DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING
Budapest University of Technology and Economics

Metal Forming

Guidelines for the semester projects

BSc - 2023/24-1

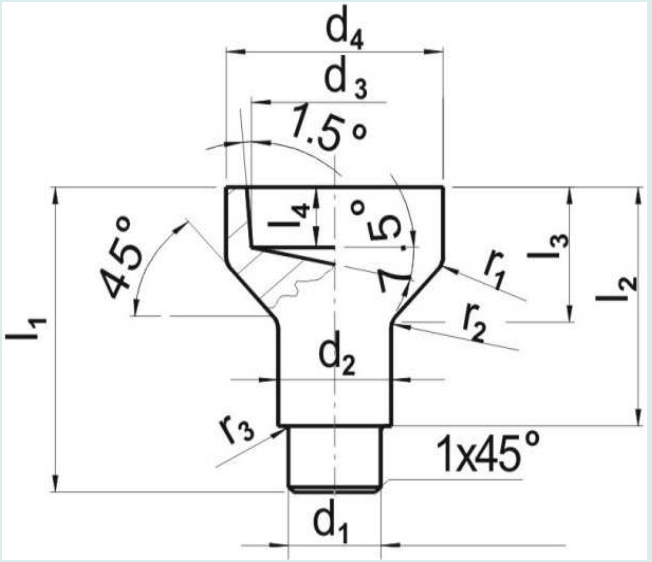
Ver. 7

Project sheet

Step zero:
Draw the real workpiece!

Task

1. Plan the forming technology for the workpiece according to the figure, using the data and material below.
2. Design the die of the last forming step.



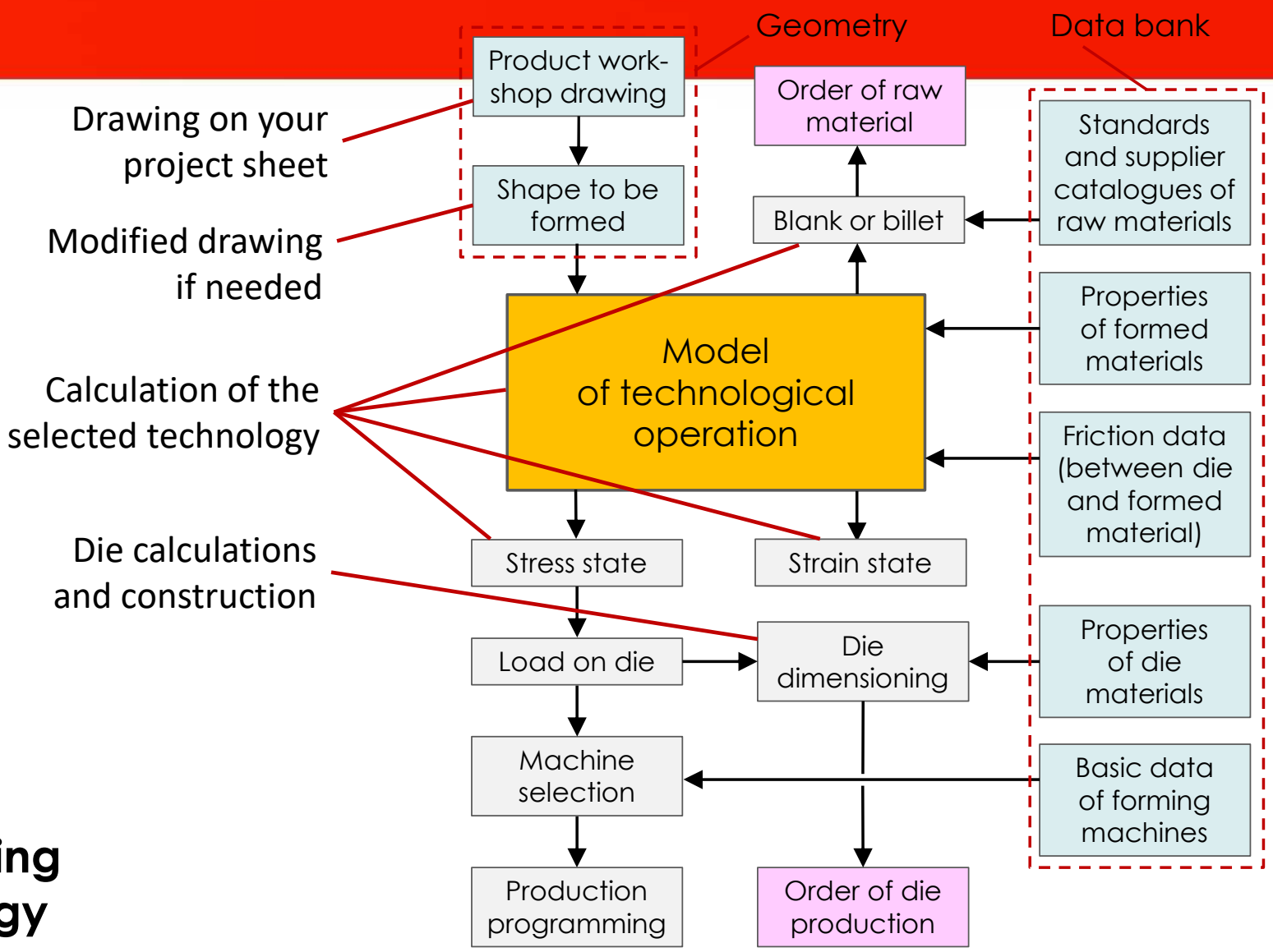
Report Content

- Issued project task sheet
- Description of forming steps with figures
- Details of calculations: analytical and (FEM)
- Drawings: full die assembly drawing of the final forming step
- Heat treatment of active die elements
- Sources (author/title/editor/date or URL/date

Data: Material: Al99.5

d_1 = **15**	l_1 = 90	r_1 = 1
d_2 = **15**	l_2 = 80	r_2 = 3
d_3 = 20	l_3 = 40	r_3 = 3
d_4 = 26	l_4 = **0**	r_4 = -

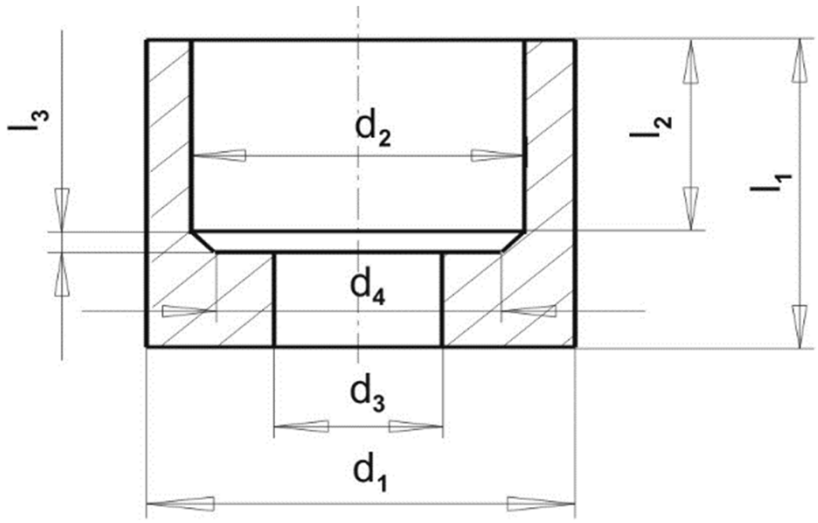
Planning of a forming technology

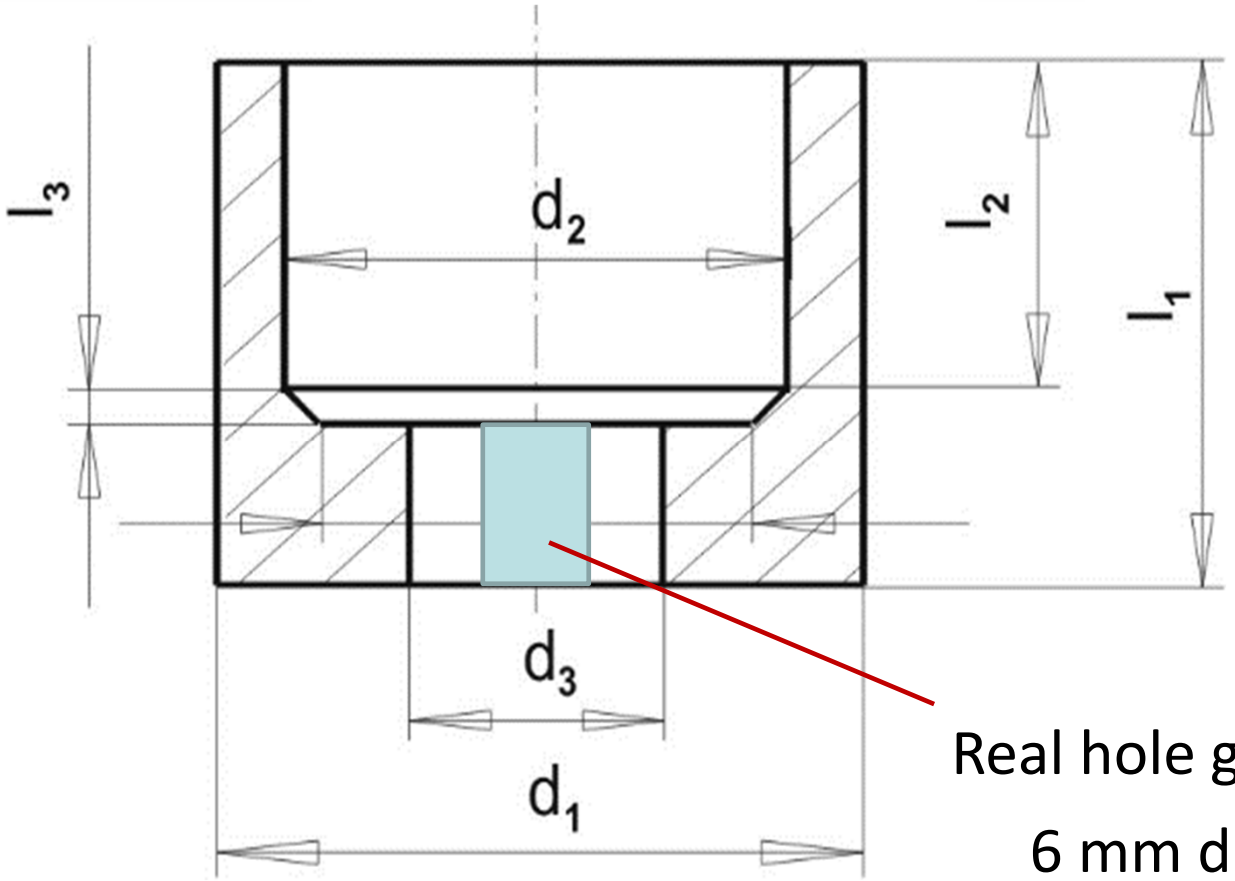


1. **Draw the proportional real workpiece using the given data**
   (see your project sheet)

2. **Check of product drawing** (see your sheet)
   Can it be made by forming?
   Is it necessary and/or possible to change the shape?

Example:
Can the hole at the bottom be formed?
   It depends on the diameter, height,
   and their ratio.
   If not, the hole has to be filled and
   manufactured later by cutting.





d_1 = 30 mm

d_3 = 6 mm

l_1 = 32 mm

l_2 = 20 mm

l_3 = 3 mm

Real hole geometry:

6 mm diameter x 9 mm height

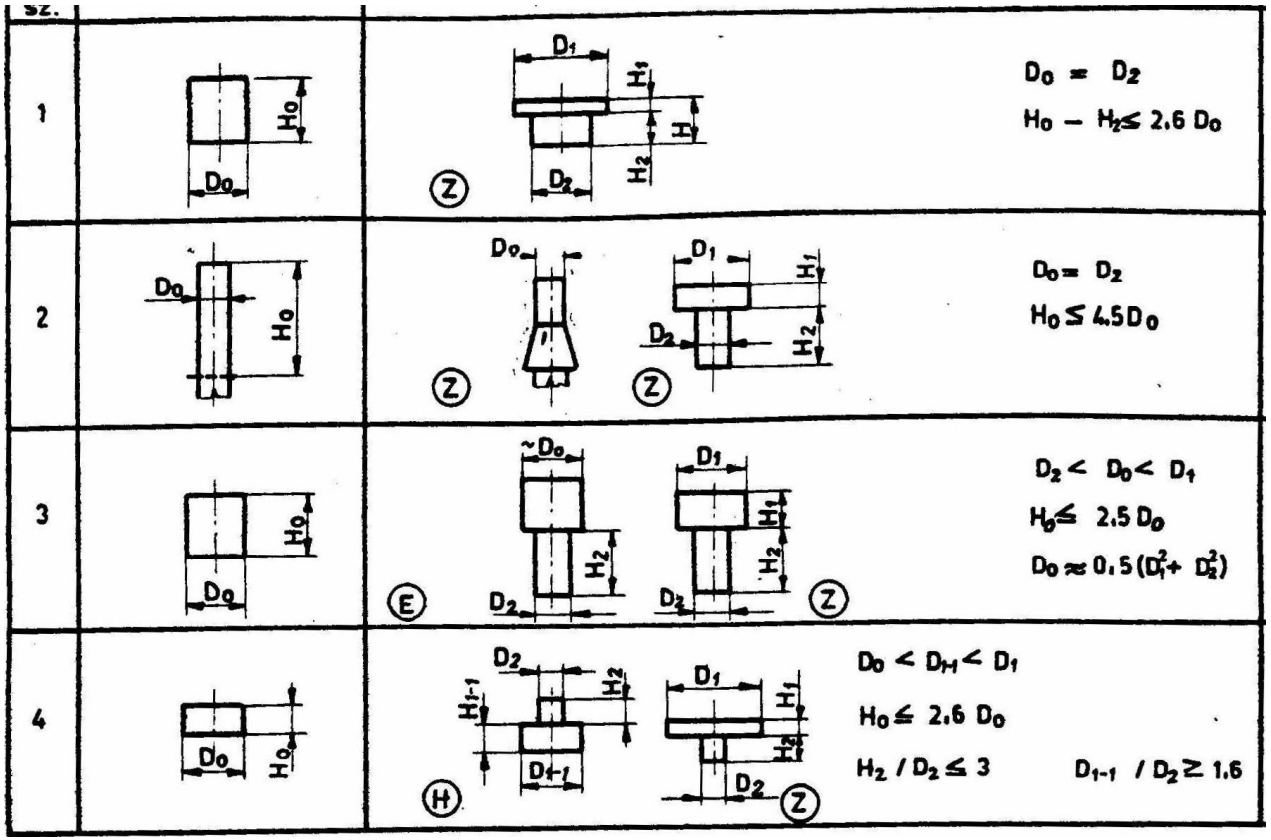
Can't be formed economically.

3. Select the forming technology

Use the „assistance sheets” on the web of subject.

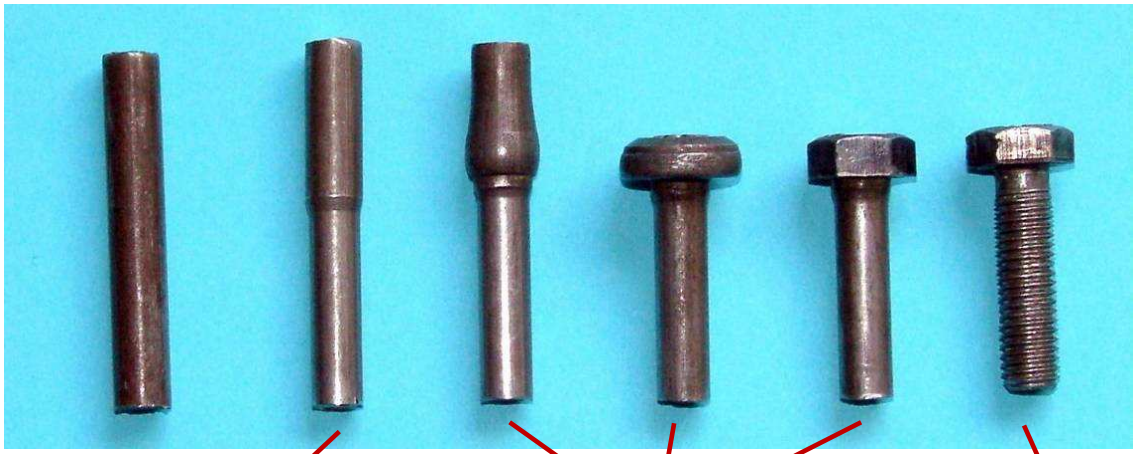
The given tasks can be performed by one of the following technologies or their combination:

- ❑ Upsetting
- ❑ Reduction
- ❑ Forward extrusion
- ❑ Backward extrusion



Examples

Screw production in 6 steps



Reduction

Upsetting/Heading/
/Hexagonal Cut

Threading

Cup made in 1 step

Backward extrusion

4. Steps of technology calculation

- ❑ Calculation of product volume with additions if needed
- ❑ Selection and calculation of the initial shape (standards and catalogues)
- ❑ Calculation and control of the geometrical limits (e.g. for plastic buckling in case of upsetting a cylinder, the ratio of height and diameter shall be less than 2.3)
- ❑ Calculation of strain (e.g. at upsetting a cylinder, the equivalent strain comes from the following equation: $\varphi = \ln \frac{l_0}{l_1}$ or $\varphi = 2 \ln \frac{D}{d}$
- ❑ Calculation of the flow stress (from equation or diagram, e.g.: $\sigma_f = C_0 + C_1 \varphi^n$
- ❑ Calculation of the forming pressure, then the forming force, loading the machine
- ❑ Calculation of loading stresses on critical die elements, then dimension them (e.g. in the case of extrusion, dimension the punch for axial stress and elastic buckling, and the recipient for internal pressure)
- ❑ Optional: Control your calculations by the QForm (or other) simulation program.

5. Steps of die dimensioning and construction

- ❑ Make a freehand sketch on the die construction for consultation
- ❑ Selection of die house from the market
- ❑ Drawing of the assembly plan based on the confirmed freehand sketch and consultation
- ❑ Compile the list of elements on the assembly plan (name, number, material standard – if exists - and heat treatment reference of the elements)
- ❑ Prepare the heat treatment instructions (these are orders, not wishes) for the active die elements, based on the die material manufacturers data, and in addition the preliminary surface treatments of the workpiece – if needed
- ❑ Compile the report describing the calculations and other main elements of your work, including the project sheet, a summary and the list of used resources.

Recipient (ring) dimensioning

The recipient is a short tube having thick wall. For the calculation of the wall thickness and the reinforcement (if needed) use the relevant Excel file from the web page of the subject. After opening the file you see the last calculation:

calculate (double click)

SZÁMOL

Rk:	52,69592		amin:	2,634796		p1max:	900

n	ki	Ei	mi	ai	Rbi	**di**
	1500	210000	0,3	1,651446	20	
	1400	210000	0,3	1,595448	33,02891	0,133688
		210000	0,3			
		210000	0,3			
		210000	0,3			

Recipient (ring) dimensioning

Clear the cells containing the data of the previous calculation.

SZÁMOL

Rk:			amin:			p1max:	

n	ki	Ei	mi	ai	Rbi	**di**
	1500	210000	0,3		20	
	1400	210000	0,3			
		210000	0,3			
		210000	0,3			
		210000	0,3			

Recipient (ring) dimensioning

Fill the Rbi (inner radius) and p1max (internal pressure) cells then double click on the SZÁMOL cell to run the calculation.

calculate (double click)

SZÁMOL

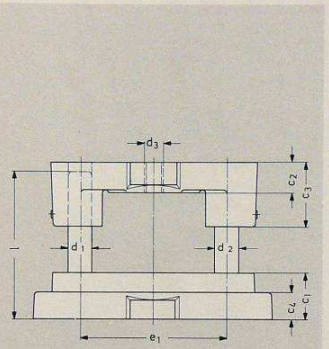
Rk:	48,30459		amin:	3,220306		p1max:	1000

n	ki	Ei	mi	ai	Rbi	**di**
	1500	210000	0,3	1,825742	15	
	1400	210000	0,3	1,763834	27,38613	0,12389
		210000	0,3			
		210000	0,3			
		210000	0,3			

Die house from a catalogue

STEINEL NORMALIEN

Säulengestelle ST 100.



Runde Arbeitsfläche
Mittig stehende Führungssäulen
Dünnes Oberteil

DIN 9812

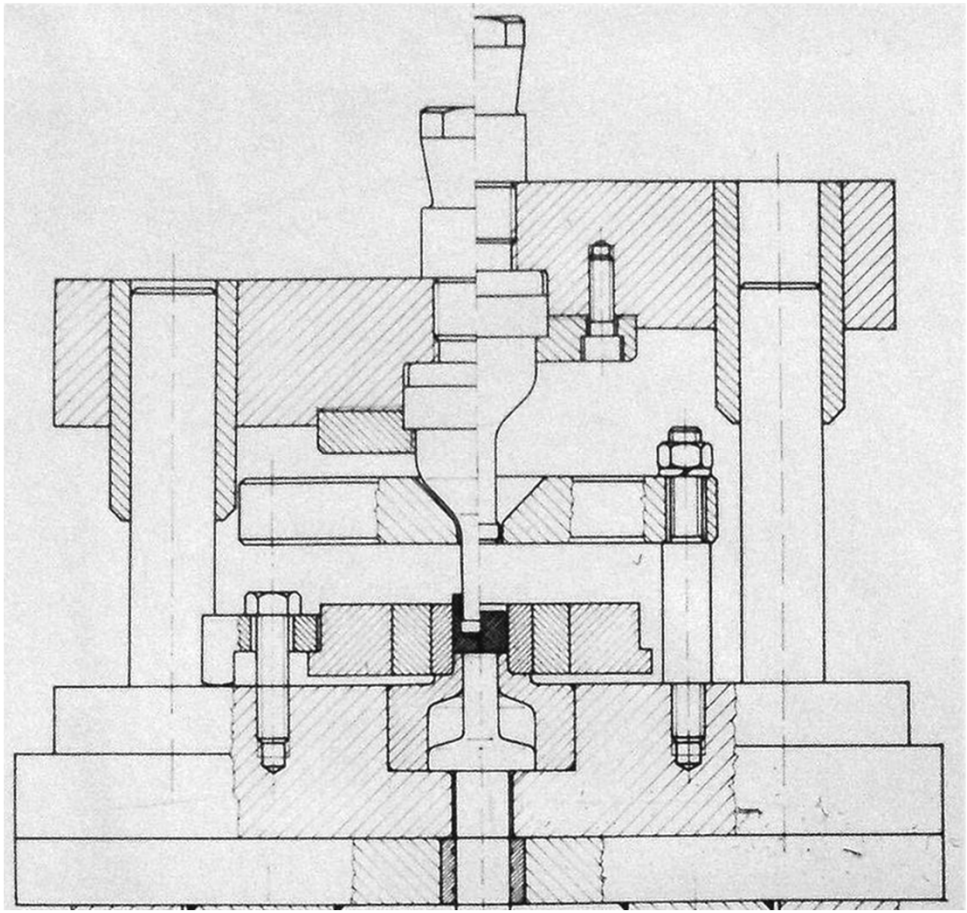
Form D: Oberteil ohne Gewinde
Form DG: Oberteil mit Gewinde

Werkstoff: Sondergrauguß GGL, legiert und ultraschallgeprüft.

Für alle Gestell-Größen sind Zeichnungsvorlagen im Maßstab 1 : 1 zum Selbstkostenpreis lieferbar, siehe betreffende Seite.

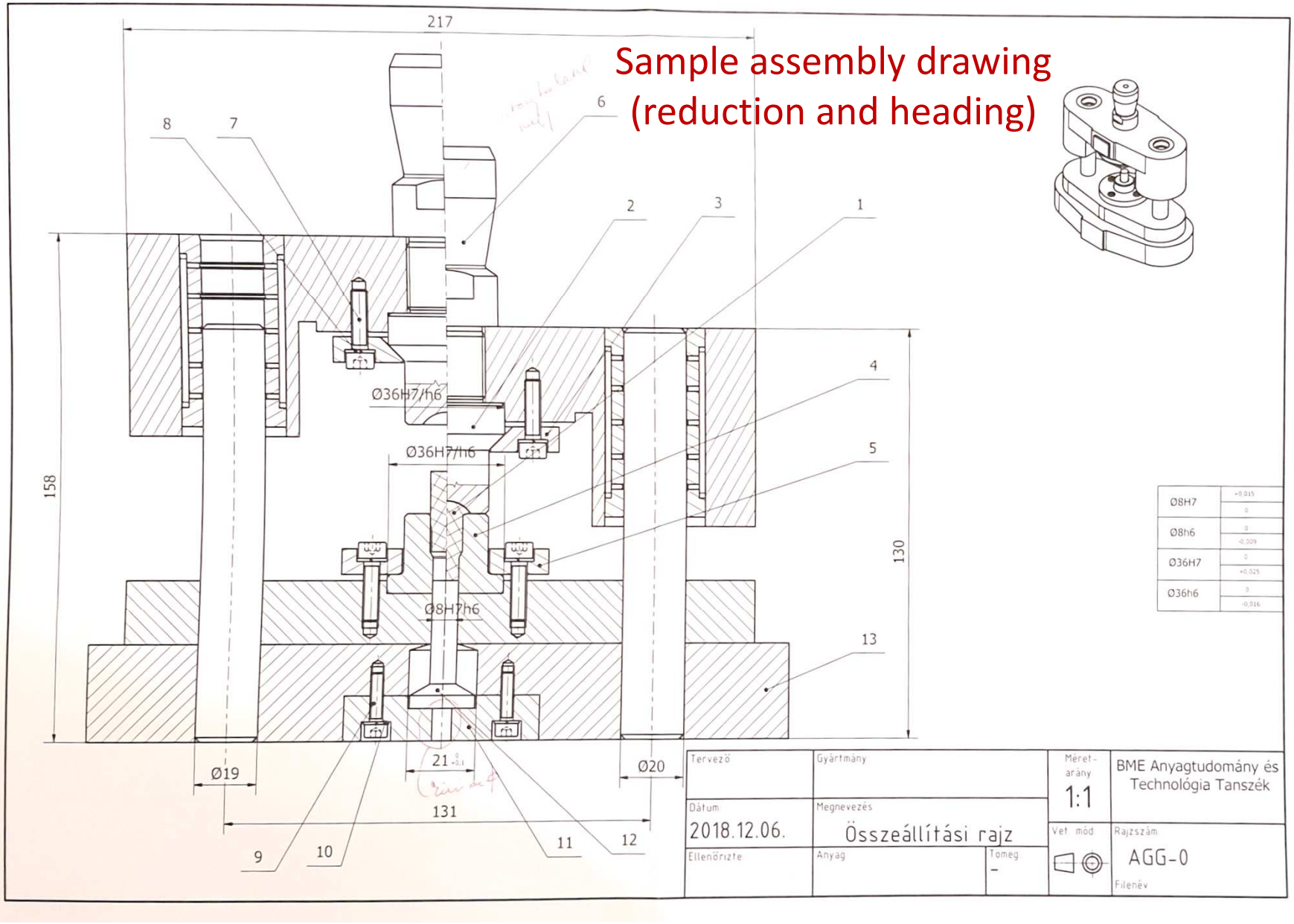
Einspannzapfen siehe betreffende Seite.

Bestellbeispiel: Säulengestell mit Gleitführung
Stahl bronzeplattiert
Oberteil ohne Gewinde **ST 1001**
Arbeitsfläche D = 125 mm
Ergänzung **125**
Bestell-Nummer **ST 1001.125**



Assembly drawing (backward extrusion)

Sample assembly drawing (reduction and heading)

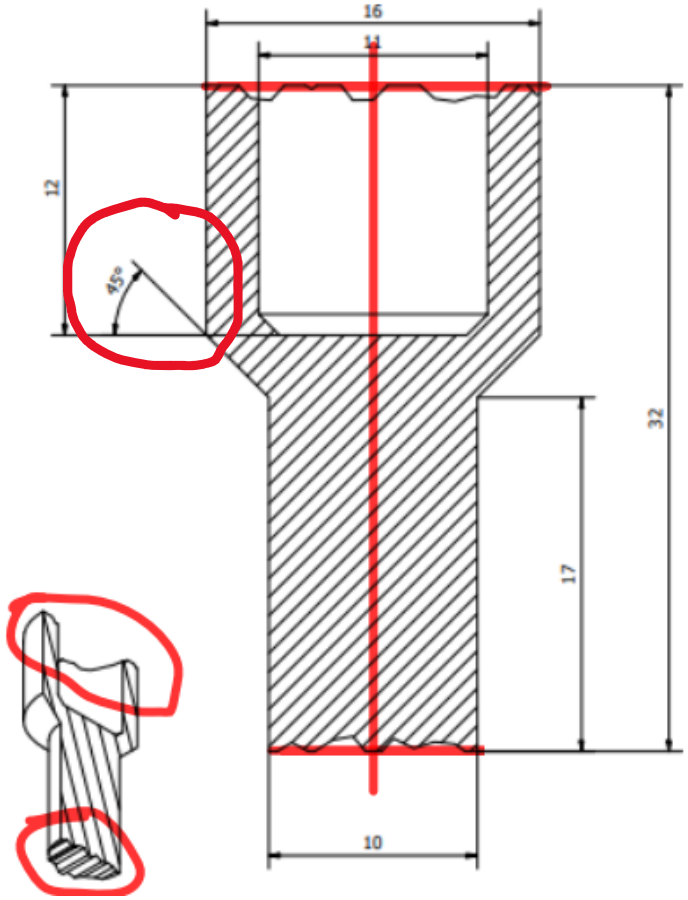


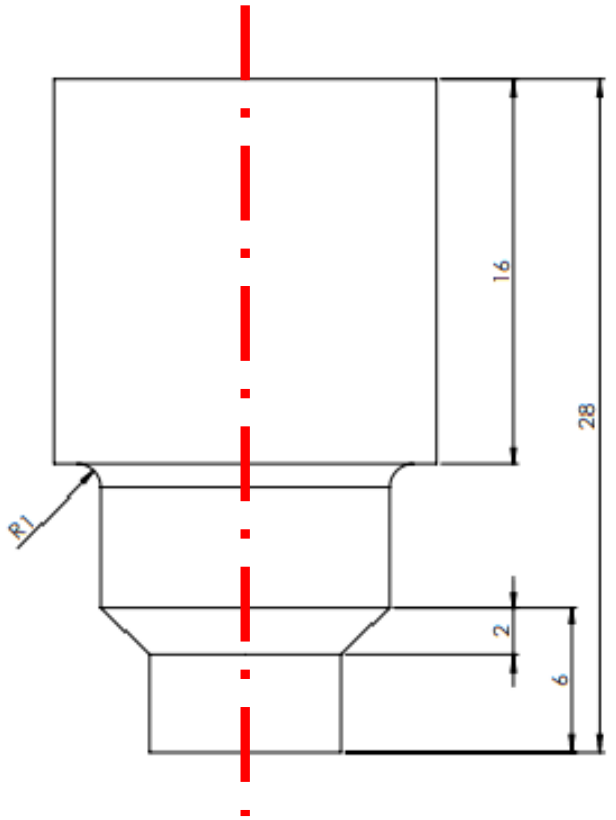
Sample list of elements

Tsz	Db	Megnevezés	Méret	Rajzszám	Anyag	Tömeg
13	1	Szeszámház	217×158	SteinelST 1001-80		3 kg
12	1	Kilökő	Ø6×40	AGG-4	X210CrW12	0,03 kg
11	1	Alaplap	Ø30×14		S235	0,04
10	4	Rugós alátét	Ø7,2	DIN 128	Fst	0,01
9	4	Bkny. csavar	M5×20	DIN 4762	5.6	0,02
8	8	Rugós alátét	Ø9,2	DIN 128	Fst	0,01
7	8	Bkny. csavar	M6×25	DIN 4762	5.6	0,02
6	1	Befogó csap	M24×79	Steinel SZ-40-35		0,05 kg
5	1	Alsó rögzítőgyűrű	Ø62×16		S235	0,03 kg
4	1	Matrica	Ø36×25	AGG-3	X210CrW12	0,14 kg
3	1	Felső rögzítőgyűrű	Ø86×12		S235	0,03 kg
2	1	Bélyeg	Ø36×35	AGG-2	X210CrW12	0,03 kg
1	1	Munkadarab	Ø10×23	AGG-1	C10	0,03 kg

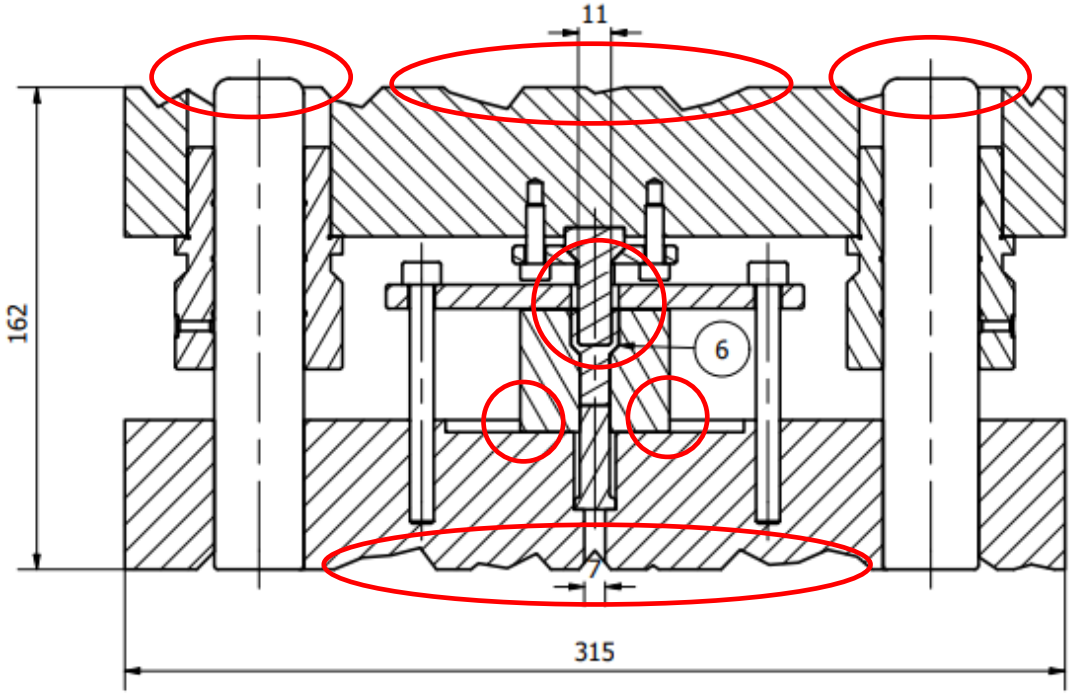
Tervező:	Gyártmány:		Méret-arány:	BME Gép és Terméktervezés Tanszék
Dátum: 201812.06	Megnevezés: Darabjegyzék		Vet. mód:	Rajzszám:
Ellenőrizte:	Anyag:	Tömeg:		Filenév:

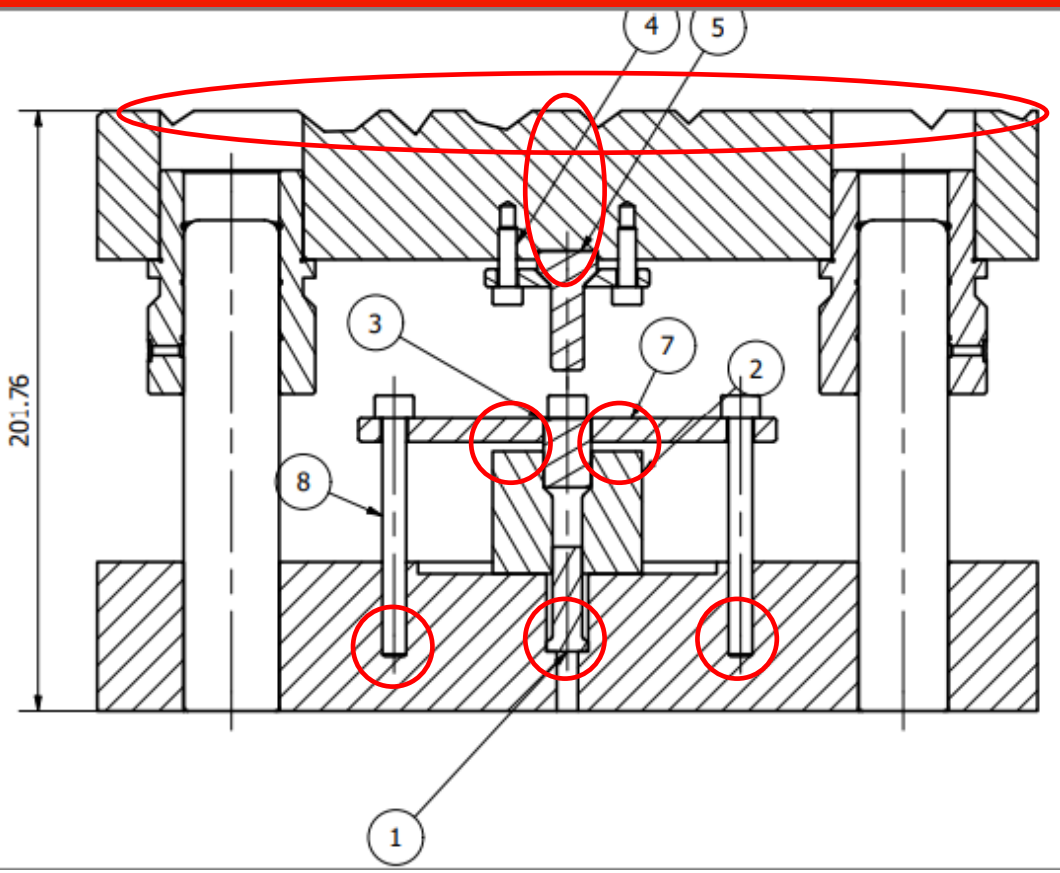
Typical drawing mistakes !!!





Typical elementary construction mistakes !!!





Always check the validity of the results after each calculation !!!

Textbooks and resources

- Department of Materials Science and Engineering webpage: *www.att.bme.hu*
- *Heinz Tschaetsch:*
  Metal Forming Practise
- *S. Kalpakjian, S.R. Smith:*
  Manufacturing Engineering and Technology
- *W. D. Callister:*
  Materials Science and Engineering, An Introduction
- Assisting documents on the department web site.