

**mt-propeller**

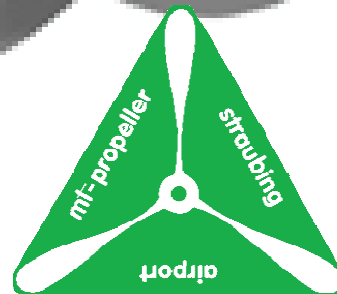
Entwicklung GmbH

Propellerplatz1  
94348 Atting / Germany  
[www.mt-propeller.com](http://www.mt-propeller.com)

August 2018

# MT-Propeller Natural Composite Technology

## FLY GREEN – FLY MT



## Natural Composite Technology

### MT-Propeller Natural Composite History

Manufacturing of the  
first natural composite blade  
in 1928 (90 years ago)  
by Schwarz Propeller in BERLIN

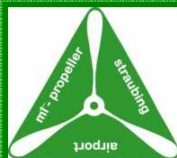


Originally developed for high power fighters, like the FW190, Messerschmitt 109, Spitfire, Hurricane, and many more.

Now also used on a restored Twin Mustang F82 program.

Latest Technology introduced for production developed by MT-Propeller using a CT (Computer Tomography) Scanner for pre-selection of material.

More than 72.000 blades made by MT-Propeller since production started in 1981.



## **MT-Propeller Natural Composite Technology -Certification Capabilities –**

### **Propeller Type Certificate (Part 35; Amendment 8):**

- Bird Strike Test**
- Lightning Strike Test**
- Static Strength Test**
- Fatigue Tests**
- Safety Assessment**
- Integration Manual**
- Propeller Type Certificate (DOA authority by the EASA and FAA)**

### **STC Part 23 Aircraft Certification up to Part 23 Commuter:**

#### **- DOA STC authority including Flight Test Part 23**

- Performance**
- Noise**
- Cooling Effects**
- Ice Protection**
- Flight Loads**

**MT-Propeller has NO active AD on any MT-Propeller, a safety record unmatched by any other propeller manufacturer.**

**Total accumulated flying hrs are 150 Million.**

**A certified TBO of 4000 hrs or 6 years for Turbo Prop Applications without any life limited parts.**



mt-propeller

## MT-Propeller Natural Composite Technology -Certification Capabilities -

MT-Propeller has Design Authority and has certified propeller blades (EASA and FAA) for the following materials:



MT-Natural  
Composite Blade

*The Winner is Propeller!*



Structural Composite Design  
MT-600-Series Full Carbon Blade  
MT-500-Series Full Kevlar Blade

*The Winner is Propeller!*



MT-400-Series  
Aluminum Blade



## MT-Propeller Natural Composite Technology -Certification Capabilities -

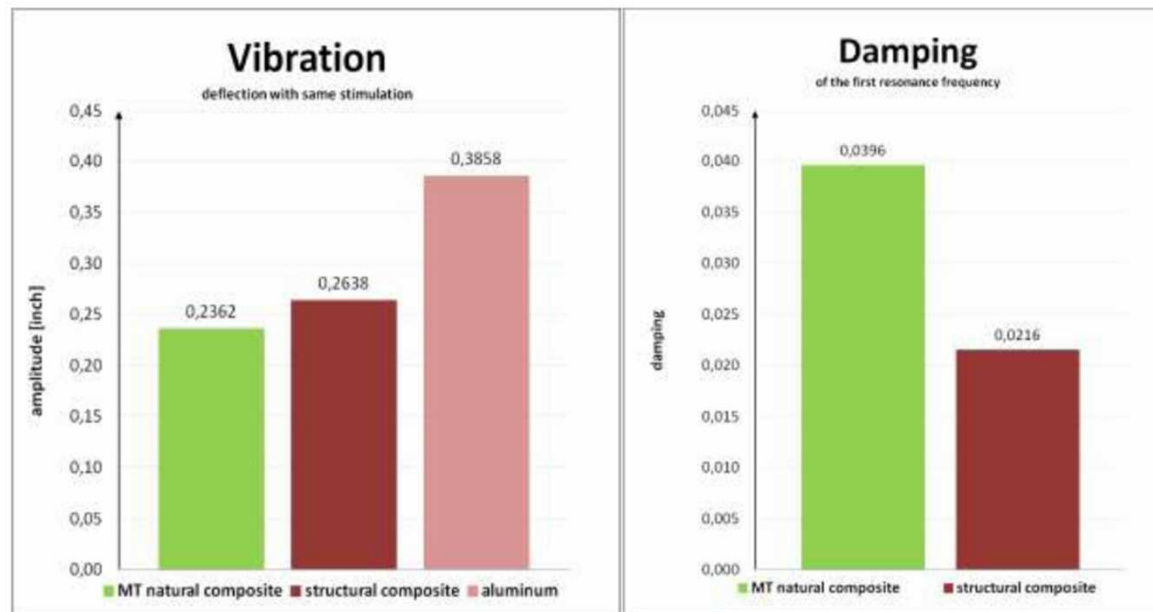
### Vibration Dampening Behavior:

Due to unbeaten vibration behavior, no ground rpm limitation or in flight rpm limitation exists for certified MT-Propeller installations using the natural composite design.

#### *Vibration comparison between MT natural composite vs. aluminum and structural composite*

The test compares the deflection of the propeller blade tips by stimulation of the first resonance frequency with an acceleration of 1 g. The left chart below shows the deflection of all 3 blades. Another result of the test is that the damping of the first resonance frequency of the structural composite blade is more than 40% less than the damping of the MT-Propeller blade resulting in higher vibration and possible limitations for structural composite.

This outcome is pictured on the right side.





mt-propeller

## Natural Composite Technology

### Bird Strike:

During the take-off run a 8 lb Stork impact - minor damage on the propeller.  
Aircraft was ferried for 2 hours back to the home base after the impact.



## Natural Composite Technology

### Lightning Strike:

Severe Lightning Strike in flight on a Turboprop. Propeller blade has minor damage and can be overhauled and returned to service.



Blade Tip and on the right hand side mid blade, minor damage.



Belly of the airplane with a burned spot and vaporized paint after the lightning left the airframe.



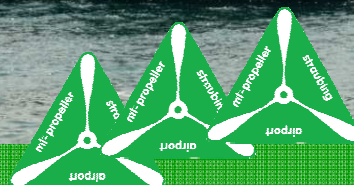


## Natural Composite Technology

### Moisture:

The MT-Propeller natural composite design is the only blade design selected by Griffon Hoverworks (biggest Hovercraft manufacturer in the world) after testing structural composite blades versus the standard MT natural composite design. Since 2013 MT-Propeller has been the only supplier of Propellers for all new Griffon Manufactured Hovercraft.

Propeller diameters up to 3,5 m (11,5 ft) are in use 3,500 hours per year without any life limitation or red bands in the harshest environment with salt water and sand. Identical blade designs are used for aircraft propellers and vice versa.





## Not all composite blades are made the same

### MT-Propeller Blades – Key Features:

- 2" wide Durable Nickel Cobalt Leading Edge. Widest leading edge on turboprop blades for best erosion protection.
- Epoxy Paint for improved erosion protection and resistance to paint cracking (NEW).
- A lightning strike does not make the blade unserviceable , because the MT-blade is not conductive. Not so for structural composite. Structural composite blades lose their lightning protection after one impact and must be retired.
- After a ground strike the MT-Propeller single piece hub can be overhauled and does not need to be retired.



## Natural Composite Technology

### Key differences vs. structural composite blades

Aerospace grade carbon fiber combined with highly compressed beech/spruce wood core has a higher strength than aerospace aluminum with no corrosion and fatigue limit.

Because the MT-blade has no spar for the load carrying core, FOD on the leading edge, trailing edge or blade mid area cannot create structural damage requiring the replacement of a blade.

MT-Propeller natural composite blades are certified for unlimited life and can be repaired in the field or at 60+ overhaul shops worldwide.

MT airfoils are designed for a relative thickness between 3% to 10% (thickness to chord ratio) depending on local MACH number.

The propeller is designed to operate below supersonic so a certain relative airfoil thickness is needed to create the most thrust. Thin airfoils are subject to stall flutter.

De-Ice Boots are integrated in the airfoil to keep the original shape. By this no extra drag from De-Icing is created on MT Turboprop blades. Not standard and available on structural composite blades.



MT - Natural Composite Blade



Structural Composite Blade, with load carrying spar. In case of damage the blade must be retired.



## Natural Composite Technology

### Competitive Assessment Performance

Proprietary MT-Propeller aerodynamic software has been optimized based on many wind tunnel tests as well as research done by the Research Institute DLR (German Research Institute) and ONERA (French Research Institute). The result is a propeller with superior takeoff, climb, and speed. Based on this work, and the resulting superior MT-Propeller designs, Airbus Helicopter has selected MT-Propeller as the supplier for two 250+ million dollar R&D programs.... "Airbus Racer" and "City Airbus".

On the LH side the typical protection of a MT natural composite blade with a 2 inch wide Nickel Leading Edge vs a structural composite blade nickel protection on the RH side.



Natural Composite Blade



Structural Composite Blade





## Natural Composite Technology

### Competitive Assessment Retention Design

Shown are cross sections from an MT-Propeller blade and a typical structural composite blade.

Same blade thickness outside the spinner shape for minimum drag.

Independent lag screw system with up to 11 lag screws are installed in the blade root.

The MT cross section shown is typical for turbo-prop construction.

No homogeny single structural material which can be damaged by FOD.

FOD on the load carrying composite shell for a structural composite blade may result in a structural damage with the need to retire the blade. This has never happened to a MT natural composite blade due to the unique manufacturing technology using different materials.



Natural



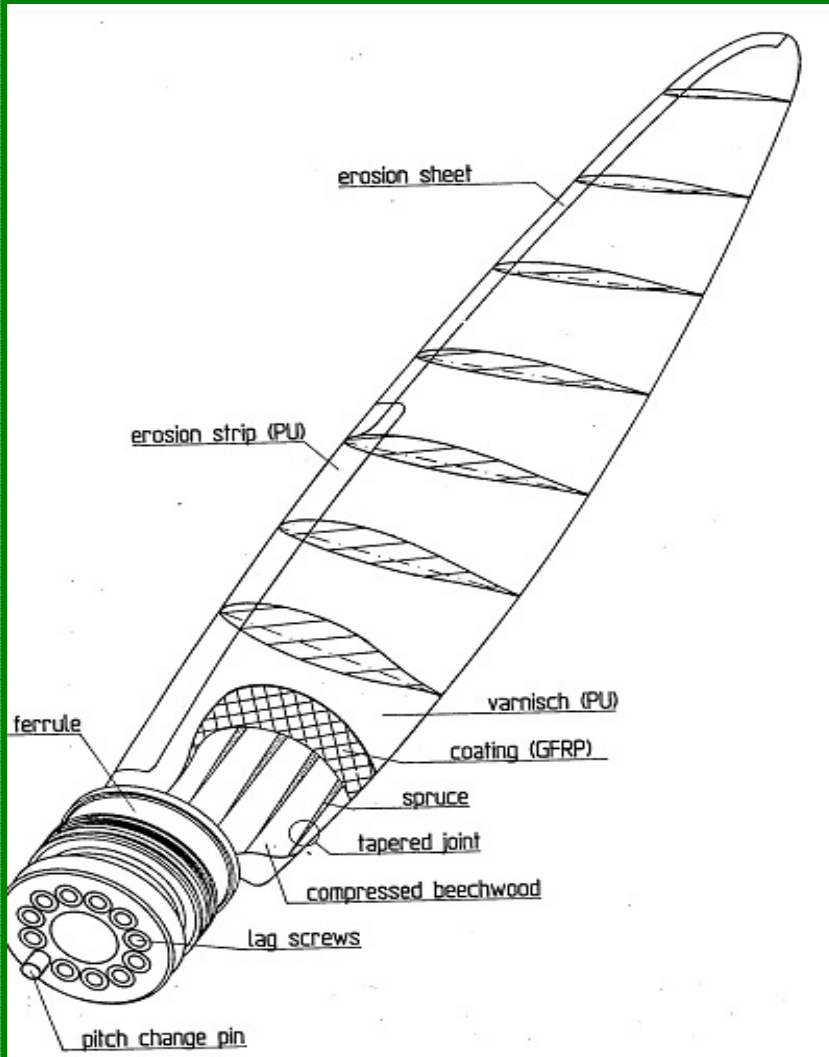
Structural

Capable of achieving ~10x CF loads.  
No Life limit in the blade retention has been introduced by the Certification Authorities.

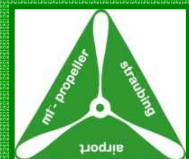


## Competitive Assessment

### - Natural Composite Blade Construction -



- ✓ Multilaminated Spruce.
- ✓ Compressed Plastified Beech Wood, also called “Superwood”.
- ✓ Carbon Fiber Composite Shell.
- ✓ Nickel Cobalt Erosion Sheet 2 “ wide and 5 times stronger than aluminum.
- ✓ Aerospace Aluminum Ferrule.
- ✓ Pressed in Pitch Change Steel Pin with no screws for fatigue.
- ✓ Patented special lag screw design. One lag screw can hold the blade and up to 11 lag screws installed.



## Natural Composite Technology

### TEST REQUIREMENTS

The requirement for the test per Part 35.36 is as follows:

- The applicant must demonstrate, by tests or analysis based on tests or experience on similar designs, that the propeller can withstand the impact of a four-pound bird at the critical location(s) and critical flight condition(s) of a typical installation without causing a major or hazardous propeller effect.
- MT has performed more than 160 bird impact tests per EASA / FAA requirements since our first natural composite certification in 1981.
- Utilizes a projectile with density equivalent to a 4 lb. (1.81 kg) bird.  
Blade is tested in a free state, retained at shank with no benefit from centrifugal stiffening.
- No limitations were issued from the Certification Authorities for the MT blade design up to 2000 hp and 3 m (10 ft) diameter applications.





**TEST REQUIREMENTS**

The MT design is certificated for the bird impact conditions calculated for the most critical flight condition (take-off rotation) for that installation.  
The test is performed at the most critical locations on the blade.

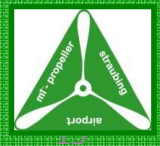
Important factors to be considered:

- Propeller RPM
- Engine HP
- Propeller Blade Angle
- Blade Impact Location
- Aircraft Rotation Air Speed

No significant structural damage is allowed....

Propeller must be controllable and continue to provide thrust without causing a hazardous effect.

**MT-Propeller Blades passed this test without any limitation.**



## Aerodynamic Capabilities

MT "Prop" Code is used for aerodynamic design and performance prediction.

Integrated code developed in-house over a 30 year period.

Aerodynamic unloading of the Blade Tip for lower VORTEX and higher efficiency.

Uses aircraft flow-field information as inputs (CFD\*-generated velocity fields, etc).

Installation effects included in performance predictions.

Coupled with structural Finite Element design (stress, frequency) tools.

Correlated against AIRBUS/RUAG wind tunnel data.

\* CFD = Computational Fluid Dynamics

### CFD Flow Solution, Numerics

#### Steady-State RANS Solutions

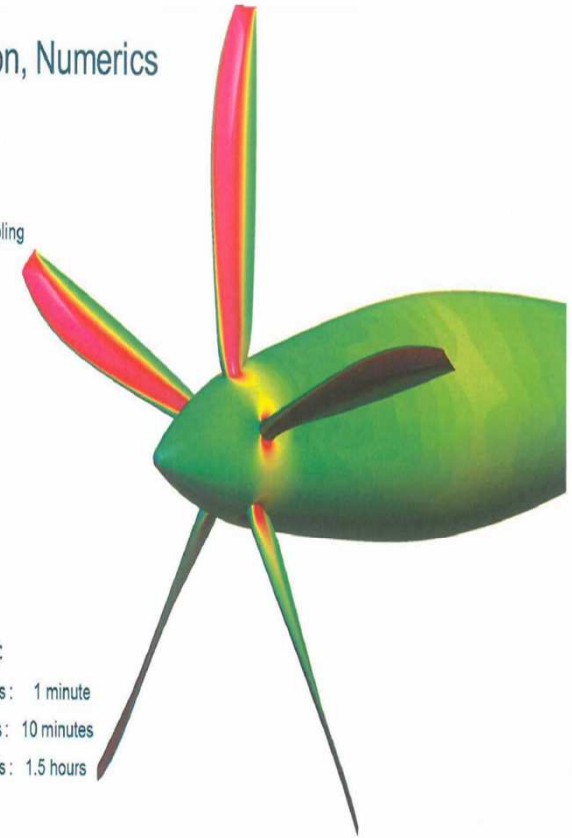
- rotating reference frame
- sliding Interface domain coupling
- K-Omega turbulence model

#### Solver

- NLR ENSOLV
- 2<sup>nd</sup> order temporal accuracy
- 3 multi-grid cycles
- 1000 iterations

#### Computational Effort (80 cores):

- coarse grid,  $0.3 \times 10^8$  cells: 1 minute
- medium grid,  $2.1 \times 10^8$  cells: 10 minutes
- fine grid,  $16.4 \times 10^8$  cells: 1.5 hours



## MT-Applications and Multiple Blade Concept

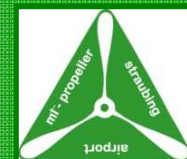
Up to 90% of the European manufacturers and up to 30% of the US manufacturers use the MT-Propellers for new production aircraft.

Since MT-Propeller was established in 1981 more and more manufacturers have changed to our system.

Since the first introduction of the 5 bladed propellers in 1995 there have been more than 2000 turboprop installations (OEM RUAG 228 NG, GROB 120 TP, King Airs, Jetstream, Metroliner, Cessna, PC12, and many more).

It has become an industrial standard with approximately 350+ 5 bladed Propellers shipped per year.

More than 220 STCs are available worldwide from MT-Propeller to upgrade any aircraft to a more modern higher performance, lower noise, lower weight propeller system.





## MT-Applications and Multiple Blade Concept

With the advantages of the MT NATURAL COMPOSITE design compared to structural composite and aluminum blade materials also certified and manufactured by MT-Propeller, the majority of MT powered aircraft are using the natural composite design.

**MT-Operators benefit from :**

- Higher Efficiency for lower operating costs,
- Lower Vibration- resulting in less fatigue for the crew and airframe,
- Lower Noise for higher flying comfort and less crew fatigue and reduced environmental impact,
- Renewable materials used for the lowest environmental impact.



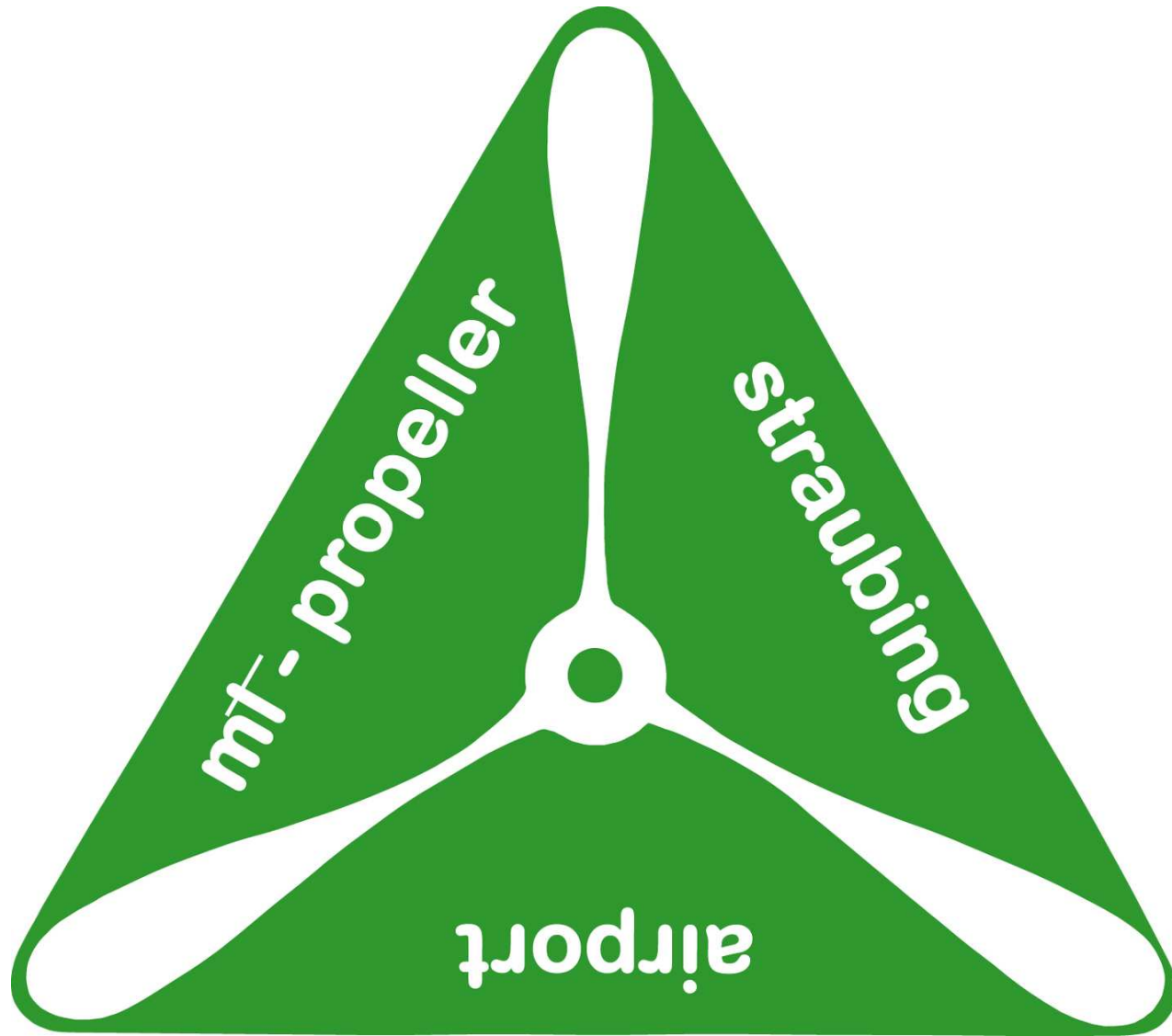
mt-propeller

## MT - Applications



10 2016





**FLY GREEN – FLY MT**