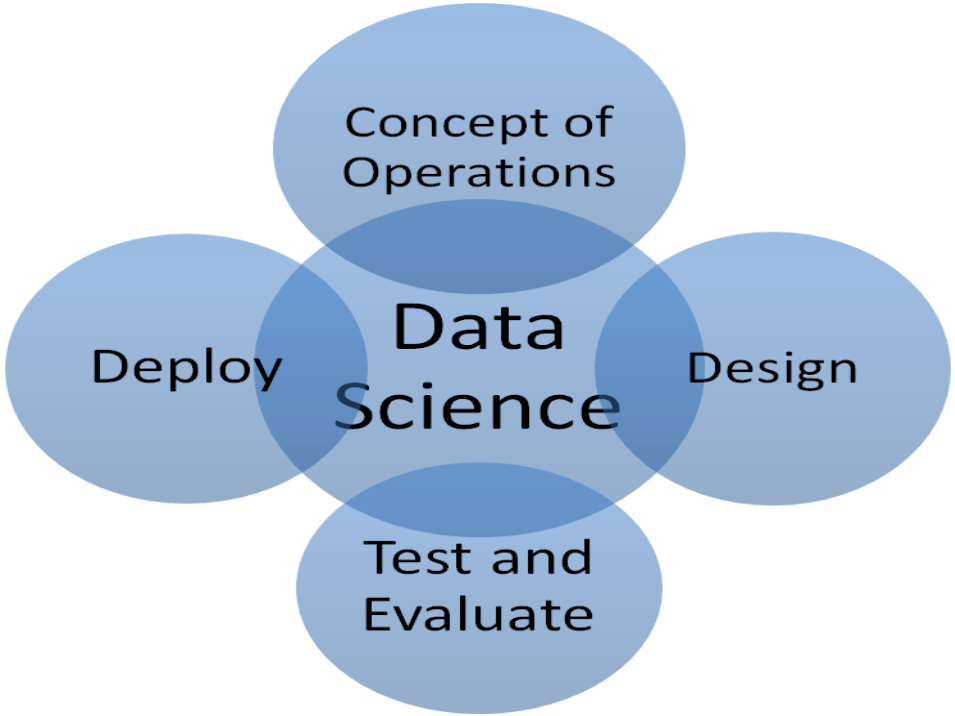
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