SUMMARY OF RECENT WORK IN UAM MARKETS AND OPERATIONS

BRIAN J. GERMAN
LANDELEY ASSOCIATE PROFESSOR
AEROSPACE ENGINEERING
GEORGIA TECH

AHS TRANSFORMATIVE VERTICAL FLIGHT WORKSHOP 2018
1. Community focus groups to assess public perception of UAM concepts

2. Stated-preference surveys for UAM travel demand modeling

3. Urban cargo delivery with passenger-class eVTOL

4. Geospatial tools for demand assessment and vertiport placement
Conducted focus groups with members of the public to understand factors that may influence UAM demand.

4 focus groups conducted, each with 5-7 participants from the Atlanta area:
- High-income households (> $200k annual household income)
- Millennials
- Physicians who work out of multiple offices or practice telemedicine
- Caretakers who travel > 1 hour at least once per month for a family member’s medical care

Goal was to note relevant comments and concerns of participants to guide formulation of research questions for subsequent surveys and other instruments.

• Profs. Garrow, Mokhtarian, and German have developed a stated-preference survey for thin-haul/UAM travel demand; survey incorporates lessons learned from focus groups; will “go live” later this month

• Goals are to determine Myers Briggs-like “travel personality” profiles and to provide data for discrete choice models for UAM demand

• Participants will be recruited from 5 cities:
  o San Francisco
  o Los Angeles
  o Atlanta
  o Boston
  o Dallas/Fort Worth

• 2,845 participants (569 per city)
Envision and explore possible concepts of operations (CONOPS) for 4-passenger-class eVTOL aircraft for cargo delivery.

- Aircraft could be used exclusively for cargo or used for passengers primarily and for cargo during off-peak periods
- Broad charter to explore “interesting” business models

Investigate these CONOPS with San Francisco Bay Area examples

Model the San Francisco CONOPS to assess feasibility/viability

- Package/cargo demand
- Vertiport locations
- Aircraft operational performance
- Operating costs
- Fleet sizing and assignment
- Cargo throughput
EVTOL CARGO: OPPORTUNITIES AND LIMITATIONS

• Any proposed application must strongly value *immediacy*, else why not use trucks?
  ➢ Time critical items
  ➢ Value of immediacy in stimulating purchases (latent demand)

• Cost of service allowed to be somewhat higher than that of trucks or other delivery modes, to the extent that the costs can be offset by additional latent demand/revenue generated by this value of immediacy.

• To create such a market, eVTOL operating costs must be sufficiently low, motivating electric propulsion and autonomous operation.

• Immediacy requires high flight dispatch frequency and reasonably high flight speeds; the value proposition improves in cities with high levels of ground traffic congestion.

• This is not a “drone delivery” model; any valid business model must aggregate sufficient cargo volume or value to justify a flight in terms of operating costs.
1. Intra-city point-to-point courier
2. Intra-city hub-and-spoke courier
3. Regional hub-and-spoke courier
4. City-to-airport freight
Concept: Operate eVTOL cargo aircraft from remote fulfillment centers to urban vertiport cargo hubs.

Goals: Reduce order fulfillment time for Prime Same Day orders to allow later last-order time. Increase fraction of Amazon inventory that can be delivered in the 2-hour Prime Now guarantee window.

Economics: Moderate cost of delivery increase allowable. Benefit is increased demand and ability to set higher prices because of “value of immediacy” effects.

Approach:
• Flights from fulfillment centers to a handful of sites (4-10) in the Silicon Valley area
• Very high flight frequencies; departures every ~15-20 minutes to all locations
• Last mile by Amazon-owned/-contracted van courier, on-demand car courier, bicycle courier, drone, etc. (TBD)
AMAZON CONOPS: EVTOL TRAVEL TIME SAVINGS

By road: 57 miles; **1hr, 1 min** (9:13 AM local, weekday)
By eVTOL @ 150mph: 49 miles; **20 mins**

By road: 64 miles; **1hr, 20 mins** (9:13 AM local, weekday)
By eVTOL @ 150mph: 54 miles; **22 mins**

OAK5– 38811 Cherry St, Newark, CA 94560
SJC7– 188 Mountain House Pkwy, Tracy, CA 95391
OAK4– 1555 N. Chrisman Road, Tracy, CA 95304-9370
OAK 3– 255 Park Center Dr, Patterson, CA 95363
The first question we addressed for this Amazon CONOPS was, “Where should vertiports be placed to serve package delivery demand?”

This is a delivery-to-consumer model, so we first considered delivery locations that are nearby to where the population lives; allows use of census data.

In later research, we plan to consider delivery locations nearby to where the population works, i.e. where people spend their days.
• We discretized the San Francisco Bay area at a census tract level
• Each tract is allowed to have 0 or 1 vertiports
• Demand was modeled as proportional to product of census tract population and per capita income
• Objective: Maximize demand served by placing a specified number of vertiports
We first consider the case in which a vertiport’s service area is limited only by the drive time required to reach the vertiport:

- Flights-per-day capacity of each vertiport presumed unlimited
- Case 1: Vertiports serve all tracts within 10 minutes (one-way) of the vertiport
- Case 2: Vertiports serve all tracts within 15 minutes (one-way) of the vertiport

We considered the optimal vertiport placement for up to 8 vertiports.

Drive time estimated with Google Maps API.

Red = Unserved Demand
Green = Served Demand
Pink = Location of Vertiport
Number = Demand units served
Case 1: 10 Minute Service Area
AIRSPACE CONSTRAINTS

- Like many metro areas, the San Francisco Bay Area, has a very complicated airspace
- As an initial attempt at modeling airspace constraints, we presumed aircraft fly VFR-like flight plans through Class G airspace
- We presume operations in Class B and C airspace must be avoided
- We therefore enforce a constraint that no vertiport can be placed in a census track whose centroid is within a Class B and C surface (SFC) restriction
- In later work, we plan to relax this restriction and consider allowable corridors in Class B and C that respect approach surfaces
AIRSPACE-CONSTRAINED FLIGHT DISTANCES TO TRACY, CA FULFILLMENT CENTER

6-vertiport example