

FORMING THE FUTURE



AEROSPACE

System solutions for the aerospace industry

FORMING THE FUTURE



SYSTEM SOLUTIONS FOR THE AEROSPACE INDUSTRY

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ALTITUDE 11,000 M, -50 °C, MACH 0.85.
AND YOU CAN RELAX AND WATCH YOUR FILM.



SCHULER AEROSPACE. INNOVATIVE FORMING TECHNOLOGIES FOR TOMORROW'S AIRCRAFTS.

The need for mobility in the global village is growing. Air travel is projected to grow at annual rates of five percent over the next two decades. This means global air traffic will have doubled within 20 years. The future of flying has just begun.

Schuler is providing the leading future technologies for this market. We are expert partners for the aviation industry with groundbreaking concepts and innovative forming technologies. Wherever the highest quality and safest process technology are called for, wherever precision, durability, load capacity and uncompromisingly reliable components are in demand – you will find machines from Schuler at work.

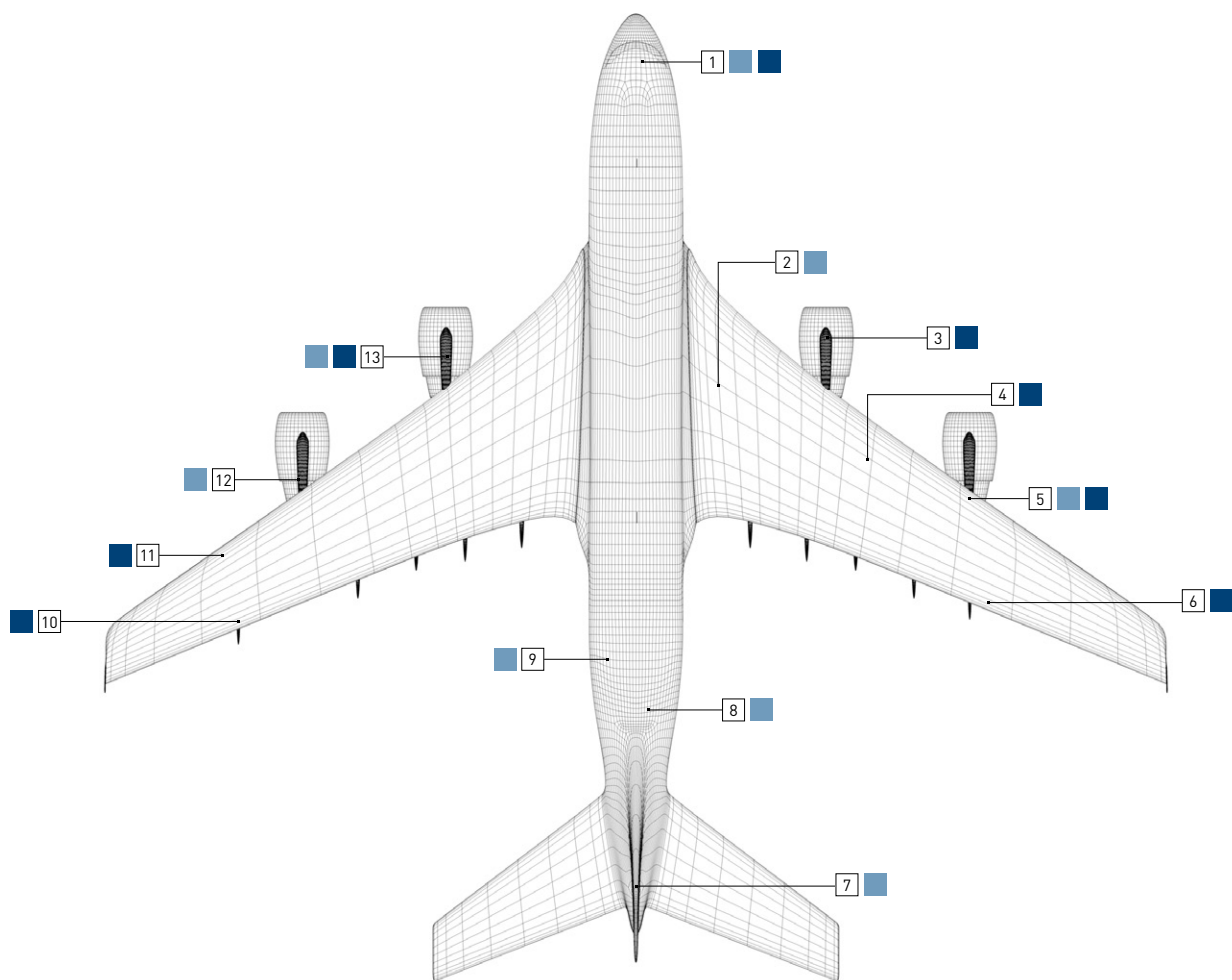
TECHNOLOGY PARTNERSHIPS. LEADING EXPERTISE FOR RELIABLE MARKET SOLUTIONS.

Schuler and FormTech. Schuler, the leading innovator in forming technology, is partnering with FormTech, the globally recognized expert in titanium forming. Together, we are developing press solutions which meet the ever-growing challenges in terms of technology, safety, environmental protection and sustainable use of natural resources.

Schuler and the AFRC at the University of Strathclyde.

The Advanced Forming Research Center was established in 2009 as another research center at the University of Strathclyde in Glasgow. The partnership with Schuler not only encompasses developing new processes on screw presses but also investigating the pre-forming process through the newly developed servo-upsetter; these innovations assist in fundamental research. Together, specific projects are developed further in forming technology and forging.

AIRPLANE COMPONENTS. THE FUTURE OF AIRCRAFT MANUFACTURING – MADE ON SCHULER MACHINES.



EXAMPLES FOR FORMED PARTS MADE ON SCHULER EQUIPMENT

■ Sheet	4 Pylon brackets	bulkhead	Compressor Blades, Disks & Rings
■ Forged	5 Pylon: several parts	9 Scuff plates	
1 Landing gear: several parts	6 Flap track: roller track	10 Trailing edge: pintle fittings	13 Nacelles: skins, attachments, attachment ring, forward bulkhead
2 Bleed air duct system	7 End cap APU	11 Slat track can	
3 Thrust fittings	8 Edge angles rear pressure	12 Engine: Fan Blades,	

Machines from Schuler allow for the economical production of sheet metal parts as well as forged components. Gas pressure forming, diffusion bonding, hot forming/calibration, closed and open die forging, isothermal forging and hot deep drawing are used, amongst others.

Titanium, for example, is a metal of particular interest due to its specific strength. Highest rigidity of shape can for example be achieved by indentations; sandwich technology also makes it possible to reach high denting resilience even with thin panels.

The high-temperature strength of titanium allows the use in areas exposed to extreme heat, such as jet engine exhausts, hot gas pipes, and pressure and fire-resistant housings. Titanium is almost unsurpassed when it comes to safety; its resistance to hydrazine, for example, makes it the ideal material for rocket fuel tanks. Its galvanic compatibility with composites (CFRP) makes it an essential factor in hybrid constructions.

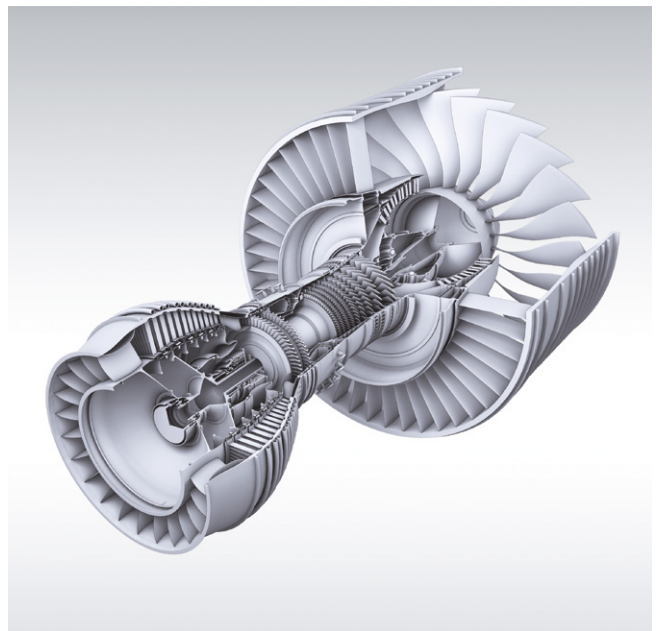
	Screw presses	Preforming presses + Forging Cell	Hammers	Hot forming presses for sheet metal	Isothermic forging presses and calibration presses with integrated heating chamber	Ring blank presses + ring rolling lines	Hydraulic forging presses	Open-die forging presses
Compressor blades	■	■	■		■			
Blower blades	■		■	■	■			
Disks and rings	■		■		■	■	■	■
Engine mounts	■		■	■			■	■
Landing gear parts, aircraft wheel	■		■				■	■
Sheet metal parts				■				
Structural and stiffening parts, fuselage bulkheads				■			■	
Ventilation system parts				■			■	
Wing and loading flap parts, stabilizer fittings	■		■	■				
Window frames				■			■	

LEADING THE FUTURE OF FORGING.

FROM THE SCREW PRESS TO THE AUTOMATED FORGING CELL.

Around the world, light and stable components made from high-performance materials are manufactured on Schuler machines in the high-tech area of aerospace engineering. For example, compressor blades have been forged on screw presses from Schuler (formerly Müller Weingarten) for more than 40 years now – an unparalleled success story in the aerospace market.

Looking to the future. Schuler's market success is based upon our outstanding innovative potential as a technological leader. Our investments in research and development become commercial advances in performance and optimization of entire process systems. To achieve this, we use various methods such as intelligent automation, new forming processes and innovative servo drive technology. The advantages for our customers are greater flexibility and increased efficiency.



Compressor blades and discs in the jet engine.

SCHULER FORGING CELL. FOR EVEN GREATER FLEXIBILITY AND EFFICIENCY.

Together with the renowned Advanced Forming Research Center (AFRC), Schuler is pushing ahead with the development of the automated forging cell in order to be able to implement and supply efficient and innovative turnkey solutions.

At the AFRC research facility in Glasgow, Scotland, significant innovations have already taken wing for the aerospace industry – often with the support of well-known manufacturers such as Rolls-Royce, Boeing or Mettis.

The heart of the Schuler forging cell is a directly driven 2600 t screw press equipped with the latest drive technology. In this respect, we are taking new approaches to production of compressor blades, for example.

A further milestone for the forging cell is the newly developed upsetter with ServoDirect Technology. With a servomechanical drive system, the appropriate forging speed is set according to the application, thereby achieving a significant improvement in quality.

Cooperation with AFRC offers Schuler the ideal conditions for testing new processes and safeguarding the lead that the company has built up. Our goal: achieving even greater flexibility in the forming process in order to offer our customers uncompromisingly the best technology for series production of an extremely wide range of materials.

ADVANCED FORMING RESEARCH CENTER

The Advanced Forming Research Center is an institution linked to the Scottish University of Strathclyde and is concerned with fundamental research and applied developments in the areas of forming and forging. The University of Strathclyde was founded in Glasgow in 1796. Its five faculties currently educate about 22,000 students, mostly in technical subjects. Interdisciplinary work represents an important focus of teaching and research as a way of breaking down the traditional limits between disciplines.



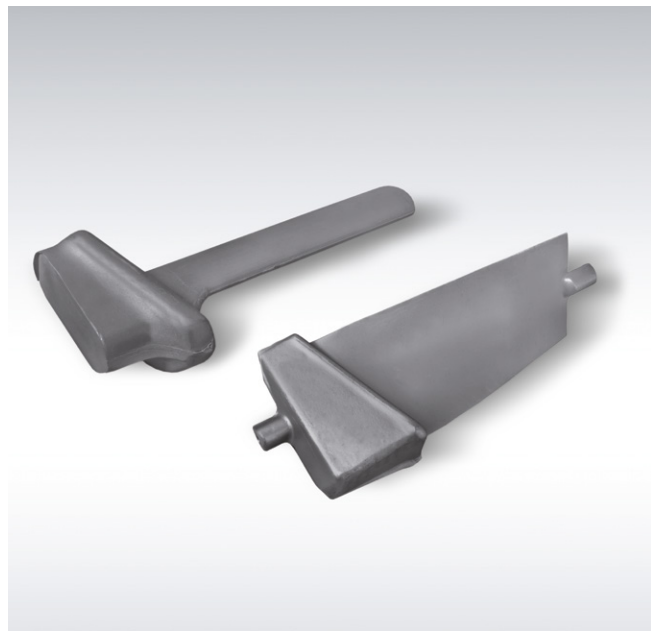
SCHULER FORGING CELL.

RELIABLE AUTOMATION PROCESS FOR AN EFFICIENT PRODUCTION OF COMPLEX PARTS.



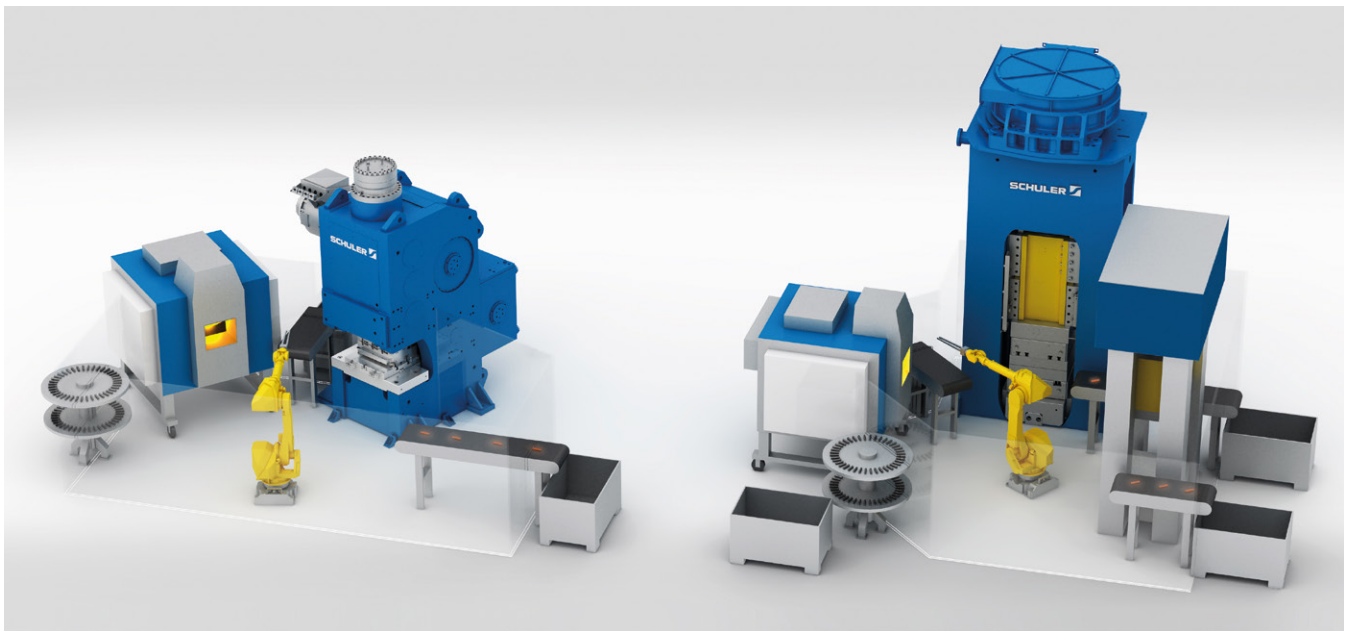
The upsetter with ServoDirect Technology manufactures pre-forms for compressor blades.

The new design of the upsetter with ServoDirect Technology with two independent servomotors makes it possible to achieve the highest production output rates and set the forming parameters to the specific forming requirements of the material. Furthermore, extremely short pressure contact times can be achieved in the clamping and upsetting work sequence. The Schuler Forging Cell combines the pre-forming process on an upsetter with ServoDirect Technology with the final forging process in the screw press.



Pre-form and compressor blade.

In order to meet customers' requirements and to offer an edge over competitors, the new Schuler controller makes complete line control possible. The upstream and downstream processes, such as heating, glass coating and cleaning can be integrated and monitored.



The Schuler forging cell combines the preforming process of the upsetter with ServoDirect Technology and the final forging process in the screw press.

The advantages of the Upsetter

- Independent slide movements performed by two servo drives
- Adaptable speed profiles for optimized forming processes, including forming advanced materials
- High output performance
- Robust structure
- Double overload protection with force and torque limitation
- Energy efficiency due to current consumption at different times

The components:

- Compressor blades incl. preforms

Forging cell advantages:

- Automated production
- Maximum efficiency
- Two independent forging cells
- Schuler line control for production data acquisition

SCREW PRESSES WITH DIRECT DRIVE. GREAT FLEXIBILITY.



Direct-drive screw press with 11,000 kN press force.



A broad product range because of great flexibility.

Screw presses. Thanks to almost 120 years of experience in building screw presses, with continuous developments, there is practically no drop forging that cannot be manufactured using a screw press. As far back as 1936, the conventional friction drive was superseded by the friction roller drive and, subsequently, direct drive. From 1963 onward, once reliable three-phase synchronous motors with rapid permitted switching frequencies were available, the door was open to a new and ideal drive system for screw presses. In this direct drive, the torque from the drive motor is transmitted to the screw without intermediate drive components, wear parts or energy losses. For more than 40 years, screw presses from Schuler (formerly

Müller Weingarten) have been delivered to customers all over the world in the aerospace industry, where they have been used for applications such as forging compressor blades.

Advantages of direct drive. The screw press drive permits optimum control of the forming process. At the same time, the forming energy can be varied, and adjusted between 5% and 100% according to the specific requirement.

Direct drive screw presses from Schuler can be expanded with additional optional automation functions. The presses are controlled using a standardized graphic user interface



Screw press with direct drive PZ S 900f with 128,000 kN press force for manufacturing heavy forgings.

which means functions for parameters which determine quality, such as impact energy, parts thickness, impact force or parts temperature are also directly monitored.

The components:

- Engine parts (compressor blades, disks, rings)
- Fuselage (fuselage bulkhead)
- Wing (landing flap carriers)
- Stabilizer (stabilizer fittings)
- Landing gear (nose landing gear)



Fan blade.

The advantages:

- Wide range of parts
- High repeat accuracy
- High operational reliability
- Variable-speed drive
- Maximum efficiency
- High flexibility
- High dimensional accuracy

OTHER MACHINES FOR FORGING. CONFIGURED FOR A WIDE RANGE OF APPLICATIONS.



Forging line for alloy wheels.

HYDRAULIC CLOSED-DIE FORGING PRESSES.

Hydraulic forging presses and lines are characterized by their high flexibility. The ability to program strokes, forces and speeds, combined with the unlimited rated capacity throughout the entire stroke makes it possible to have a very broad range of applications.

Programmable ejector systems make it possible to use different dies, providing the flexibility to manufacture a variety of parts, such as disks, rings, suspension and structural parts as well as chassis components and rims.



Ring rolling line.

RING BLANK PRESSES AND RING ROLLING LINES.

Forging ring blanks is the first forging operation when manufacturing seamless rings. It is used for rolling the precursor products for engine casings, bearing shells, blade carriers and different structural elements.

Hydraulic presses are particularly well suited to forging ring blanks: High forces, long strokes and an unlimited rated capacity are the preconditions for efficient forging of ring blanks.



Open-die forging press for aircraft parts.

OPEN-DIE FORGING PRESSES.

High flexibility is one of the significant properties of hydraulic open-die forging presses. The forging takes place using simple dies (upsetting dies) – the accuracy of the press and the flexibility of the control system deliver dimensional accuracy and the ability to produce complex forgings.

The presses can be delivered as “pull down” (MHFU) or “push down” (MHFT) with a two- or four-upright design. Schuler open-die forging presses are built in cooperation with Wepuko-Pahnke, and are characterized by the extreme rigidity of the cast steel frame and absorption of high off-center loads.



Counterblow hammer with 800 kJ working capacity.

HAMMERS.

Bêché counterblow hammers are predominantly used for manufacturing large and ultra-large forgings. The high impact energy and tonnage of the hammer dies, moving in opposite directions, permits precision forming of large forgings.

Short-stroke hammers are used for many kinds of applications, and are particularly suitable for small-to-medium sized parts. The sturdy, monoblock U-frame design, in conjunction with precise guides with a large surface area, provides high forging accuracy.

HOT PRESSES FOR SHEET METAL FORMING.
SPF, HOT DEEP DRAWING, DIFFUSION BONDING
AND SPF/DB.



FORMING TECHNOLOGY OF THE FUTURE. SCHULER'S PARTNERSHIP WITH FORMTECH.

Schuler stands for innovation and experience. We are leading because we always go one step further – providing the most convincing and ground-breaking solutions for the market. In the “Titanium Forming Alliance” we are developing a new generation of hot presses for the aerospace industry together with FormTech.

As the partner for process and technology, FormTech is contributing their outstanding expertise in titanium forming into the cooperation with the global market leader Schuler. FormTech has the highest levels of expertise available in forming processes, materials, die and components design as well as prototype manufacture and part production.

TITANIUM FORMING ALLIANCE



Partners in Super Plastic Forming

And Schuler has the technological expertise and capability to convert these innovative developments into reliable forming machines ready for mass production.

Thereby Schuler has opened up a new approach for using materials in aircraft production which are both lighter and offer higher performance, enabling sustainable design solutions. After all, fuel consumption and costs per seat and miles flown can be reduced further on the basis of these modern materials.

The titanium forming technology developed by Schuler and FormTech makes it possible to exploit the benefits of this material. An extremely wide range of parts can be formed efficiently with only small material losses: hot forming of titanium panels and plates ensures processing with efficient use of resources and an enormous reduction in production costs. Schuler is thus showing that it is economically feasible to increasingly incorporate titanium alloys with their high strength into aircraft design. The result: lighter designs with outstanding properties. This opens up totally new perspectives due to cost benefits.

FORMTECH

FormTech has over than 20 years of experience in the development and production of titanium components in aircraft construction. Today, the portfolio also includes production of sheet metal components made from titanium, aluminum, nickel and steel materials for additional areas of the industry. The company is a partner in various international development projects on new materials and applications such as noise reduction, laminarization of turbulent wing flow dynamics and optimization of hybrid components. FormTech has leading expertise in hot forming processes that can be used for high-strength materials.



Press technology from Schuler. Leading expertise from FormTech combined with the mass production skills of Schuler represent the first step into a new era of aircraft component production. Schuler's experience in global manufacturing plant design allows a reliable and efficient titanium forming process. The technological foundation for this has been proven in many applications such as mass production in the automotive industry or forging of high-stressed components. Now we are combining innovative forming processes from FormTech with Schuler's experience. Our new and ground-breaking solutions for hot forming presses offer economical production from the beginning and remain reliable over the long haul.

New generation of hot presses. The new hot presses from the alliance of Schuler and FormTech are designed for an unparalleled service life. Newly developed heating and insulation elements guarantee even heat distribution and high surface quality due to particle-free production, as well as a reduction of energy consumption. The low external temperature reduces stress on machine elements and increases operator safety. High-quality construction of all press components with a precise press force profile plus finely adjustable speed and precise guide systems increases component quality, guarantees high reproducibility and extends die service life. As an option, the automated part loading, preparation for hot die changes and production data acquisition allow for a further increase in productivity.

Aerospace industry. During configuration of the manufacturing systems, special attention is paid to the requirements of the aviation and space industry. Specific requirements such as small batch sizes, typical cycle times for titanium forming and high quality requirements in terms of temperature tolerance or surface quality can be met without compromise.



Hot forming cell with hot press, preheating furnace for dies and part manipulator.

SUPER PLASTIC FORMING (SPF).

For super plastic forming, sheet metal parts are formed by hot gas pressure at high temperature. A heat chamber is integrated into the press and ensures the consistently high temperature at the workpiece. Only one operation is needed to form complex parts with very high accuracy.

DIFFUSION BONDING (DB).

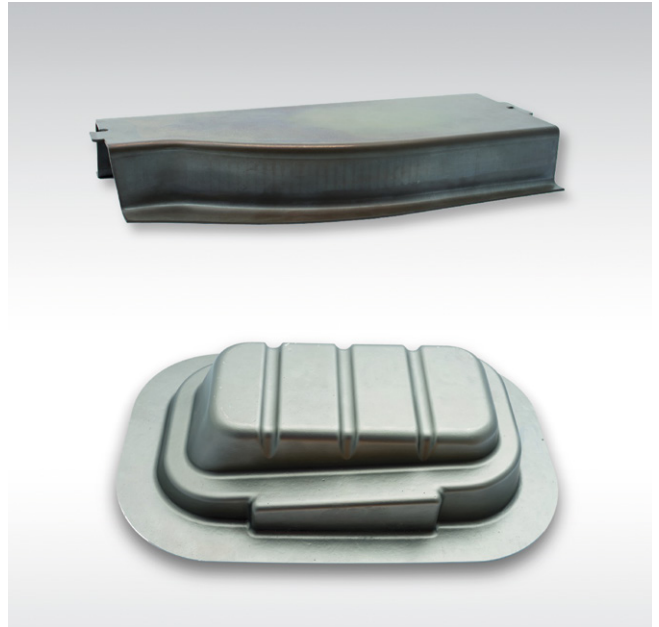
During diffusion bonding, the individual metal parts (that can be of different composition) are subject to high pressure and heat in a vacuum or inert gas atmosphere. The resulting bond of the parts is very strong.

COMBINATION OF SPF / DB.

Certain areas can be kept from bonding during the DB process by applying an inhibitor on the surfaces. The not-welded gaps can be expanded by gas pressure. Complex hollow structures such as integrally stiffened sandwich-like panels can be produced by this combination of SPF and DB.



Tie rod (SPF), cooler outlet duct (SPF-DB).



Door frame surrounding (hot deep drawing), Housing for freighter conversion (SPF).

Parts: FormTech

HOT FORMING (HF).

During hot forming, sheet metal parts are formed by matching dies. Forming speeds are slow and the forming temperature is below SPF-temperature. Cold formed sheet metals parts can be hot calibrated.

HOT DEEP DRAWING (HDD).

The hot press is equipped with a drawing cushion in order to produce deep drawn parts. The cushion force is transferred onto the blank holder by heat resistant drawing pins. As the blanks are rather soft at elevated temperature, blank holder forces must be low. A precise and sensitive control of the drawing cushion is very crucial for obtaining good deep drawing results. Low forming speeds for hot deep drawing make yet another high demand on the control quality of the hydraulic system of the press.

The parts:

- Scuff plates, door frame surroundings
- Half shells for tanks, ducts
- Window frames
- Stringers, Ribs
- Pylon parts
- Fanblades
- Skin parts
- Nacelles
- Housings
- Lipskin

The advantages:

- Long service life of machine components
- Innovative heat chamber design
- Low heat loss – improved energy efficiency
- Precise temperature control
- High productivity
- Repeatable high part quality
- Precisely controlled drawing cushion (for hot deep drawing)

ISOTHERMAL FORMING PRESSES AND CALIBRATING PRESSES. HIGH FORCES WITH THE HIGHEST PRECISION.



6,300 kN Isothermal forming press with integrated heat chamber.

High Deformation Degree with Isothermal Forming. Die and workpiece have the same, constant temperature throughout the isothermal forming process. Complex geometries with high dimensional accuracy can be manufactured, and parts with high degrees of deformation are feasible. The major strain rate and flow stresses are very low, preserving the die and supporting material distribution in the cavity.

Isothermal forming presses from Schuler offer a high-precision control of ram speed and ram force, which can be adapted to the changing part geometry during the forming process.



Heat chamber in isothermal forming press.

Removal of Residual Stress with Calibration Presses. Calibration or thermal fixation can be applied to remove residual stress of the workpiece, caused for example by previous (cold) trimming operations. Parts are subject to a constant pressure in the press die, with the furnace heated slightly below forming temperature. Thermal stabilization can last several minutes.

Calibration presses from Schuler keep the selected pressure constant during the calibration or fixation process, which can last up to several minutes.



Compressor blade for jet engine, disk for jet engine, blisk for jet engine.

Process-optimized lines for maximum efficiency. Special attention during line design is directed to the needs of the aviation and space industry. Specific requirements such as typical cycle times, high demands regarding temperature tolerance or surface quality can be met without compromise.

The integrated energy-saving heat chambers and their precise heat control are complying with the highest demands. Together with the optional process data acquisition and recording, the production can be set up in accordance with process specifications of the space and aviation industry.

Precise forming of high-performance light-weight materials. Light-weight materials such as titanium, aluminum, magnesium and increasingly titanium-aluminide can be formed with a high degree of deformation and free of residual stress. The outstanding process control of isothermal forming presses from Schuler is allowing for a high-precision part production.

The parts:

- Compressor blades
- Disks
- Blisks

The advantages:

- High-precision control of ram speed and ram force
- Variable and part-specific ram speed
- Precise temperature control
- High energy efficiency
- High machine rigidity

TRIPLE-ACTION DEEP DRAWING PRESSES. MACHINES IN A NEW DIMENSION FOR THE AERONAUTICS AND SPACE INDUSTRY.





Hydraulic press for manufacturing individual parts for booster rockets used in civil spaceflight.

Hydraulic presses at greater magnitude. Booster rockets are getting bigger and bigger so they can transport heavier payloads into the orbit. The components of which the rockets are made are also increasing in size – and with them the machines that are used to produce them. With a bolster size adapted to the dimensions of the aerospace industry's components, Schuler is capable of meeting the requirements of this highly specialized industry.

The enormous dimensions of these machines impose significant challenges on the facilities that produce them. With decades of experience in building large-scale machines, the experts at Schuler are capable of reliably meeting such enormous requirements.

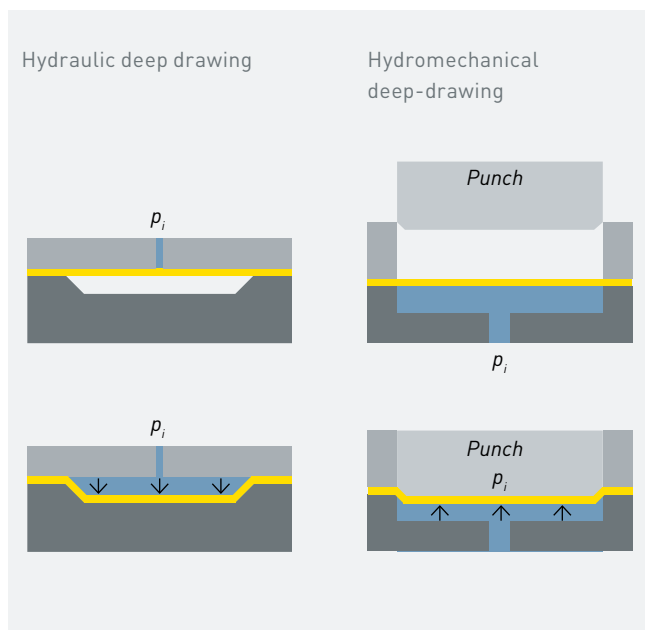


Civil booster rocket Soyuz-2.1b.

The solution are double or triple-action hydraulic presses for deep-drawing of metals or special materials. They produce parts such as fuel tank bottoms, nozzles of rocket engines, payload fairings and other rotationally symmetrical components.

They must be extremely resistant to withstand the highest stresses, above all during a rocket launch.

HYDROFORMING AND FORMING FIBER-REINFORCED PLASTICS. MACHINES FOR WEIGHT REDUCTION AND GREATER DESIGN FREEDOM.



Sheet metal hydroforming.

HYDROFORMING BY SCHULER.

Hydroforming tailored to requirements. Schuler offers various sheet metal hydroforming processes for manufacturing parts with complex shapes. The parts are formed with a fluid under pressure. In contrast to conventional drawing processes, it is possible to manufacture spherical geometries in one production step. At the same time, dimensional accuracy and surface quality are significantly superior to what can be achieved in conventional forming.



Hydraulic press for manufacturing fiber-reinforced plastics at Schuler.

PRESS SYSTEMS FOR FIBER-REINFORCED PLASTICS

Minimal part weight. Fiber-reinforced plastics offer a great deal of scope for design, as well as minimum component weight. These advantages are also proven in autobody production. Schuler hydraulic press systems deliver innovative solutions for high volume production of fiber-reinforced plastics, and meet the most demanding requirements for component production. Hydraulic press systems are suitable for series production of SMC (sheet molding compound) components, GMT (glass mat thermoplastics) components, and RMT (resin transfer molding) components.

PARTNER TO THE AEROSPACE INDUSTRY.
SCHULER IS ON YOUR DOORSTEP WITH ITS OWN
SITES AND AGENCIES.



WHEN BUSINESS AS USUAL BECOMES TOTAL SATISFACTION.

THE SERVICE IN METAL FORMING TECHNOLOGY



Do you need quick help with your system?
You can count on our **24/7 Hotline & Remote Support** – wherever and whenever you need it.



Thanks to our worldwide service centers, our experienced **Field Service** specialists can be on-site in no time at all to solve any problem.



And if one of the components of your system ever fails, we can quickly and easily help you with a suitable **spare part** and thereby minimized expensive system downtimes.



Would you like future-proof systems, with efficiency and performance like on the first day and also fit for Industry 4.0? Whether it be a press from Schuler or a third-party manufacturer, with our **overhaul and modernization solutions** you can make your system ready for the future now.



So you can remain flexible at all times in production, around 400 **used presses** – mechanical and hydraulic presses from a wide variety of manufacturers – can be delivered quickly.



Increase the efficiency of your systems in the press shop with our **Digital Solutions**, from camera-assisted die monitoring to digital fault cause identification right through to the smart use of machine data – find out, based on real-life examples, how digital solutions are easy to retrofit and will really prove their worth in your press shop too.



We support you in achieving your financial and ecological goals. Save energy costs and improve your CO₂ footprint by retrofitting the Eco-Form package and the **Energy Monitor**.

Learn more and visit the Schuler Service website:
service.schulergroup.com



SERVICE
MADE
FOR YOU



SERVICE MADE FOR YOU

**WE REDEFINE SERVICE.
MADE FOR YOU!**

**DISCOVER NOW HOW THE NEW SCHULER
SERVICE CAN BENEFIT YOU.**

Service – Made for you stands for service that is precisely tailored to your needs. Regardless of what type of press or system you work with.

Fast. Competent. Reliable.

ABOUT THE SCHULER GROUP – WWW.SCHULERGROUP.COM

Schuler offers customized cutting-edge technology in all areas of forming – from the networked press to press shop planning. In addition to presses, our products include automation, dies, process know-how and service for the entire metalworking industry. Within the Metris platform by ANDRITZ, Schuler brings together digital solutions for networking forming technology and develops them continuously to further improve line productivity and availability. For battery production in gigafactories, Schuler provides equipment and services in the process steps of cell assembly and formation. Our customers include automotive manufacturers and suppliers, as well as companies in the forging, household appliance and electrical industries. Presses from the Schuler Group mint coins for more than 180 countries. Founded in 1839 at our headquarters in Göppingen, Germany, Schuler has approx. 5,000 employees at production sites in Europe, China and the Americas, as well as service companies in more than 40 countries. The company is part of the international technology group ANDRITZ.

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