

# Use of reverse engineering for manufacturing a reflector for Jawa 250 Duplex

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## ***Abstract:***

*The thesis is about rediscovering technology manufacturing processes, tools and products that have been forgotten over time or technologies now rarely used (manual metal spinning technology), in the light of new technologies. Reverse engineering, which facilitate the designing part (coordinate measuring machine, CNC lathe, CNC milling machine). This thesis discusses how the various materials that have been tested for the production of the reflector, as well as their properties, using the same tools and processes.*

## ***Keywords:***

*Spinning, spinning form, reverse engineering, coordinate measuring machine, Jawa 250 Duplex, data parameterization.*

## **1. Description of hypothesis for experimental production of reflector**

In determining the basic hypothesis of the experiment draft production reflector Jawa 250 Duplex, it was already known that this experiment because of the specified requirements for production technology extrudate will not be easy and may have unexpected conclusion. When manually pushed material sheets are formed in traces of forming tool which is called cue. Cues exist in several types according to their use for gradually forming components and cues roughing, smoothing, parting, deburring etc. Furthermore cues vary according to the material that is used for forming the tip, that is, steel, brass, aluminium or mica, for shaping the material coated. The body itself cue is made of wood. These tracks, otherwise also known as fiber pushing are not recognizable; do not differ in shape or topography of the surface. Deleterious manifestation fibers pushing occurs only when need be embossed perpendicular to the pressed surface such as a cylindrical vessel. Because the material is pressed through pushing individual fibers, there is an increase in tension of the material and its subsequent fracture. This fact was known before the actual design of experiments, and many experts in the field of metal spinning discouraged us from the experiment, due to the expected failure of the practical test. Our practice verification after the development of appropriate instruments, for spinning, as well as stamping, we wanted to perform a different materials and different thicknesses. This is to compare potential dependence.

## 2. Description of the technology of metal spinning

According to [1]. Spinning is a very old technological process of chip less metal processing. Only in recent years, however, there was a significant qualitative shift in applications of this technology. The new view is metal spinning now recognized as one of the most advanced industrial technologies pushing sheets for the manufacture of hollow rotating bodies forming. It can be used not only for production of hollow circular part, but also to produce hollow containers elliptical shape, forming a curve whose profile can have a completely arbitrary shape. Pushing technology you can do. These technological operations:

- flanging,
- piping,
- expansion,
- swaging,
- rifling,
- mounting at the edge or in the jacket shaped surface convex or concave.

Technology of metal spinning (spinning, circling) can be divided into two main groups:

- classic metal spinning without wall thinning as arts – so called simple (conventional) metal pressing. Includes forming a rotating blank space with a closed surface generally shaped container with a concave or embossed surface without reducing the wall thickness;
- pushing the reduction of wall thickness (thinning of the wall thickness as arts) - i.e. Pushing the shear plate, in which unlike simple push is deliberately wall thinning as arts (extrudate), wherein the original thickness of the precursor has a bottom product.

Technology of metal pressings without wall thinning is original, hundreds of years old technology in which the final thickness of the moulded vessel wall remains the same with the initial thickness of the blank.

Technology metal pressings thinning the wall is already progressive technology in which the wall thickness of the final product depends on the angle of the curve forming at the contact roller. The precursor is several times thicker than the wall thickness of the finished rotating parts. Technology metal pressings thinning wall brings high material savings, in some cases up to 95%. The surface quality of internal shapes virtually replicates the surface texture parameters used mandrel. The surface structure of the external shape of the component is determined by the surface geometry and used pulleys and technological parameters. The precursor (roundel) for this technology does not always have a circular shape. It is possible to start the blank square of scissors, welded blank, pipes, pre-pressed cup etc.

### 2.1 Production possibilities

Further development of the original manufacturing process known metal spinning were discovered entirely new possibilities for using the principles of this technology for the development of advanced, high-precision engineering technologies in the field of sheet metal

forming technology, which can even be surface treated. Wider use of technology pushing assumes that through the development work will be expanded range of parts molding techniques with respect to the achievable precision products. Furthermore, for the economic use of forming processes will be reduced mostly due to high numbers of pieces. The basic goal setting derives also from the fact, that within the engineering industry are rotationally symmetric parts small and medium series, which are traditionally processed mainly machining technologies.

Economic production of small and medium-sized number of pieces is required also in the range of forming technology development and deployment of flexible and automated manufacturing sectors inexpensive to operate. Are suitable for this forming process, in which the forming of the sheet takes place by means of relative movements between the product and the tool. That can be achieved by modern CNC device a high degree of automation while flexibility of production.

Spinning procedures have independent kinematics comparable to machining, which is an advantage for combined forming and machining in a single clamping of the material.

## **2.2 Advantages and disadvantages of of rotary metal spinning**

The general advantages of production with hydraulic rotary spinning lathes mainly includes:

- Low cost tooling, which are simple and largely universal,
- short set-up times (simply because it pays to apply that technology to produce a small quantity or even making one piece)
- possibility of process automation in small and large quantities, (i.e. For single and serial production)
- very good possibilities of making larger components, e.g. a diameter of 3600 mm and a thickness of 4 mm,
- the possibility of making a part with high accuracy ( $\pm 0.05$  mm), low manufacturing tolerances and high quality finish,
- saving of material in the manufacture of conical shapes pushing a special way,
- saving of material, using a rotary pushing part of cylindrical shape, in which there is a thinning of the wall plate,
- rotary push technology allows forming only deep-drawing steel, but stainless steel, heat resisting steel, ferro-chromium, titanium and its alloys, steels with higher strength, but also ferrous metals.

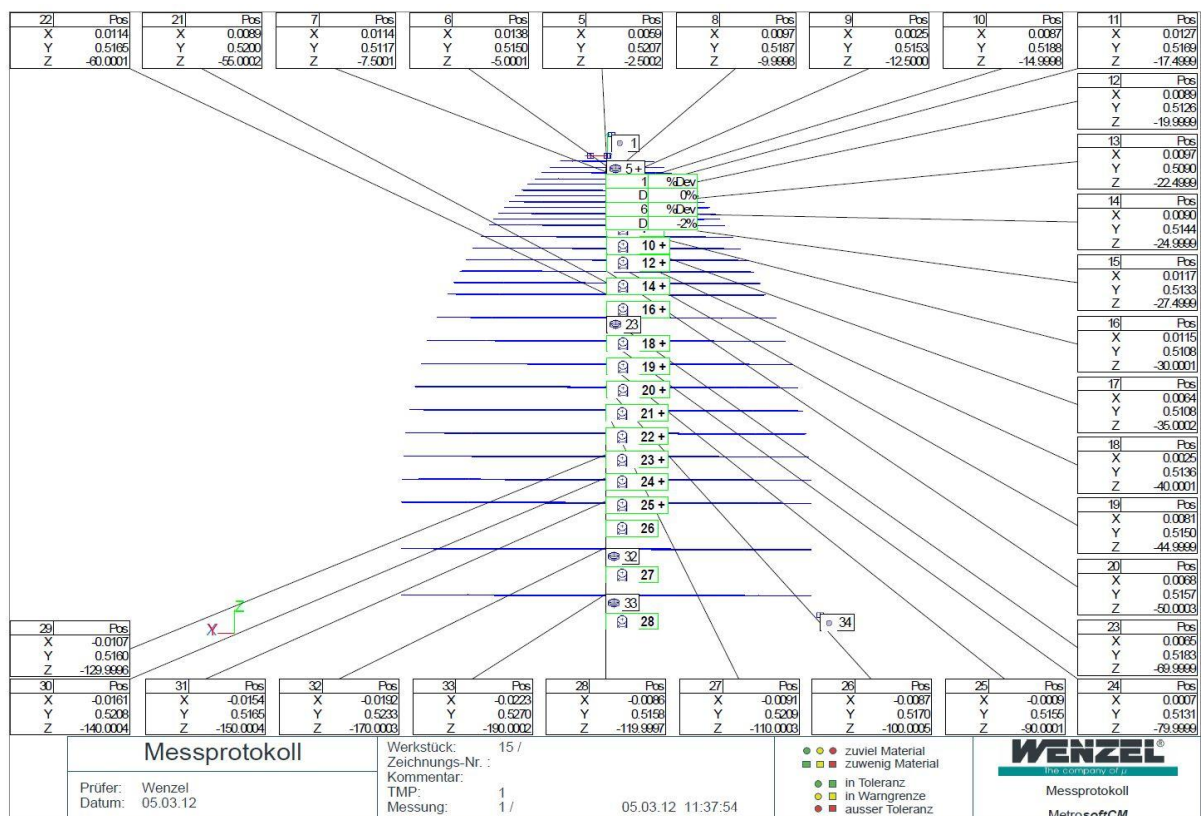
The benefits include mainly the relatively lower labour productivity in comparison with some deep drawing technology.

### 3. Description of the production process of the mould - reverse engineering

#### 3.1 Measuring the shape of the reflector 3D SMS

For the production of the spinning the mould, the procedure itself will be described subsequently, it was necessary to determine the exact shape of the reflector, which is a rotational paraboloid. The shape has been recorded with the 3D coordinate measuring machines (CMMs), by single-point reflector at predetermined coordinates. To verify the values we were to take the spotlight and experimentally using scanning head, where we received instead of discrete values of the continuous. Coordinates and measured discrete points formed a network that had a variable density. The density of the densest networks in the top paraboloid because of that in the peak paraboloid most changes shape itself and therefore this place for our experiment is very important.

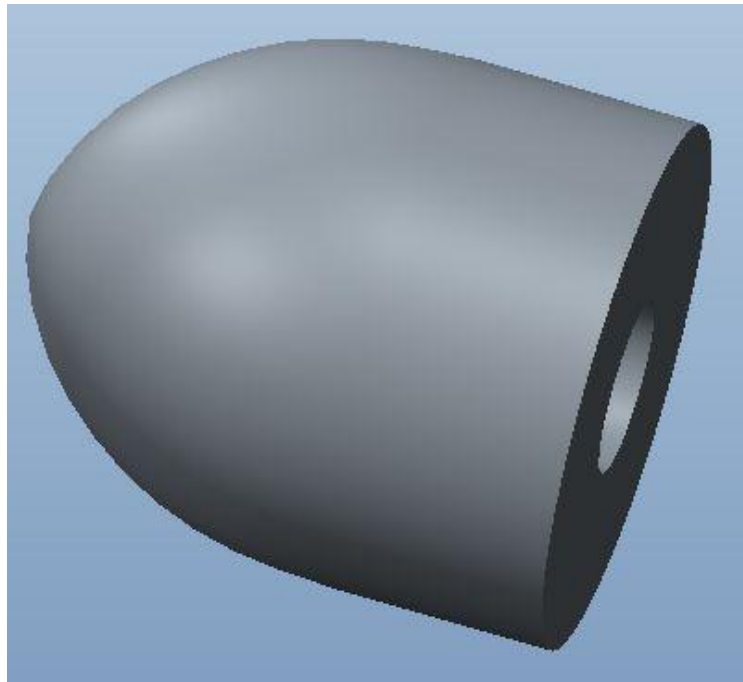
After scanning the actual coordinates of discrete points on the paraboloid SMS, it was necessary to parameterize these points and space them a curve. An important factor in the parameters measured data, determine whether the designated points can curve space or not. Therefore it was necessary when the parameter data exclude some points. The error in measurement has occurred for several reasons. The most important was that, because it is almost 80 years old parts, which are signed by the ravages of time, and despite the fact that the surface (stripped of all coats of paint blast) was repolished, it was not ideal.



Picture 1. Measuring protocol reflector Jawa 250 Duplex

### 3.2 Production of the spinning mold

Spinning mold for making the reflector Jawa 250 Duplex was manufactured on a CNC lathe according to data obtained from 3D SMS. The material mold was elected dural with properties that are very useful. The wooden mold was inappropriate because of further use of mold. Steel on such a large mold is not used because of the heavy weight. As seen from Figure No.2 is spinning very simple form. Often used advancement form i.e. a few simple forms through which the formed final product.

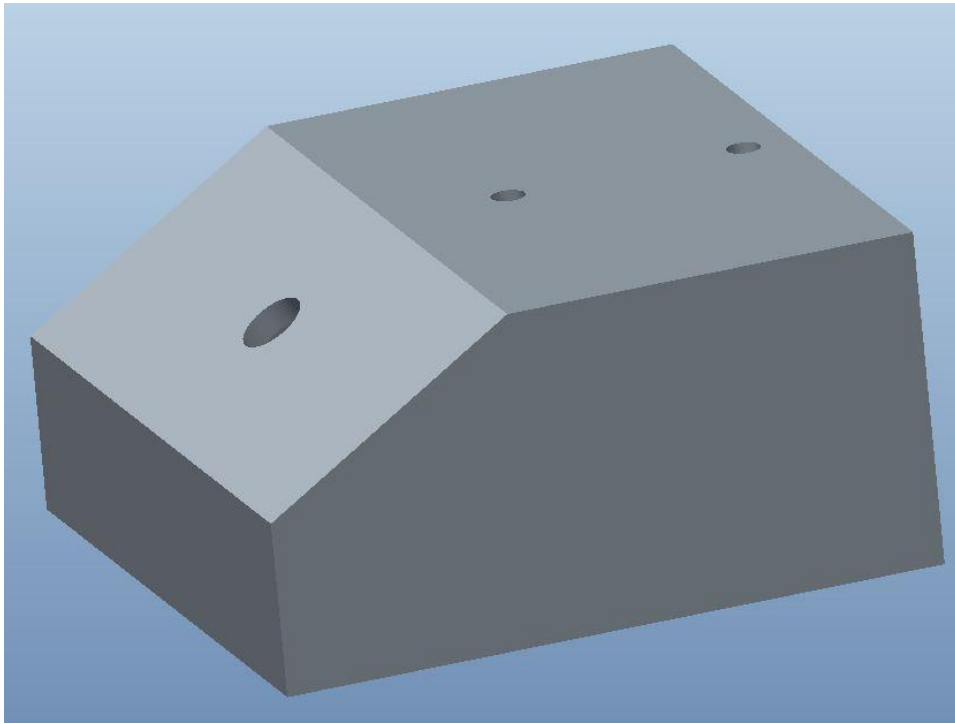


*Picture 2. Model spinning forms*

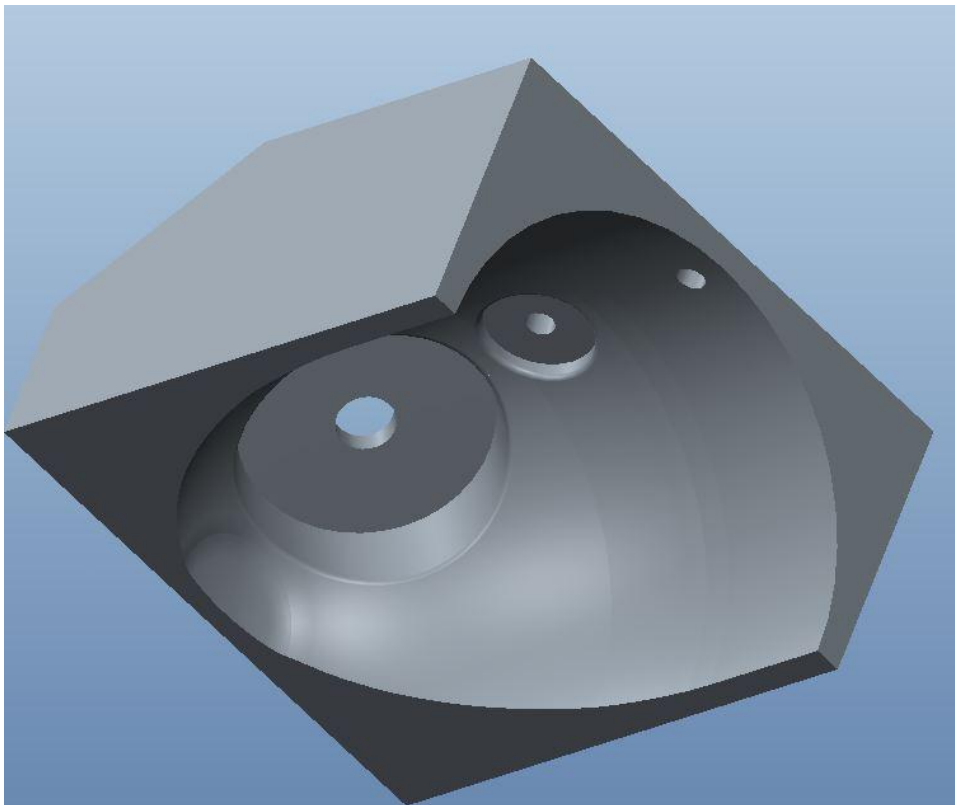
### 3.3 Production of tools - Holding Puncheons

Tool - upper and lower holder was developed because of the need dragging rotating vessel (place where it will be placed on the reflector tachometer) perpendicular to the fiber pushing. It was assumed that during this campaign will be material to crack. Retainers were made on CNC milling machine from data scanned 3D SMS when a measurement of the finished shape of the extrudate, because the assumption that the material slightly springs. In this second form measurement were compared scanned values, which suggest that the cushioning material was constant and according equidistant from the original shape. The lower and upper retainers were optimized using a number of experiments where the most important parameter was the possibility of creep, wherein the flow of material must be sufficient to tear the material. The problem with large freedom for the material flow is that the material starts to deform the material begins to undulate and translate.

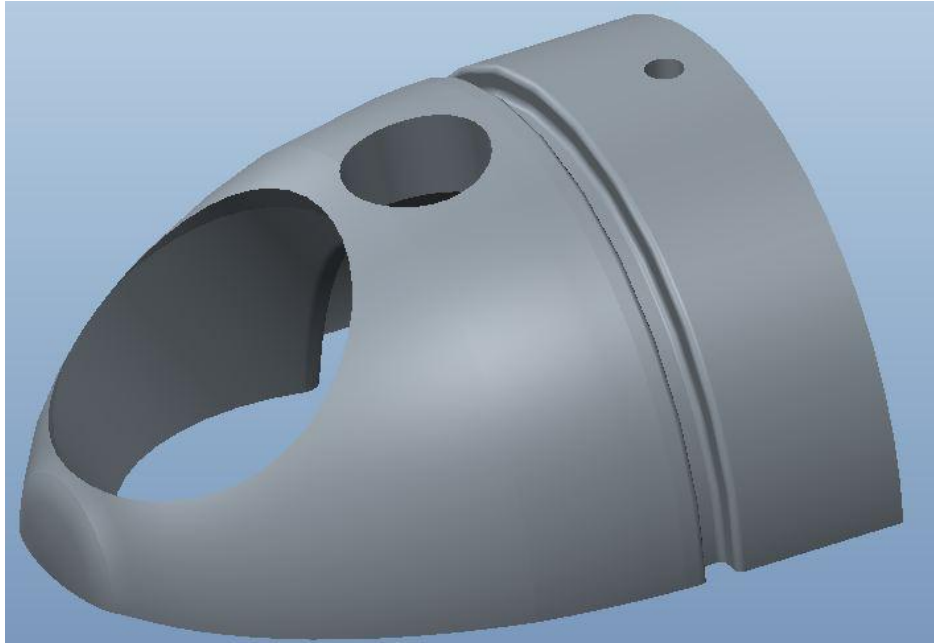
To develop reflector Jawa 250 Duplex was very important to develop a rolling punch. Original assumption was Puncheons have two, one sliding (a conical shape with a large pitch angle) and one calibration (the negative shape of the final extract).



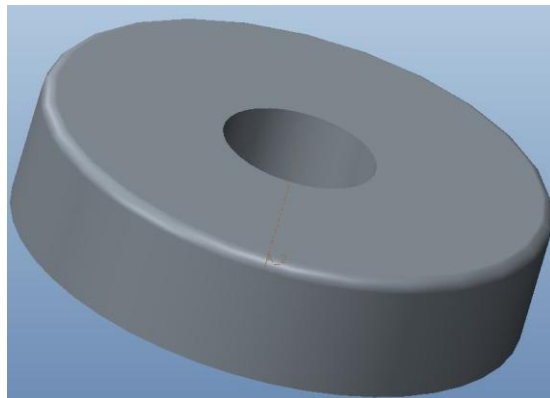
*Picture 3. Model upper blank*



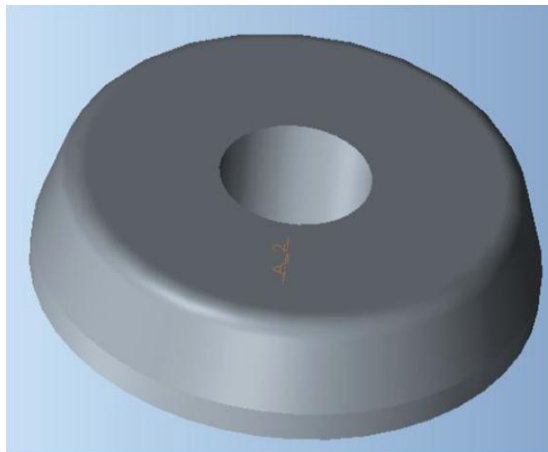
*Picture 4. Model upper blank*



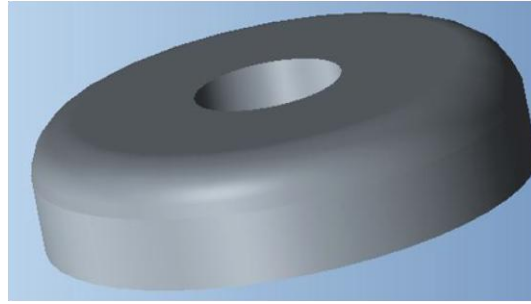
*Picture 5. Model lower blank*



*Picture 6. Model calibration rolling punch*



*Picture 7. Model expander rolling punch*



*Picture 7. Model expander radio rolling punch*

During experiments it was found that despite the material will optimize for creep deforms and snaps. For this reason, there was a further rolling to produce the punch that is no longer conical, but has a large radius. To perform the tests, it was found

#### **4. Experimental findings cutout diameter of the cylindrical container**

It was also experimentally determine the diameter of the blank at the bottom of the cylindrical container. Already from the initial hypothesis, and balance for the overall development of the reflector has been determined that the bottom of the blank to be cut out twice. Option that the hole cut out in the base after the final pressing eliminated after the first test, the material can not flow despite developed progressive broachers material cracked. For this reason, all the other tests, it was suggested that it will establish the largest possible diameter of the primary cutting under conditions that left on the overall material quality molding with allowance for trimming.



*Picture 8. Extrusion and molding reflector Jawa 250 Duplex*





*Picture 9. Extrusion and molding reflector Jawa 250 Duplex*

From Fig. 9 it is evident how the shape looks like deformation. The split holes. After completing twelve compression experiments have the split hole analogous shape. That created a small crack on the material does not affect the functionality of the extrudate - Extracts, because this section is in addition to trimming.

## **5. Conclusion**

When developing tools spotlight on Jawa 250 Duplex method was used reverse engineering, where the components exist and production documentation process from scanned shape corresponding rotational paraboloid, flow-through production molds CNC lathe. During the development tools used CNC milling machine. Extrudate was checked whether any cushioning material. After evaluation of the measured data were made on optimizing flow-form.

When setting the basic hypotheses of the experiment draft production reflector Jawa 250 Duplex, it was known that this experiment due to specified requirements for production technology extrudate will not be easy. Because when you manually push plates are formed on the material traces of the mold. This initial hypothesis has been confirmed and the problem with the fibers pushing proved essential for the completion of the reflector. After many experimental molding were developed upper and lower retainers. They have proved to function properly as a major pressing. With these retainers it is possible to flow the material in the pressing direction without its tearing, waves or other deformation. Have also been proposed to follow brochures that after the results of individual experimental moves have been optimized so that the excavated material had the best quality and also to shape the direction and the surface of the extruded cylindrical vessel closely resembled reflector, which served as a template for stamping.

The project was the production of the spotlight through many problems that arose due to the combination of two technologies that are distinct in their principles, successful and according to the attached photos in Chapter 4, it is clear that despite the complications it is possible to use this principle to other types of reflectors, or like parts.

## **6. Application Literature**

[1] Rotační tlačení plechu s povrchovou úpravou. *MM průmyslové spektrum* [online]. 2001, roč. 2001, č. 7 [cit. 2014-04-13]. Available z: <http://www.mmspektrum.com/clanek/rotacni-tlaceni-plechu-s-povrchovou-upravou.html>