



## Potential Use Cases for Micro-UAVs in Yemen

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In late May 2015, Uplift Aeronautics conducted an informal survey of colleagues, humanitarian workers, and medical professionals in Yemen about the utility of Micro UAV (unmanned aerial vehicle) aid deliveries. These small aircraft can only deliver 1-2 kilogram packages per flight, but can penetrate dangerous areas, deliver cargo to precise locations, and respond quickly to urgent needs. The paradigm can scale with larger numbers of aircraft.

Respondents saw these deliveries as having utility, although they acknowledged limitations as well. It is not possible, for example, to supply large amounts of water, food, fuel, or NFIs (non-food items) such as blankets, mattresses, and clothing. However, respondents did identify many items that are in short supply in Yemen (particularly in the governorates of Aden, Taiz, Abyan and Lahej, which have seen some of the worst fighting in recent weeks) and which could be transported by UAVs. These items include the following (a more detailed list can be found in the appendices):

- I. Medications. Most medicines would qualify for UAV delivery and can be considered as essential, life-saving humanitarian necessities. General examples include the following. Appendix A lists current needs in Aden hospitals.
  - a. Insulin
  - b. Painkillers
  - c. Antibiotics
  - d. Vitamins (especially Vitamin A for reduction in infant/newborn mortality)
  - e. Vaccinations (DTP, Polio, Measles, Tuberculosis, Hepatitis B, Varicella, Pentavalent, Rotavirus, Tetanus, MCV)
  - f. Allergy medications
  - g. Malaria medication
  - h. Anesthetics
  - i. Blood pressure/Cardio medication
  - j. Chemotherapy medications (see Appendix B for specifics)

- II. Surgical and medical supplies
  - a. First aid kits (see Appendix C for contents)
  - b. Field surgical kit
  - c. IV bags and fluids
  - d. Prosthetics
  - e. Chest drain and Trocar Tubes with bottles
  - f. Surgical masks
  - g. Latex gloves
  - h. Hair nets
  - i. Surgical booties
  - j. Ground tarps (for field treatment)
- III. Hygiene
  - a. Antibiotic gel
  - b. Women's sanitary napkins
  - c. Soap/shampoo
  - d. Toothbrush/paste
  - e. Dust masks
  - f. Washing powder
- IV. Food
  - a. Power bars / gels
  - b. Infant formula / powdered milk
  - c. Nuts (and other high-energy foods)
  - d. Seeds (for growing crops)
  - e. Cash (for destitute and institutional purchases)
- V. Emergency Supplies
  - a. Small solar USB chargers
  - b. Solar flashlights
  - c. Mobile/satellite phones
  - d. Radios
- VI. Small amounts of fuel
  - a. Water purification tablets / backpacking filters
  - b. Whistles
  - c. Insect repellent (help with malaria control)
  - d. Women's dignity kits
  - e. Flip flops
  - f. Insecticide treated nets
  - g. Critical spare parts for equipment (including medical equipment)

Shortages of these supplies have impacted the lives of countless Yemenis during the current conflict. Almost everyone that Uplift spoke with indicated some level of deprivation. In some cases, this deprivation has resulted in lives being lost. Colleagues report many cases of deaths amongst the elderly—often likely resulting from myocardial infarctions and strokes caused by the stress of the conflict and complicated by factors such as extreme heat and dehydration brought on by the lack of sufficient potable water supplies. Many of these lives could have been saved with basic medical care and accessible supplies. Colleagues also reported about suffering cancer patients who are receiving no treatments, not even palliative painkillers, since these are in short

supply. There are similarly reports of dialysis patients who either cannot get to treatment because of fuel shortages or because the treatment center is shut down due to fighting or electrical outages. Aden's Republican Hospital currently only has one working dialysis machine. Insulin for diabetic patients is another concern, and it is noteworthy that diabetes is growing more rapidly in the Middle East than in any other region of the world. Other diseases/illnesses reported in Aden hospitals include Dengue Fever (45 suspected cases with two fatalities to date), three cases of rabies, and an unspecified number of cases of malaria.

One of the common concerns expressed by Yemenis is that of humanitarian supplies falling into the hands of combatants. Fighting groups manage traditional aid inflows and often benefit materially and directly from the aid, restricting or even preventing it from reaching the most affected populations and redirecting it to their supporters. In Aden, in particular, people have been cut off from receiving significant aid for weeks. According to OCHA, checkpoints outside of Aden have stopped most, but not all, attempts to deliver aid by land. Adeni citizens report the same. [OCHA, "Yemen: Escalating Conflict," Situation Report No. 8 (as of May 22, 2015, p. 2)]. UAVs could bypass such issues.

Even when aid does make it to affected populations, it sometimes falls into the hands of profiteers, who then re-sell it on the open market for exorbitant prices. Yemenis report buying bags of wheat flour marked with "Gift of Germany" in grocery stores. In other cases, Yemenis report that officials tasked with distributing the food sell it or ask for bribes. In still other cases, medications may be available, but many who most urgently need those medications cannot afford them, as businesses have been shuttered for months and most employees (including government employees) have not received salaries for two months (as of May 2015). Again, targeted UAVs could help alleviate these problems by delivering targeted aid directly to affected individuals who are in urgent need of assistance, particularly medicine. UAVs could even deliver cash to institutions whose reserves are exhausted to enable them to purchase supplies on the open market, in cases where they might still exist.

Further, Yemenis and aid groups working in Yemen note that, in many cases, the "cold chain" for the storage and transport of medicines and vaccines has broken down due to fighting, damaged infrastructure, and the lack of fuel and power. Given their quick travel times, UAVs could deliver viable vaccines and medications almost immediately to patients and doctors. On a related note, we are hearing that pediatric immunizations have effectively been halted by the conflict, meaning that a new generation is at risk of contracting and spreading (both at home and abroad) virulent, contagious diseases (<http://www.irinnews.org/report/101511/children-bear-brunt-of-yemen-s-war>).

In conflict-ridden areas as well as natural disaster areas, damaged and destroyed infrastructure presents further problems for aid distribution. According to UNHCR, it took ten trucks bearing humanitarian supplies three days to reach Aden from Sanaa. In pre-conflict days, that trip would have taken one day at most. [<http://www.unhcr.org.uk/news-and-views/news-list/news-detail/article/rapid-assessments-in-yemen-find-desperate-situation-for-displaced-civilians.html>]. Many areas of Yemen, which is an extremely mountainous country and has few paved roads, are almost inaccessible to humanitarian deliveries. Yet, the majority of Yemen's population still

lives in rural, not urban, areas. If lives urgently depend on aid delivered by ground transportation, it is likely that those lives will be lost.

Conflict has plunged much of Yemen into darkness. The capital, Sanaa, has power outages lasting for days at a time; parts of Aden (which has seen some of the heaviest fighting in the past two months), has had no power for nearly one month. UAVs could deliver small USB solar charging devices to at least enable citizens to charge phone batteries and be able to communicate if networks are running. Other alternatives for communications include satellite phones and two-way radios, which could also be delivered by UAV.

OCHA reports that six out of Yemen's twenty-two governorates currently have no food available on the markets. Aid is unable to reach millions of Yemenis for many of the reasons listed above. In the governorate of Saadah (adjacent to the Saudi border) alone, an estimated 500,000 people are without access to medical supplies, food, water, and NFIs, as most humanitarian assistance organizations left after the humanitarian pause when coalition forces recommenced heavy. Throughout Yemen, UN reports indicate that humanitarian aid has slowed or stopped due to persistent concerns regarding insecurity and the risks of being targeted by one or parties to the conflict (aid workers have been killed and a few IO and NGO-supported facilities have been targeted in past weeks). Humanitarian organizations estimate that Yemen's 850,000 malnourished children (January 2015) may double to 1.7 million. Using traditional methods of delivering aid, organizations were able to only reach 700 of these children during the five-day humanitarian pause. [OCHA, "Yemen: Escalating Conflict"]

In summary, this preliminary survey of individuals and organizations working in Yemen suggests that UAVs could effectively overcome limitations in the traditional model of humanitarian aid.

While the capabilities of micro-UAVs are limited (1,000 drones could only deliver a total payload of about 1,000 kilograms, or one metric ton, at one time), it is important to remember that flights could occur continuously in the aftermath of a natural disaster, and nightly in a conflict zone. Theoretically, tens of tons of goods could be distributed by swarming drones making successive round trips. In Yemen, the five-day humanitarian pause that took place in mid-May was simply an insufficient amount of time to reach most of Yemen's populace. While thousands of metric tons of supplies were brought in during this five-day period, a scaled up micro-UAV platform could continuously deliver critical supplies to affected populations - in time and on target.

## Appendix A: Medications Identified as Critical by Aden Hospitals as of May 2015

- ! Human Albumin
- ! Suxamethonium injection
- ! Atracurium injection
- ! Thiopental injection
- ! Aminophylline injection
- ! Phenobarbitone injection
- ! Ergometrin injection
- ! Alpha chymotrypsin injection
- ! Quinine injection
- ! Fortum injection
- ! Dopamine injection
- ! Nitroglycerin injection
- ! Erythropoietin 4000
- ! Streptokinase
- ! Dextran drip
- ! Anti-D injection
- ! Factor 8
- ! Factor 9
- ! Tacrolimus (Prograf)
- ! Cyclosporin (25 mg., 50 mg., 100 mg.)
- ! Mycophenolate 500 mg.
- ! Angised tab sublingual
- ! Local anesthetic eye drops
- ! Halothan
- ! Isofluran
- ! Human insulin (mixed and soluble)
- ! Aspirin
- ! Plavix
- ! Pantozol injection
- ! Adrenaline injection

**Appendix B: Chemotherapy Medicines Lacking and Quantities Needed as Identified by an Adeni Cancer Specialist:**

|   |           |
|---|-----------|
| Epirubicin injection (50 mg.)             | 200       |
| Docetaxel injection (80 mg. / 20 mg.)     | 100 / 200 |
| Paclitaxel injection (100 mg. / 150 mg.)  | 200 / 200 |
| Venorelbine injection (10 mg.)            | 300       |
| Vincristine injection (1 mg.)             | 200       |
| Oxliplatin injection (100 mg. / 50 mg.)   | 200 / 200 |
| Carboplatin injection (450 mg. / 150 mg.) | 200 / 200 |
| Gemcitabin injection (1 gram)             | 200       |
| Fulvestrant injection (250 mg.)           | 80        |
| Liposomal Doxorubicin injection (20 mg.)  | 300       |
| Ifosfamid injection (with mesna) (1 gram) | 500       |
| Neupogen (G-CSF) injection SC (300 mg.)   | 500       |
| Zoledronic Acid IV (4 mg.)                | 200       |
| Irinotecan injection (100 mg.)            | 300       |
| Cytarabin injection (500 mg.)             | 300       |
| Daunorubicin injection (20 mg.)           | 200       |
| L-Asparaginase injection (10000 UI)       | 200       |
| Venorelbine tablets (30 mg.)              | 500       |
| Letrozole tablets (2.5 mg.)               | 3000      |
| Exemestane tablets (25 mg.)               | 3000      |
| Capecitabine tablets (500 mg.)            | 10000     |
| Sorafenib tablets (400 mg.)               | 3000      |
| Tamoxifen tablets (20 mg.)                | 10000     |

## **Appendix C: First Aid Kit Essential Contents Requested by Yemeni Medical Personnel**

- ! Gauze pads (5 cm x 5 cm and 7 cm x 7 cm)
- ! Non-adherent dressings
- ! Finger splints
- ! Antiseptic towelettes
- ! Ointments
- ! Povidone / Iodine
- ! Trauma dressings
- ! Eyepads
- ! Tape