Mechanics and machines, Lecture 1

Introduction
Engineering Drawing

Innopolis University

General information and course outline

Lecturers/Instructors

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@Lupasic

Course goal

To understand engineers:
their problems and
their terminology

by *doing **their** job*
*using **their** tools*

Course purpose and objectives

The development of any class of robots and the use of robots in industry requires the engineer to have knowledge and skills in:

- the ability to read engineering drawings,
- the analysis and synthesis of mechanisms,
- the dynamic calculation of mechanisms and machines,
- the calculation of strength and rigidity,
- the technological production processes,
- the work in modern CAD and CAE systems.

Course outline and organization

Лекция	Лаба	Этап проекта	
Engineering drawings	CAD, details 1		
Kinematic pairs	CAD, detail 2	Project Selection	
Kinematics of mechanical gears, belts	CAD, assembly 1	**Defence selection**	Kinematics, analytical solution
Synthesis of planar mechanisms	CAD, assembly 2		
Force and dynamics analysis of mechanisms 1	CAE, motion simulation 1	**Defence Kinematics, analytical solution**	Dynamics, analytical solution
Force and dynamics analysis of mechanisms 2	CAE, motion simulation 2		
Mechanisms Balancing	Mechanisms Balancing	**Defence Dynamics, analytical solution**	Dynamics, simulation
Types of machine parts joining 1	Extra CAD stuff		
Types of machine parts joining 2	Overview of parts manufacturing methods	**Defence Dynamics, simulation**	CAD modeling
Overview of materials used in mechanical engineering	3D printing, how to prepare detail for it		
Strengh of materials 1	CAE, durability analysis 1		
Strengh of materials 2	CAE, durability analysis 2	**Defence CAD modeling**	Durability analysis
Strengh of materials 3	Render	**Defence Durability analysis**	Implement a mech in hardware, Render CAD
			Defence the comlete project

Grading criteria

Criteria:

Research project: 40%.

Homework assignments: 30%

Final Exam: 30%

Late policy: -50% of max grade

The scale:

A: 85.00-100%

B: 65.00-84.99%

C: 50.00-64.99%

Failed: 0-49.99% or less than 50% by any criterion, Project should be implemented in hardware

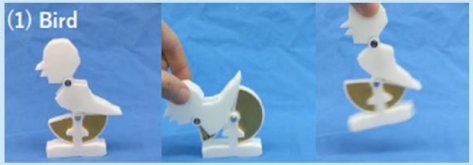
Research Project

- The project covers the main stages of the development of the mechanism: idea, synthesis and analysis of kinematics, analysis of dynamics, design, manufacture, verification
- Project gives you 40%
- Project defense will be organized as a conference at the end of the course
- Ideal project = results can be presented at international conferences or published in international journals

IROS 2020 - Best Student Paper Award

Computational Design of Balanced Open Link Planar Mechanisms with Counterweights from User Sketches

Takuto Takahashi, Hiroshi G. Okuno, Shigeki Sugano, Stelian Coros and Bernhard Thomaszewski



Information about project

In another slides

Engineering drawings

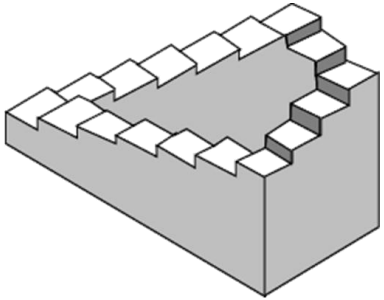
Projections

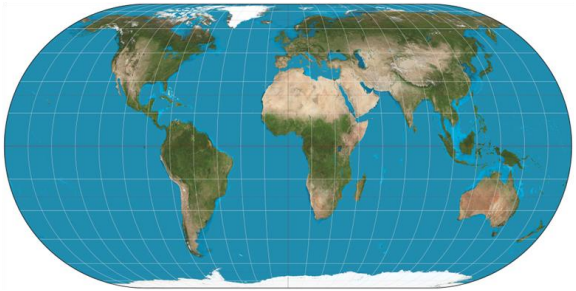
We work with 3D-objects which must be shown in a flat drawing. This is a problem.

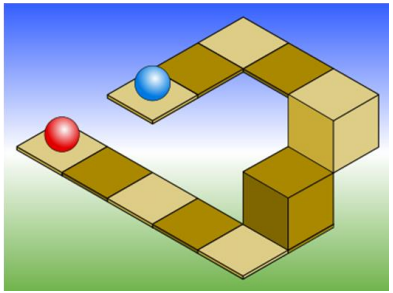
Projections

On the one hand, we cannot accurately show curved surfaces.

On the other hand, we can draw something absolutely impossible or something possible but unclear.

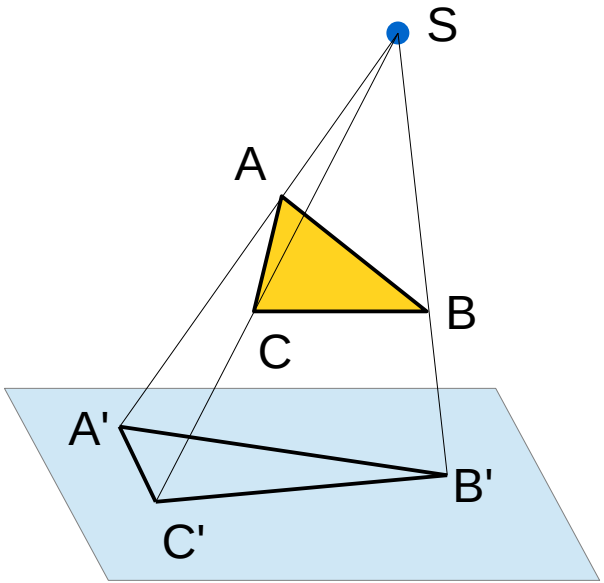






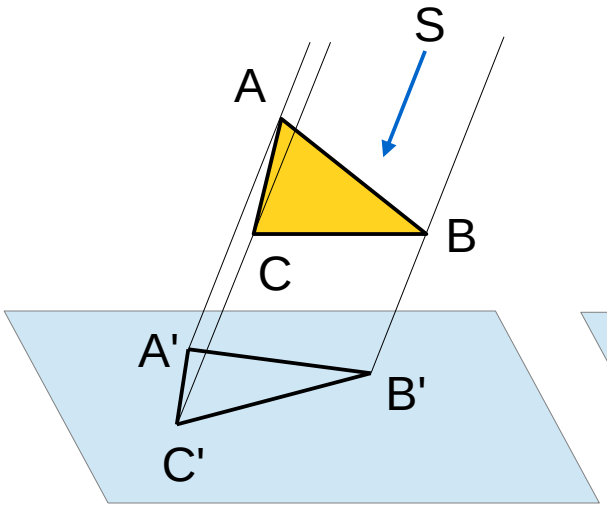
Parallel and perspective projections

Central (perspective) projection

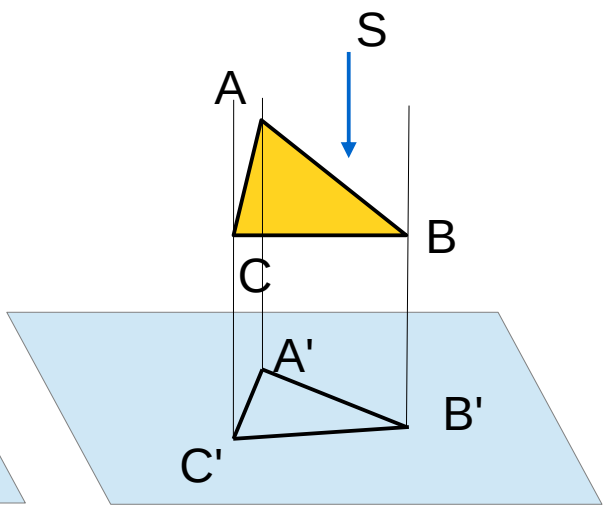


Parallel projections

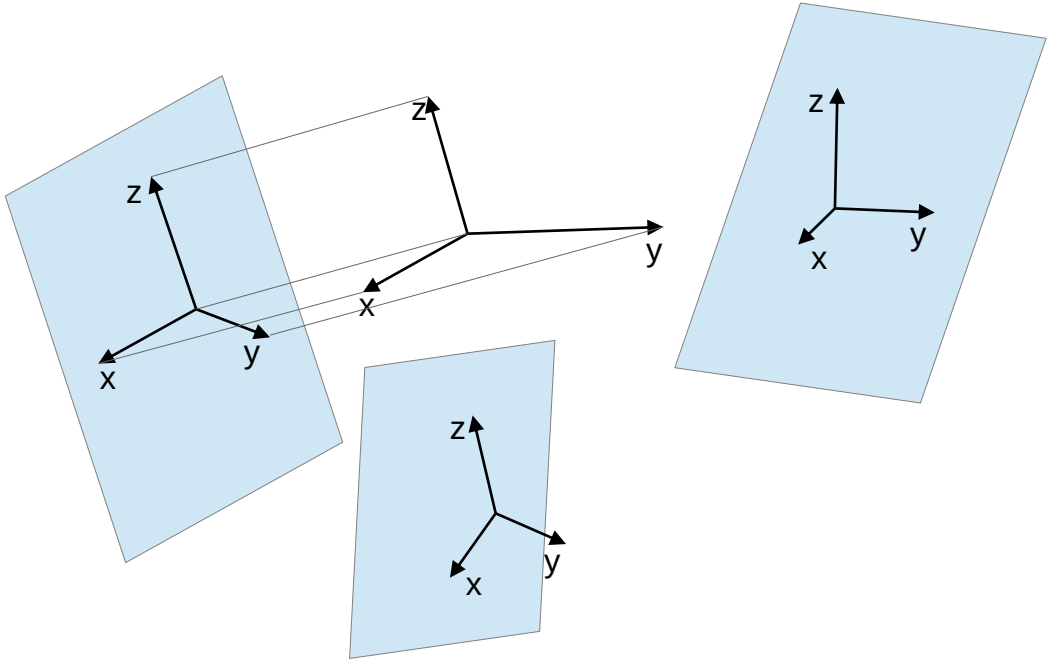
General (oblique) case



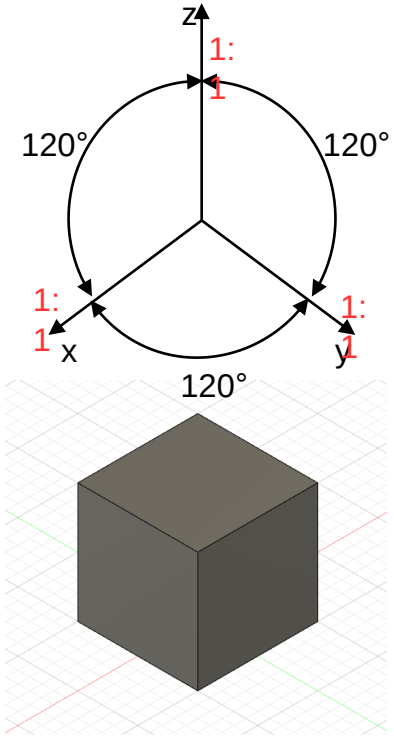
Orthografic projection



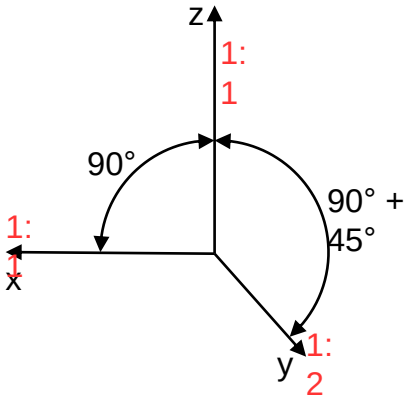
Axonometric projections



Axonometric projections

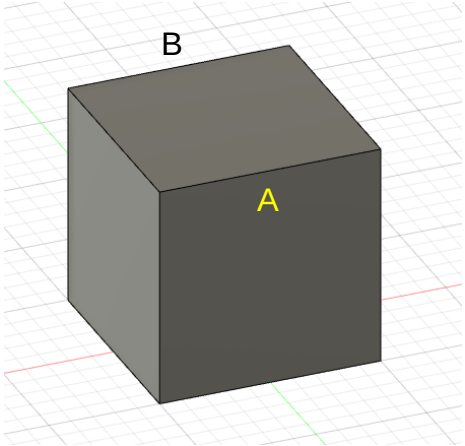


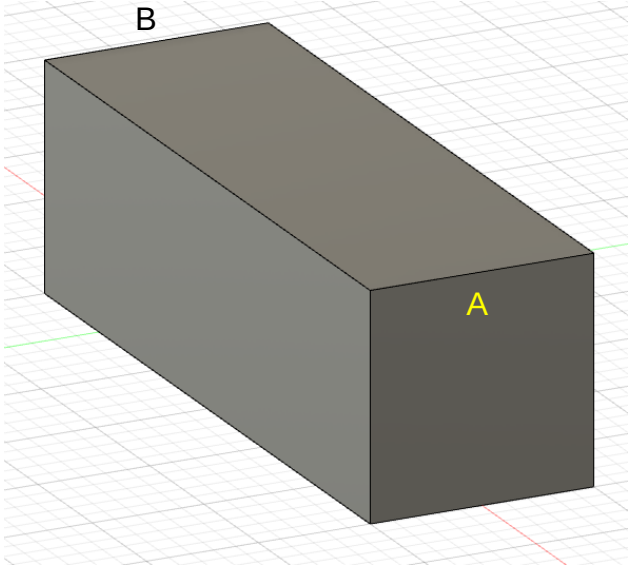
Orthographic isometric projection



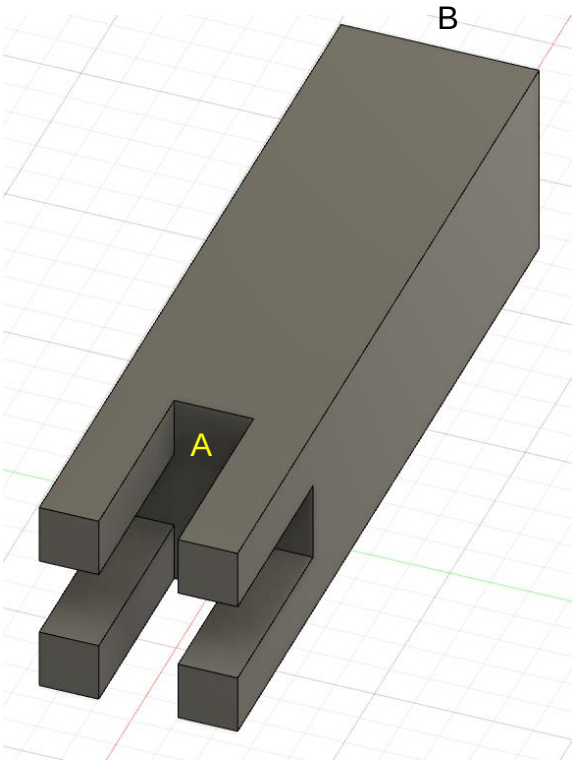
Oblique 'cabinet' projection

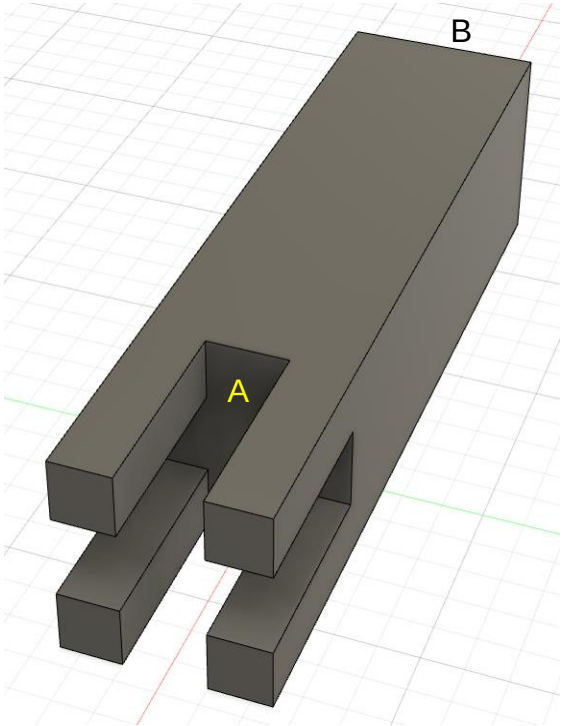
Parallel projections



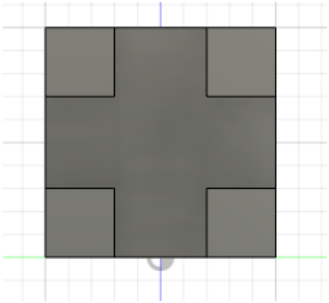


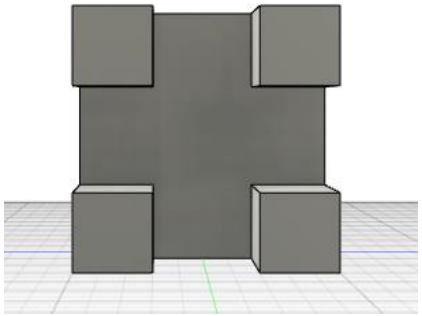
Parallel and perspective projections

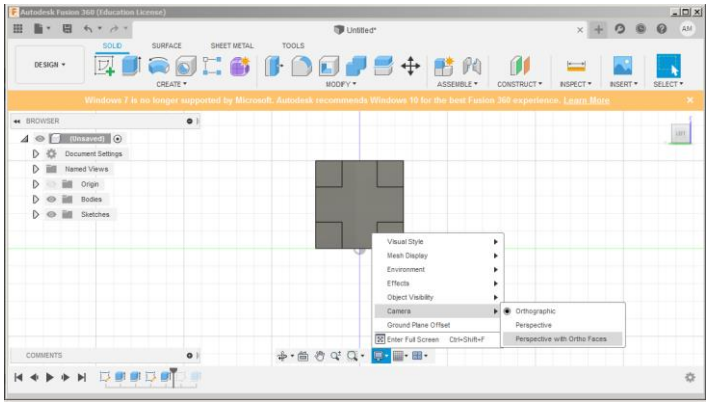


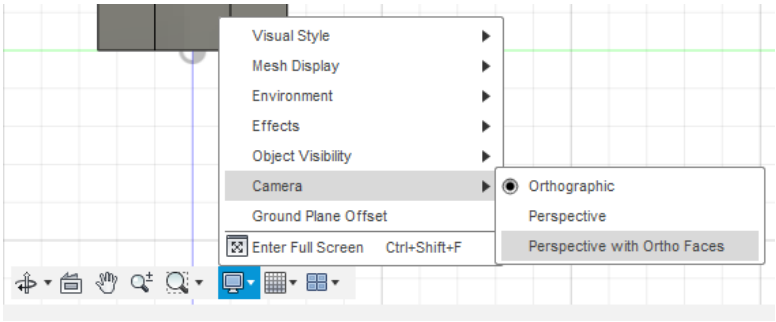


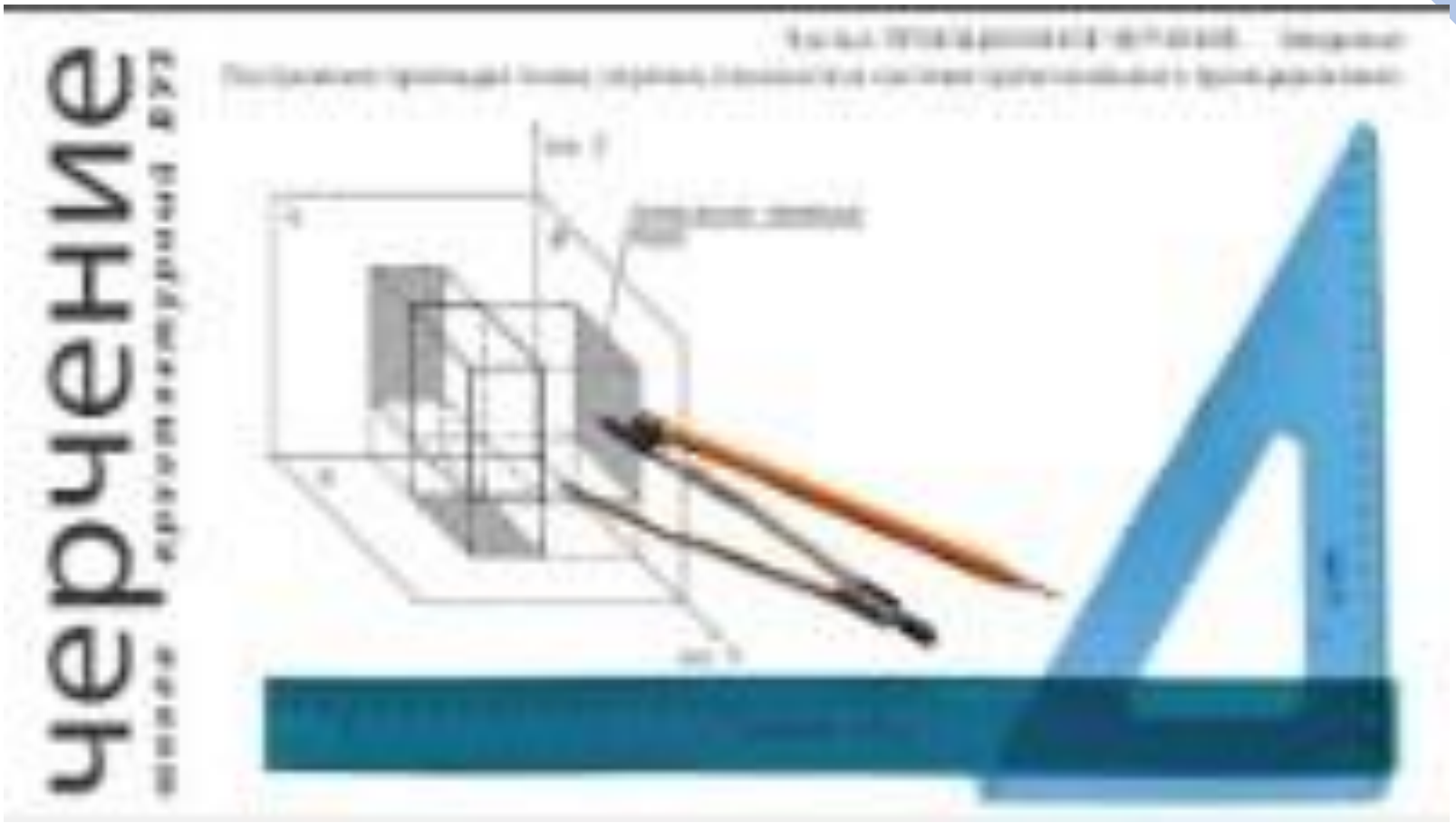
Parallel and perspective proiections







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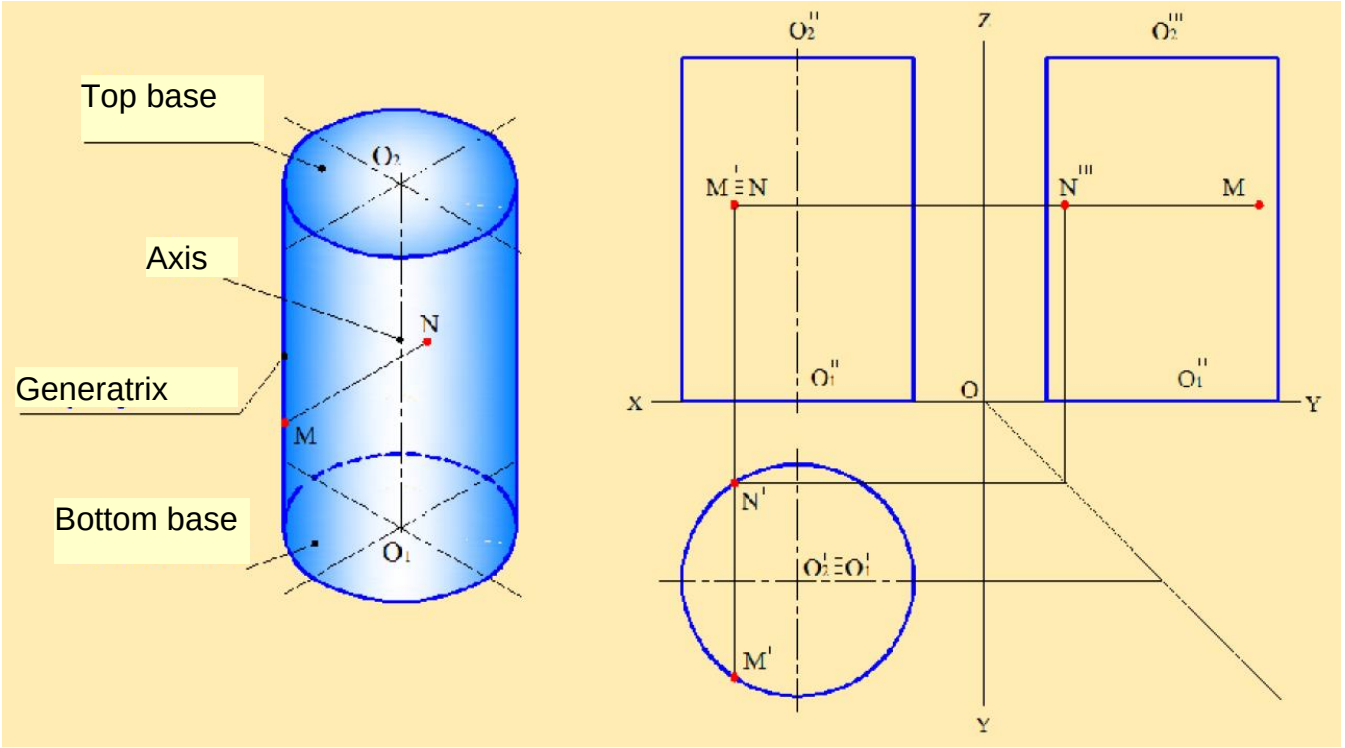
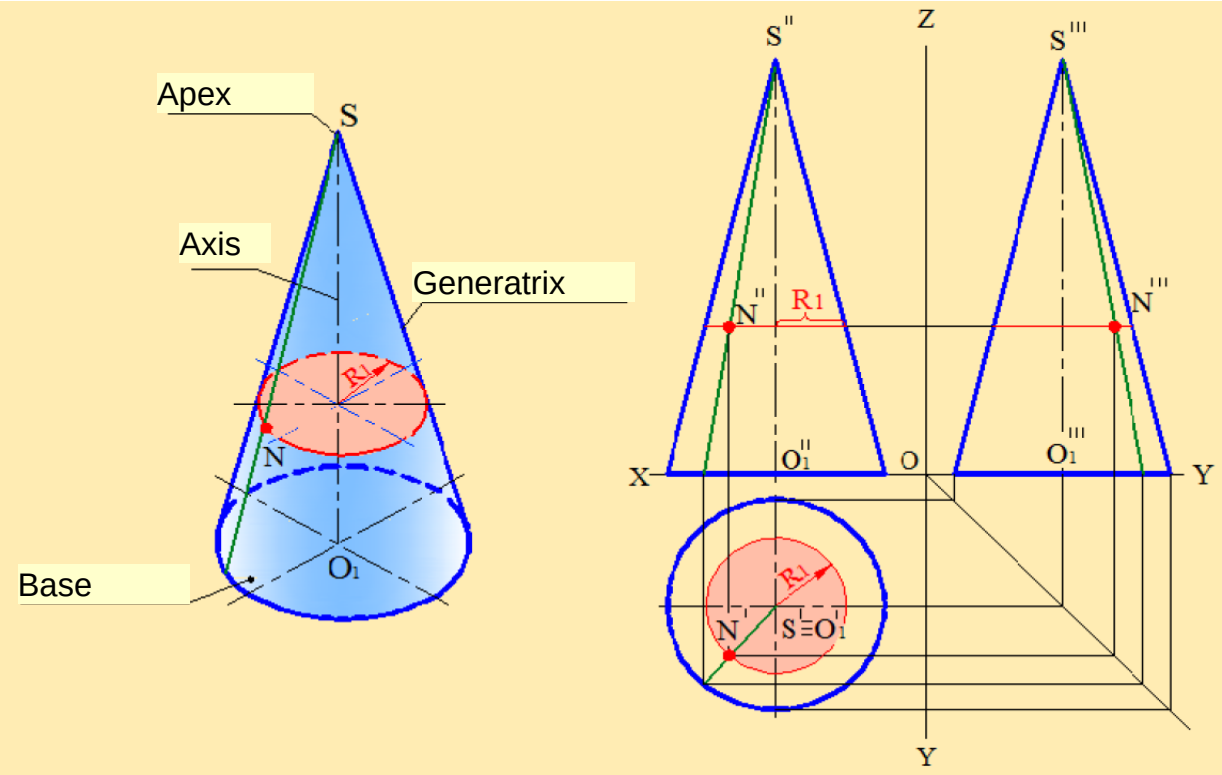
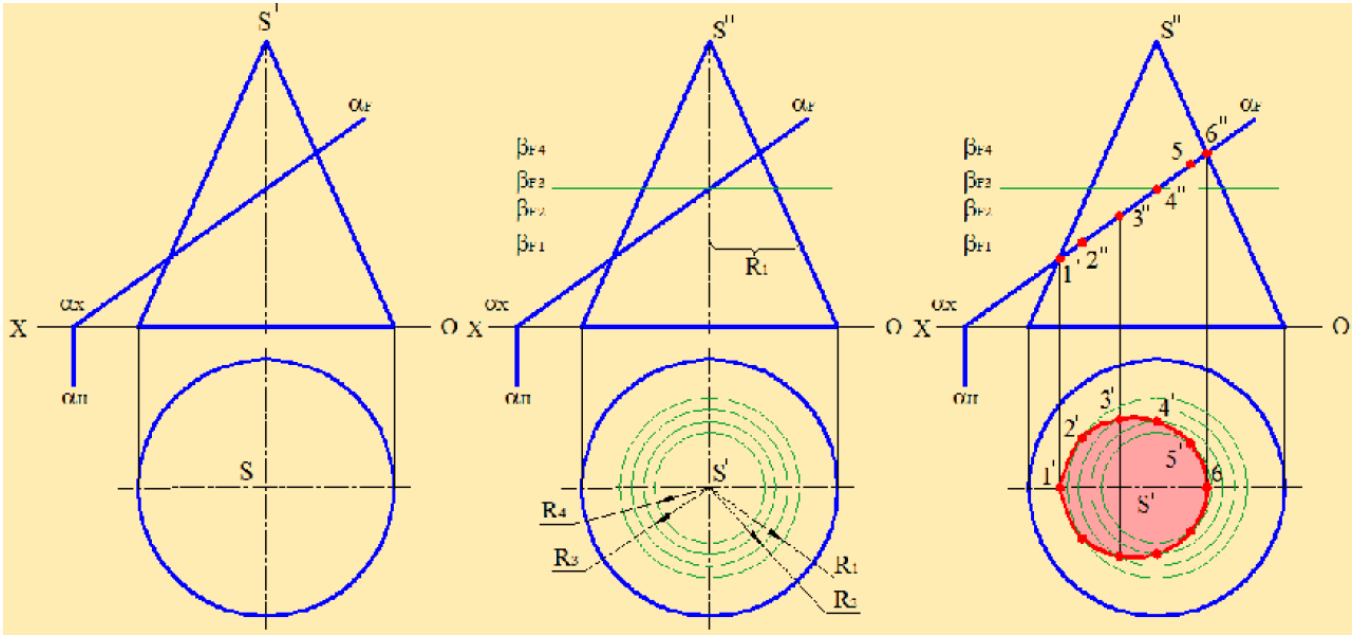
Orthographic Multiview projections



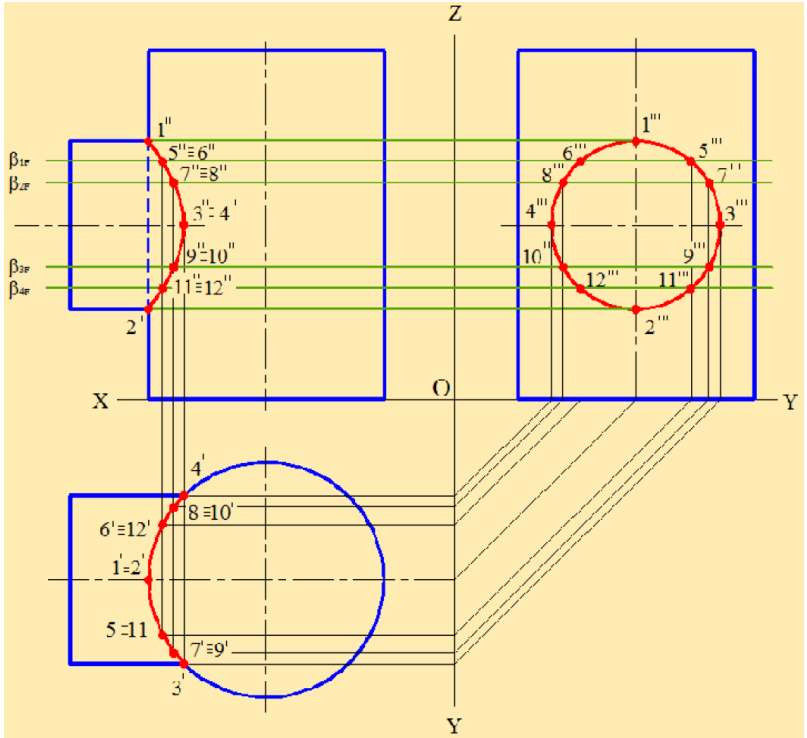
Orthographic Multiview projections



Orthographic Multiview projections

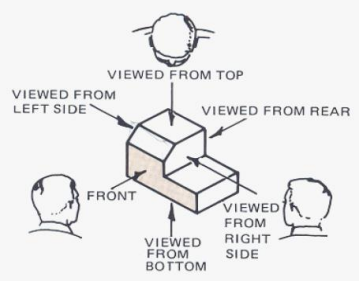


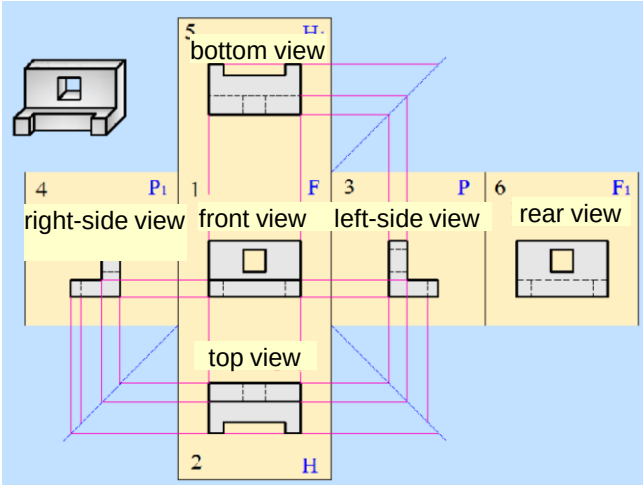
Orthographic Multiview projections

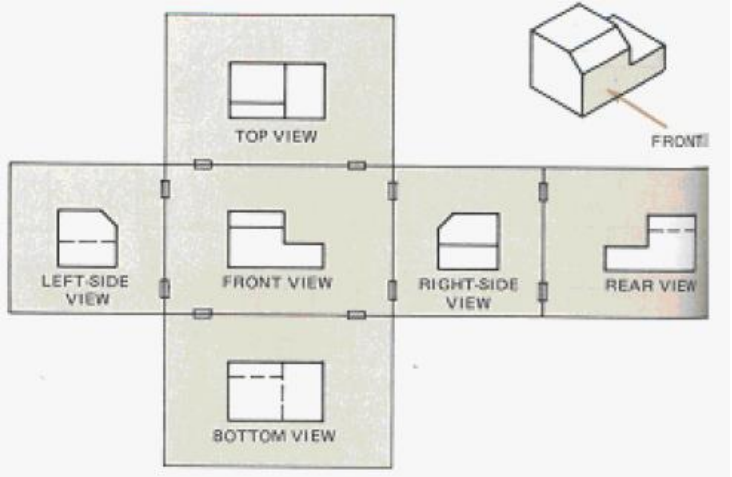


Orthographic Multiview projections

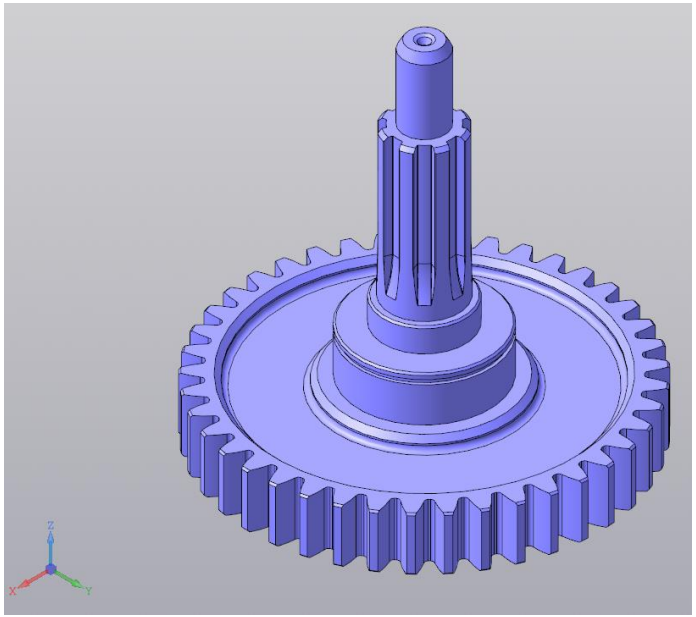
The difference between European and American standards



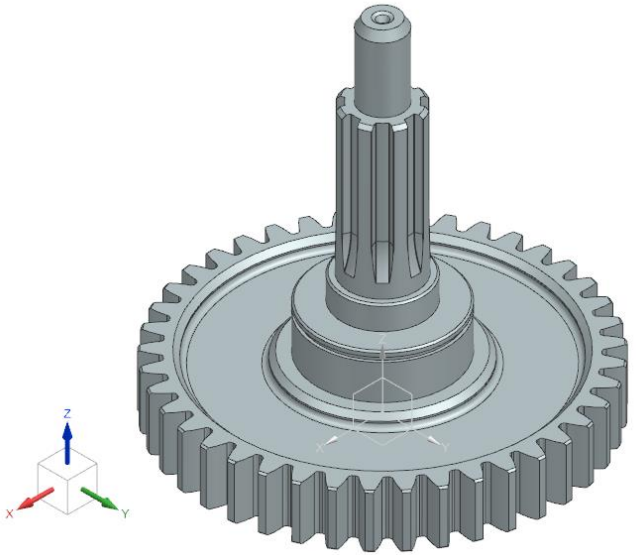




Orthographic multiview projections

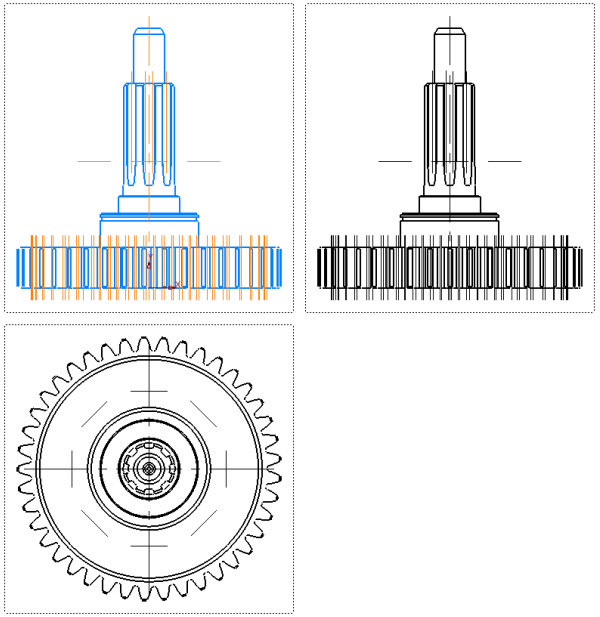


Kompas 3D

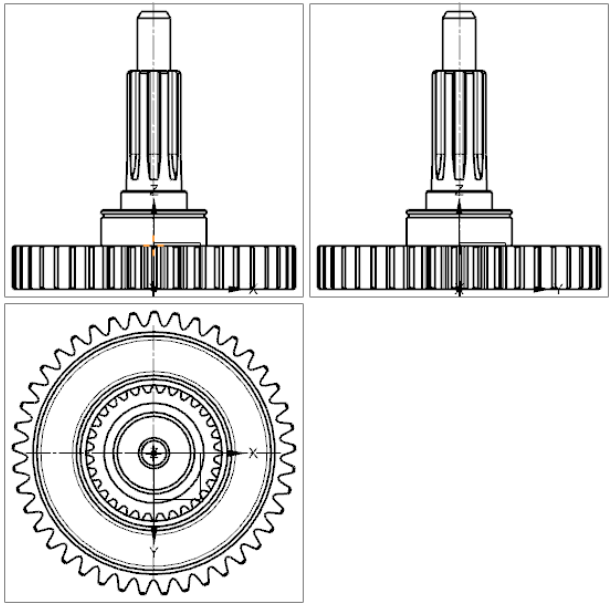


Siemens NX

Orthographic multiview projections

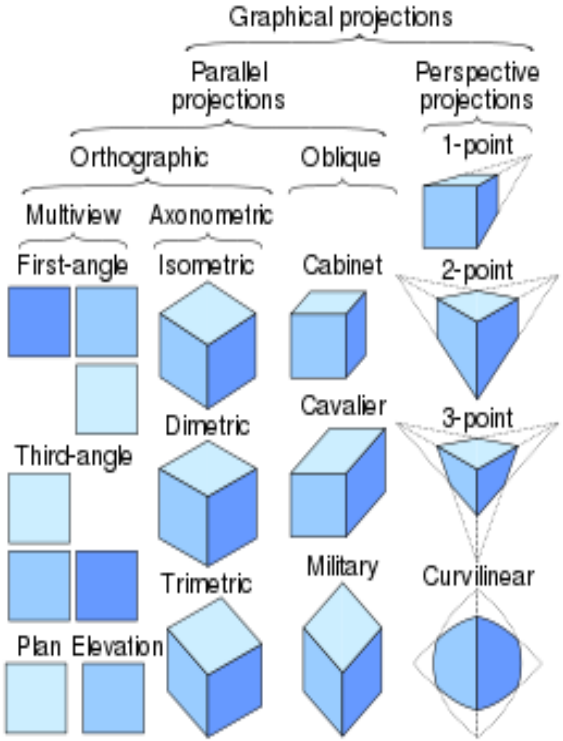


Kompas 3D
(European system)



Siemens NX
(American system)

Classification of some 3D projections

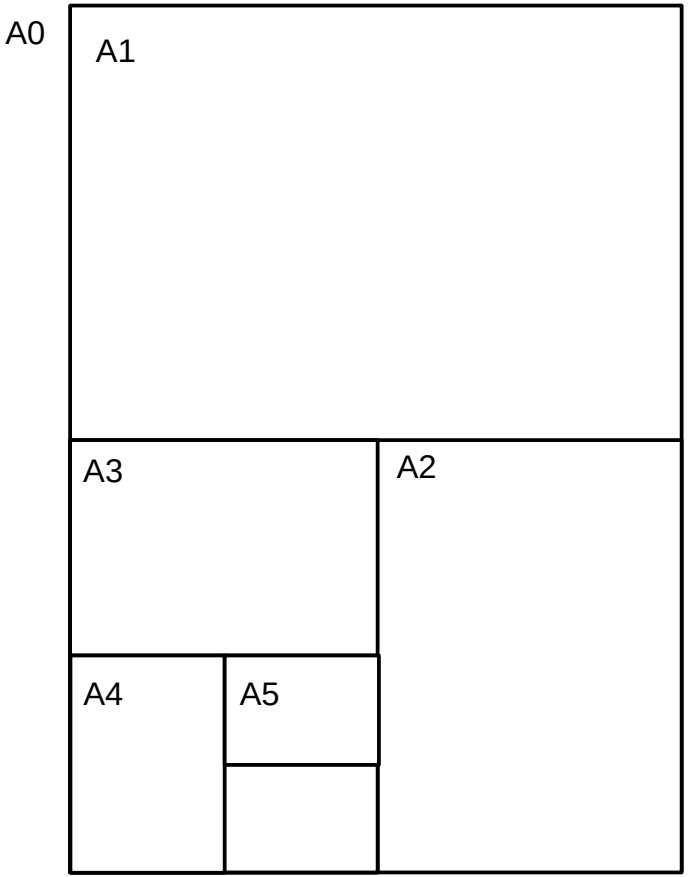


Standards

Paper sizes

European size destination	Russian size destination	Sheet dimensions in mm
11	A4	297x210
12	A3	297x420
22	A2	594x420
24	A1	594x841
44	A0	1189x841

Scales of reduction: 1:2, 1:2.5, 1:4, 1:5, 1:10, 1:15, 1:20, 1:25, 1:40, 1:50, 1:75, 1:100 etc.
Actual size: 1:1
Scales of increase: 2:1, 2.5:1, 4:1, 5:1, 10:1, 20:1, 40:1, 50:1, 100:1



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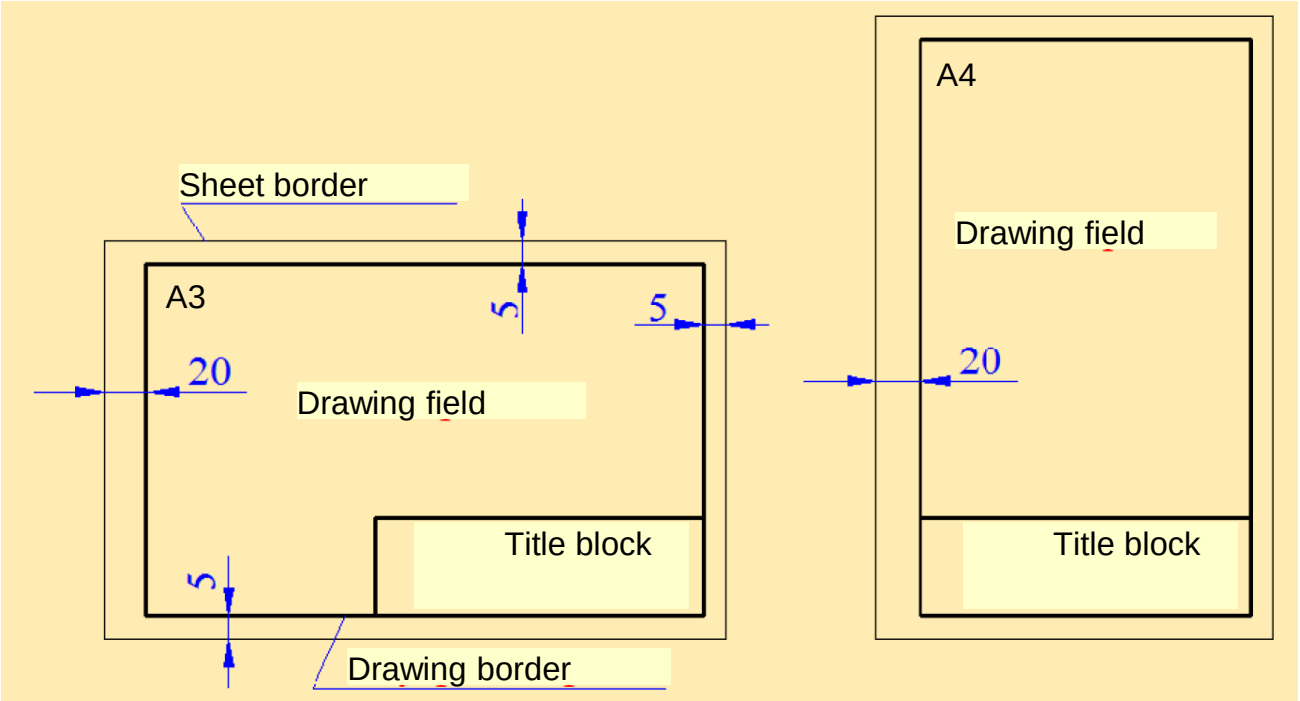
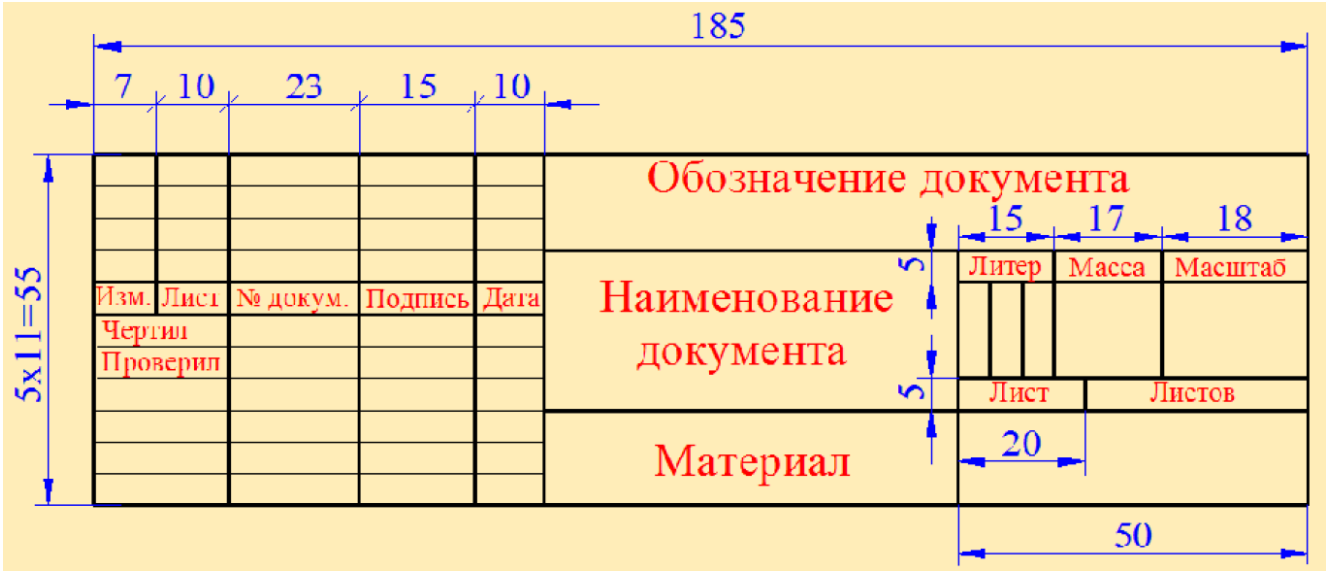

A3
Sheet border
5
5
20
Drawing field
Title block
5
Drawing border
A4
Drawing field
20
Title block

Standards


185
7
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5x11=55
Обозначение документа
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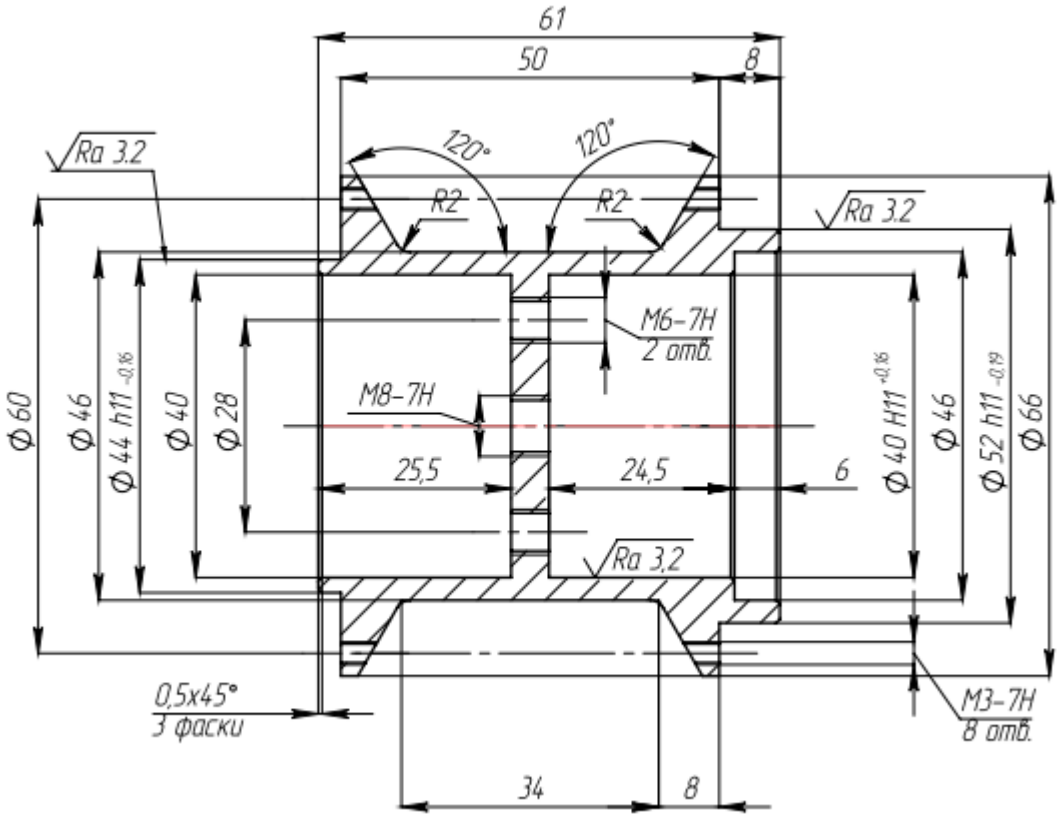
17
18
Литер
Масса
Масштаб
Изм.
Лист
№ докум.
Подпись
Дата
Чертил
Проверил
Наименование документа
5
5
Лист
Листов
Материал
20
50

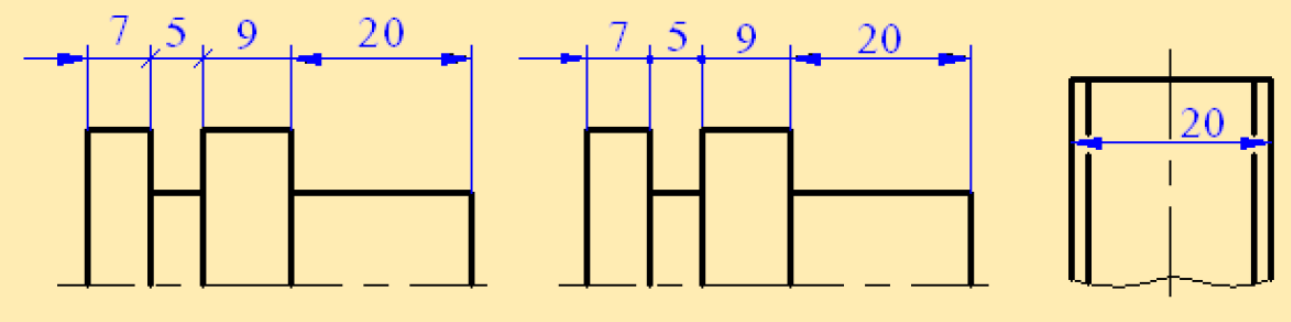
Standards

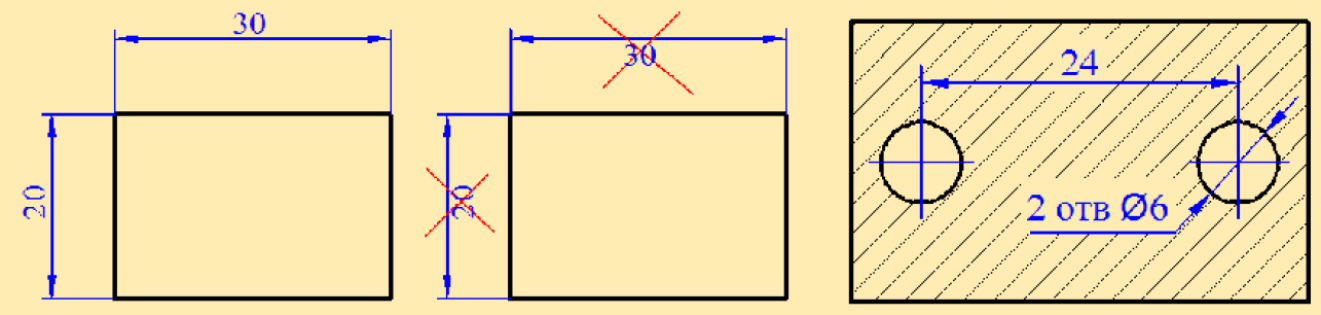
№	Name	Line	Thickness, mm
1	Visible line		S=0,6...1,5
2	Thin line (hatching of section, dimension, extension, arrows)		S/3...S/2
3	Freehand line		S/3...S/2
4	Hidden line		S/3...S/2
5	Dash-dotted line (thin)		S/3...S/2
6	Dash-dotted line (thick)		S/2...2/3S
7	Line for section marking		S...1,5S
8	Long-break line		S/3...S/2
9	Phantom line		S/3...S/2



1 *Размеры для справок.
2 Общие допуски по ГОСТ 30893.1 H14, h14, ±IT14/2.
3 Общие допуски формы и расположения по ГОСТ 30893.2–K.

Standards





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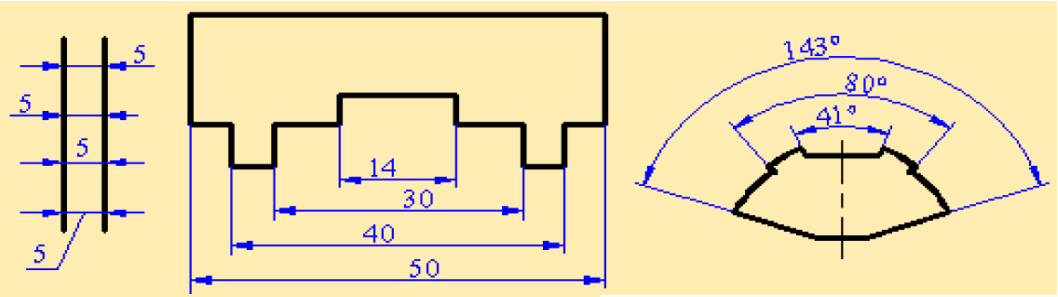
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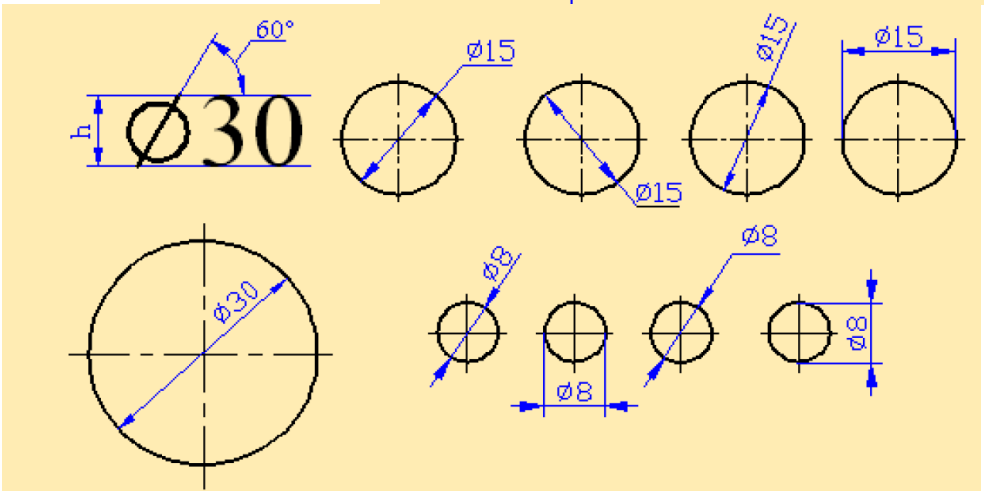
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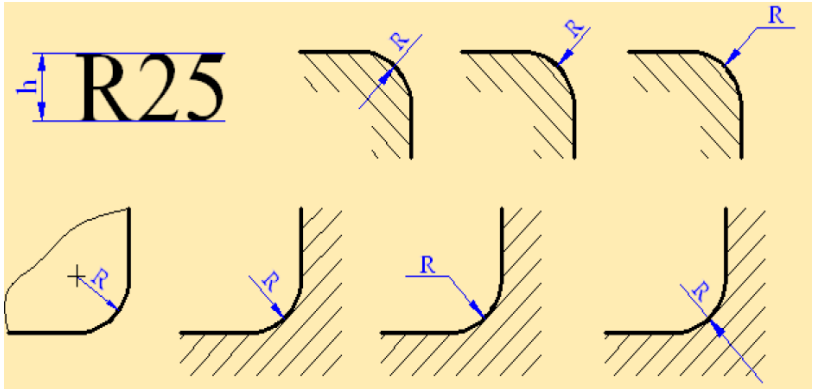
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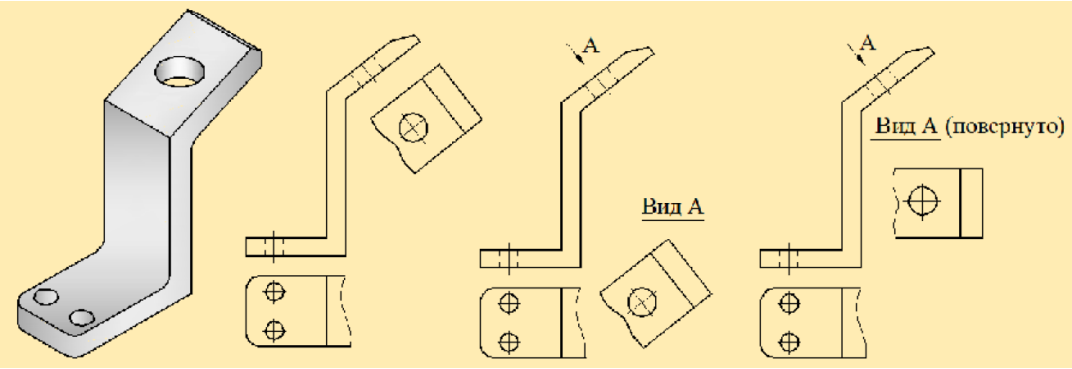

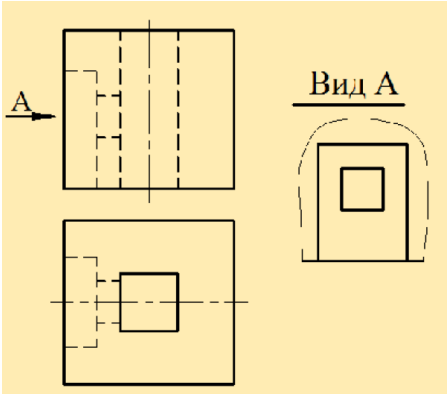

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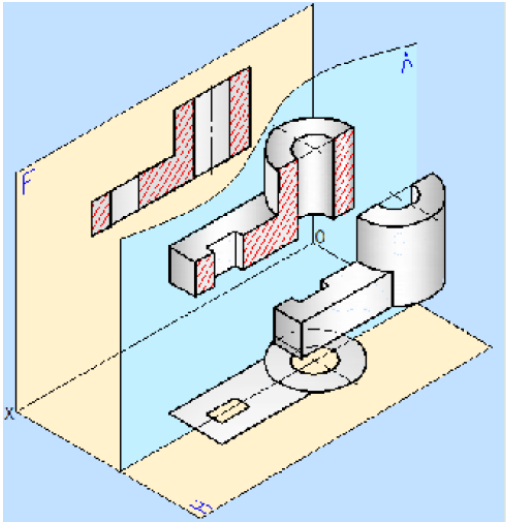

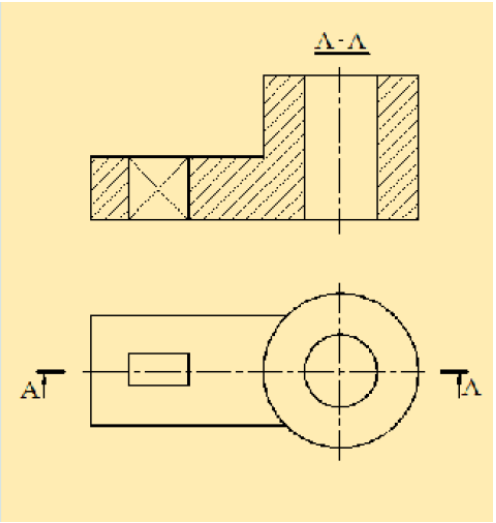

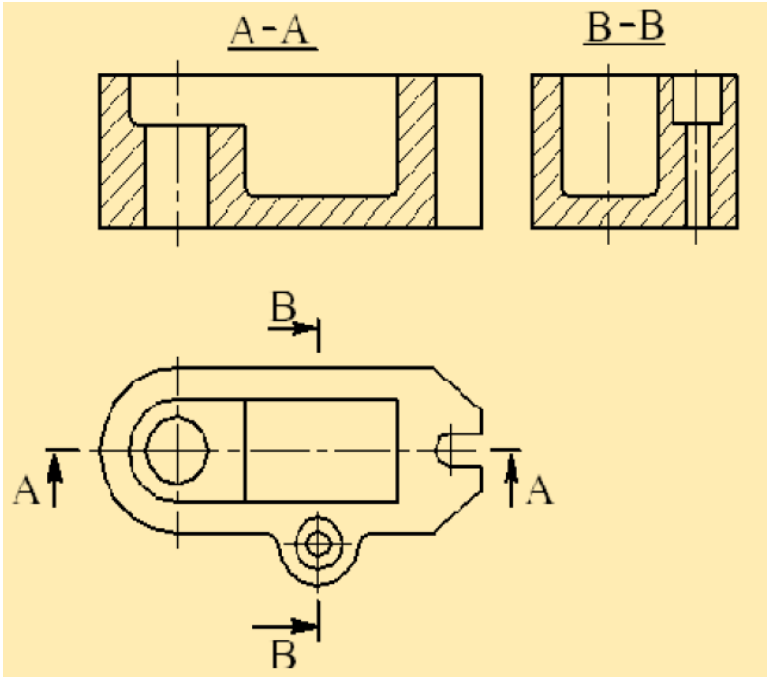

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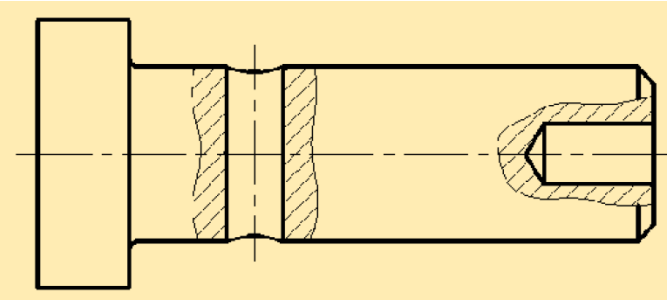

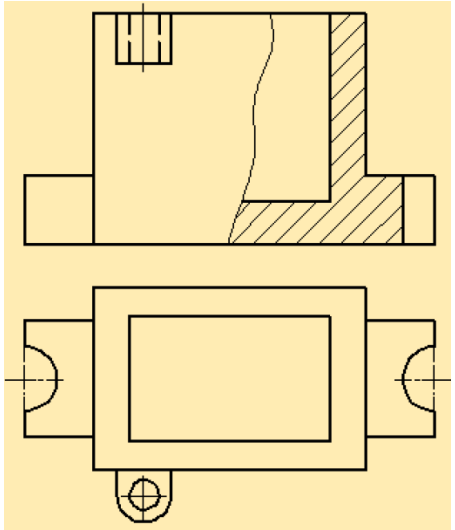

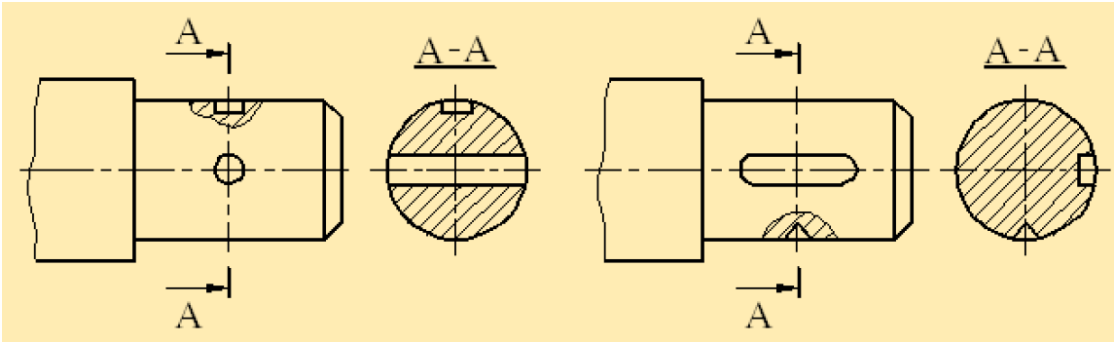

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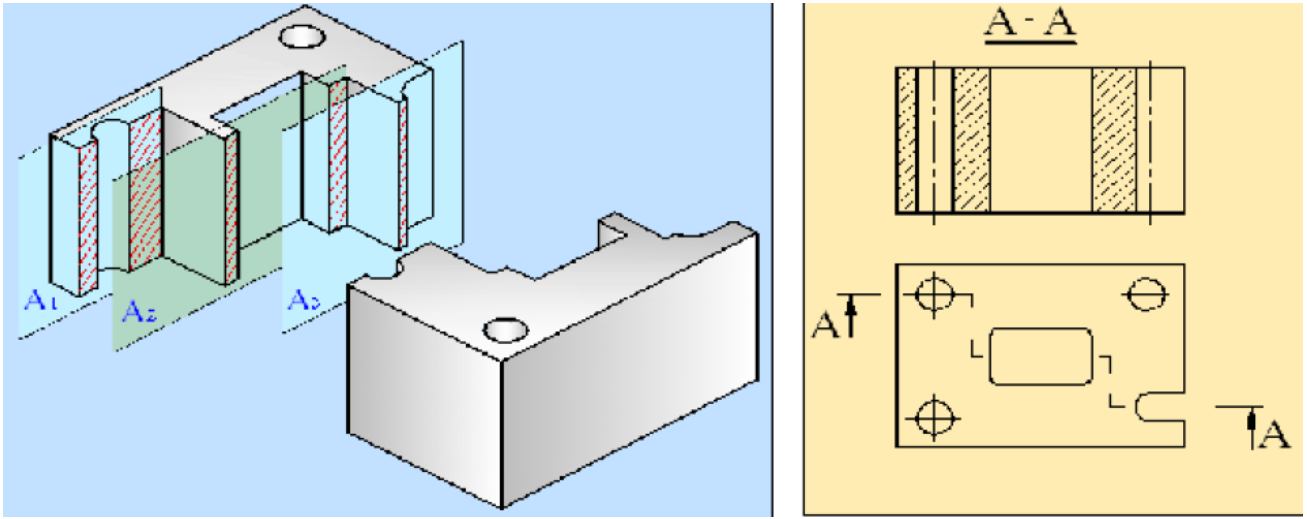
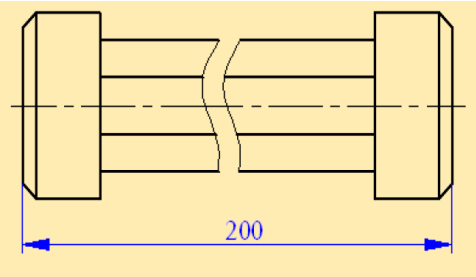
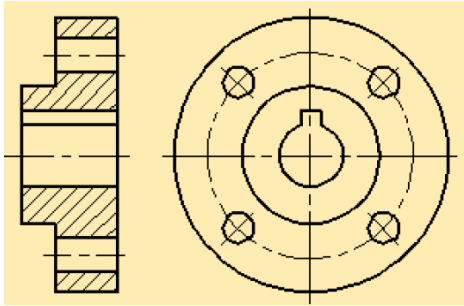


Standards





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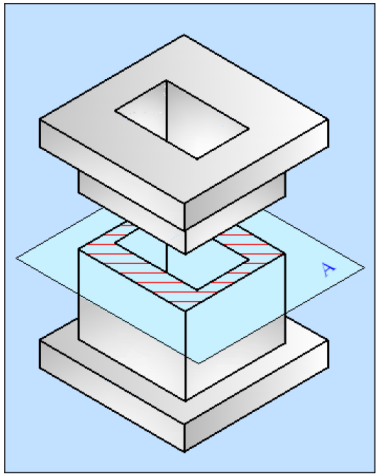

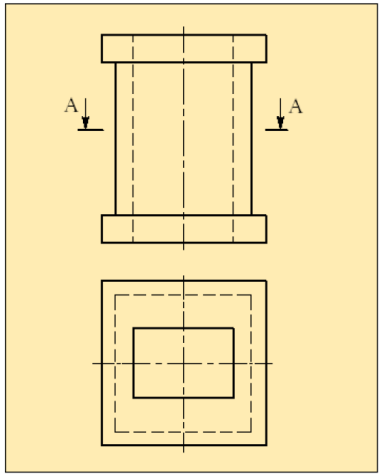

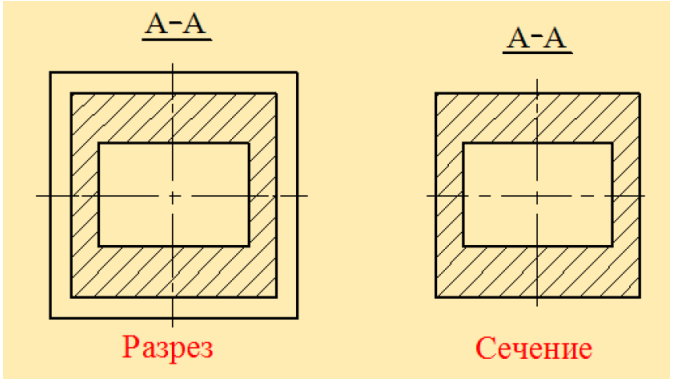

Reference material

1. Исследование «американской» и «европейской» систем проецирования
2. Методы проецирования (rus)
3. Инженерная графика (rus)

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