GF Machining Solutions

We keep you flying

Aerospace

GF Machining Solutions: all about you
When all you need is everything, it's good to know that there is one company that you can count on to deliver complete solutions and services. From world-class electrical discharge machines (EDM), Laser texturing and Additive Manufacturing through to first-class Milling and Spindles, Tooling, Automation and software systems—all backed by unrivaled customer service and support—we, through our AgieCharmilles, Microlution, Mikron Mill, Liechti, Step-Tec and System 3R technologies, help you raise your game and increase your competitive edge.

Passion for Precision

We keep you flying

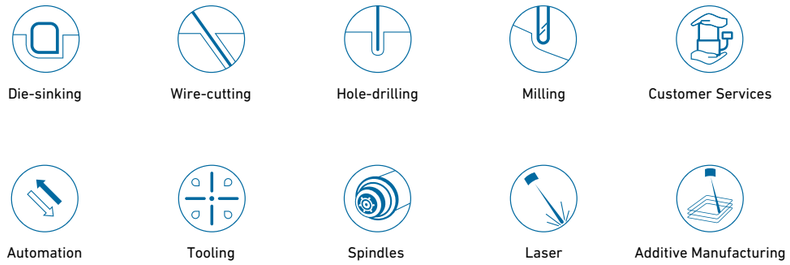
With over a half a century of expertise and key aerospace machining technologies, GF Machining Solutions keeps aerospace OEMs, Tier 1 and Tier 2 suppliers, maintenance repair and overhaul (MRO) partners and other contract manufacturers soaring high above the competition.

From prototyping to manufacturing structural parts, fuselage frame components, fuel delivery systems, auxiliary power unit (APU) components, jet engine components and avionics, to turbine blade repair and traceability solutions, GF Machining Solutions has the best-in-class technologies, products, solutions and services to drive your success with:

- **Innovative machining processes**
- **Repeatable quality**
- **Increased productivity**

Our high-speed and high-performance Milling, superior Electrical Discharge Machining (EDM), Laser texturing, Automation, and peerless Customer Services solutions increase your productivity, support your lean manufacturing processes, shorten your turnaround times and make you more competitive in an increasingly demanding global marketplace. In parallel, GF Machining solutions is paving the way for intelligent machines, zero-defect manufacturing, and self-optimizing machines and systems within an Industrie 4.0 environment.

That's why aerospace market leaders collaborate with GF Machining Solutions and count on us for the machine tools, services and the success-enabling application and process solutions critical to their daily operations and continued growth. Moreover, GF Machining Solutions offers the world's most comprehensive suite of Customer Services: extensive basic and advanced preventive services, Spindle repair and refurbishment and Nadcap certification support to drive your success in aerospace manufacturing.



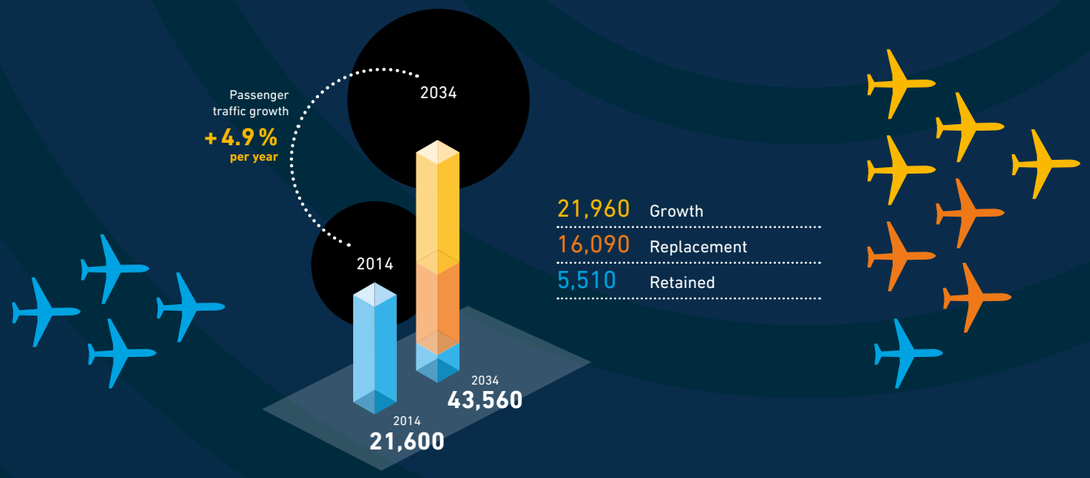
Unprecedented challenges

The global commercial aviation industry, with a market value of nearly US $5 trillion, is poised to accommodate unprecedented growth in the coming decades, thanks to soaring travel demand driven by increasing globalization, growing gross domestic product, liberalization of air transport, and decreasing travel prices. By 2031, the global passenger fleet is expected to double.

At the same time, the aerospace industry is committed to reaching ambitious targets for boosting fuel efficiency and reducing aircraft weight. As a result, the aerospace value chain faces a constrained capacity scenario as production ramps up. Given the sophisticated designs of new aircraft models, that increase could be upward of 70 percent by some accounts.

Essential to meeting these challenges are superb quality, integrity and accuracy in manufacturing processes in a time when aerospace components—and the demands they fulfill—are becoming increasingly complex.

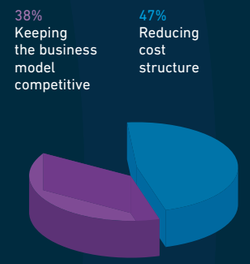
Resilient growth



Preparing for growth, managing costs

As the aerospace industry prepares for growth, managing costs will be a key success driver. Our customers in aerospace and other booming market segments count on us to help them attack internal costs and stay competitive.

What are manufacturers' top priorities?



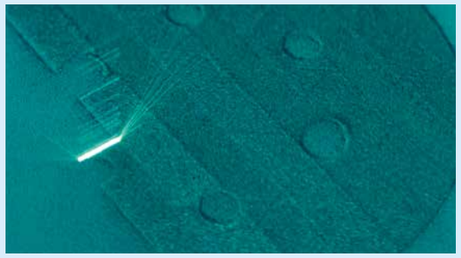
2015 aerospace industry global overview (in US dollars)

Aerospace manufacturing market trends

Additive Manufacturing
From engine and turbine parts to interior cabin parts, aerospace manufacturers are turning to the cost-effective and tool-free Additive Manufacturing (AM) process of industrial 3D printing technology for the production of lightweight, high-tech components.

Additively manufactured components still need a secondary manufacturing process such as EDM to remove the components from the build plate or machining to achieve precise accuracy and optimized surface quality, for example.

GF Machining Solutions is actively involved in developing solutions that pair perfectly to processes that include AM technology. We are at the forefront of combining the most efficient ways of blending traditional and new manufacturing technologies.



Ceramic machining
With their light weight and thermostability at high temperate, advanced ceramics and ceramic matrix composites (CMC) are increasingly finding their way into essential aerospace electrical, structural and turbine components. GF Machining Solutions' high-precision solutions help you cost-effectively meet the challenges of machining ceramics and CMCs.

Automation
Increased flexibility, higher quality and greater productivity are key success factors in today's highly competitive aerospace component manufacturing environment. Our System 3R Automation solutions keep you productive day and night so you achieve shorter lead times, higher productivity and quicker payback on your capital machine investments.

GF Machining Solutions is the ideal partner for **aerospace** companies working with **new manufacturing processes and technologies**.

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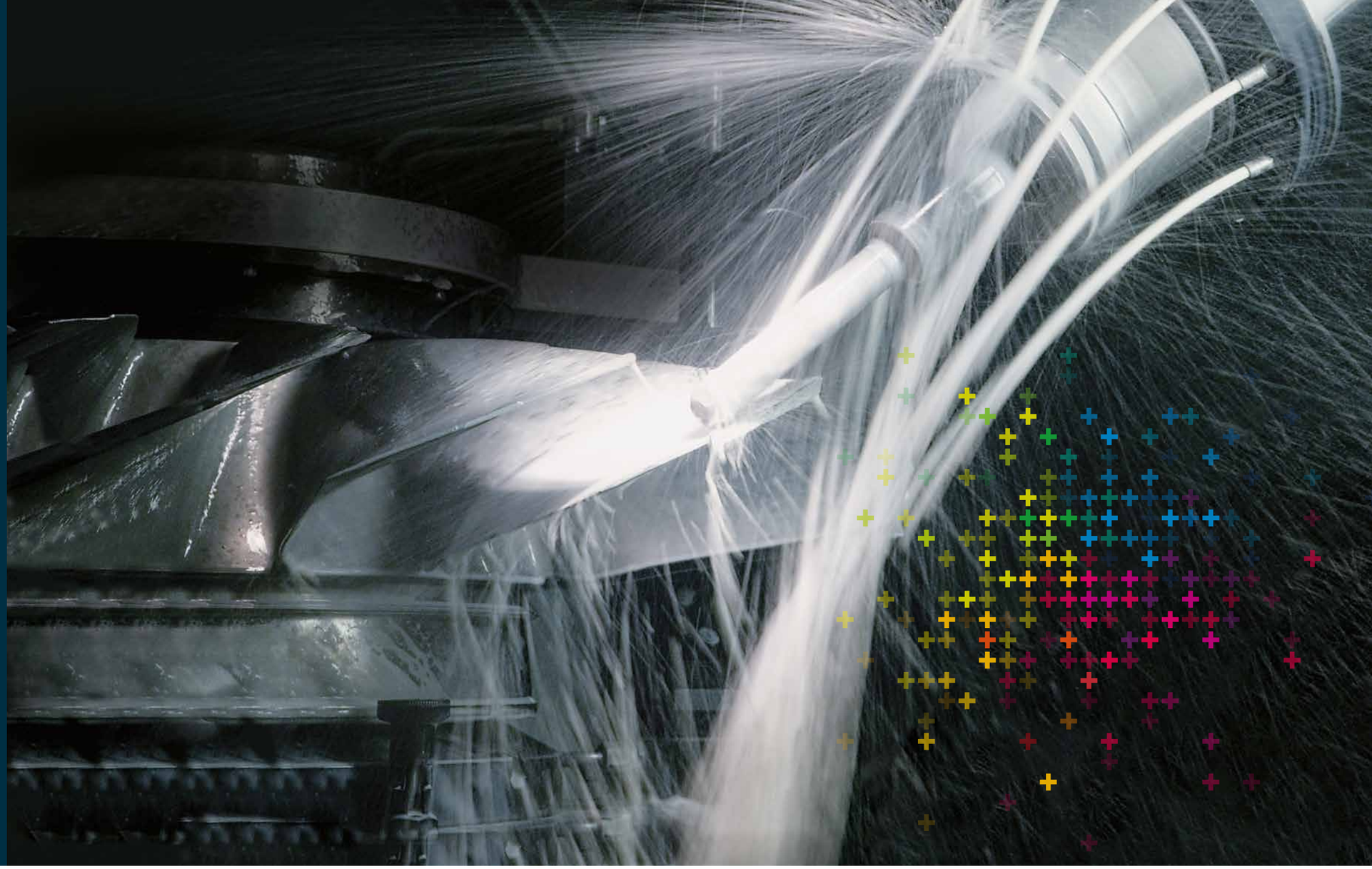
Milling

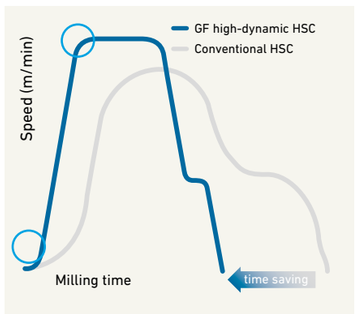
Highly dynamic machining

Increase your profit and flexibility with our solutions for highly dynamic machining for the aerospace industry. GF Machining Solutions' Liechti and Mikron Mill products make accuracy, quality, and autonomy easily accessible to aerospace manufacturers.

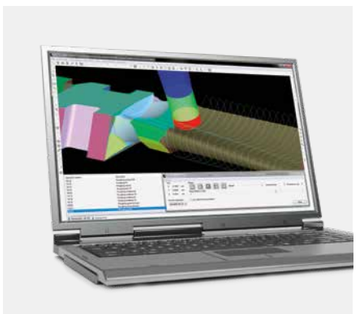
Our renowned expertise in five-axis Milling is supported by our in-house Step-Tec Spindle manufacturing and technical know-how.

Our Milling centers offer superb price/performance ratio to keep your operation running full speed. With very high dynamic machine platforms, state-of-the art controls, enhanced chip evacuation systems, tool identification systems, and peerless thermostabilization, our Milling solutions pave the way to success in aerospace manufacturing.





High jerk control
for uncompromising surface finish.



TURBOSOFT plus
automates flow path generation for high speed cutting on complex airfoils.

Step-Tec Cool-Core Spindle
increases tool life and improves machining time.

Machine and Spindle Protection (MSP)
reduces your maintenance cost and downtime.

Leading computer numerical control
from Siemens or Heidenhain for challenging aerospace applications.

smart modules
are intelligent machine services that increase your productivity.

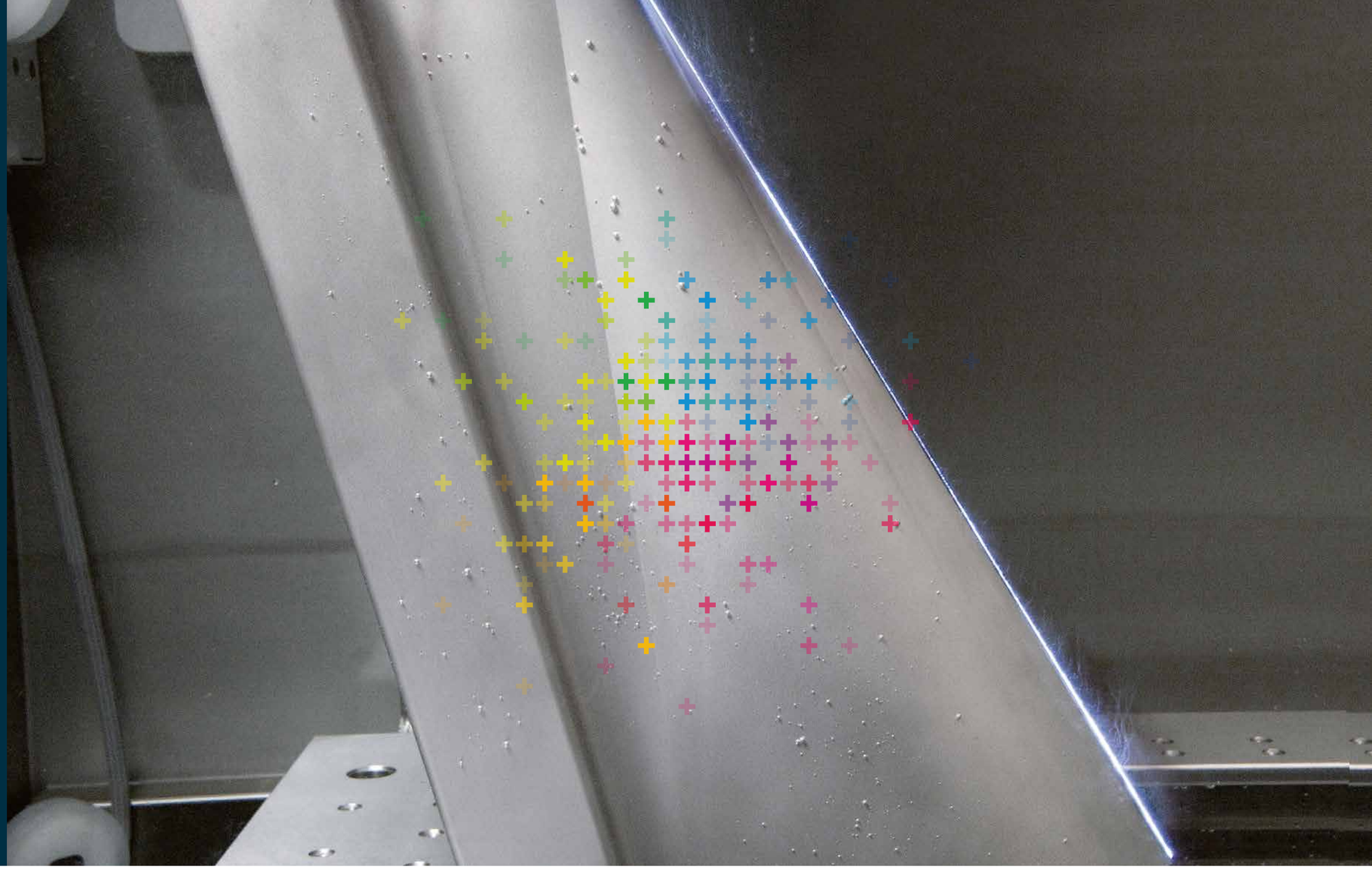
EDM

Collaborative research

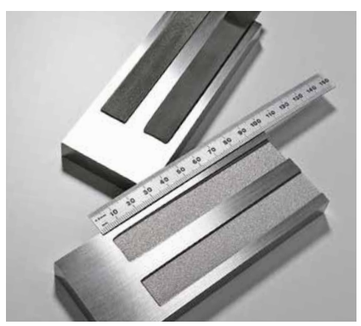
GF Machining Solutions is committed to partnering with aerospace leaders and research institutes worldwide. These include the Manufacturing Technology Center (UK), the Laboratory for Machine Tools and Production Engineering at RWTH Aachen University and the Fraunhofer Institute (DE), the Commonwealth Center for Advanced Manufacturing (US), the Swiss Federal Institute of Technology and the eight-nation Foundation for the Sustainable Factory of the Future.

As a result, our latest-generation EDM technologies boost machining speed while leaving no visible recast layer when working with Inconel or titanium.

Our comprehensive onboard data acquisition software, eTracking, supports traceability and certification of your manufacturing processes.

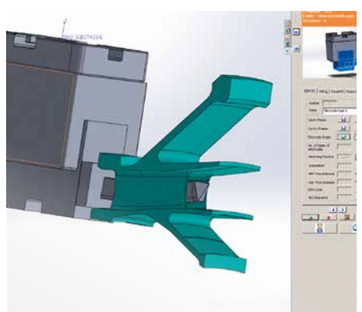


Digital Intelligent Speed Power Generator
yields best surface quality on even the toughest material.

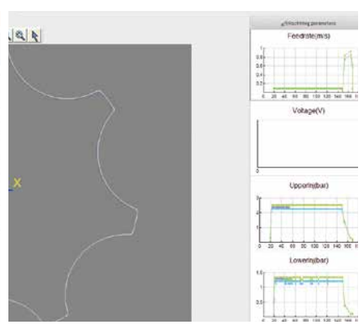


iQ technology
reduces electrode wear and production cost.

IVU onboard optical measurement system
controls the process and increases productivity.



Multi-Process Preparation (MPP)
reduces costs in preparation time in five-axis operations.



Live eTracking monitoring
ensures process control and traceability.

Integrated Collision Protection
increases machine uptime.

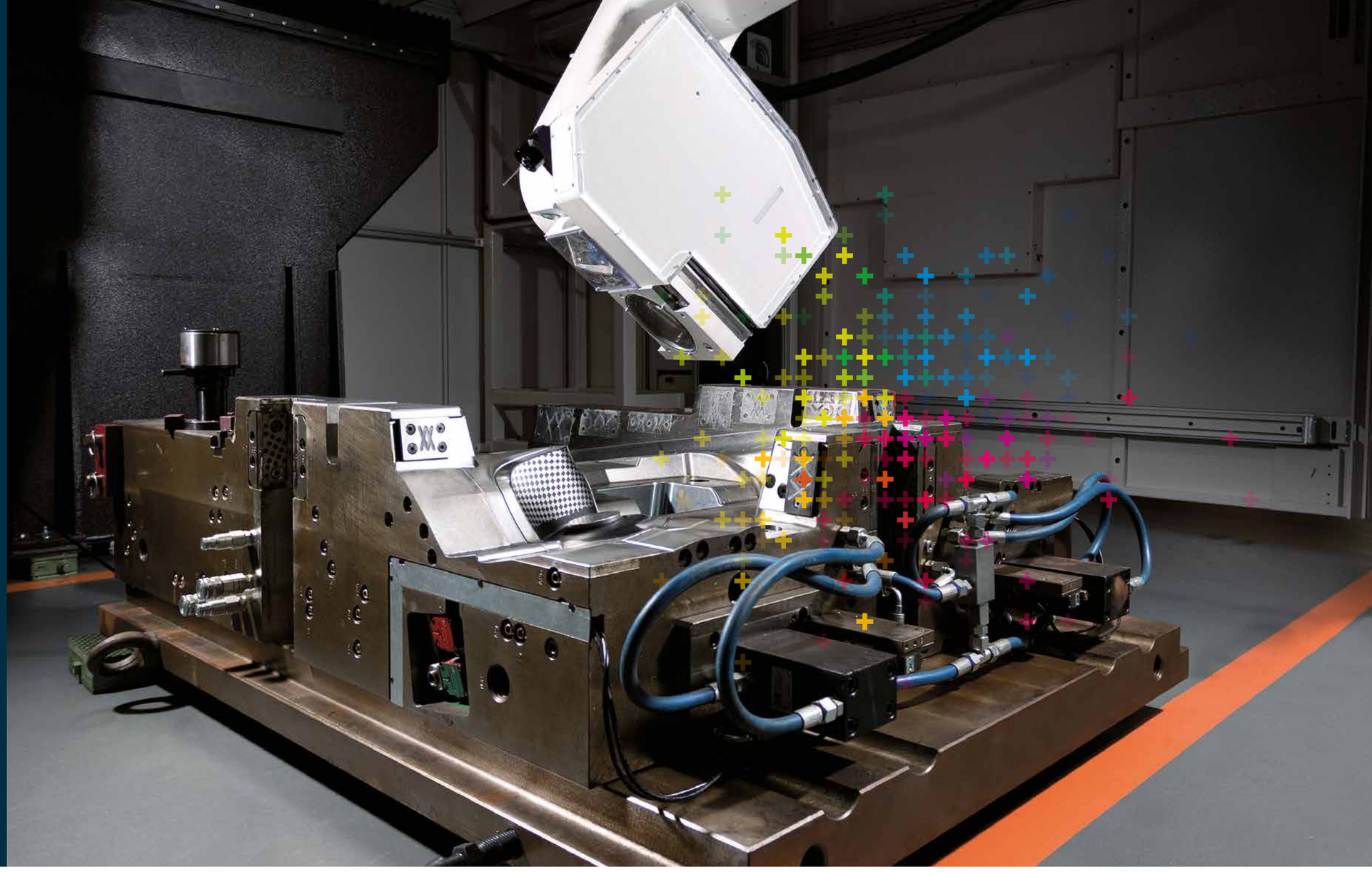
Laser texturing

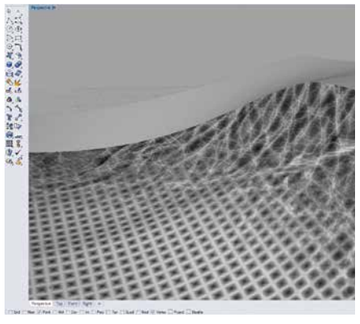
Bringing the future to you

Make your distinct mark on 3D geometries with GF Machining Solutions' high-precision Laser texturing solutions.

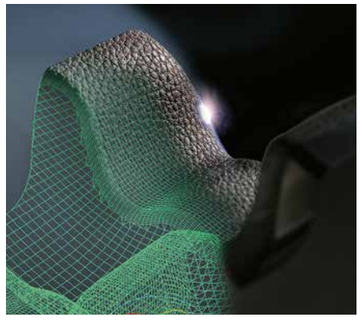
Our Laser technology opens new fields of possibility with functional texturing to add value to your application. Combined with five-axis texturing capability, you can apply any texture on any complex 3D shape with impressive homogeneity.

The advantages of using a 100 percent digital process in combination with your products are undeniable. Achieve perfect repeatability with unlimited design possibilities and high quality. What you see is what you get.



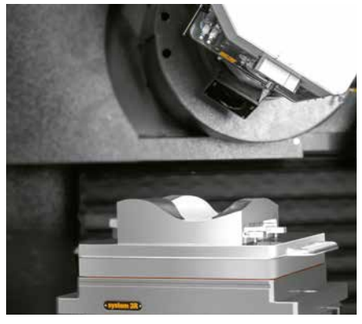


Most powerful proprietary software package
saves time from design phase to execution.



Fully digital process
so what you see is what you get.

All-in-one Laser head
simplifies your use.



Automation readiness
increases productivity with reference system from one partner.

Touch probe included in the head
guarantees high positioning accuracy.

Versatile Laser solution
supported by our expertise in ultra-short pulsed Laser.

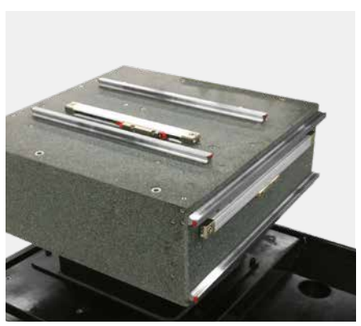
Micromachining

Solutions for microgeometries

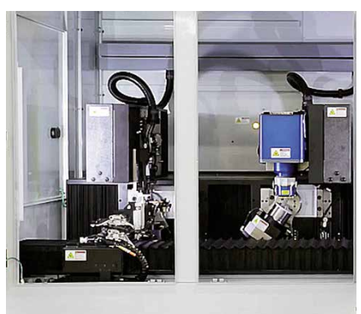
Today's micro parts—and those of the future—require more than standard CNC machining, due to their decreasing size and increasing sophistication.

Such parts demand integrated systems that coordinate accurate measurement, rapid part handling, motion control and ultra-precise machining. Microlution delivers this integration with complete manufacturing solutions enabling companies to create economically and technically feasible precision parts.

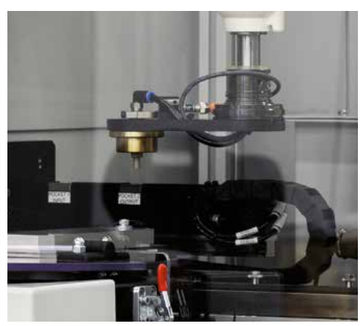
With Microlution, manufacturers arrive with a precision parts challenge and leave with turnkey integrated micro manufacturing solutions. Microlution solutions deliver unsurpassed precision, cycle times and part consistency on factor floors around the world.



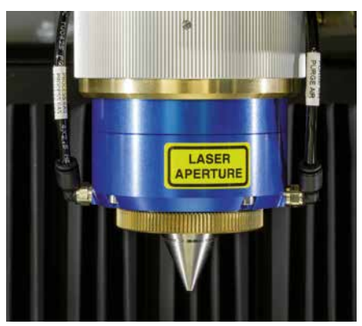
Axes mounted on the granite base
for maximum thermal and dynamic stability.



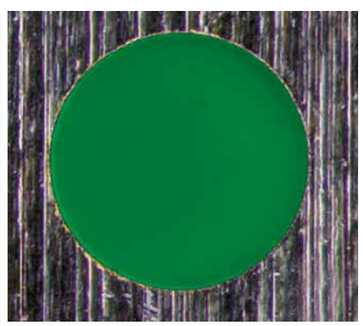
Dual five-axis stations
to combine Milling and Laser machining.



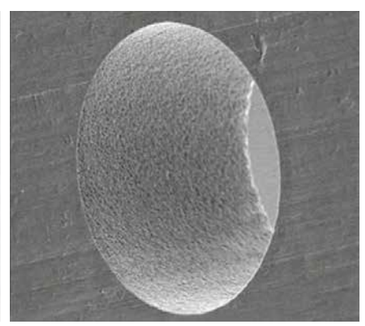
Integrated palletized workholding
for high-volume production capacity.



Femto laser
for athermal machining.



Micro hole
with micron accuracy
and sub-micron repeatability.



True athermal ablation
leaves no heat-affected zone.

Automation

Greater ROI

Achieve increased process control, greater efficiency and faster time to market with our System 3R Automation and Tooling solutions, which are fully compatible with our full portfolio.

As a single-source Automation provider, GF Machining Solutions supports you with custom Automation cells; engineering expertise and system software for controlling machine tools and recording and exchanging data between system components; and Tooling for palletizing and fixturing workpieces and tools.

Our aero partners rely on our accurate reference systems and work holding devices. Whether you need 10 pallets or 40 tools, our modular magazines can be combined to flexibly meet your specific needs.

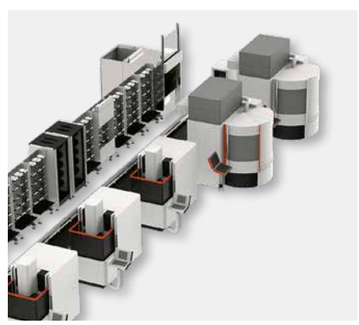
Complete range of clamping systems
can easily adapted to any part or electrode.

Delphin reference system
vibration damping for better surface quality.

System 3R cell management software
easily connects to your shop floor management system.

WorkPartner
boosts productivity by housing part and Tooling in close proximity to the machine.

System 3R robot Automation
optimizes your complete process.



Complete Automation cell
keeps the work process clean and efficient.

Solutions for you

Optimizing your productivity is at the heart GF Machining Solutions' broad range of customizable Customer Services solutions. Close to you — wherever you are in the world — our local Customer Services teams speak your language and know your concerns.

More value for aerospace production

High equipment availability
Our tailor-made services contracts increase your equipment availability up to 95 percent as per VDI 3423.

Nadcap certification support
We assist you with your approval and certifications procedure as per Nadcap AC7116 and AC7116/3.

Enhance performance
using certified consumables specifically dedicated to fulfilling your application needs and secure traceability of your production process.

Improve your expertise
with our own academy supporting your staff development with basic to advanced skills related to your technical challenges.

Dedicated Solutions

GF Machining Solutions drives your success with best-in-class technologies, solutions and services and delivers high precision, accuracy and surface quality to aerospace customers.

Dedicated Solutions

A Boeing 777's GE90 engine is subjected to stringent controls, including a run on a test bench.

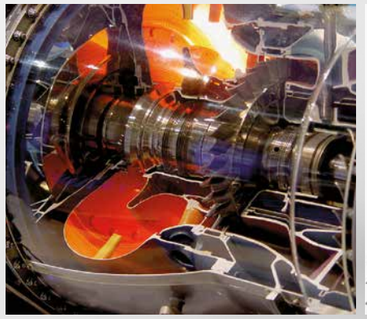
Fir-tree disk

In order to meet consumption and environmental challenges, turbine designs are pushed to the limit with combustion temperatures up to 2,000 degrees Celsius. Sustaining such working conditions has required the use of new superalloys, including latest materials from powder metallurgy. GF Machining Solutions answers the new manufacturing challenges of machining such materials. No alloy is too tough for our digital EDM generators for fir-tree disk production.

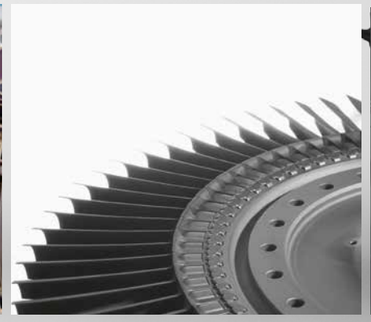
Surface integrity preserved

Fully traceable and repeatable process

Unlimited material hardness



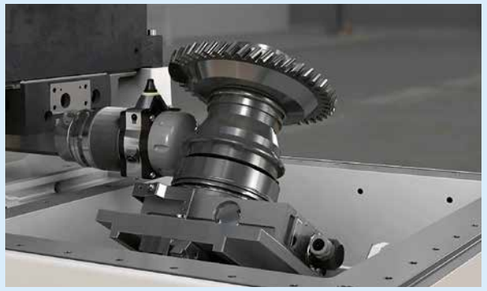
Hot gases up to 2000 °C enter the turbine.



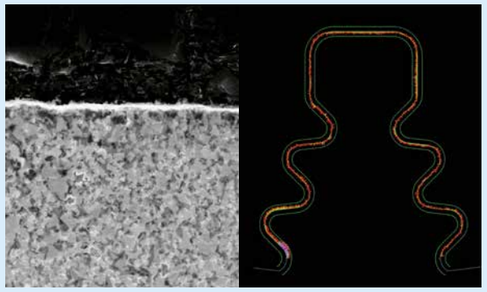
Increase fir-tree accuracy and reduce leakage at the blade root.

Any geometry can be machined in any material.

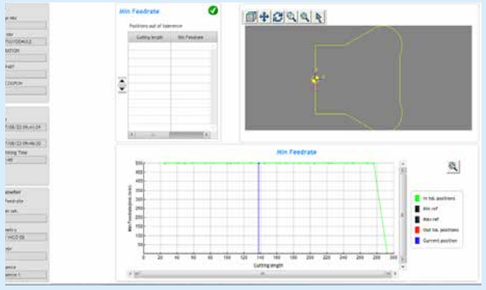
Our CUT 200 Dedicated wire EDM solution is already replacing the conventional broaching process in aerospace applications, bringing a cost-competitive manufacturing process to our customers.



A tilting and rotary axis combined with integrated probe ensures accurate part repositioning for fir-tree slot machining.



Digital EDM technology for minimum heat-affected layer, maximum speed.



eTracking: real time quality monitoring data traceability.

Blisk production

To meet the immense challenges of the increased need for new aircraft due to increased global travel demand and fleet replacements, future blisk/IBR production must become more efficient. Our solutions help you to fulfill these requirements and position you to meet the demands of the future.

Clean and chatter-free leading and trailing edge quality

Machining time reaches new lows

Turnkey solutions, including specialized software from one single source

Maintaining compressor stability and operability depends on stringent maintenance.

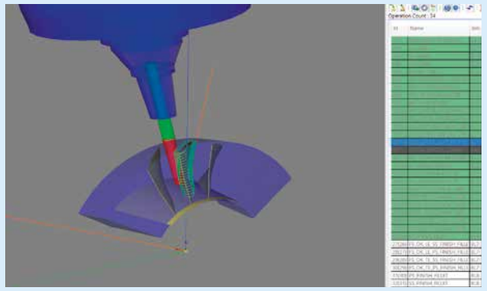
Weight savings of up to 30 percent due to manufacturing as a single structure.

Thin, twisted, complexly shaped blades.

Blisk machining done to perfection. Our Liechti Dedicated Solutions machine complex, full five-axis blisks/IBRs in one single setup at highest performance.

Rigid machine design to allow ultra-dynamic Milling with high jerk and without vibration marks.

High acceleration horizontal Spindle tilt rotary table configuration for best accessibility and complete blisk machining in one setup.



Our specialized TURBOSOFT plus CAM software for efficient programming and process optimization of blisks/IBRs.

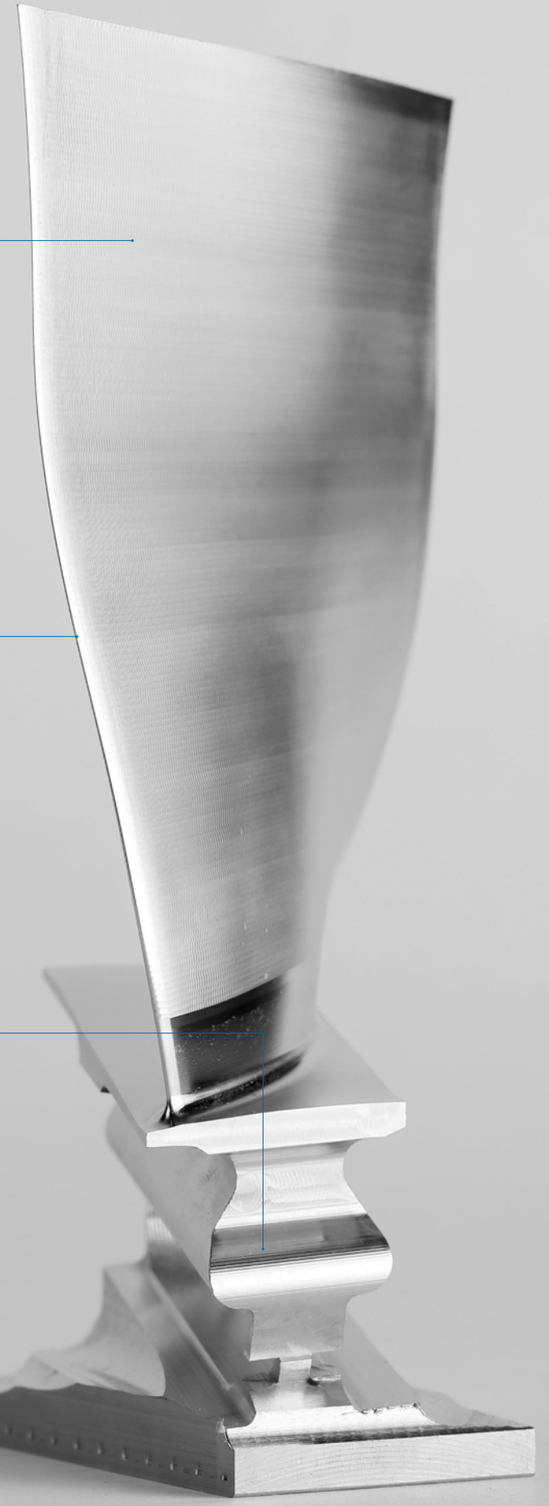
Blade

The fleet replacements spurred by ambitious international emissions reduction targets push original equipment manufacturers (OEMs) to develop engines with exotic materials like turbine steel, Inconel, Udimet, René and titanium aluminide. Take your leading position in managing these challenges, with GF Machining Solutions' competence and solutions.

Highest profile accuracy in shortest machining time

Clean and chatter-free leading and trailing edge quality

Turnkey solution including specialized TURBOSOFT plus CAM software



Composite blades need protective metal leading edge.

Sharp leading and trailing edge.

Exotic materials like Inconel increase the requirements of the machine.

Blade machining at highest performance. Strengthen your productivity and increase your profit due to high process efficiency delivered by our solutions fully dedicated to blade machining.

Rigid, compact layout of all axes for high jerk machining.

Twin Spindle machining with automatic tool length compensation.

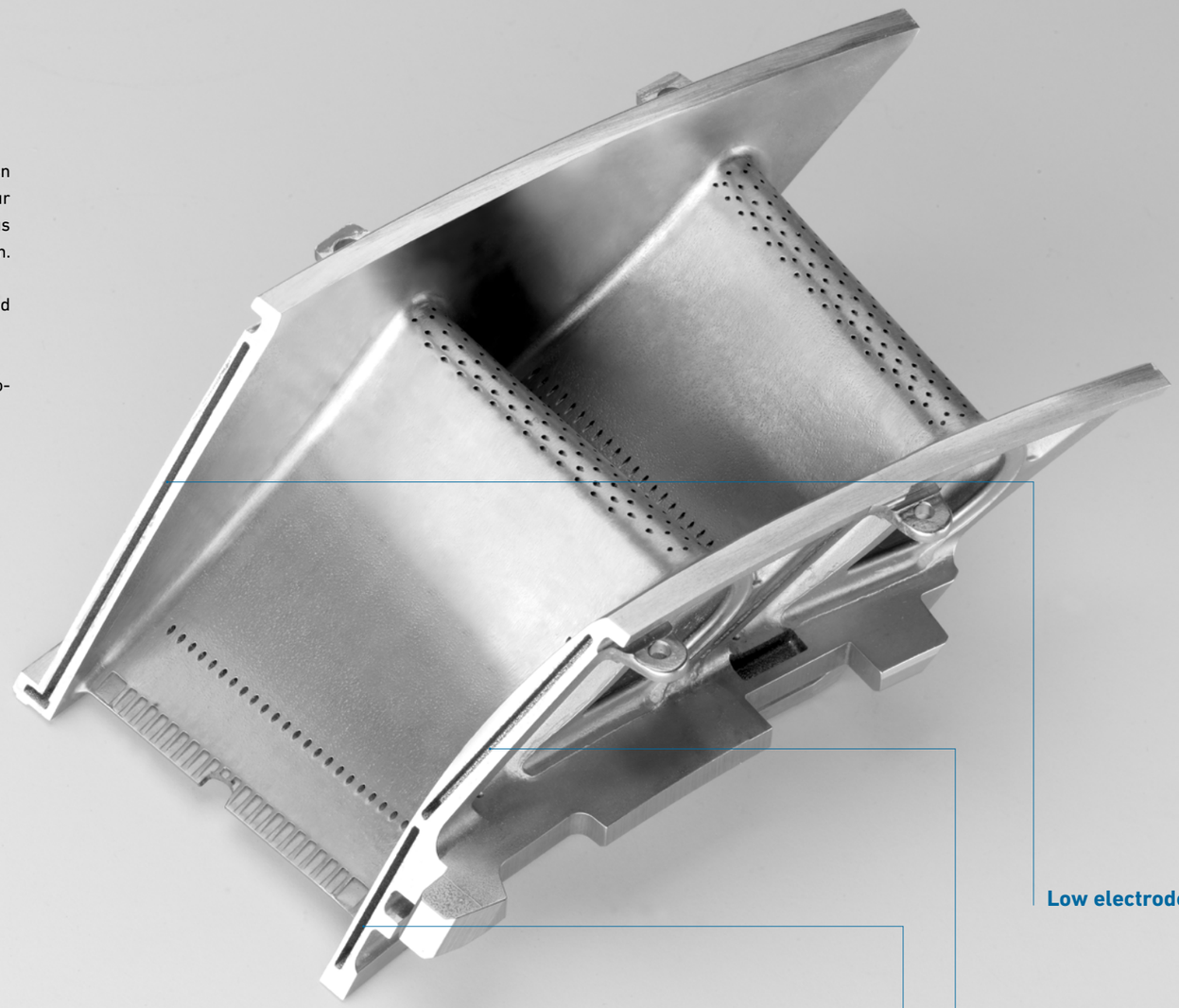
Complete machining in one setup, including bar feeding, five-axis Milling, turning, root machining, threading, chamfering, engraving and brushing.

Seal slot

Efficient engine performance depends on tight seals between nozzle guide vanes or shrouds to reduce hot gas leaks. Our solutions allow you to machine the tightest tolerance, thus improving turbine efficiency and reducing fuel consumption.

Reduce costs with the best balance of machining speed and electrode wear.

Increase productivity with easy-to-use, off-the-shelf Automation.

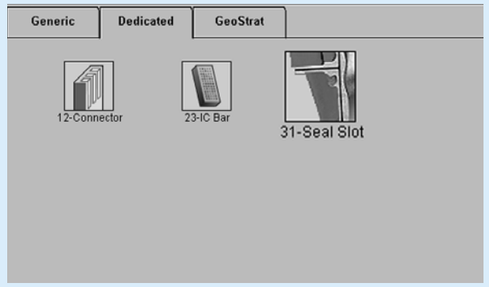


The nozzle guide vane maximizes downstream blade performance.

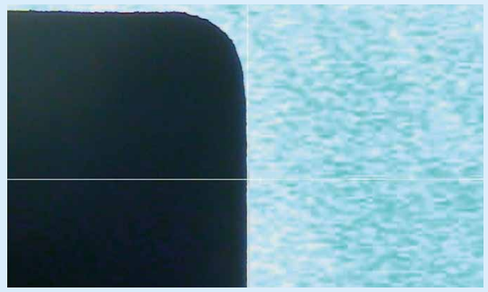
Tight seal slot reduces turbine leakage.

Embedded technology for multi-rib slots.

GF Machining Solutions helps seal slot producers achieve fast cycle times, low electrode wear for better precision and minimal recast layers to ensure surface integrity.



Fast and repeatable process due to fully integrated seal-slot technology accessible directly from the HMI.



Reduce resharpening frequency with low erosion wear.

Scalable Automation with automatic offset for autonomous production.

Diffuser

The main function of a diffuser is to prepare the incoming air for proper air-fuel mixing and combustion. The designer of this critical component is faced with a dilemma. On one hand, maximum room must be provided for the incoming air to reduce speed and to build up pressure. Optimal pressure is required for good combustion. On the other hand, weight and space are always tight in engine designs. The outcome is ever-increasing complexity of airfoil shapes. A diffuser today is one of the most complexly shaped parts to produce.

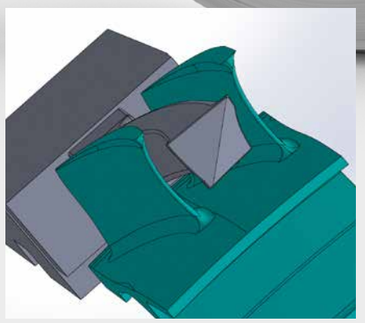
Complete liberty in the choice of material

Reduce costs with a repeatable and traceable process

Any 3D airfoil design can be machined with multi-axis EDM

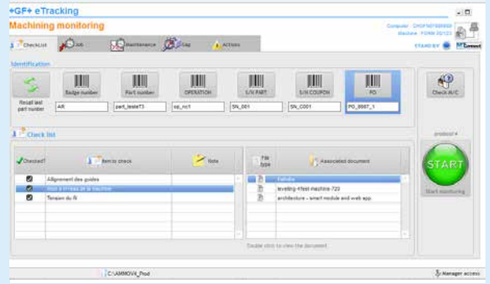
Diffuser design complexity increases engine performance.

Complex 3D airfoils with small root radii.

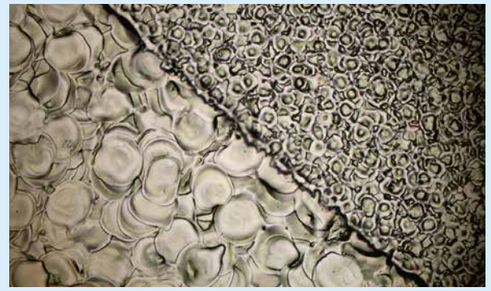


Complex profiles can only be machined with five-axis continuous machining.

Along with the machining process, GF Machining Solutions provides the complete turnkey including: electrodes consumables, electrode Milling solutions, software and Automation.



eTracking: Ensure full traceability and real time quality monitoring during machining.



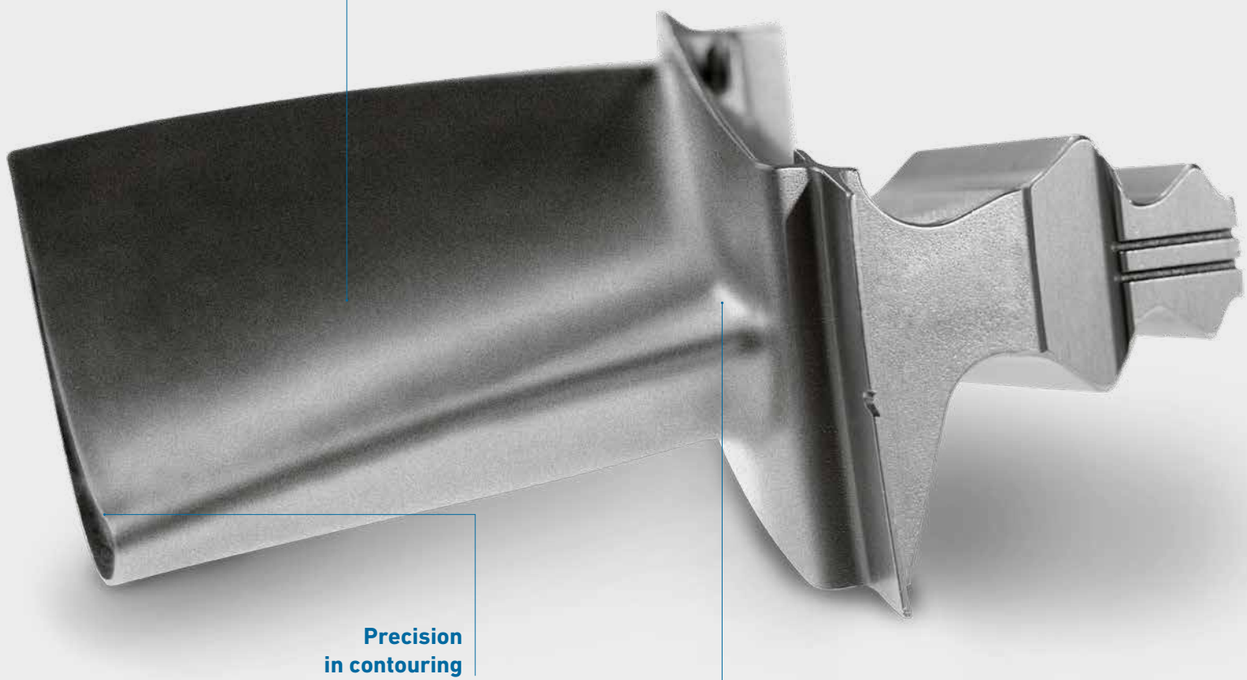
Extensive research allows us to design the right sparks for achieving ultimate recast layer control and repeatability.

Automation-ready solutions allow for carefree unmanned production.

Laser blasting

Increase adhesion with our Laser blasting solution for both composite bonding and metal coating. Laser blasting, a fully repeatable and ready to use process, offers outstanding surface homogeneity. Thanks to our fully digital process, you can ensure perfect surface continuity and contouring. With our solutions, Laser blasting becomes sustainable with respect to the environment and your operators. Do your own Laser blasting in-house and—with our digital process—step into the world of Industrie 4.0.

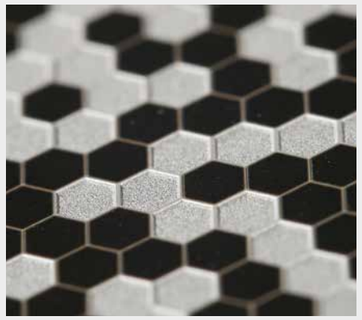
Fully repeatable digital process



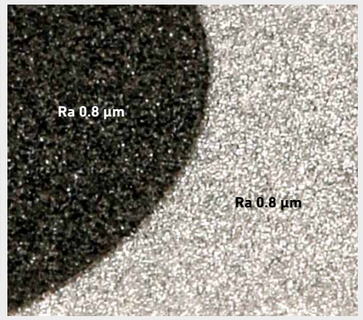
Precision in contouring

Flexibility on surface structuring

Texture any material with confidence.

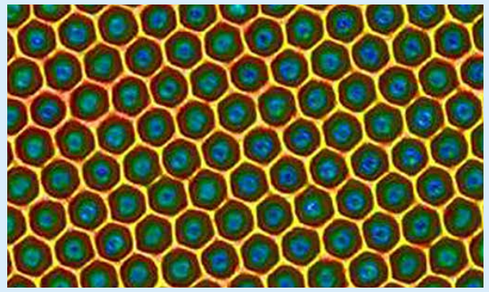


Perfect contours between textures.



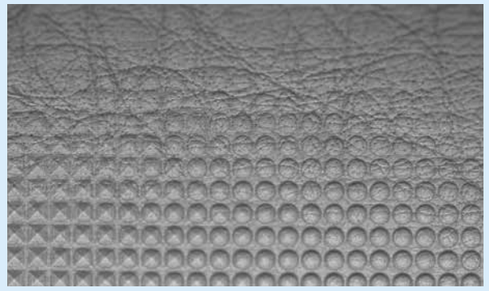
Open new possibilities for R&D.

Our Laser texturing technology uses a high-powered ytterbium pulsed fiber Laser to create highly differentiated five-axis Laser-blasted surfaces.



Increase surface homogeneity.

Unique complex shape surfacing and undercut capabilities.

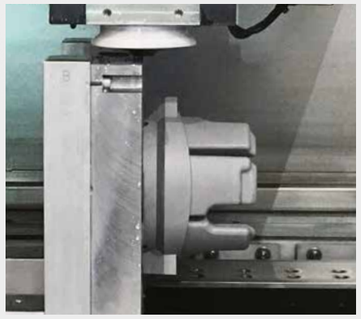


Easily manages random, morphing and overlapping textures.

Additive post-processes

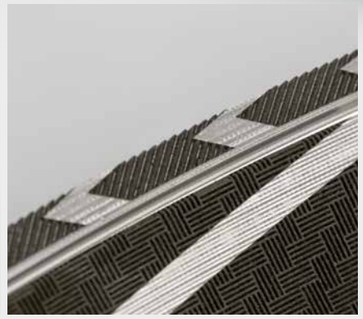
All additive manufacturing parts used in aerospace require machining. GF Machining Solutions' expertise in fine machining of hard material is a perfect match with Additive Manufacturing (AM).

Additive Manufacturing brings new challenges for addressing more complex shapes, fine geometries and exotic materials. From wire EDM to separate the part from the build plate, to five-axis milling, Laser and die-sinking EDM, we propose off-the-shelf solutions to meet these new challenges, so you can focus on unleashing the power of Additive Manufacturing.



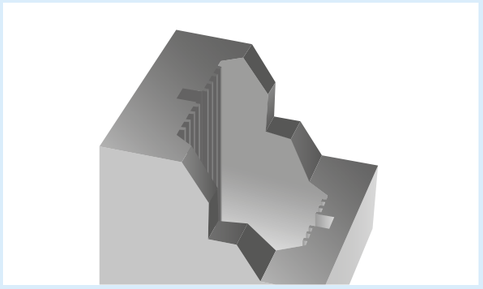
Separation from build plate is needed for 100 percent of additively manufactured parts.

Improve surface finishes and small shapes requiring five-axis Milling.



Five-axis Laser machining is needed for geometries smaller than AM layers.

GF Machining Solutions helps you seamlessly integrate Additive Manufacturing into your manufacturing process chain to expertly address complex shapes, fine geometries and exotic materials.



POWER-EXPERT prevents wire breakage on parts with multi-cavities and trapped powder.

By accessing part from all directions, five-axis machining can finalize complex features initiated in Additive Manufacturing.

Latest linear drive technology delivers speed and accuracy to remain competitive even in executing small cuts in the hardest materials.

Turbine group

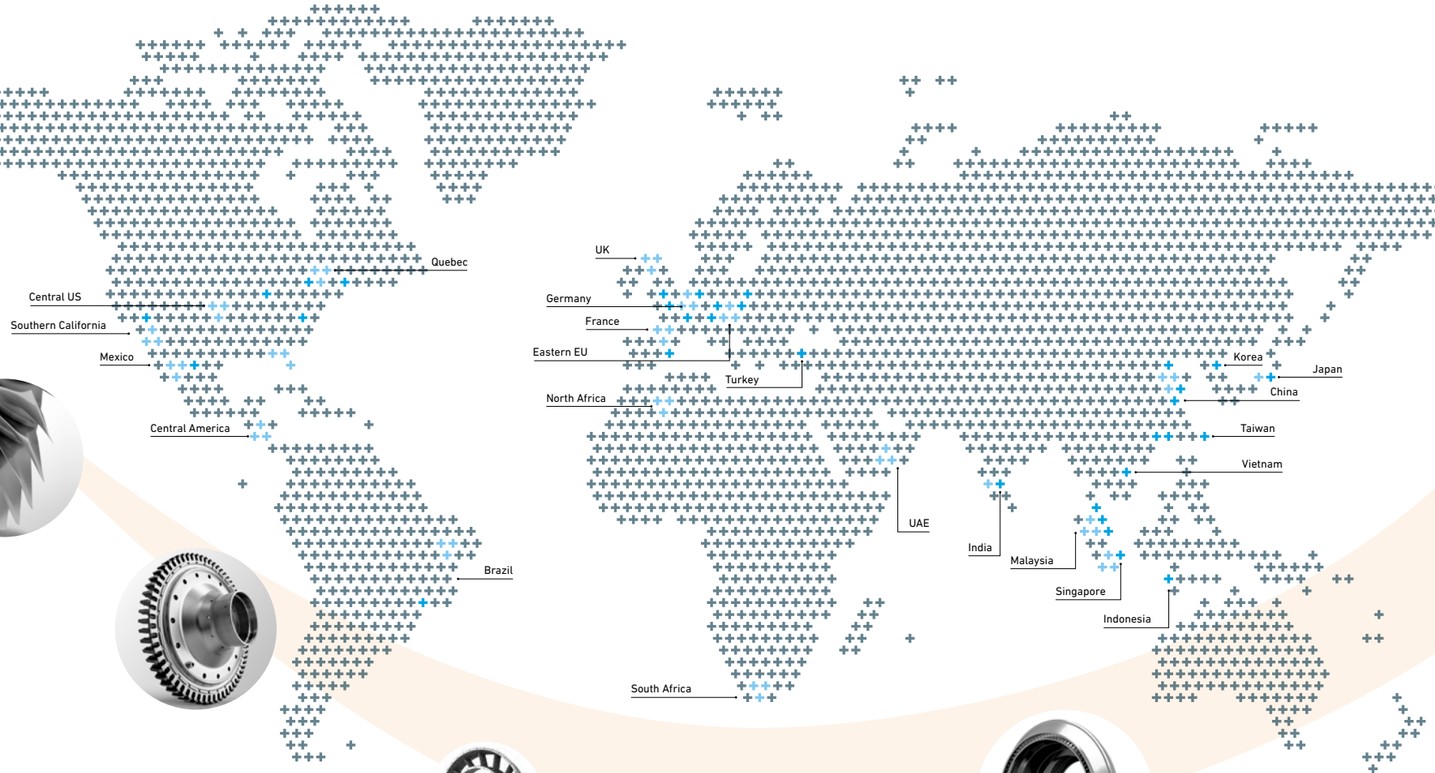
Powerful solutions for turbine manufacturing

We get you started and keep you running

1st P: Plan your profit

Get direct access to high value-added solutions and expertise, adapted to your specific production needs

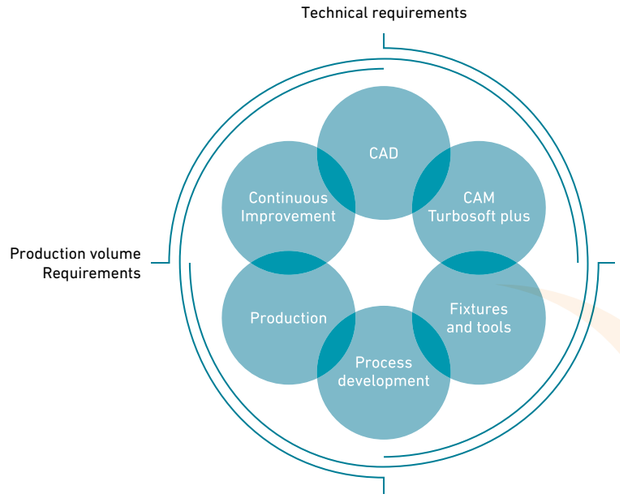
You can now have direct access, through a single point of contact, to premium sales and service solutions engineered by our aerospace and energy specialists and encompassing all GF Machining Solutions' technologies, from Milling, EDM and Automation to Laser, micromachining and Additive Manufacturing post-processes.



2nd P: Performance

Benefit from a global network of experts at your fingertips

The Turbine Group provides the most complete solutions adapted to your specifi c needs in a business requiring deep expertise, extensive consulting and responsive, 24/7 support.



3rd P: Partnership

Get the support of an efficient and reliable project organisation

4th P: Profit increase

Ramp up your productivity, achieve the lowest cost per part

Apply GF Machining Solutions' 4P model and turn-key solutions to achieve a lower cost per part, a higher ROI and benefit from a profitability increase of 30 percent.

1 st P Plan your profit

Solution engineering of your technical and economical production requirements

2 nd P Performance

Innovative technology for highest qualityand quantity output

3 rd P Partnership

Support and performance updates over entire machining solution life cycle

4 th P Profitability increase

> 30%, at lowest cost per part

+ **GF Machining Solutions**


Quebec
Central US
Southern California
Mexico
Central America
Brazil
UK
Germany
France
Eastern EU
Turkey
North Africa
UAE
South Africa
India
Malaysia
Singapore
Indonesia
Korea
Japan
China
Taiwan
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Established clusters
Emerging clusters

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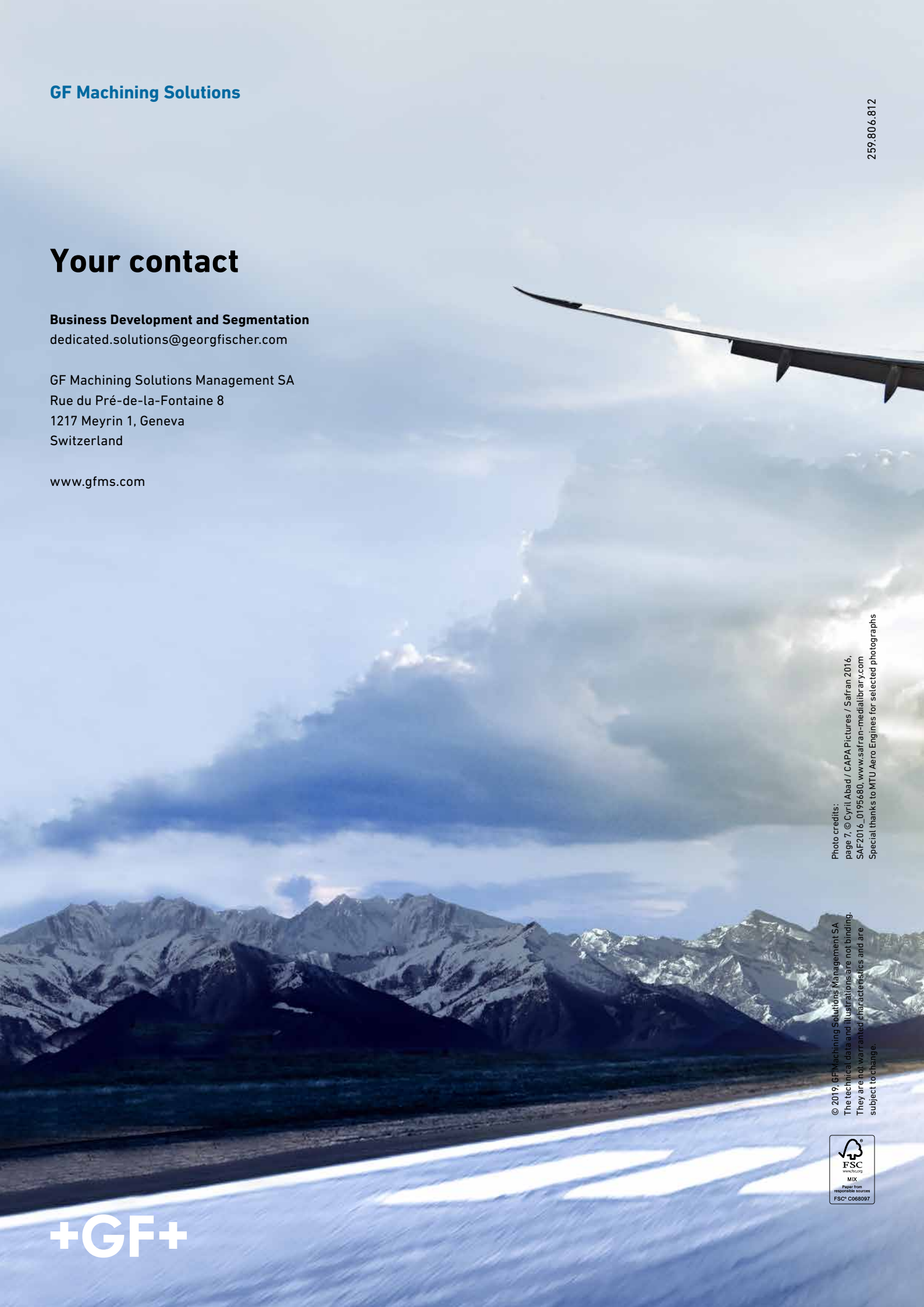

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