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Technological design and technical preparation of production

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Deparment of textile and single-purpose machines

What is technological design? (manufacturability)

Technological design is basically a design that allows production with the least effort, respectively. production costs.

Technological design - construction of a machine that meets the requirements for its **function** (eg. economy, productivity, efficiency, ...) and also the requirements for its **production** (eg. low production costs, low weight, ...) and use (easy to repair, reliable, ...).

Technical preparation of production

The design methodology must be based on a concept that will be effective both in the design of the new equipment and in its critical analysis. Requires decomposition of a complex task into subtasks.

- **Dynamic tasks –** based on the customer's wishes (weight, service life, energy, control, etc.).
- **Production tasks –** are based on the technological possibilities of the machine park of the company.

Principles for technological design

- Simple shapes respecting production technology.
- Simple kinematic schemes.
- Reasonable demands on manufacturing accuracy.
- Clearly defined quality requirements.
- Prevention of defects.
- Choice of suitable material.
- Utilization of norm and standardized parts and semi-finished products.
- Utilization of production possibilities of the company.
- Minimizing production preparation.
- Minimizing production (overhead) costs.
- Use of mechanization and automation.
- Depending on production needs, suitable choice of dimensioning method.
- Respect built-up area, assembling and disassembling.

Methods of prototyping

Rapid prototyping: is a collection of 3D printing technology. In principle, it is a lamination of materials in sections.

- Stereolithography – laser curing resin.
- Selective Laser Sintering – caking of special powder.
- Laminated Object Manufacturing – layering of laser cut foils.
- Fused Depositing Modeling – layering of construction material and support material.
- Multi Jet Modeling – printing photopolymer.

Methods of prototyping

Adventages of prototyping:

- possibility of manufacturing complex parts,
- quick verification of prototype functionality,

Disadventages:

- worse surface quality,
- limiting on the materials used,

The criteria of evaluation technological design:

Material consumption:

$$m_1 = \frac{weight\ of\ new\ product}{weight\ of\ old\ product} \qquad m_2 = \frac{weight\ of\ product}{usage\ of\ material}$$

$$m_3 = \frac{weight\ of\ product}{number\ units\ of\ power} \qquad m_4 = \frac{weiht\ of\ non-ferrous\ metals}{weight\ of\ product}$$

Laboriousness of production:

$$p_1 = \frac{laboriousness\ of\ new\ tipe\ of\ product}{laboriousness\ of\ old\ tipe\ of\ product} \qquad p_2 = \frac{laboriousness\ of\ assembling}{total\ laboriousness}$$

$$p_3 = \frac{production\ time}{weight\ of\ product} \qquad p_4 = \frac{production\ cost}{weight\ of\ product}$$

Technic – economic measures:

$$r_1 = \frac{number\ of\ tipped\ elements}{total\ number\ of\ constructions\ units}$$

$$r_2 = \frac{number\ of\ norm\ elements}{total\ number\ of\ parts} \qquad r_3 = \frac{number\ of\ part\ taken\ over}{total\ nmber\ of\ parts}$$

Main requirements of construction technology
Material selection:

- Use of metallurgical semi-finish parts.
- Limitations on the number of types and sizes of semi-finishd parts.
- Choose materials with otimal utilization of their properties. Use heat treatment.
- Use of optimal production technology (weldment, castings part, pressed part …)
- Optimize production waste.

Chooce of shape and dimenzions of part:

- Dimensioning of components based on technical calculations.
- Do not require unnecessarily high degree of surface accuracy and quality.
- Do not use chain dimensioning.
- Choice of simple shapes.
- Choice of shapes with respect to the use of universal tools, jigs and gauges.
- Use of forming technology.
- Use of purchased elements and semi-finished products.

Assembly, maintenance and disassembly:

- Reduced assembly work.
- Create assemblies so that they can be assembled separately.
- Designing of parts with regard to the use of assembly and disassembly aids.
- Finding solutions with minimal maintenance requirements.
- Designing parts so that fast-wearing parts can be easily replaced.
- Minimize the need for special aids.

Overview of modern production methods in engineering:

- precision casting, investment casting process,
- precision forging of semi-finished products,
- precision cutting of semi-finished products,
- advanced welding methods FSW, plasma, laser, electron beam, resistance, friction,
- cold finished, extrusion, rolling,
- electroerosion and electrochemical machining,
- use of progressive production machines,
- introduction of CNC production lines with control programs,
- use of new types of semi-finished products,
- increasing the life of cutting tools by coating,
- changes in metallurgy (vacuum hardening, ballotinisation),

The main principles in the design of forgings press forging

It is intended for the production of semi-finished products for the construction of machinery.

- minimum wall thickness,
- machining allowance,
- radius – on the edge R_{min} = 6 mm, external R_{min} = 2 mm,
- drafts – external 3°, internal 7°,
- the material should not be upset,
- straight joint (divideing plain),
- mass production

The main principles in the design of pressing parts

Extrusion

- suitable material selection,
- geometry of surfaces on formed to the final shape,
- use calibration options for precise surfaces,
- reduce the number of protrusions,
- gradual transitions between thin and thick cross-sections,
- consideration of metal creep into the so-called reduction cavity,
- reduce the number of ribs close together,
- Respect the ratio of adjacent cross-sections to maximum deformation for the material used.
- Technological planes, eg for clamping of the compact during machining.

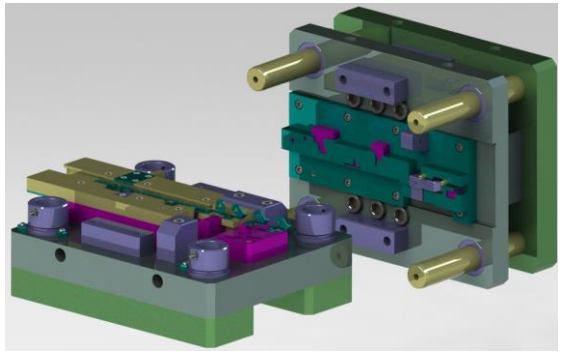
The main principles in the design of pressing parts

Cutting, bending, drawing

- optimal cutting layout plan,
- suitable material selection,

Combined follow die:

- consider the shape of the cutting edge,
- consider the direction of the cut,



The main principles in the design of pressing parts

Bending

- consider with spring-back effect,

Drawing

- proseed from simulation of drawing,
- optimal shape of the blank,
- to take into account anisotropy of input material properties,

Main principles in designing machined parts

- machining with a few number of grip as possible,
- sufficient rigidity of the product for clamping,
- optimal selection of semi-finish parts,
- minimal material consumption (optimal machining allowance),
- good machinability of materials,
- little machined surfaces, good accessibility, multi-surface machining,
- designing shapes with respect to the applicability of universal tools,
- machined surfaces of minimal dimensions and optimal shapes,
- good conditions for smooth run in and run out,
- select the precision and roughness of the machining surfaces choos only as required by function and assembly,
- dimensioning of machined parts create with regard to technology,

Main principles in the design of welded structures

- guaranteed weldability of materials - C content up to 0,2%, t <25 mm,
- material is chosen according to load and working conditions,
- Weld shape selection dependent
  - on the design
  - on the shape and thickness of the welded parts
  - on the character the load forces
  - on the chosen technology
  - production and operating conditions
  - good accessibility to the weld site

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Main principles in the design of welded structures

- avoid the build up of welds,
- avoid the combination - solid material and large thickness,
- avoid notch effect, especially for dynamically stressed welds,
- avoid welds in inaccessible places,
- do not place welds in stress exposed areas,
- do not machine welds,

Conclusion

Only the choice of technology does not affect the cost of manufacturing engineering products. The designing of the components and the whole assembly has a greate influence to cost too. Technological design is of great economic importance. It largely gives **productivity** and **competitiveness**.

Questions:

- Define some modern methods for prototyping?
- List the criteria of evaluation technological design
- Vyjmenujte zásady při navrhování obráběných dílů.

Topic of the next lecture:

„ Standardized building elements of machines“

Thank You

Used literature and sources of information:

http://projekty.fs.vsb.cz/459/ucebniopory/Technologicnost_konstrukci.pdf