Cold-Formed Parts
ESKA® manufactures complex precision cold-formed parts for applications with large and medium quantities. The highly-efficient cold-forming process ensures economic manufacture of near-net-shape metal components with minimised material input. For this purpose, ESKA® uses up-to-date multistage heading machines with up to six forming stations.

A wide range of cold-formable steel grades and aluminium alloys are used as wire materials within a diameter range from 5 mm to 34 mm.

These materials are then shaped into finished parts by means of complex forming dies designed and made by ESKA® to meet the specific product requirements. This is done almost chipless with production output rates between 100 and 300 parts per minute, thus ensuring maximum utilisation of material used.

Reproducibility of manufacturing process is ensured thanks to the use of latest process monitoring equipment, tracking the force-path characteristic of any individual forming step and displaying any variations such as, for instance, die breaks.
Load-Bearing Microstructure

Upon cold forming, the material microstructure is aligned along the material flow. This can be detected by the micrograph pattern as so-called fibre orientation. This alignment mostly complies with the load direction of component whereby the parts so manufactured will get a distinctly higher loadability as compared to components made in a purely machined process. In particular, the strength under alternating loads can be considerably improved by specifically applied residual stress. Thanks to the forming process, the material is strain-hardened as a function of local forming degrees. Suitable design supposed, the increase in strength so achieved will already suffice to meet the component functionality; any additional heat treatment is not required any more.

That is why cold-formed parts can be frequently dimensioned smaller and lighter.

Thanks to intelligent tool design, it is also possible to form-on other functional elements. As a consequence thereof, additional cost-intensive machining steps become unnecessary.

Large diameter gradations can be implemented upon cold-forming without and/or with minor material waste.
The core competence for manufacture of cold-formed precision parts includes the constructive design of forming process and tool set required to this end.

Here, ESKA® falls back on experienced personnel as well as latest aids such as forming simulation, computer-based design of sequence of operations and FEM-calculation of die loads, ensuring statements regarding feasibility and efficiency right at the enquiry stage.

Development of a new cold-formed part is an ambitious task. As cold-forming technology offers other possible solutions than machining technology for a concrete job definition, the manufacture of a new component should already be defined in detail at an early stage upon design thereof. Cost-effective design is associated with constructive design meeting the requirements of cold-forming process, at the same time the component geometry is also optimised for process-reliable manufacture.
Tool Shop

Latest production lines installed in the own tool-making shop and excellently trained experts will support the development and manufacture possibilities for ambitious forming parts.

5-axis CNC-milling machines, wire and vertical eroding machines as well as automatic lathes of the latest generation complete the standard program of our tool manufacture.

A repair service available around the clock ensures high availability of cold-forming machines that is nowadays indispensable for efficient production of large-batch parts.

Own tool competence ensures flexibility and quality!
Guidelines for Engineering and Design

Cold-formed parts are normally characterised by rotationally symmetrical geometry and are designed in compliance with the following design guidelines. Further, special processes may be used to make non-rotationally symmetrical or other complex geometries. However, design of such parts requires special know-how of the part manufacturer.

The constructive design of cold-formed parts is mainly based on three fundamental forming variants which are different, in particular, by the maximum feasible deformation degrees:

- **Direct impact extrusion**
  
  Sectional reduction max. 75 %
  
  i.e. final diameter approx. 0.5 times the initial diameter

- **Indirect impact extrusion**
  
  Sectional reduction 30 to 70 %
  
  Cup depth up to approx. three times the cup diameter

- **Upsetting**
  
  Initial length up to 2.4 times the initial diameter per stage
  
  Final diameter up to approx. 2.5 times the initial diameter
What are the Key Issues?

Avoid material accumulations
Geometries with local material accumulations may cause problems in the cold-forming process as regards material flows, pressing forces, and tool lifetimes. Therefore, technical feasibility must be verified in the individual case together with the manufacturer.

Avoid asymmetrical component shapes (see Graphic 1)

Avoid strong wall thickness transitions (see Graphic 2)
Strong wall thickness transitions must be avoided. If necessary, transitions must be provided with sufficient radial transitions.

Provide transition radii
The forming parts to be manufactured should not have sharp edges and angles as far as possible in order to preclude early wear and tear of forming tools. Incorporation of additional edges or small radii will require additional forming steps.

Provide fillets
Geometrical offsets such as, for instance, diameter gradations require sufficient transition radii to ensure adequate material flow. Chamfers should also be designed with fillets, too.

Blind holes
Blind holes can be produced by indirect impact extrusion. It must be noted thereby that a rectangular shape cannot be realized at the cup bottom without cutting. Normally, the cup punches used require taper centres with an angle of ~160°.

Through holes
Display of through holes in pressing direction is subject to some definite restrictions as regards the length vs. diameter relationship and must be verified in the individual case. Hole diameters under 10 mm should be precluded.

Undercuts
Undercut geometries can be realised by design concepts with collapsing tools which, however, require defined diameter and length ratios as well as transition bevels and, thus, constructive design by an expert. It must be noted here that segmental marks on the smaller diameters enclosed cannot be totally precluded.

Supplementary functional structures
Further to the proper component geometry, supplementary structures such as serrations, longitudinal notches or other shaped elements can be made by the cold-forming process. However, the structure must be aligned in main axis direction there.

Avoid tapered structures (see Graphic 3)
Unlike forged parts, tapered design of structures is not required for cold-formed parts. If need be, the required pressing force demand as well as tool loads must be investigated together with the manufacturer in order to ensure economic manufacture.
Boundary Conditions and Limits of Cold Forming

Materials

Adequately composed and manufactured materials featuring sufficient ductility as well as appropriate strain-hardening behaviour are used for cold-forming purposes. This normally implies low-alloy steels without sulphur and low carbon content, very often with boron content in order to maintain hardenability. However, higher-alloyed steels may be used for high-strength parts or even wrought aluminium alloys can be used.

Surfaces

Wire sections to be processed are sheared off the wire coil on the forming machine and, therefore, show end faces with shear-surface characteristics that cannot completely be eliminated in most cases. Further, the wire surfaces also show minor scarredness depending on material due to the removal of surface coating. Therefore, demands on the surface finish should be carefully considered in order to preclude cost-intensive post-processing steps.
Parts Handling

Thanks to the high efficiency of cold-forming process, parts are usually manufactured in bulk solid processes. This should also be considered even in the constructive design of forming parts.

Tolerances

When tolerancing the component measures, particular care must be taken to adjust the tolerance positions from the conventional machining process to the technical forming process as far as functionally possible. So, additional downstream machining operations can be frequently precluded.

Comparison of achievable tolerance positions of different manufacturing processes

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<th>Main group</th>
<th>Manufacturing process</th>
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<td>Circular grinding</td>
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- Normally achievable
- Achievable by special measures
- Achievable in exceptional cases

Length sizes

Upon shearing off the wire coil, volumetric variations of the blank might occur. In case of sectional reduction, said variations go squared into the length variation.

Diameter

Component diameters are partially upset over several stages and may vary in length. Once a diameter is specified, for instance, by an extrusion die, enlargement of diameter due to die wear must be considered with increasing die lifetime. Upon free upsetting, the material flow is not entirely uniform so that roundness deviations and diameter variations may occur. Therefore, the selected tolerance positions and specified demands made on process capabilities are decisive criteria for the possible lifetimes of forming dies and, thus, for the efficiency of overall process.
Application Examples

**Ball stud**
- **Application:** Fixing of gas springs, dampers, electric drives
- **Material:** 23MnB4 - 8.8, 10.9, if need be, case-hardened or aluminium
- **Forming:** 5 to 6 steps
- **Specialties:** Chipless manufacture of ball by forming in collapsing tools, no welding of separately produced ball, no secondary machining

**Hinge pin**
- **Application:** Integral part of a hinge system for car doors to ensure the latching function upon opening and closing
- **Material:** 23MnB4, 1.200 MPa, case-hardened
- **Forming:** 6 steps
- **Specialties:** Fitting notches without subsequent machining, directly extruded

**Bellied bush**
- **Application:** Inner core for elastomer bearing on steering arm
- **Material:** QSt 32 (untempered)
- **Forming:** 6 steps
- **Specialties:** Chipless generation of spherical contour by cold forming, achieving required pressure stability thanks to strain hardening and load-compliant fibre orientation

**Spacer bush**
- **Application:** Car tank suspension (rubber-coated)
- **Material:** C10C (untempered)
- **Forming:** 5 steps
- **Specialties:** Chipless manufacture of undercut geometry by forming in collapsing tools, achieving required strength thanks to strain hardening and load-compliant fibre orientation
Stop pin
Application: Location of catch hooks for tip-up car seats
Material: 23MnB4 – 8.8
Forming: 5 steps
Specialties: Chipless manufacture of undercut geometry by forming in collapsing tools

Bearing pin
Application: Fastening of coupling rod to stabiliser on car chassis
Material: 23MnB4 – 10.9
Forming: 6 steps
Specialties: Weight saving thanks to cupped head design, chipless manufacture of cupping by indirect extrusion

Eccentric pin
Application: Position correction of car dashboard during car assembly
Material: 23MnB4 – 8.8
Forming: 5 steps
Specialties: Forming of non-rotationally symmetrical geometry, correct positioning of wrench flats to thread position during the forming process

Valve housing
Application: Central camshaft screw with integrated control valve for camshaft phasers
Material: 41Cr5S4 – min. 1.000 MPa
Forming: 6 steps
Specialties: Manufacture of lathe blank by cold forming with downstream precision machining
If you have questions associated with the products of ESKA®, our expert personnel and technically competent field service consultants will always be available to give you relevant advice.

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