Markforged × ASTER Technology

CUSTOMER STORY



ASTER-SWARM prototype. Photo: ASTER Technology

CS-D27 · DEFENSE · UNMANNED AIRCRAFT SYSTEMS · TAIWAN

# ASTER Technology 3D prints its FPV drone airframe with continuous carbon fiber, built to survive high-speed flight and Force 9 winds

ASTER prints every structural part of the ASTER-SWARM airframe on a Markforged X7 Field Edition, laying continuous carbon fiber along the load paths to solve the deformation, vibration and cracking that ordinary 3D-printed airframes suffer in high-speed flight. Five standardized modules let design revision, repair and production all happen in Taiwan.

**100%**
Airframe structural parts 3D printed

**9**
Beaufort Force wind test 20.8–24.4 m/s mean wind

**5**
Standardized airframe modules, M1–M5

**2**
Roles, one airframe Mission · training

BLUF · BOTTOM LINE UP FRONT

01 **Every structural part printed**: all structural parts of the ASTER-SWARM airframe are printed on an X7 Field Edition, with continuous carbon fiber laid in high-stress zones such as arm roots and motor mounts.

02 **Passed a Force 9 wind test**: the prototype completed takeoff and high-speed flight functional tests and passed a Beaufort Force 9 wind-resistance test (mean wind speed 20.8–24.4 m/s)[3], verified by the National Chung-Shan Institute of Science and Technology (NCSIST).

03 **Modular**: the airframe splits into five standardized modules. A damaged airframe needs only one part reprinted; a design revision touches only one module's file.

04 **Made in Taiwan**: design, printing and assembly all happen in Taiwan, with no purchased carbon-plate frames and no outsourced machining. Fitting propeller guards turns the same airframe into a training drone.

**AT A GLANCE**

| | |
|---|---|
| Customer | ASTER Technology Co., Ltd. |
| Industry | Defense · Unmanned aircraft systems |
| Location | Taiwan |
| Equipment | Markforged X7 Field Edition |
| Materials | Onyx™ + continuous carbon fiber |
| Application | FPV airframe · modular structural parts |
| Verification | Force 9 wind test · verified by NCSIST |

**ASTER-SWARM**

ASTER-SWARM is a one-way attack FPV drone developed by ASTER Technology, with an airframe built from five standardized modules.

An FPV (first-person view) drone is flown from the live feed of its onboard camera, and must hit full throttle, bank hard and dive within seconds. The airframe has to carry those loads, change with the mission, and be replaceable in the field when damaged. It also carries a special paint finish, applied mainly for low observability.

## 01 // Ordinary 3D-printed airframes can't survive high-speed flight

THE CHALLENGE

Airframes printed in common filaments such as PLA, ABS or PETG develop four kinds of structural problems under high-speed flight loads, each one degrading flight-control stability and mission success:

01
### Arm flex
Arms without enough stiffness bend under hard acceleration and turns, pulling the motor axes out of line and costing thrust and attitude accuracy.

02
### Structural resonance
High motor RPM excites frame resonance. The vibration noise reaches the gyro, causing PID oscillation and jittery FPV video.

03
### Delamination
Interlayer bonding is the weakest point of an ordinary FDM part. Under sustained vibration and impact it cracks along the layer lines.

04
### Fatigue and thermal creep
Near the motor mounts, constant heat and cyclic stress make plastic parts creep, loosening screws and cracking arms at the root.

**The other route: CNC carbon-plate frames**

Strong enough, but dependent on imported carbon-fiber sheet and outside machining. Every design change means new cutting and another lead time: too slow for prototype iteration, and a weak basis for a self-reliant supply chain.

## 02 // Continuous fiber reinforcement along the load path

THE SOLUTION

ASTER chose the Markforged X7 Field Edition. The X7 prints part geometry in Onyx™ (micro carbon fiber–filled nylon) and lays continuous carbon fiber along the load paths in selected layers, giving the arms and frame a stiffness and strength that ordinary 3D printing cannot reach.



**ASTER-SWARM prototype with flight battery (top view)**. Photo: ASTER Technology

### Continuous carbon fiber reinforcement

Laid in high-stress zones such as arm roots and motor mounts. Continuous carbon fiber reaches 800 MPa tensile strength, about 2.6× that of 6061-T6 aluminum, at 1.4 g/cm³, roughly half the density of aluminum.[1]

### Built-in laser micrometer

An integrated laser micrometer handles adaptive bed leveling and pre-print calibration. With the Inspection feature (formerly Blacksmith, purchased separately) it also measures parts during printing.[1][2]

### Field deployment

Ships in a ruggedized case and goes from case to printing in under 3 minutes[2], so parts can be made and replaced at a forward base.

### Secure environments

A no-Wi-Fi hardware version[1] and offline software are available. The operating system is STIG-compliant (U.S. DoD Security Technical Implementation Guide).[2]



**X7 Field Edition**
Deployed in the field
Image: Markforged

**X7 FIELD EDITION · FIELD DEPLOYMENT SPECIFICATIONS**

| | |
|---|---|
| Process | FFF + Continuous Filament Fabrication (CFF) |
| Build volume | 330 × 270 × 200 mm |
| Laser | Bed leveling, active print calibration; in-process inspection with Inspection (purchased separately) |
| Deployment | < 3 min to first print |
| Case | Ruggedized, 86 kg packed · 914 × 914 × 762 mm |
| Power | 100–240 VAC, 150 W |
| Materials | Plastics: Onyx, Onyx FR, Onyx ESD, Nylon White<br>Fibers: Carbon Fiber, Carbon Fiber FR, Fiberglass, Aramid Fiber (Kevlar®), HSHT Fiberglass |
| Testing | Included in MIL-STD-810 testing conducted by the U.S. military |

Sources: Markforged X7 Field Edition Product Specifications F-PR-3013 REV 1.0a (2021-11-11); deployment time, environmental testing and STIG from the X7 Field Edition Brochure REV 1.5 (2022-02-16).

## 03 // A modular airframe built to scale and resupply

MODULAR BY DESIGN

ASTER-SWARM splits the airframe into five standardized modules, each printed and replaced independently on the X7. A damaged airframe needs only one part reprinted; a design revision touches only one module's file.



**Illustration: exploded view of a modular FPV airframe**. Image: Markforged

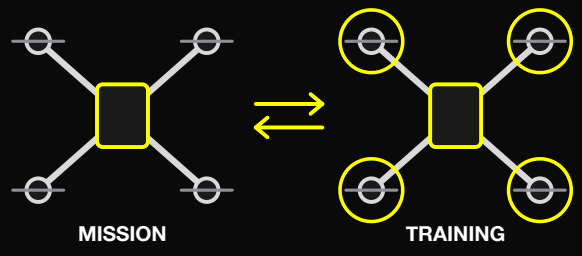
**M1** **Top plate** TOP PLATE
Protects the flight controller and electronics; swappable to suit the mission configuration.

**M2** **Base frame** BASE FRAME
X-shaped main frame; arms reinforced with continuous carbon fiber to carry high-speed flight loads.

**M3** **Standoffs** STANDOFFS
Standardized standoffs for fast assembly and disassembly of the upper and lower decks.

**M4** **Front guard** FRONT GUARD
Camera guard, interchangeable to fit different camera modules.

**M5** **Payload interface** PAYLOAD INTERFACE
Standardized mounting interface, so one airframe can carry different mission modules.




Schematic: the same airframe with propeller guards (yellow rings) fitted or removed

ONE AIRFRAME, TWO ROLES

### Mission drone and training drone

Fitting 3D-printed propeller guards to the same airframe turns it into a training drone. Operators train on the same airframe, with the same flight feel, as the mission drone, and parts damaged in training can be reprinted on site.

### Fast iteration

Edit one module's CAD file and reprint. No new tooling, no outsourced machining.

### Field repair

The X7 Field Edition deploys with the unit; damaged parts are reprinted and replaced at a forward base.

### Scalable production

Standardized modules print in parallel on multiple printers to build the fleet sizes that mass deployment requires.

## 04 // From prototype to verification, made in Taiwan

THE RESULTS

| 100% | 9 | 5 | 2 |
|---|---|---|---|
| Airframe structural parts 3D printed | Beaufort Force wind test 20.8–24.4 m/s mean wind | Standardized airframe modules, M1–M5 | Roles, one airframe Mission · training |

- **High-speed flight validation**: The prototype completed takeoff and high-speed flight functional tests. Its continuous carbon fiber–reinforced arms stayed stiff under high loads, without the flex and resonance typical of ordinary printed airframes.
- **Independent verification**: A verification document for the Force 9 wind-resistance test was issued by a measurement and verification unit of the National Chung-Shan Institute of Science and Technology (NCSIST).
- **Local production**: Airframe design, printing and assembly are all done in Taiwan, with no purchased carbon-plate frames and no outsourced machining.
- **Train as you fight**: Training and mission drones share one airframe, so operators train on the real platform and parts worn out in training are reprinted on site.

> “
>
> **An ordinary 3D-printed airframe shakes and cracks once it flies fast. With Markforged continuous carbon fiber printing, we could, for the first time, 3D print an airframe that truly holds up to high-speed flight. Add a modular design, and ASTER-SWARM can be revised, repaired and produced at scale entirely in Taiwan. That is exactly the capability self-reliant defense needs most.**
>
> — Joe Tai, CEO, ASTER Technology Co., Ltd.[5]

> “
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> **With 3D-printed drones, the question is not whether the airframe can be printed. It is whether the printed airframe survives high-speed flight. That depends on where the fiber goes: continuous carbon fiber laid along the load path gives the arms the stiffness to carry the load. The X7 Field Edition deploys with the unit, so a damaged airframe is reprinted at a forward base instead of waiting on outside machining.**
>
> — Brian Chen, Country Manager, Greater China Region, Markforged

**Notes**

1. Markforged X7 Field Edition Product Specifications F-PR-3013 REV 1.0a (2021-11-11). Continuous carbon fiber values are material test-coupon data; actual part performance depends on the amount and orientation of the fiber laid.
2. Markforged X7 Field Edition Brochure REV 1.5 (2022-02-16).
3. Beaufort Force 9: mean wind speed 20.8–24.4 m/s, per the Beaufort scale of Taiwan's Central Weather Administration.
4. ASTER-SWARM test results, module design and photos provided by ASTER Technology.
5. Quotation translated from the original Chinese.




X7 Field Edition · Image: Markforged

TAKEAWAY

# If the airframe is still changing and must be resupplied in the field, put continuous fiber printing on the list

In these three situations, a continuous fiber printed airframe is worth comparing with a CNC carbon-plate frame on cost and lead time:

- The airframe or its structural parts still change often, and every change to a CNC carbon-plate frame means new cutting and another wait for outside machining.
- Parts must be resupplied or repaired at a forward base or in the field, without waiting on rear-area supply.
- Training consumes airframes, and the training drone needs the same platform and the same flight feel as the mission drone.

**Assess drone airframes and structural parts**

Markforged engineers can assess fiber layout and printers against your airframe design, load paths and deployment conditions, and arrange a demonstration in Taiwan, Hong Kong or Vietnam.

### About ASTER Technology

ASTER Technology Co., Ltd. is a Taiwanese IoT systems company working in technology-assisted traffic enforcement, smart security, smart transportation and smart care. ASTER-SWARM is the modular FPV drone it developed. www.aster-iot.com.tw

### About Markforged

Markforged, Inc. makes industrial additive manufacturing systems: continuous-fiber composites and metal that let manufacturers and maintenance units produce functional parts, tooling and spares where they are needed.

SOURCES

1. Markforged X7 Field Edition Product Specifications F-PR-3013 REV 1.0a (2021-11-11)
2. Markforged X7 Field Edition Brochure REV 1.5 (2022-02-16)
3. Markforged X7 Field Edition product page, markforged.com/3d-printers/x7-field-edition
4. Central Weather Administration (Taiwan), Beaufort wind scale
5. ASTER-SWARM test results and prototype photos: provided by ASTER Technology. Exploded-view illustration and X7 Field Edition photos: Markforged

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