

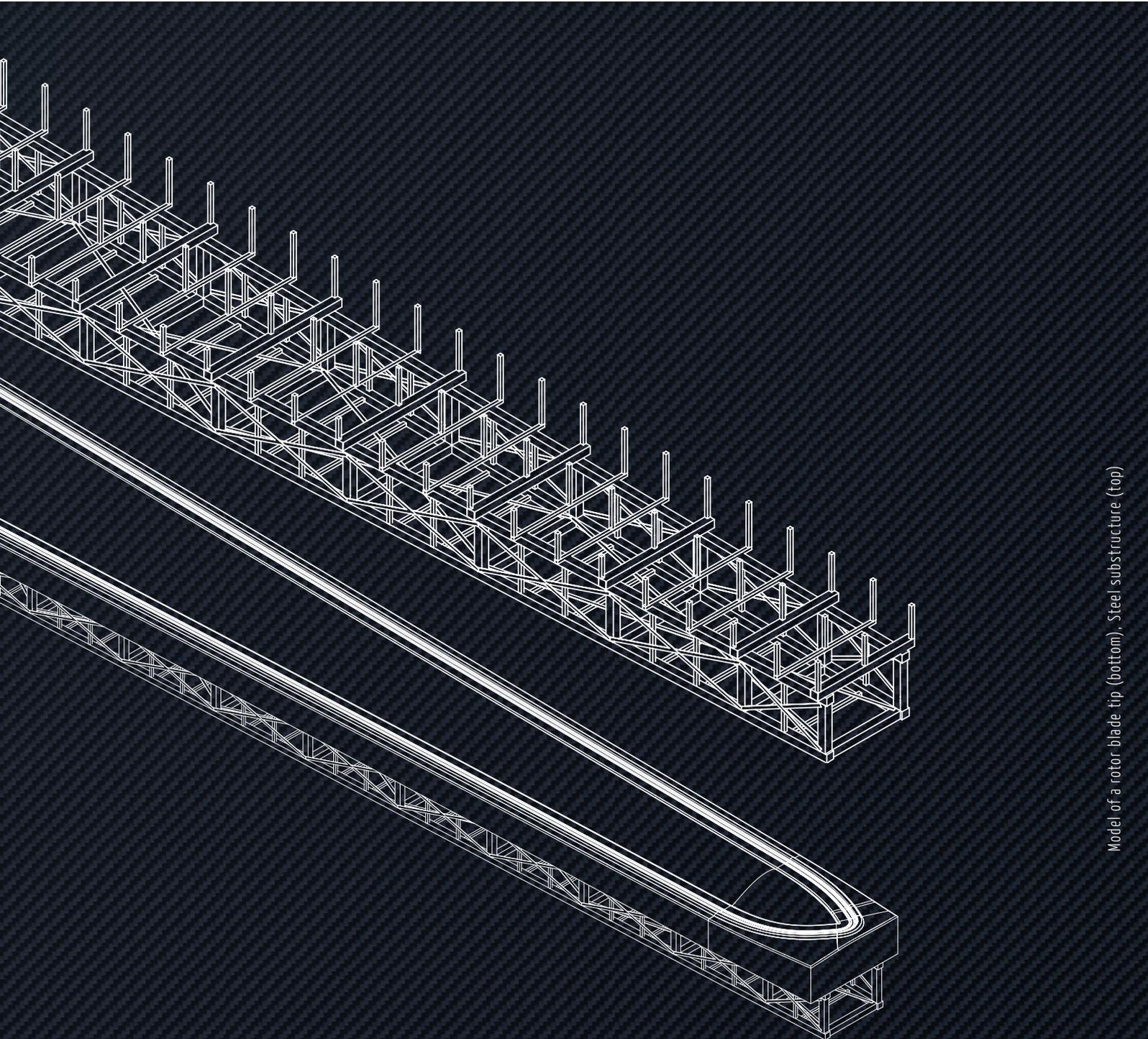
KNIERIM  **TOOLING**

committed to precision

COMMITTED TO PRECISION

We meet your requirements regarding accuracy and quality.

KNIERIM stands for reliability, innovation, high tech, and finest finish – precise to a fraction of the millimeter!



Model of a rotor blade tip (bottom), Steel substructure (top)

THE COMPANY

KNIERIM Tooling GmbH, founded in 2004 for the purpose of operating the milling machines, has its origin in KNIERIM Yachtbau GmbH, a Kiel based company with [more than 50 years of tradition](#) in boat and yacht building.

Building yachts has always involved the design and construction of large molds, such as boat hulls and decks. KNIERIM uses its [outstanding expertise](#) in this field through [many years of experience](#) in the construction of large industrial components for wind turbines, planes, ships, submarines and cars.

KNIERIM's location directly at the Kiel Canal with a long deep water pier in front of the plant means that parts can be [easily shipped all over the world](#).

Customer's growing demand for accuracy and quality of work as well as the need to reduce production time led KNIERIM to purchase [three customized CMS 5-axis milling machines](#).

The first one was installed in 2004 with the dimensions of 32.5 by 8.5 meters and a workable height of 4 meters. In 2009 a small one (6x5x2 meters) and another large one (34x8.5x4 meters) were added. The 3 milling machines guarantee [short processing times](#) even for complex projects, [flexibility](#) regarding customer's demands, and ensure [reliable on time deliveries](#).

[From a first concept to a finished part](#) KNIERIM covers the entire production process for you in cooperation with its partners, all of them renowned consulting engineers. Depending on the customer's requirements, KNIERIM does the design, the laminate calculations and the construction of your parts.

No matter what your needs are, KNIERIM is [prepared to deliver](#) master plugs, molds, and, as the latest development, heatable direct negative tools for all purposes.

KNIERIM is able to [master challenges](#) like the conception of the solar powered high tech catamaran TÛRANOR PLANET SOLAR which was built by KNIERIM's boatyard.

Managing directors
Gunnar Knierim (left) and Steffen Müller



One of KNIERIM's three customized 5-axis milling machines fine cutting a rotor blade plug



TECHNOLOGIES

A precise mold is produced of styrofoam, MDF, or block material. If necessary it will be covered by a layer of laminate before the high quality epoxy paste is applied. Machining the paste precisely to the given geometry gives the mold the exact shape.



Composite technology KNIERIM Tooling builds molds from GFRP and CFRP by a hand laying technique or with vacuum infusion and prepreg technology. These methods ensure the optimized ratio of resin and fiber for minimum weight at maximum strength. Carbon or glass fiber sandwich technologies are used according to the requirements regarding durability and performance.

KNIERIM uses epoxy resin as well as sandwich materials and cores by known producers all tried and tested in boat building. Curing times can be precisely controlled either with heating pads or in an oven to ensure an even cure and high quality.

As most molds are built with vacuum technology, vacuum tightness is an important feature.

KNIERIM offers a vacuum testing system for its master plugs if required. During this test KNIERIM's products may show a maximum drop in vacuum of less than 10 hPa/h.

KNIERIM Tooling GmbH is certificated with a Workshop Approval of Germanischer Lloyd / DNV GL.

KNIERIM's composite technology - tried and tested at toughest conditions



Long-lasting master plugs are built on a steel substructure with an epoxy sandwich laminate.

Master Plugs Different projects require different master plugs. KNIERIM developed a procedure to build master plugs for 1, 5 or up to 10 demoldings depending on the geometry and surface finish.

Method of construction KNIERIM's experienced engineers design steel substructures for customized plugs. Thanks to the cooperation with KNIERIM Yachtbau, KNIERIM Tooling can offer further services such as manufacturing fitting pieces, heating and cooling facilities.

The steel substructure is covered with plywood on which a laminate of multiple layers of E-glass with epoxy resin is applied. For the next layer 50 mm of contoured balsa core and/or PVC foam is used. It is glued with epoxy resin using vacuum technology. The core material is machined before the next layer is laminated with E-glass and epoxy resin.

Next is a vacuum test followed by the application of a high quality epoxy paste. KNIERIM Tooling uses premium pastes of renowned producers. Highly accurate paste application minimizes material waste and optimizes finishing times.

The paste is precisely machined to the required geometry before scratch lines and marks are set.

The final job is finishing the surface to customer's needs in the range from sanding with P240 to polished EP or VE primer.

KNIERIM delivers plugs, molds, and tools ready to use. Measurement of machined parts can be done by laser tracking or scanning or customer supplied templates.



Five axis, three machines, one result: excellent plugs and molds



PRODUCTS

Premium-quality master plugs are basis for premium-quality molds made of E-glass or carbon fiber.

Molds In series production of composite parts male molds are used. They ensure a constantly smooth surface and the same exact shape of any finished part.

Precise molds are build with E-glass or carbon fiber using a carefully prepared master plug. Only a top quality master plug leads to a top quality mold.

Materials and sandwich construction are chosen according to the requirements of the finished part and the specification of the integrated heating, if any. The heating layer is an integral part of the sandwich construction.

The mold can be heated by using a piping system with warm water, or by using an electrical heating with either a wire mesh or a carbon fiber layer.

A substructure can be added to the mold if requested.

Beside a cost effective method of construction and high quality materials, a detailed quality control and the highly skilled and experienced employees ensure the high-end quality of KNIERIM's molds and tools.



Surface coating To further improve the durability of the tool the surface can be coated with a special topcoat.



For some structural parts Direct Female Tools (DFT) are the future method of construction, as they reduce production steps to a minimum. The result: shorter production periods and reduced costs.

Direct Female Tools In the past, series production of structural composite parts for example of a wind turbine was done in three steps. First, a master plug was produced which was used for making a mold, as the second step. The final parts were built from this mold. Following these three steps it took sometimes a few years from ready to use CAD data to the start of a series production.

Using a **direct female tool** made by KNIERIM **reduces cost** and **time of production significantly** and allows a fabrication of at least 100 pieces without any decrease of quality.

Direct female tools are built in a similar way as master plugs. Except the **outer layer of the sandwich construction** is different. According to customer's requirements it will be a laminate of GRP or CFRP with epoxy resin. This layer is **machined to the final shape** and the surface will be finished to customer's needs.



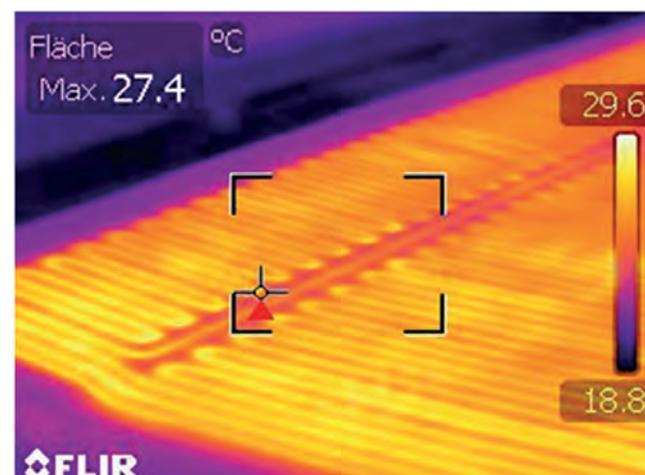
Optimal tools - with integrated heating and topcoat finish

A **controlled curing process** is essential in composite part construction. One option is to use a mold integrated heating.

In case a heating is requested it can be done either with a wire mesh or a layer of carbon fibre (which requires a CFRP laminate).

The heated layer will be covered with a layer of laminate which is machined into shape precisely to a fraction of a millimeter and finished as desired.

The wire or carbon fibre will be connected to an **extra low voltage** (48 to 60 V) power supply providing, together with the cover layer, an evenly heated surface.



QUALITY

Innovation KNIERIM values highly the dependability of proven methods of construction, but since founding the company KNIERIM is looking for **innovations to permanently optimize its products**. Before new methods and materials are used they will be extensively tried and tested, and employees will be trained to ensure **reliability** which is one of KNIERIM's quality features.

Quality KNIERIM's products are always state-of-the-art. Standards are maintained to guarantee a **constantly high-end quality**. At KNIERIM, quality is not a matter of size, small or large - up to 80 meter length - plugs and molds satisfy highest demands. Durability and precision are also part of it, as well as flexibility for a quick response to client's individual needs.

Experience KNIERIM's boat building tradition is a big advantage as their **years of experience** in high-tech composite boat building in carbon fiber sandwich technology can be used. Also in race boat building **minimum weight at high strength** are the key to success.



Technical data of KNIERIM's three CMS Poseidon 5-axis milling machines

Machine 1	6,000 x 5,000 x 2,000 mm
Machine 2	32,500 x 8,500 x 4,000 mm
Machine 3	34,000 x 8,500 x 4,000 mm
Rotation of axis B	110°
Rotation of axis C	300°
Feed rate X/Y-axis	85 m/min
Feed rate Z-axis	45 m/min
Feed rate B/C-axis	25 rpm
Nominal power milling unit KX5	15 kW
Nominal rpm	12,000 rpm (max. 24,000 rpm)
Protection category	IP54
Electronic spindle code	9988
Tool holder KX5 connection type	HSK 63/E
Chuck type	40

PROJECTS

Large objects like rotor blades for wind turbines are masterpieces in composite technology.

Wind industry Durable master plugs with high-end precision are necessary to run a series production for efficient rotor blades with an optimal shape.

In 2009 KNIERIM built the master plug for the **largest rotor blade of the time** with a length of **more than 70 meters**. It was built in 6 segments (tip, middle and root on each side) precise to a fraction of a millimeter.

KNIERIM's long-lasting master plugs lead to a growing demand for also building the respective molds which are offered since a few years. Nowadays KNIERIM is manufacturing master plugs and molds for rotor blades as well as for **various by-forms** according to client's specification.



KNIERIM **delivers world-wide**. Thanks to the location directly at the Kiel Canal and a long deep water pier **shipping is easy to any destination**. Also, transportation by truck using the nearby highway is possible.



Large size objects with profile - that's what we are specialized in



PROJECTS

Applications are limitless – from filigreed art objects to oversized advertising icons, from futuristic race cars to palatial deck lounges on mega yachts, or simply industrial parts.

Yachts and boats KNIERIM is building yachts to [customized designs](#) in latest composite technologies, in carbon or glass fiber. From [30 ft to 30 meters](#), sail or power, from elegant daycruiser to luxurious offshore yacht or [high tech racer](#), KNIERIM's experience is your advantage.

Deck furniture Every mega yacht is unique and [every part is tailor-made](#) to suit the owner's desires. KNIERIM is building main and bell masts, hatches, cocktail bars, counters, lounges, pool landscapes, and whatever is required.

Industrial parts Large composite parts made of GRP or CFRP are used in [aeronautical](#) and [aerospace](#) industries, in high-tech [ship](#) and [submarine](#) construction, in [agriculture](#) and many other industries.

From [structural components](#) to [storage solutions](#), production of any composite part, no matter what shape and size, whether for [prototype](#) or [series production](#), requires a tool. KNIERIM is your experienced partner for producing tools to any given specification. Also, [mock-up models](#) can be machined of various materials.

KNIERIM 36 Runabout - mold construction and boat building by KNIERIM



From mold to GRP part: KNIERIM delivered counters and seats for a mega yacht



Ker 51 VARUNA - carbon fiber race yacht built by KNIERIM



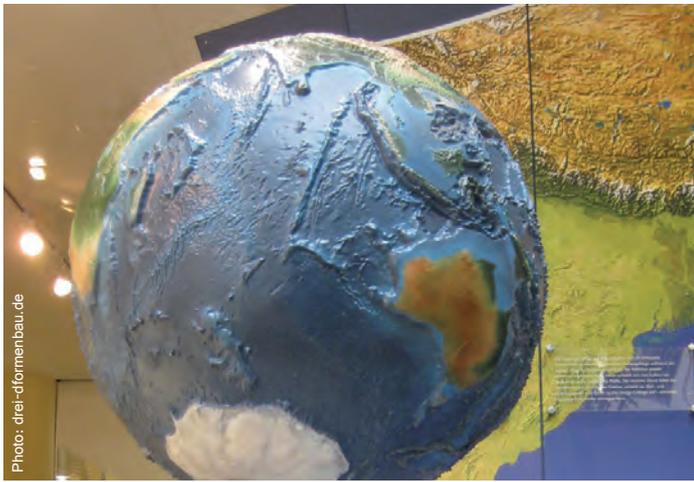


Photo: drei-dformenbau.de

Architecture and art objects Casting and architecture models, sculptures, art objects and **all kind of prototypes** can be machined of block material, epoxy paste, solid laminate, wood, or aluminum. Recent examples are relief-milled globes, oversized pills and soccer boots for an exhibition.

In the early 20th century the so-called **TET-city** was designed for the German biscuit manufacturer Hermann Bahlsen. It was an ambitious project which has been never realized but now, based on Hoetger's Egyptian style architecture, the German HAWK University created a **3D model** of the TET-city **for an exhibition** in Hannover. Central part of the TET-city is the **TET column** which was designed as the connecting part between residential and factory complex. This column was built by KNIERIM, made of epoxy paste on a wooden core which was rough and fine machined to give it precisely the final shape before it was **finished by hand**.



Automotive Race cars have always been forerunners of new technologies. One focus is on **reducing weight**, and therefore research and development departments are looking for **light-weight materials at optimal strength**. Carbon fiber composite technology is a possible solution for fairings and other parts. Nowadays more and more composite parts made of carbon fiber are used in the automotive industry.

KNIERIM has been involved in **race car projects** like the Formula Student HAWK Racing Team of the University of Hamburg or **special projects like the solar cars** developed by the University of Bochum. KNIERIM is also **sponsoring school projects** like the small race car designed by 13-year-olds and machined according to their data at KNIERIM's workshop.



As versatile the demand - as unique the result

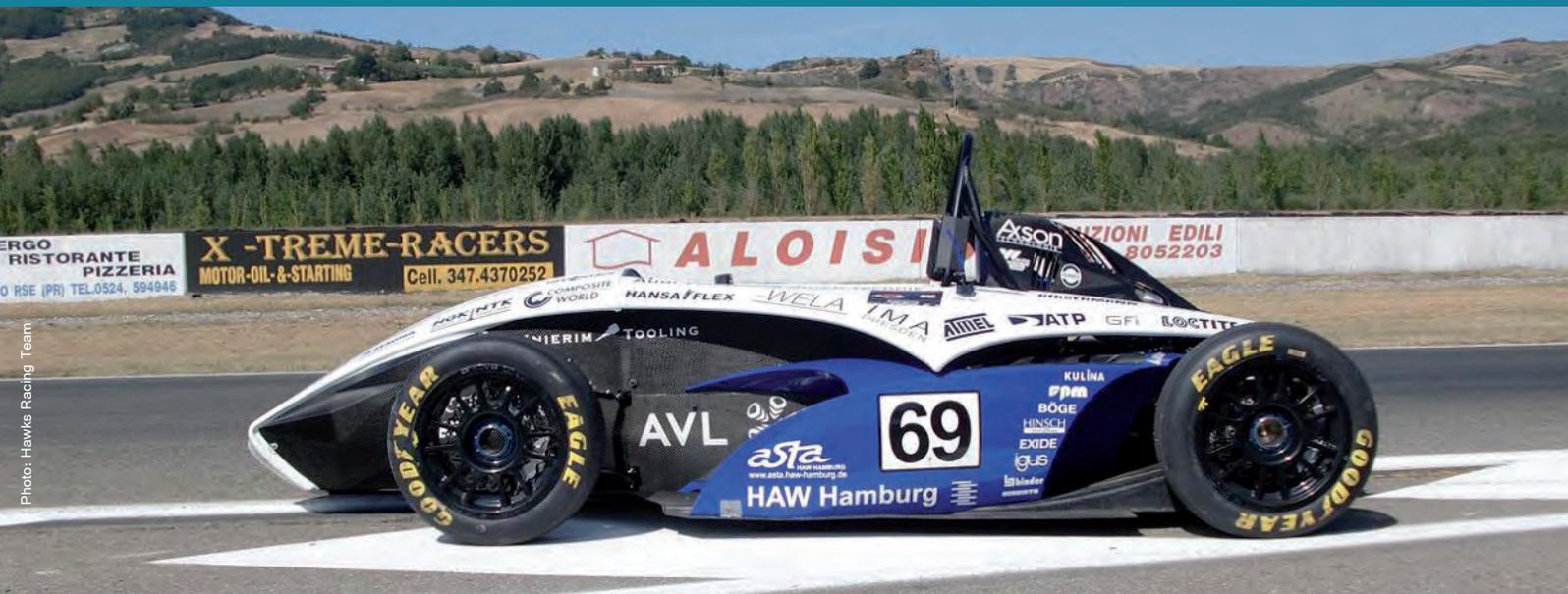


Photo: Hawks Racing Team



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