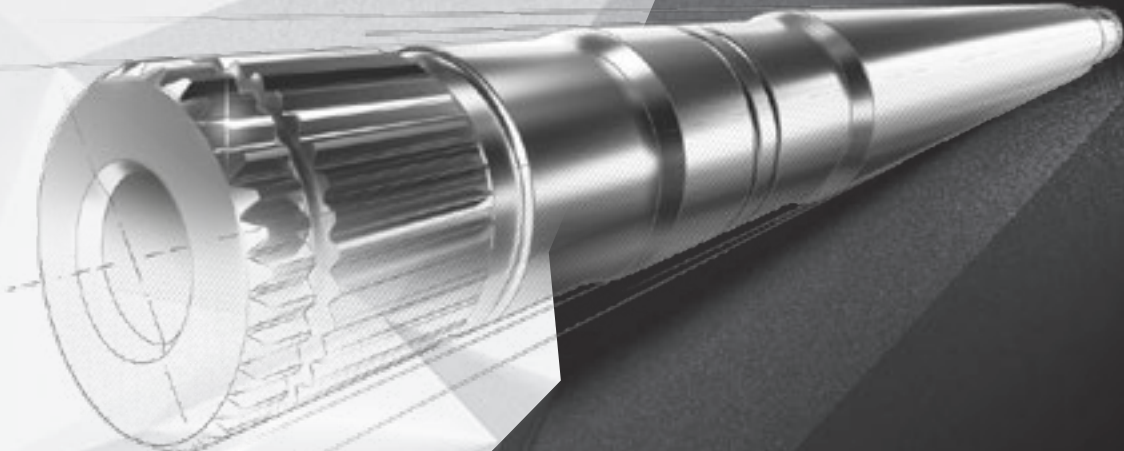


FELSS

The smarter way of forming.



AXIAL FORMING

THE TECHNOLOGY

THE BENEFITS OF AXIALFORMING



LIGHTER

By axialforming splines can be formed directly on very thin-walled sections, therefore the component can be designed in regards of a lightweight design.



STRONGER

Axialforming increases the strength of the spline due to cold work hardening. The precise profile increases the fatigue strength by up to 30%.



FASTER

By axialforming all teeth are formed simultaneously. The process is up to 3 times faster as gear shaping for inner splines. With a suitable part design inner and outer spline can be even formed simultaneously in one clamping by several forming axis.



MORE PRECISE

Highest level of reproductibility. Highest quality in regards of pitch error, profile deviation and OPD. Significant improvements compared to roll-formed splines of up to 40% improvements.

AXIAL FORMING.

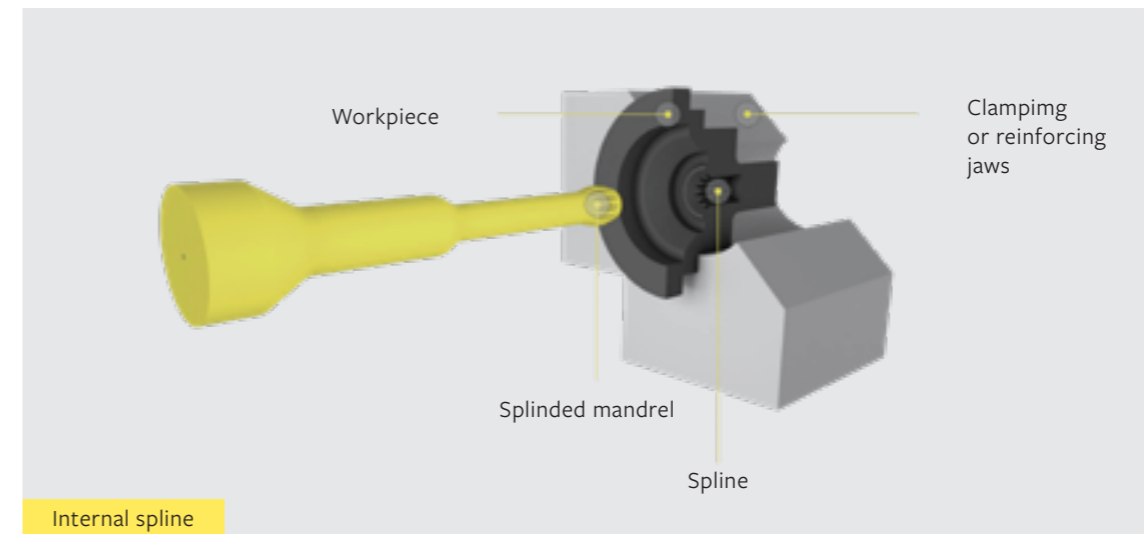
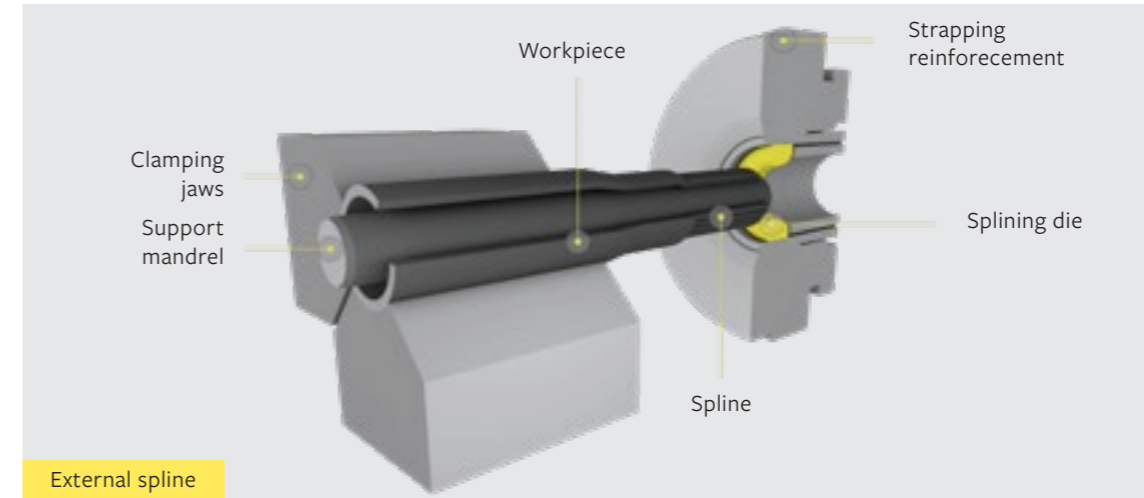
PRECISE AND ECONOMIC MANUFACTURING SOLUTIONS.

HOW DOES IT WORK?

The principle of axial forming is quite simple: A splining die presses the external splines in an axial direction onto a hollow or solid component. The forming process is highly precise as all teeth are directly formed with a one-piece tool at the same time. So a precise tool forms a precise spline. Internal splines are produced in the same way. Axial forming, especially in blind holes, provides highly precise and economic manufacturing solutions. Plus: Vertical and horizontal axial forming machines make it possible to manufacture internal and external splines in one clamping by up to three forming axis and automatic tool changing system.

HIGH QUALITY, LOW COSTS AND HIGH FATIGUE STRENGTH

You can profit from axialforming in many different application fields: everywhere high quality spline components are produced. All spline dimensions are given with the highest precision. As the teeth are an exact copy of the tool, there are basically no pitch errors. The profile is highly precise and the fillet radius is completely symmetrical. This considerably increases the fatigue strength. Felss solutions also guarantee a big plus in terms of the economic efficiency of the production processes. Each component is created in short process times and unlike cutting manufacturing processes, the strength of the components is increased. They become stronger.



RECURSIVE MODULATION.

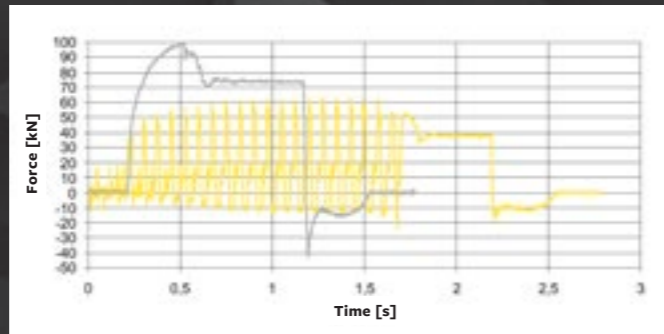
A KEY FACTOR IS MOVEMENT.

Lower forming force, highest splining precision and reduced wear of the tool – the advantages of recursive modulated axial forming are numerous. The process patented by Felss enhances the possible applications of this innovative forming technology.

In conventional axial forming, the die moves at a constant speed. If the forming forces are too high, the workpiece may buckle – especially in thin-walled tubes or components where the wall thickness has been reduced.

With recursive modulated axial forming, the forming movement consists of small, repetitive forwards and backwards movements.

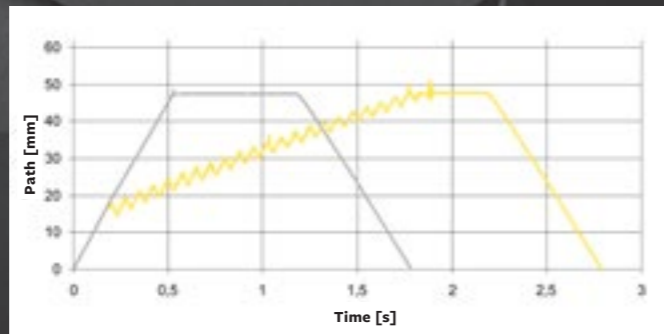
- The flow behavior of the material changes.
- The lubricating film that is needed is constantly renewed.
- This allows higher forming degrees and minimizes the forces that arise.
- This means that even thin-walled components can be axially formed.



Conventional

Recursive

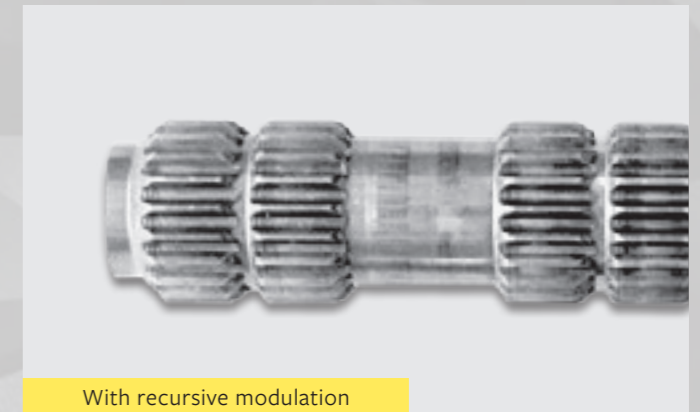
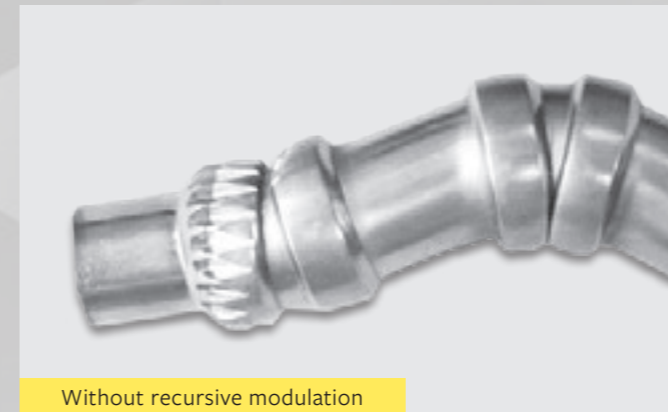
FUNCTIONALITY OF RECURSIVE AXIAL FORMING (patented). The axial force is reduced by 40% due to small forming steps.



Conventional

Recursive

FUNCTIONALITY OF RECURSIVE AXIAL FORMING (patented). The backwards movement is decisive for reducing force.





Splining die

Die Data:

- Highest in-house manufacturing precision within 2-3 microns
- Infeed angle 15-29°
- Different infeed profiles
- Tungsten carbide material, twice coated
- Adjustable OPD by +/-0.03mm by using a strapping reinforcement system

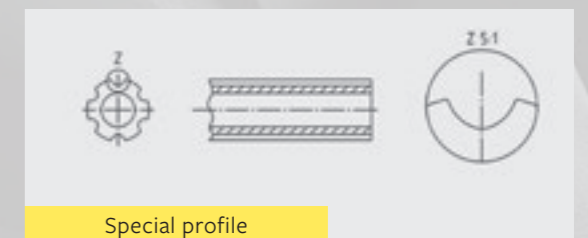
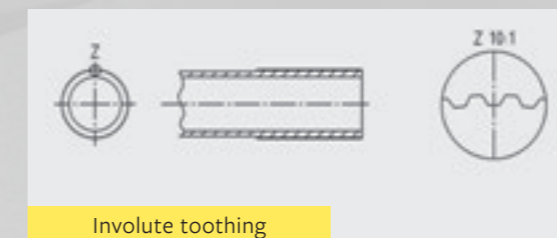
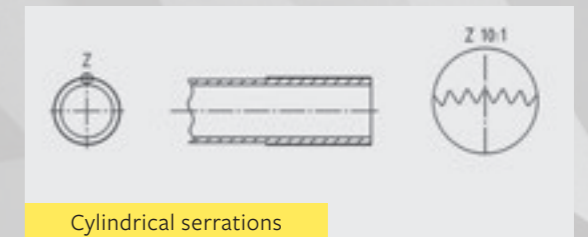
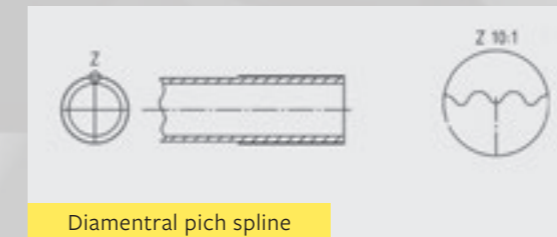
POSSIBLE GEOMETRIES.

Splines:

- Serrations, Involute toothing, Diametral pitch
- Max. major diameter: 65 mm
- Max. helix angle: 1°
- Max. module in a process: 2.5
- Max. length of external spline: up to 250 mm
- Max. length of internal spline: up to 120 mm
(Longer also possible but need a case by case check)

FORM VERSATILITY GUARANTEED.

PROFILES THAT AXIAL FORMING MAKES POSSIBLE.



THE RECURSIVE AXIALFORMING PATENTED BY FELSS FOR:

- Internal and external splines
- Internal splines especially in blind holes
- Different spline profiles as involute splines, serrations and other profiles as ball profiles
- External spline on very thin-walled components without wall reinforcement directly on the final contour
- Highest spline precision of up to DIN class 5
- Due to simultaneous forming of all teeth with a one-piece tool highest quality in regards of pitch error, profile deviation and OPD
- OPD tolerances of up to +/-0.01mm even with cm/cmK values possible
- Highest output of up to 5 parts/minute

With axialforming a wide range of profiles can be formed. It is possible to form involute profile, diametral pitch profiles, serrations as well as special profiles as ball profiles.

OUR AUTOMOTIVE APPLICATIONS.



Transmission Shaft



Idler Shaft



Rotor Shaft



Camshaft



e4 Smart Shaft



Torsional Vibration Absorber



Input Hub



Sun Shaft

**CAMSHAFT:**

This Felss camshaft was developed together with a customer, and active cylinder management was realized in a large series four cylinder TSI engine for the first time. When less power is required, the active cylinder management of the vehicle therefore changes automatically to a mode in which only two cylinders work. This automatically increases efficiency and reduces fuel consumption. The car thus saves 15 % fuel on average.

**IDLER SHAFT:**

Idler shafts produced by Felss are distinguished by high-strength spline systems in thin-walled areas and offer greater fatigue strength due to precise spline forming. The tempering procedure is dispensed with due to cold stabilization – the service life of the toothing increases without heat treatment.

**SUN SHAFT:**

This Felss sun shaft is produced in the rotary swaging process, among others. This cold stabilization offers exceptional surface quality and the highest degree of process security. The lightweight design solution enables considerable material and weight savings with simultaneously high precision.





e4 SMART SHAFT:

The e4 Smart Shaft consists of a uniform central shaft of variable length and individualized end pieces, and thus offers the highest degree of versatility of use. Relevant energy and material savings should be achieved in future with this solution due to the use of the most up-to-date processes and proven Felss technologies.



INPUT HUB:

In the case of this input hub, Felss can offer the greatest possible process security due to the technologies: the internal and external splines are applied with only one clamping due to the axial forming process. This allows for consistently high spline quality and exceptional surface qualities.



TRANSMISSION SHAFT:

This Felss transmission shaft is distinguished by excellent surfaces and consistently high spline quality. The uninterrupted grain flow offers greater stability with simultaneously reduced component weight, and thus lower costs thanks to the lightweight design process. In production, the application of seven external spline systems on one clamping diameter with a reduced cycle time of approx. 95 seconds is possible.



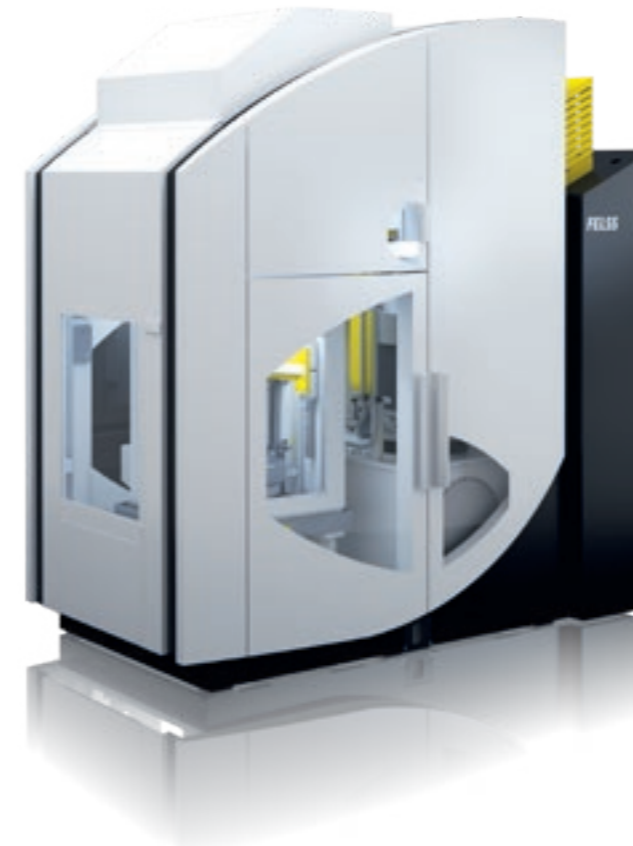
PERFECTLY ADAPTED SYSTEMS.

MODULARITY - FROM THE SINGLE MACHINE TO THE INTERLINKED LINE.

Felss relies on a modular and very flexible concept that makes it easier to adapt the technology to the requirements of customers. The axial forming unit is also used by individual machines whilst at the same time being a central part of a transfer system with several forming steps.

The demand on Felss is the same for every axial forming machine: Each component is produced efficiently, with high precision, and quickly. The modular, standardized structure, change-over friendly design in connection with an NC-control system guarantee high availability as well as high flexibility during the production process.

Felss axial forming machines are available with a horizontal design or with a vertical design, with different levels of automation – from the single-station machine with manual loading to the multi-station machine, fully automatic transfer systems that integrate both cutting and non-cutting machining methods.



AXIMUS Vo2

ABOUT THE MACHINE

The Aximus Vo2 is used to form one or more highly precise internal and /or external splines on hollow or solid parts. This machine model can form splines by up to three forming axis. The AXIMUS Vo2 model is mainly used for components with a length up to 300 millimeters or sometimes up to 400mm. The machine can be equipped with a double tool changer in order to, for example, carry out on internal spline and external spline in one machine pass.

ADVANTAGES:

- Forming of internal and external splines even in one clamping
- Forming of one or more highly precise splines in one machine pass due to an automatic tool changing system
- Short cycle times, often less than 20sec
- Highest repetition accuracy over the entire run time
- High degree of dimensional stability due to one-piece tool
- Axial and radial clamping of the components possible

Max. workpiece length: **300 mm or 400 mm**

Max. major diameter: **65 mm and up to 85 mm with smaller spline module**

Max. helix angle: **1°**

Max. modules in one forming stroke **2.5 mm**

Max. external spline length: **up to 270 mm**

Max. internal spline length: **up to 220 mm**

Spline outlet angle: **max. 29°**



AXIMUS Ho2

ABOUT THE MACHINE

The Aximus Ho2 is used to form one or more highly precise internal and/or external splines on hollow or solid parts. This machine model can form splines by up to two forming axis. The AXIMUS Ho2 model is mainly used for components longer than 270 millimeters. The maximum components length can be even 1,800mm. The machine can be equipped with a double or a six-fold tool changer in order to, for example, carry out all splines for gear shafts in only one run.

ADVANTAGES:

- Forming of internal and external splines even in one clamping
- Forming of one or more highly precise splines in one machine pass due to an automatic tool changing system
- Short cycle times, often less than 20sec
- Highest repetition accuracy over the entire run time
- High degree of dimensional stability due to one-piece tool
- Axial and radial clamping of the components possible

Max. workpiece length:
1,000 mm or 1,800 mm
(depending on feed unit type)
Max. major diameter:
65 mm and up to 85 mm
with smaller spline module
Max. helix angle: 1°
Max. modules in one forming stroke 2.5 mm
Max. external spline length: **up to 270 mm**
Max. internal spline length: **up to 220 mm**
Spline outlet angle: **max. 29°**



BASICLINE

ABOUT THE MACHINE

The axial forming machines of the AFH product family are suited for the cost-efficient manufacture of external splines with the highest quality. Thanks to our patented recursive axialforming, the AFH machines offer a reduction of axial forces. The AFH machines thus offer high tool service life and short cycle times for economical production.

ADVANTAGES:

- Forming of external splines in highest precision with low cycle times
- Highest output of up to 4 parts per minute
- Highest repetition accuracy over the entire run time
- High degree of dimensional stability due to one-piece tool

Max. workpiece length:
120-280 mm or 280-800 mm
(depending on the machine model)
Max. major diameter:
65 mm and up to 85 mm
with smaller spline module
Max. helix angle: 1°
Max. modules in one forming stroke 2.5 mm
Spline outlet angle: **max. 29°**

MAKE: FELSS SYSTEMS.

MECHANICAL ENGINEERING

As experts in lightweight design, we realize optimal solutions and processes for our customers' individual machines, production systems, and process chains. Furthermore, we support customers at all times – be it with maintenance and training measures, with the providing of new tools, and with the possibility to further develop and expand upon systems on request.

BUY: FELSS ROTAFORM.

COMPONENT MANUFACTURING

The Felss Group offers component manufacturing extending from prototypes to large series. In the process, we concentrate not only on our core technologies, but instead also offer a broad range of services for ready-to-install components through additional in-house technologies.

FELSS SERVICE.

The Felss Group produces machines, manufactures components, and develops processes in the cold forming segment. Thanks to this experience, we know how important good support is. Our goal is to offer the best service in our industry. Close contact with our customers is essential for this. Thanks to this exchange and out decades of competence, we always have the appropriate solutions at the ready for you. As your partner, it is our ambitions to offer you individual and customized support. From classic support with malfunctions through the use of digital services to 24/7 support.



CONSULTATION, HELP LINE, FIELD SUPPORT



MODERNIZATION AND CONVERSION



TOOL SERVICE



REPLACEMENT AND WEARING PARTS



SERVICE AGREEMENTS



TRAINING MEASURES AND SEMINARS



DIGITAL SERVICES

FELSS

The smarter way of forming.

USA

COMPONENT MANUFACTURING
+ New Berlin // WI

GERMANY

MACHINE BUILDING
+ Königsbach-Stein
+ Pforzheim
+ Nesselwang

COMPONENT MANUFACTURING
+ Bretten-Gölshausen
+ Pforzheim

CHINA

COMPONENT MANUFACTURING
+ Wujiang

SLOVAKIA

COMPONENT MANUFACTURING
+ Ilava

SWITZERLAND

COMPONENT MANUFACTURING
+ Triengen

THE FELSS GROUP

MACHINE BUILDING: FELSS SYSTEMS

Machines, production systems and processes developed optimally.

COMPONENT MANUFACTURING: FELSS ROTAFORM

Component manufacturing by specialists – including in high volume.

Felss Group GmbH
Dieselstrasse 2
D-75203 Koenigsbach-Stein
T +49 7232 402-0
F +49 7232 402-122
info@felss.com

THE FELSS GROUP

The Felss corporate group, founded in 1905, is a provider of solutions in the field of cold forming of tubes and solid materials and a specialist for the automobile industry. Since the integration of the HMP companies purchased in May 2019, Felss now also serves numerous customers in other sectors. Among these are customers from industry, aerospace and precision mechanics.

As lightweight construction experts, we develop optimal processes, machines or also the finished product in component manufacturing for our customers. Around 1,100 employees work worldwide at our nine locations in Germany, Switzerland, the USA, China and Slovakia.

www.felss.com