THE UAS TRIBUNE

Unmanned Cargo Aircraft
A New Paradigm for Future Sustainable Transport

By Gilles Fartek
Integra, Denmark

Over the last decade, the growth in logistics needs has been exponential due to the increased globalisation of economic relocations and its consequences in volumes of international freight traffic. But this expansion is also due to the ever-increasing expectations of consumers to receive products purchased through e-commerce in ever shorter lead times. This practice, further reinforced by the COVID-19 crisis and never denied since a virtual return to normal, now aims to meet the expectations of large e-commerce companies to be capable of delivering products purchased in a few hours. This evolution contradicts all efforts developed to limit the transport footprint, improve environmental protection and mobility, and drastically reduce CO2 emissions from 2035. The very high number of trucks serving urban centres contributes to the increasing congestion and pollution observed in most cities. The ecological transition imperatives developed in recent years, in particular with the Green Deal established by the European Commission in 2019, now require public authorities to take the necessary measures to limit the impact of transport activities on citizens' health as much as possible.

The Need for Alternate Transport Modes

While the maritime sector takes the lion's share of freight transport, especially over long and very long distances, air transport continues to occupy an important place, particularly for moving products that cannot withstand long periods at sea, are of strategic importance, or require quick delivery. Air cargo services consist of transporting mail and freight domestically or internationally by aeroplanes and helicopters, with many products requiring different speed deliveries. Consequently, the market needs and the volume of cargo exchanges by air may differ depending on the areas to be served, the level of competition between transport segments, the market trends, and the opportunities open to air freight companies. In 2022, the global air cargo services market represented around 59 billion Euros, showing an annual growth of 7.4% compared with 2021 [1], despite the international situation and the remaining effects of the COVID-19 pandemic.

In that context, developing drone solutions to deliver goods by air should constitute an exciting chance for the logistics sector. Initial drone transport applications were essentially focused on small packages at a short distance, ideally beyond the line of sight. However, recent developments of innovative technologies have created great expectations for the logistic sector to be capable of operating large-weight drone cargo over long distances in a reasonable timeframe. Accordingly, remotely piloted cargo aircraft (UCA) can already be considered a serious alternative of complementary means to legacy transport modes, better answering new commercial needs and practices. The latest projections [2] show that the worldwide drone transportation market could be worth 28 billion Euros by 2027. With a global drone economy still in development, and many companies struggling to fulfil their initial business plans, logistic services using drones could be the fastest-growing category with a high potential market value in the next twenty years. This should favour the emergence of UCA operations as part of the Innovative Aerial Services (IAS) [3]. This should bring opportunities for changing the paradigm for some international, regional and urban air mobility as part of the promising emerging Innovative Air Mobility (IAM) market, accommodating operations with novel aircraft designs operated in unmanned configuration, offering new air mobility for people and cargo-based operations supported by integrated air and ground-based infrastructure.

The Rise of Unmanned Cargo Aircraft

The UCA concept concentrates on the delivery of relatively large volumes of goods outside the urban environment, offering new services building on UCA cutting-edge capabilities, with new potential applications and advantages already identified:

- Transport manufactured goods from production areas to industrial parks or assembly lines, reducing distribution time while simplifying and improving logistic distribution based on specific routes not currently served by manned air freight services. This could present a significant interest, particularly by better connecting logistic and distribution centres and cities where no airport or important route or rail infrastructure allows industrial or commercial development and exchanges.
- Quickly and permanently serve areas where high-value products, raw materials, production equipment and spare parts are produced, better supporting local developments and opening new opportunities for

[1] Air Cargo Services Global Market Report by the business research company, October 2022
[2] https://www.stattimes.com/drones/cargo-drones-and-regulations-giving-wings-to-future-of-logistics-1345013
[3] According to the European Aviation Safety Agency (EASA), IAS correspond to operations and services benefitting to citizens and aviation market, enabled by new airborne technologies, include transportation of passengers and/or cargo and aerial operations.

settling locally new economic actors without the fear of being off distribution routes. Such an approach would particularly suit products in international demand but with too small volumes produced to be subject to dedicated cargo flights or not benefiting from regular passenger flights where cargo could be loaded cargo. In addition, this would reduce the problems encountered by regions having a reasonable number of inhabitants but struggling to attract scheduled long-range connections or appropriate transport infrastructures, especially when the income per capita is low.

- Establishing UCA ports could be relatively cheap compared to the benefits gained, requiring limited infrastructure, control equipment and loading facilities, and relatively easy to operate and maintain. Cargos could be transported on specific non-classic routes without having to operate from or to existing logistic hubs or aerodromes, as is the case today with manned aircraft, creating more flexibility and adaptability to the traffic. This could bring cost-benefit since the low UCA operating cost would allow for transporting directly lower volumes of cargo without waiting to reach the critical mass for transporters, also limiting the risks of damages, delays or loss of products as is the case when mixing very different types of goods.
- Using standardised UCAs, specifically designed and operating new types of air containers, would maximise the operational use and turnover of systems and rationalise costs. For example, operating cargo drones in series would not necessarily require them to return to their home bases, being potentially reused indifferently according to maritime containers. UCA rental services could also be opened to shipping companies, the air vector being stored at the destination until being used by other clients for following operations.
- In addition, UCAs could reveal their particular interest in supporting specific civil operations to deliver emergency or disaster areas supplies. This could also serve temporary needs in some regions where market needs may be irregular, seasonal, or unpredictable, with no possibility of adapting the availability of scheduled flights to the demand.

The UCA concept relies on operating multi-ton aircraft on medium to long distances at cruising speeds ranging from dozens to hundreds of kilometres per hour. Their design should offer sufficient flexibility for cargo operations and better adaptability to the needs in terms of size, speed or maximum take-off weight (MTOW) of the vehicles operated. The intention is to run UCAs mainly out of existing airports, from/to specific drone ports or small strips established in proximity of logistic centres or industrial parks and could efficiently serve the needs of different logistic companies or industries. This would create a better fluidity of logistic exchanges, providing a quicker and safer solution to distribute goods and the opportunity to establish operational pads in areas not served by regional airports or locations where the geography or the typology of exchanges does not allow easy access for logistic flows.

Cargo drones could even be particularly suitable and relatively easy to operate from rough strips or local roads, i.e. closed at night to enable this specific type of operation. This would mainly accommodate capabilities offered by new generations of Vertical Take Off and Landing (VTOL) drone systems that could arrive and depart almost vertically without requiring long prepared surfaces, hence cutting infrastructure and equipment costs for operators. Cargo drones could also complement manned cargo fleets by ensuring the last-mile delivery of large volumes of goods directly to little-populated areas or remote areas where access is quite complicated, better accommodating and complementing e-commerce requirements.

For countries where developing road or rail infrastructure is very expensive or complex to achieve technically, creating a new logistic infrastructure independent of geographical or climate constraints would offer suitable solutions to national or regional authorities. This is already a matter of great interest for distributing goods over large unpopulated areas, with a particular interest for countries where manned aircraft operations are dangerous, uncertain or too costly. Of course, UCA operations should avoid as much as possible conflicting with manned aircraft activities, establishing strict rules and processes by deconflicting them geographically, laterally and/or vertically, timely when possible, or segregating them until more advanced solutions exist to integrate them fully in the airspace.

Emerging New Types of Aircraft Designs

The absence of crew on board UCAs allows for designing them somewhat differently than manned aircraft, less dependent on requirements to preserve persons on board, and more optimised for welcoming cargo in terms of structure shape, engines, safety systems, exit doors, etc. In this context, the absence of pressure inside the aircraft allows for a lighter and simpler design if flying below 25 000 feet, perfectly matching local or regional operations.

The current structure of the cross-section of the fuselage could very much evolve to better fit cargo containers, shaping the aircraft more efficiently for the purpose. This would also provide opportunities to move away from conventional aircraft shapes, not necessarily dynamically efficient, and increase the use of Blended Wing Body (BWB) or flying wings considered up to 30% more fuel efficient, greater operating range and better offload capabilities.

At the same time, broader targets would be to reduce the reliance of air cargo on fossil fuels, with the possible integration of new technology engines currently developed by the aviation sector but also by the drone industry, more oriented to new generations of electric, gas, fan-in-wing or hybrid propulsion systems. This would therefore contribute to lowering pollution and reducing the noise impact of drone operations. Since the fire on board is considered one of the main safety hazards for a cargo aircraft, the absence of persons onboard the UCA would open the possibility for introducing innovative fire suppression techniques such as using inert gas like nitrogen generated by onboard equipment.

In terms of operations, the remote position of the pilot would favour the emergence of local or regional

centralised control centres. Several UCAs could also be handled simultaneously on routes specifically designed by certified drone operating service companies handling the entire traffic in a given area, each controller being responsible for a specific segment or airspace. The notion of centralised control centres could therefore bring substantial savings with the possibility of assigning one operator to handle all UCA take-offs and landings at specific drone ports, as is already the case for pilots operating ships entering harbours, while operations along the routes could be in maximum autonomy of the drone. The knowledge of the local circumstances of these controllers would even highly increase the levels of safety and efficiency. Accordingly, unmanned air cargo operations should directly rely on permanent and dedicated infrastructures established by regional, national or European authorities, eventually under partnerships between public and private partnerships.

This could include creating dedicated transmission networks and hardened ground-air communication systems, relying on the U-space concept below 500 feet and benefitting from appropriate interfaces between the current Air Traffic Management (ATM) systems and the future Unmanned Traffic Management (UTM) systems. Dedicated air routes could be specifically defined under the form of temporally activable portions of airspace designed by aviation authorities, subject to aeronautical information, and not penetrable by other airspace users as currently the case for some areas used for decades by military fighters training at low altitude and high speed over the territories.

Regarding ground infrastructures, it will be important to ensure that the UCA design reduces the complexity of the required tasks for loading and offloading the cargo and the need for specialised ground handling equipment to be used on cargo ports.

Challenges & The Way Forward

In April 2021, the Commissioner for Transport, Adina Văleanrones, confirmed that drones are clearly a potential part of the future transport and logistics landscape, with a vast potential for new cargo and delivery services. However, operating UCAs routinely in a reasonable time will require, beyond resolving the technical challenges, expanding the current legal framework to ensure the highest possible levels of safety, security, and public acceptance. This is essential to establish the well-functioning, trusted and safe environment required to enable a competitive European drone cargo services market, contributing to increasing sustainability and smart mobility of a European transport system supported more resilient to future crises.

The European Commission has already initiated the work as part of its new “Drone strategy 2.0 for a Smart and Sustainable Unmanned Aircraft Eco-System in Europe”, which is to be released by the end of November 2022. It is supposed that it will largely rely on the work of the Drone Leaders’ Group contained in a dedicated report published in April 2022 .

To ensure the necessary market visibility to the industry and the potential investors of the UCAs sector, Europe will have to quickly focus on regulatory areas not yet covered, or only in part, such as standardisation, certification, insurance, operations, personnel licences, internal competition, etc. It will also need all regulatory elements developed to be demonstrated by appropriate testing, verification and validation to favour the acceptance of routine cargo drone operations by citizens and political deciders. Specific research and development will also need to be funded through public and private investments in technological domains where specific improvements and innovation are necessary. Reaching success in constrained timelines will only be possible by adopting a holistic approach at the European level, associating the regulators, manufacturers, users, academia and research centres in a joint effort.

Potentially subject to the creation of thousands of jobs in Europe, especially for the youngest citizens, the drone cargo sector may also highly benefit from the enthusiasm, open mind and reactivity of the new technology industry sector, having already proved its capability to overcome challenges by developing and implementing new solutions quickly.

Ready to support the upcoming rise of UCAs, the Integra company is already involved in designing new solutions to help reduce technological and regulatory gaps, while intending to offer a broad set of transport services based on cargo drones in five to ten years.

Gilles Fartek
Director European & NATO Affairs
Integra
Denmark
integra.dk

[4] Report of the Drone Leaders’ Group in support of the preparation of “A Drone Strategy 2.0 for a Smart and Sustainable Unmanned Aircraft Eco-System in Europe” dated 26 April 2022