



Mechanics and machines, Lecture 1

Introduction
Engineering Drawing



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



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

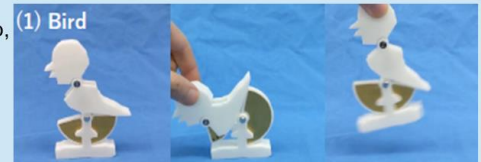
Research Project

- 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



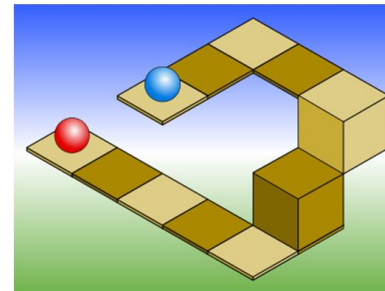
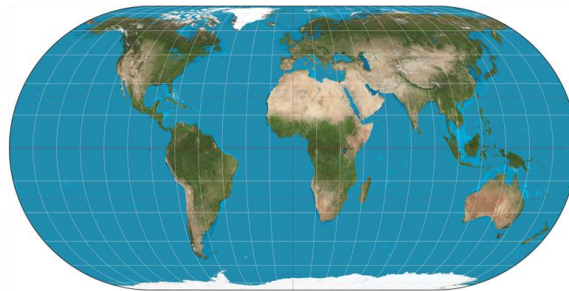
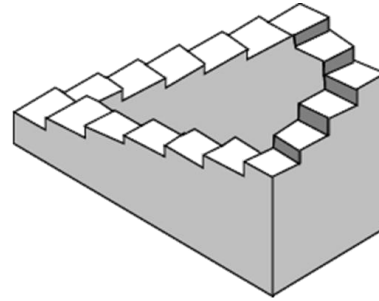
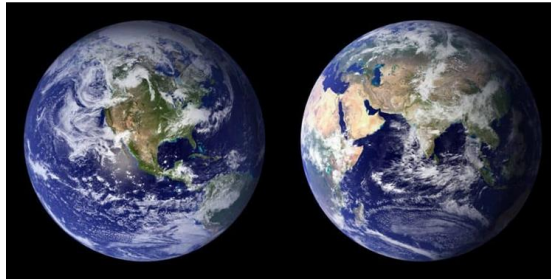
We work with 3D-objects which must be shown in a [flat drawing](#). This is a problem.



Projections

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

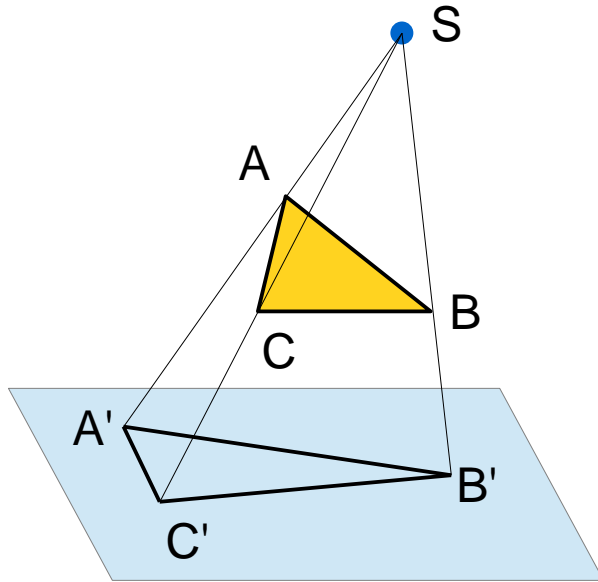
On the other hand, we can draw something absolutely impossible or something possible but unclear.



Parallel and perspective projections

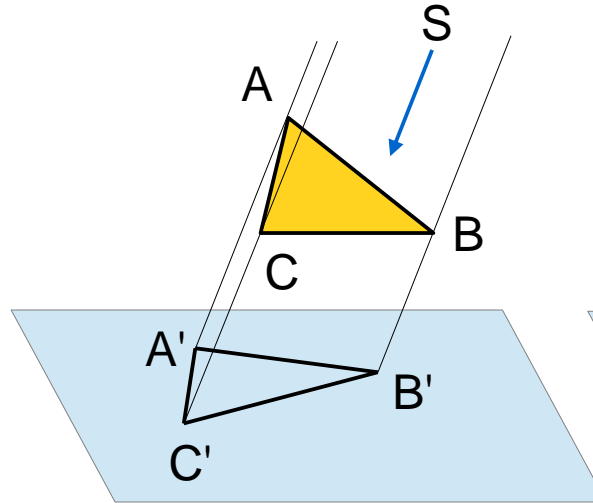


Central (perspective) projection

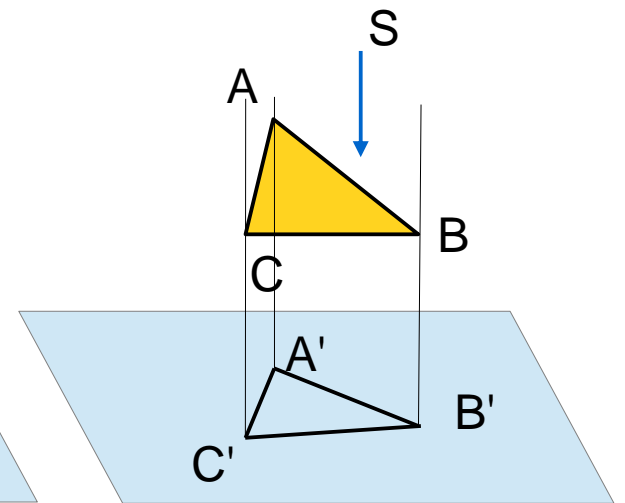


Parallel projections

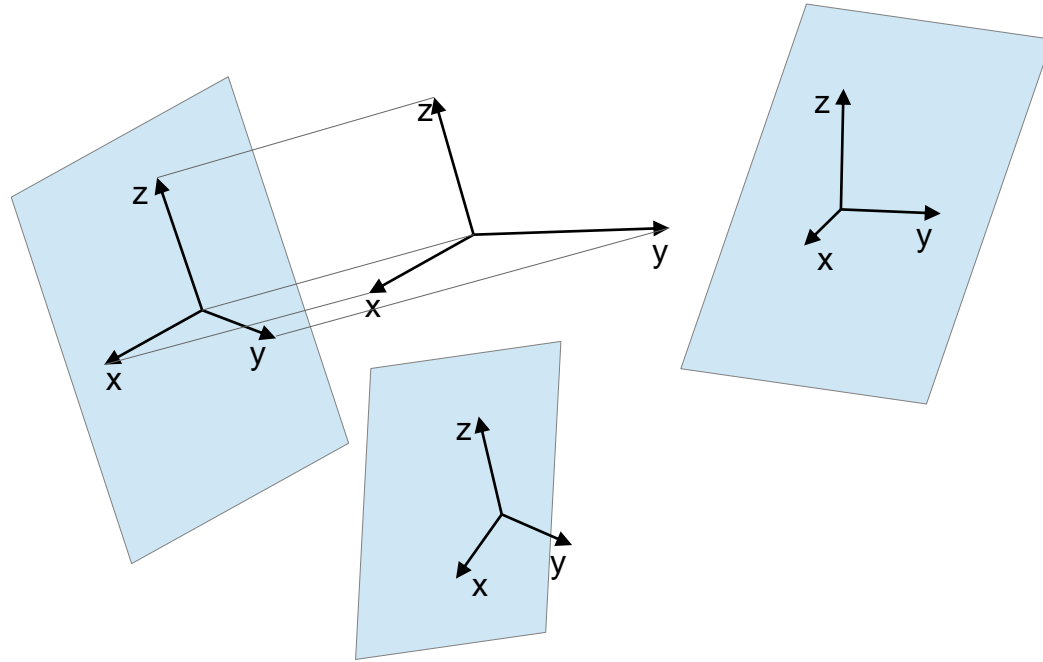
General (oblique) case



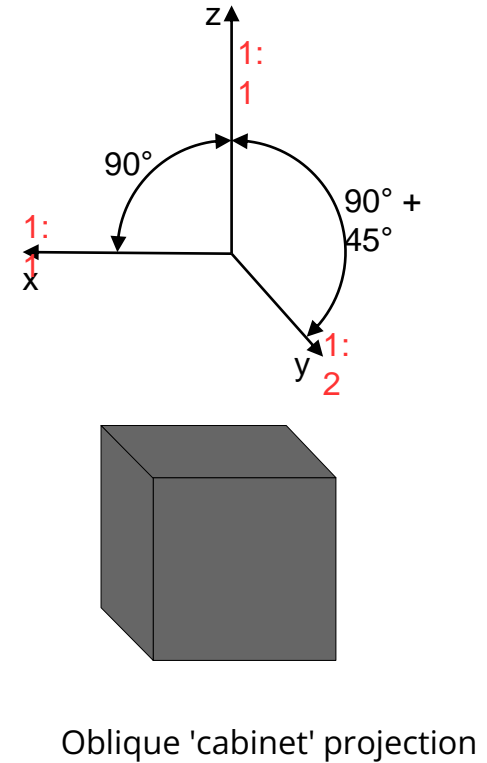
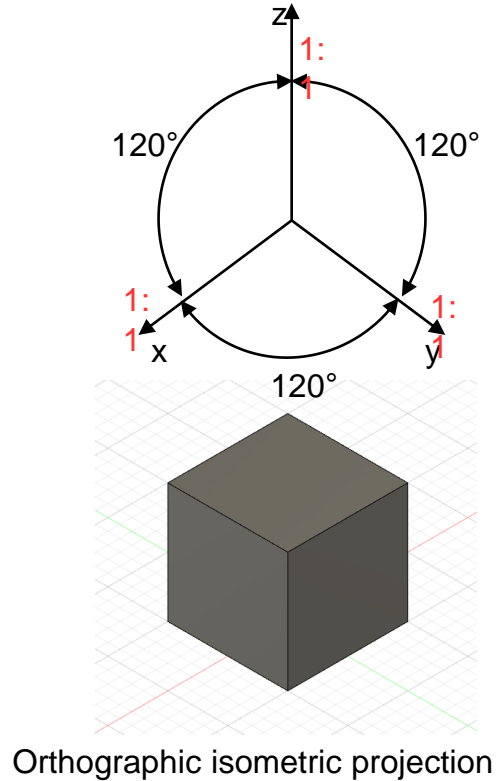
Orthographic projection



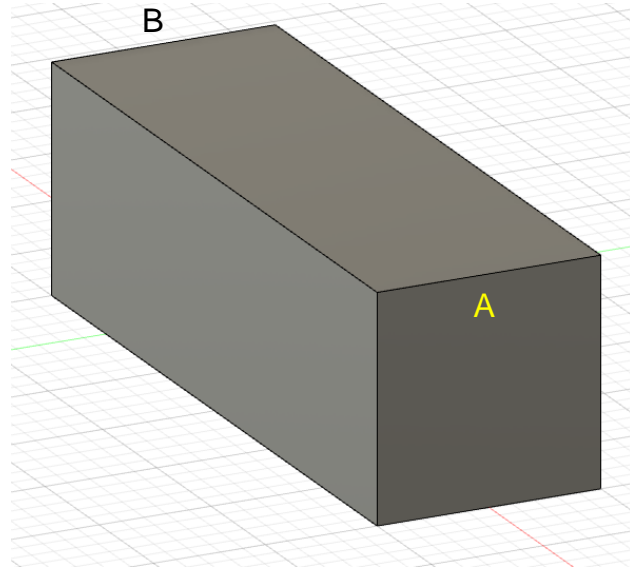
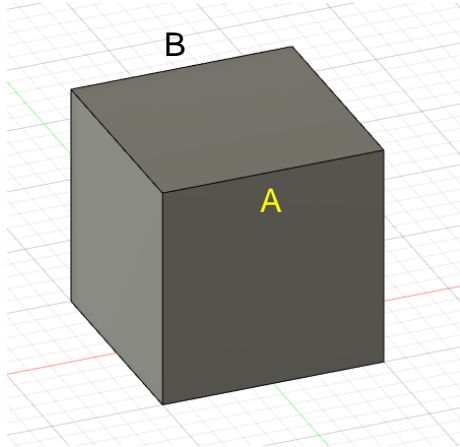
Axonometric projections



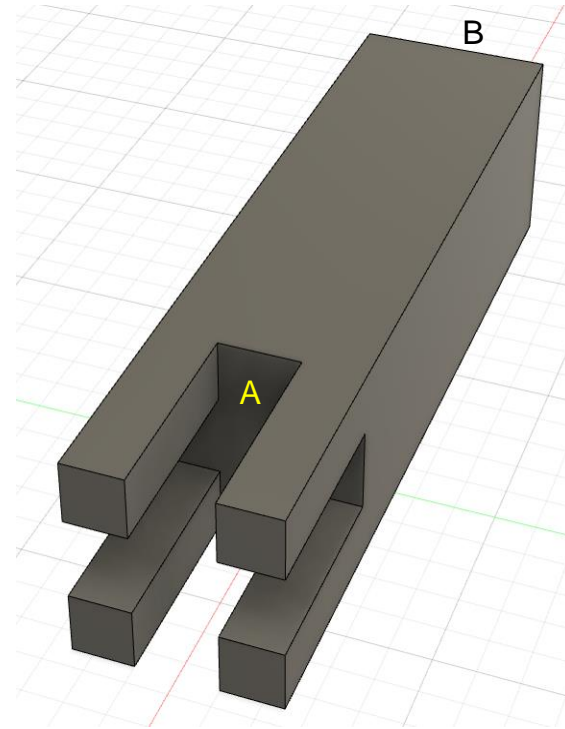
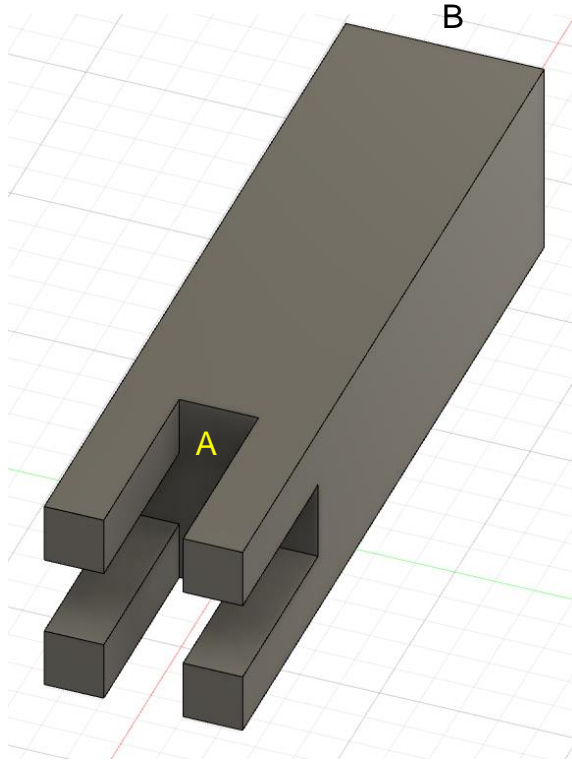
Axonometric projections



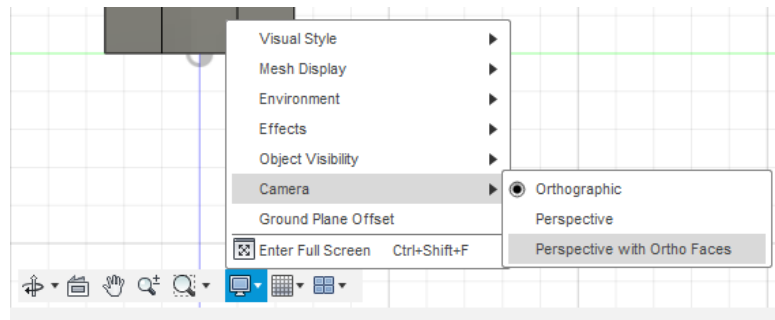
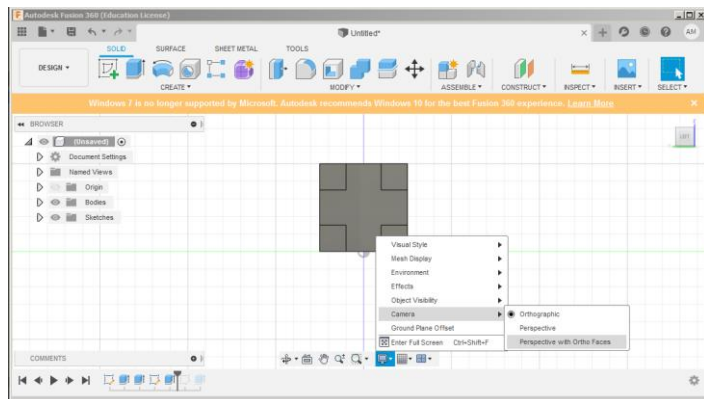
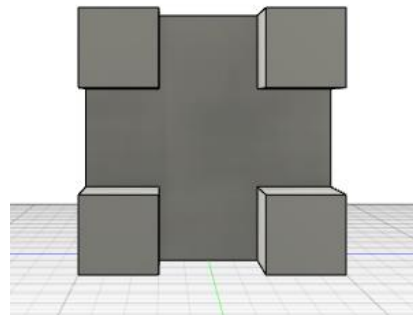
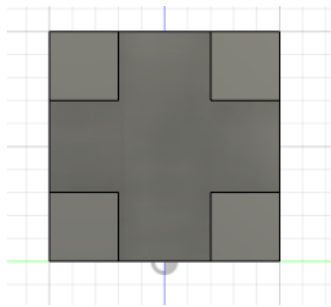
Parallel projections

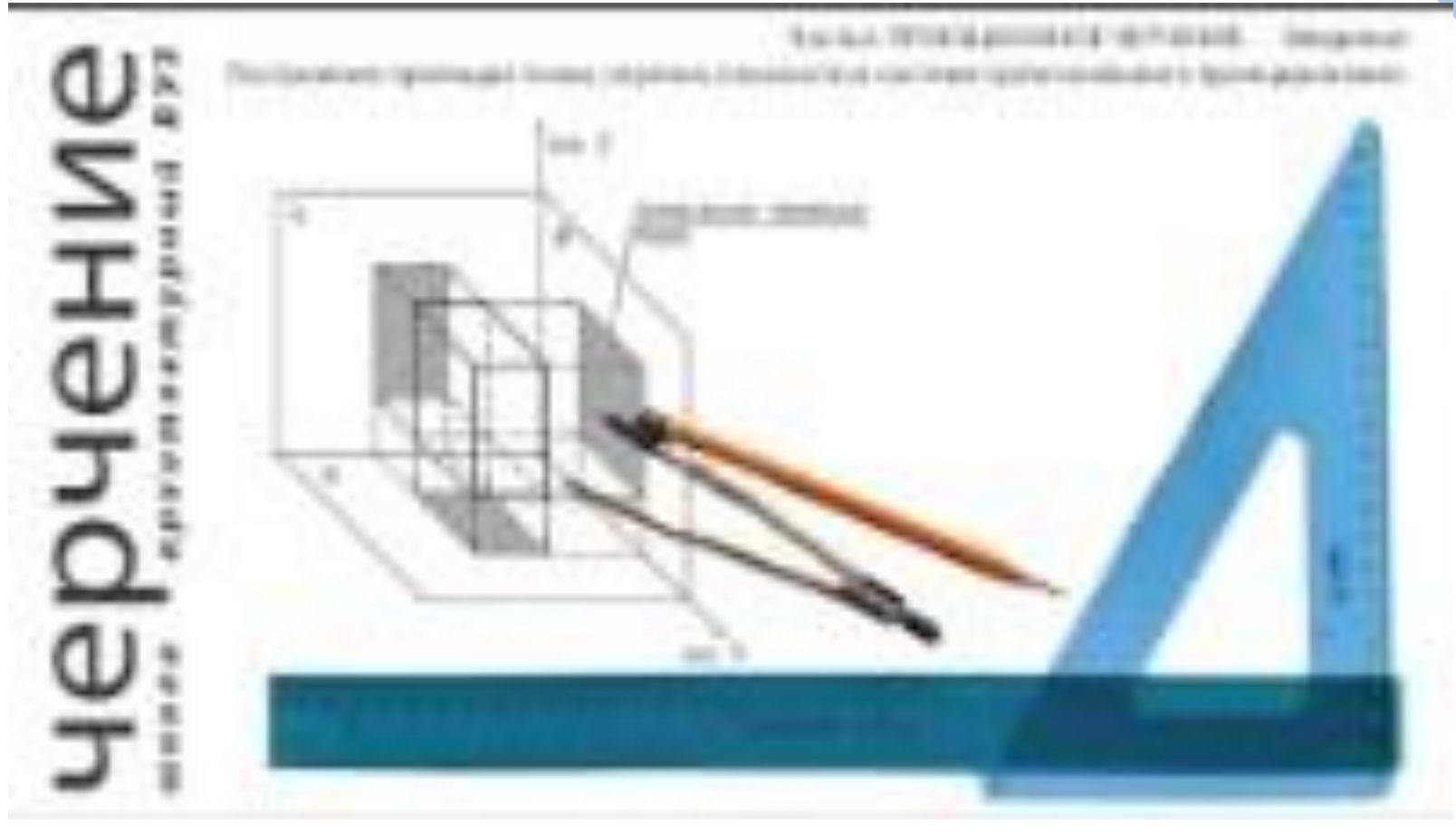


Parallel and perspective projections

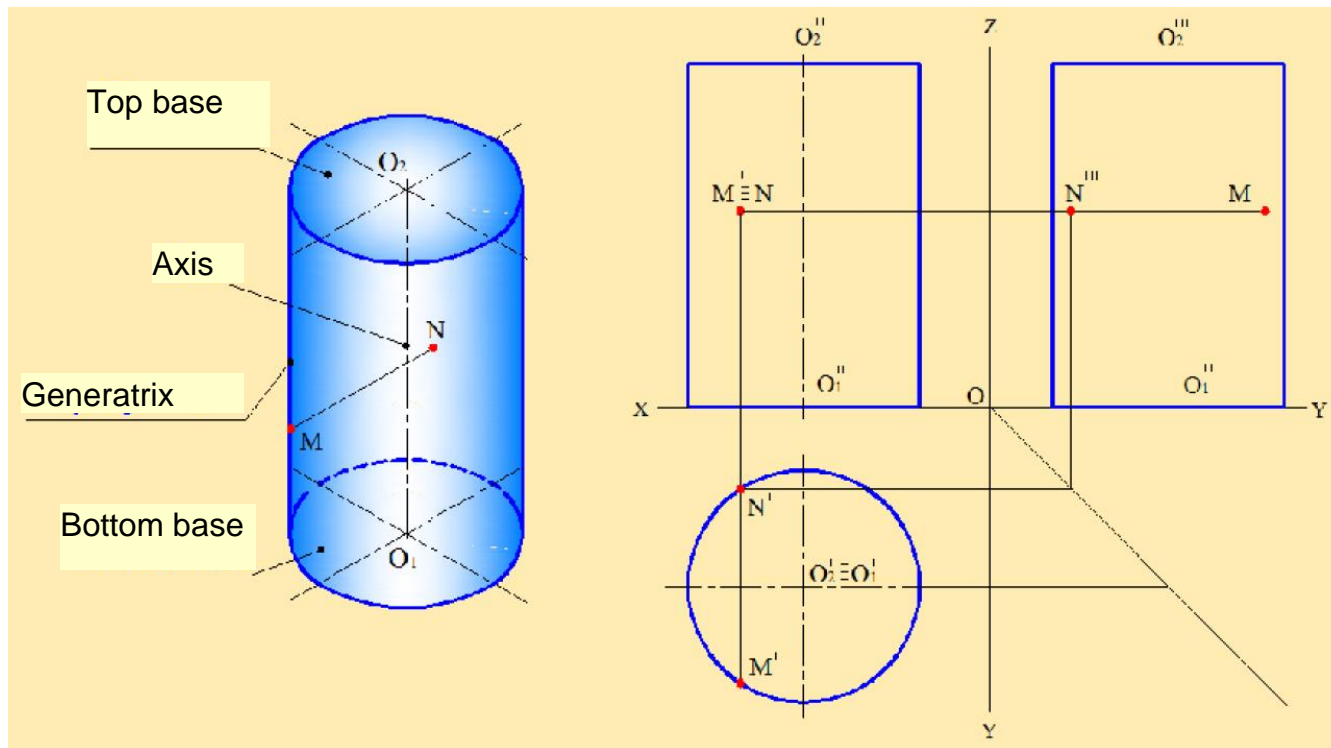


Parallel and perspective projections

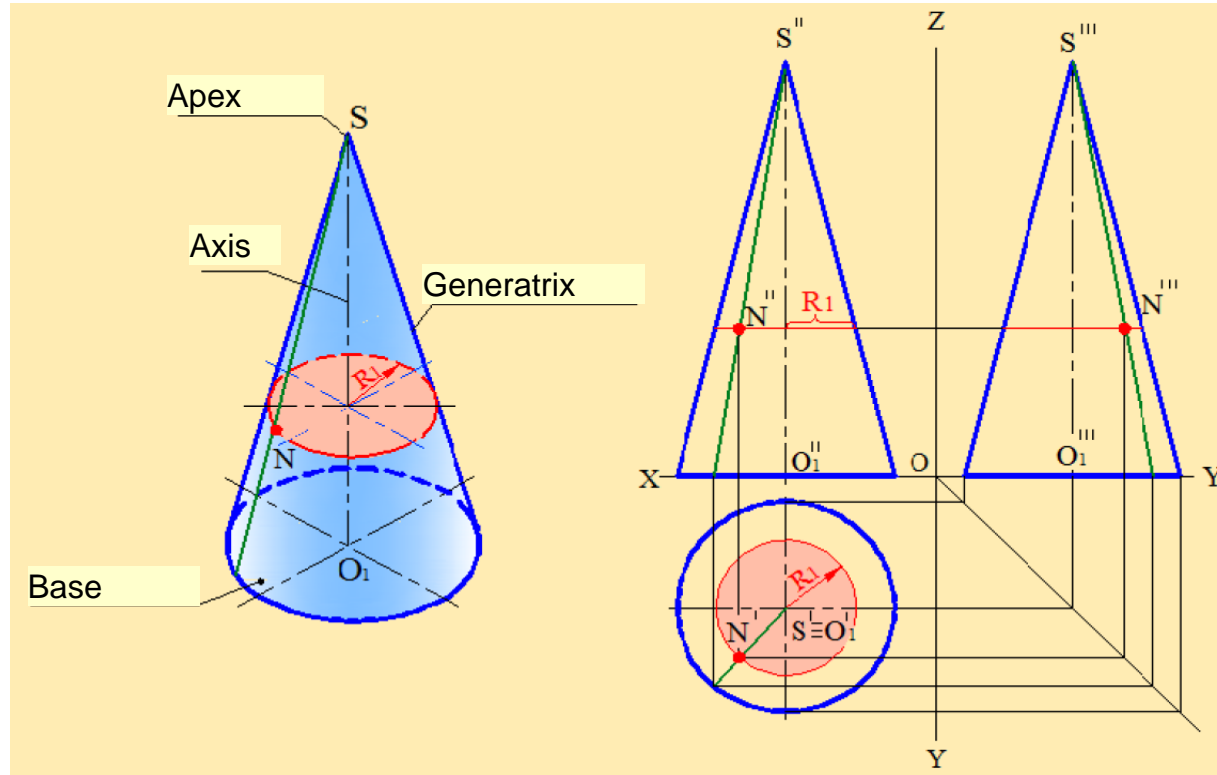




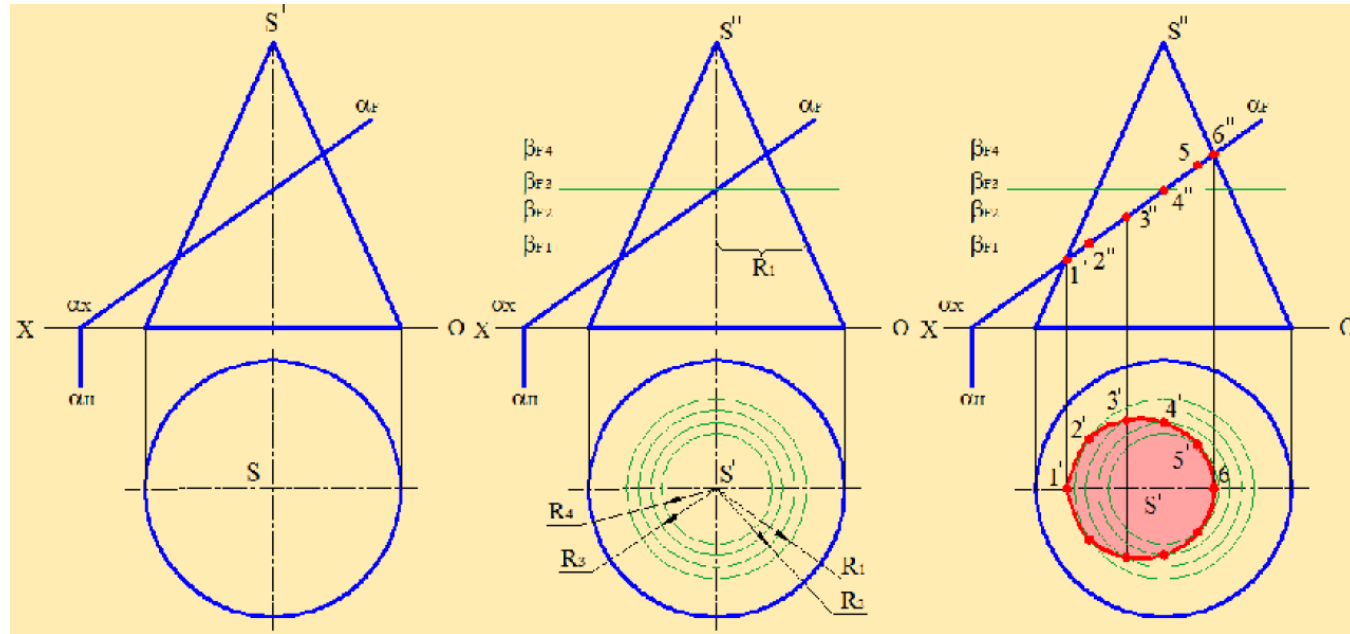
Orthographic Multiview projections



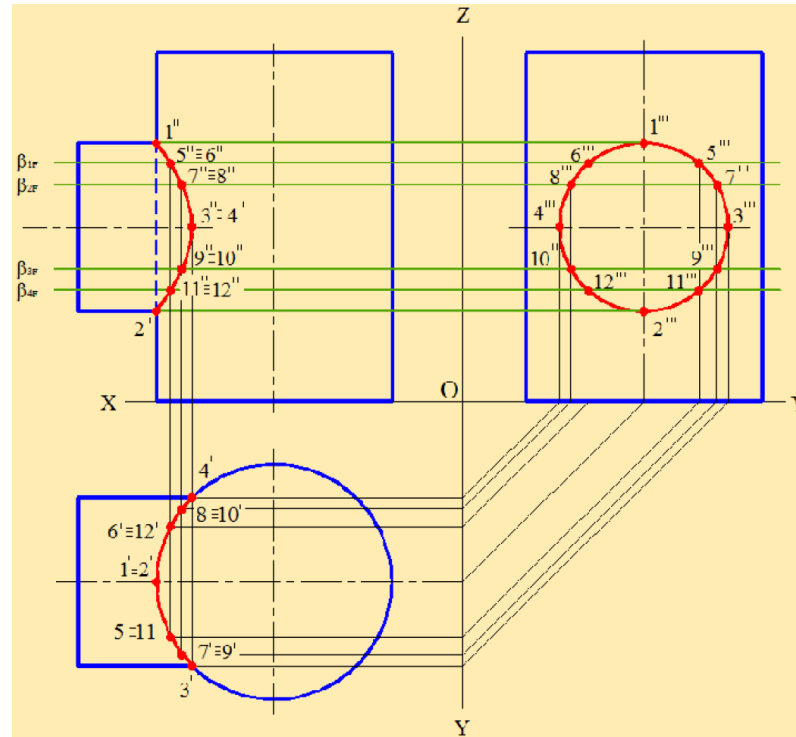
Orthographic Multiview projections



Orthographic Multiview projections

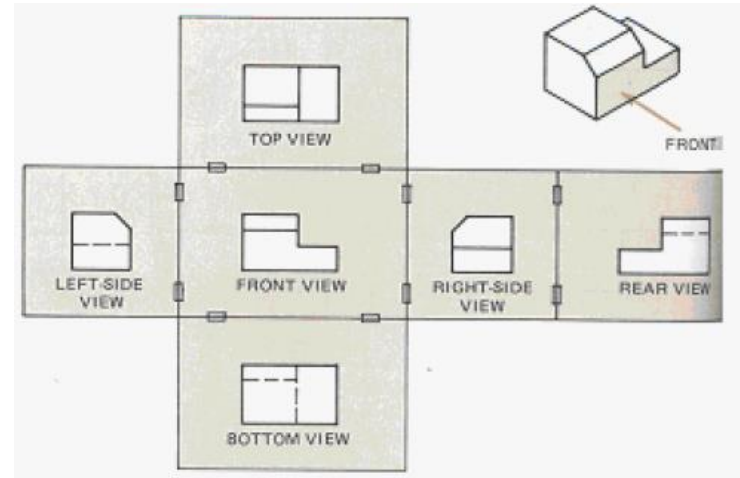
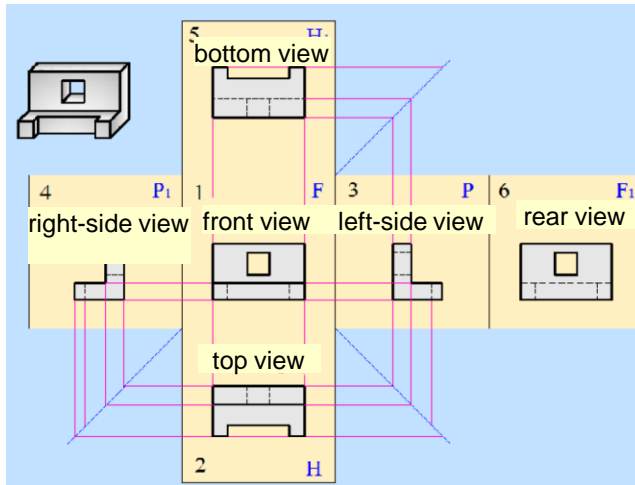
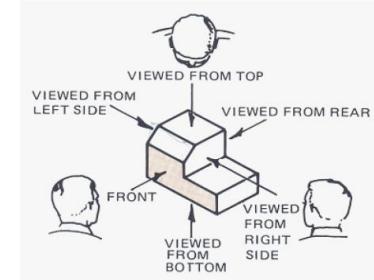


Orthographic Multiview projections

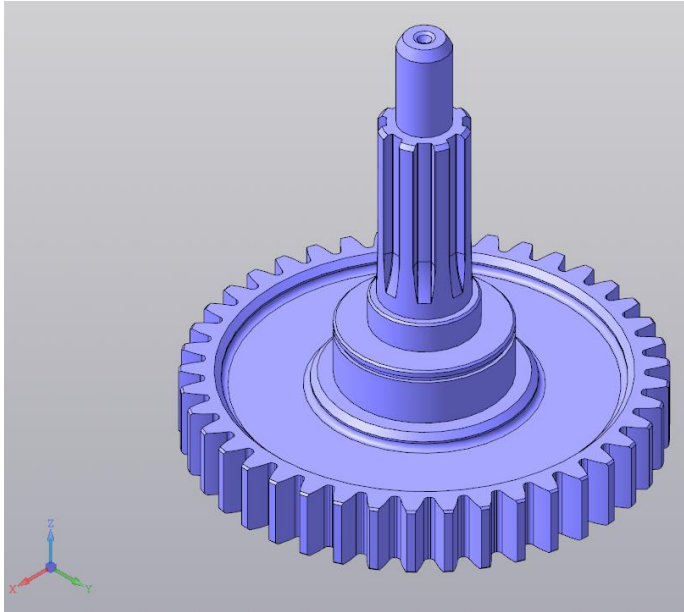


Orthographic Multiview projections

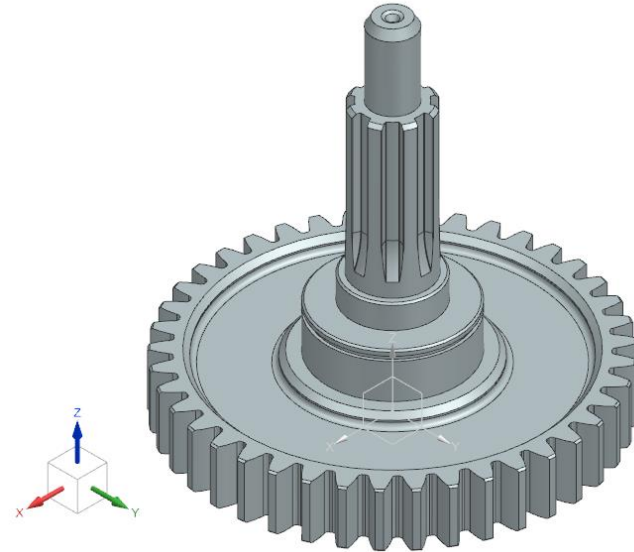
The difference between European and American standards



Orthographic multiview projections

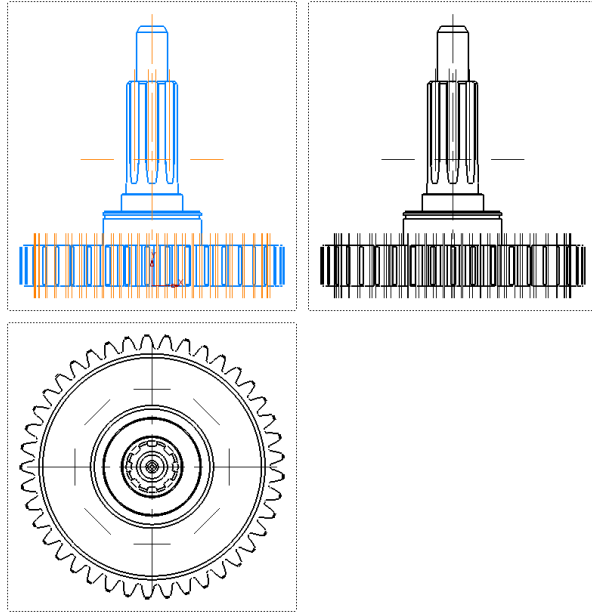


Kompas 3D

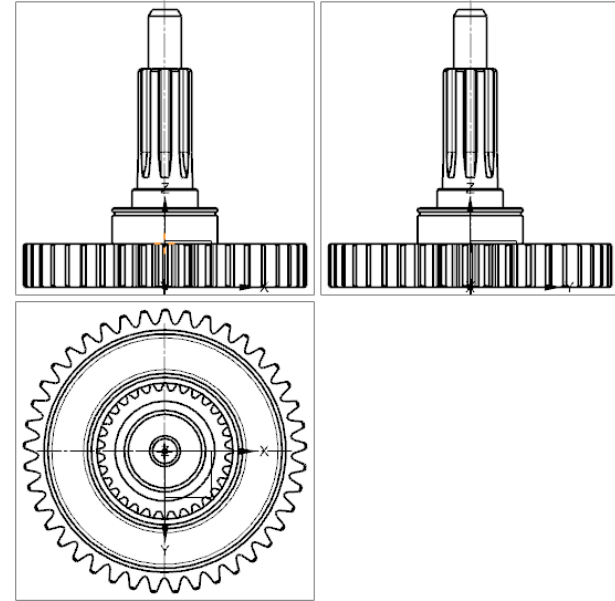


Siemens NX

Orthographic multiview projections

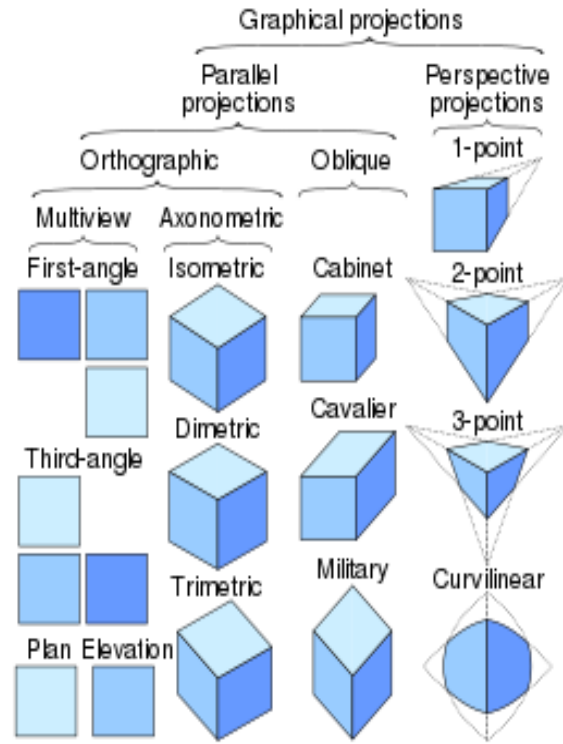


Kompas 3D
(European system)



Siemens NX
(American system)

Classification of some 3D projections



Standards

Paper sizes

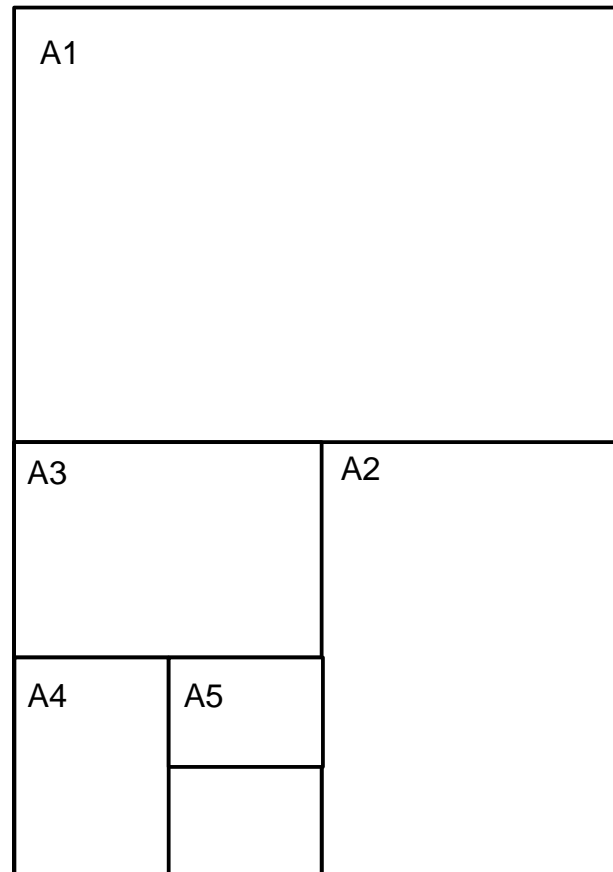
European size destination	Russian size destination	Sheet dimensions in mm
11	A4	297x210
12	A3	297x420
22	A2	594x420
24	A1	594x841
44	A0	1189x841

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.

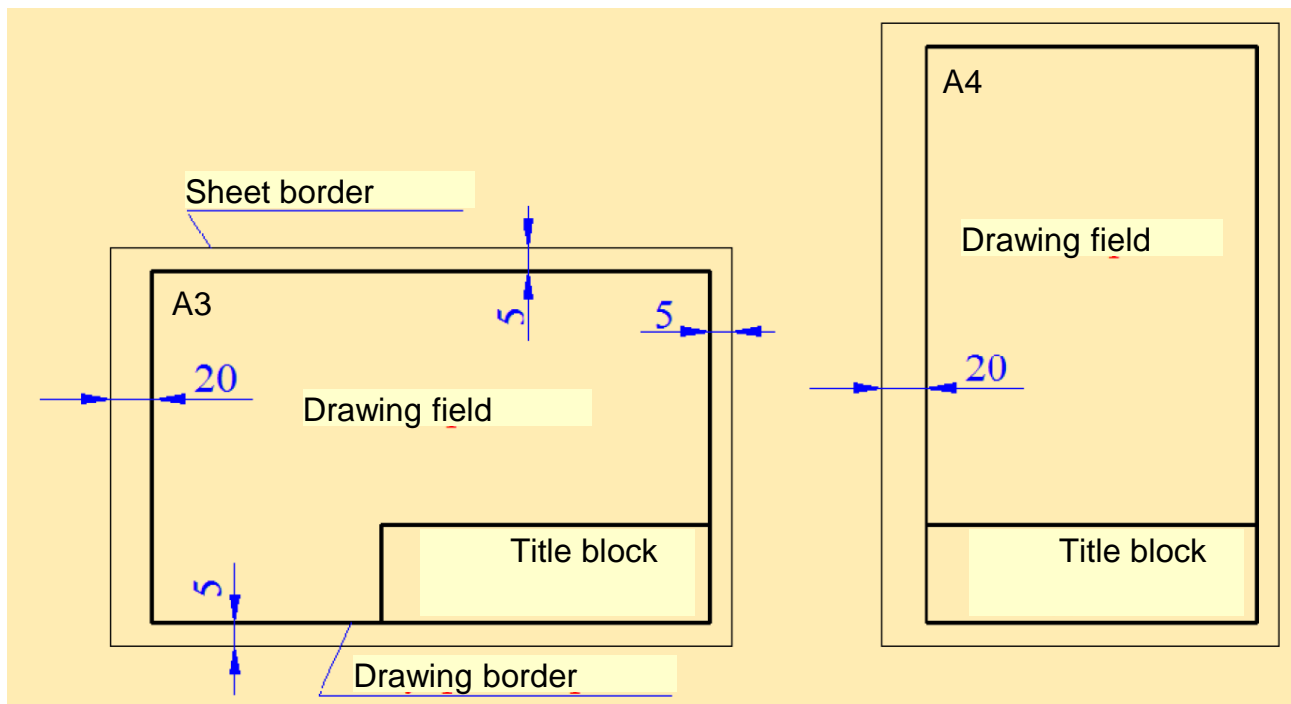
Actual size: 1:1

Scales of increase: 2:1, 2.5:1, 4:1, 5:1, 10:1, 20:1, 40:1, 50:1, 100:1

A0



Standards









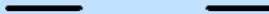

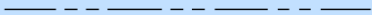
Standards

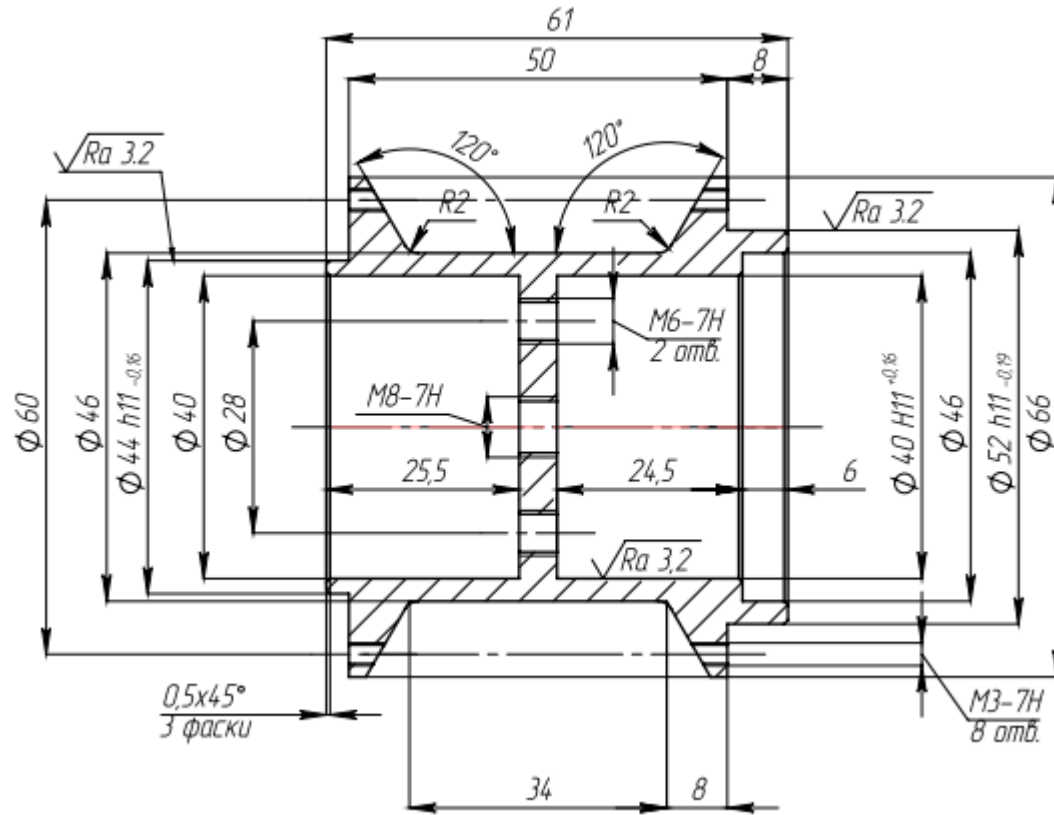


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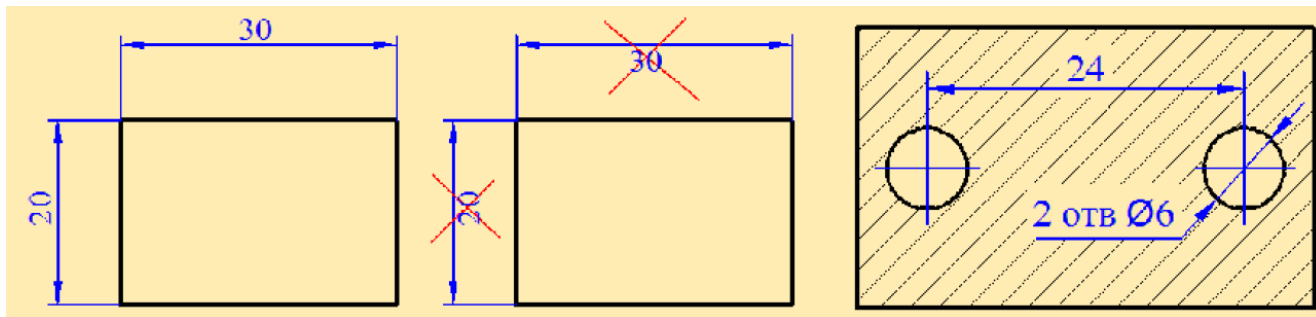
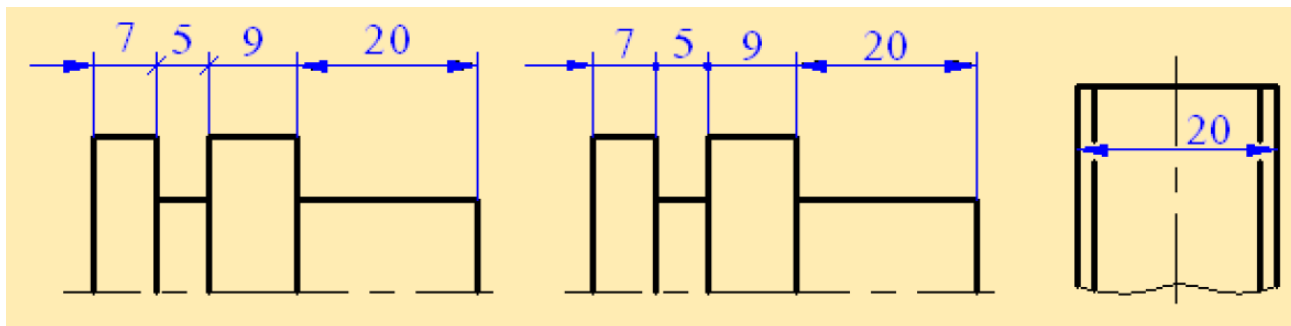


No	Name	Line	Thickness, mm
1	Visible line		$S=0,6...1,5$
2	Thin line (hatching of section, dimension, extension, arrows)		$S/3...S/2$
3	Freehand line		$S/3...S/2$
4	Hidden line		$S/3...S/2$
5	Dash-dotted line (thin)		$S/3...S/2$
6	Dash-dotted line (thick)		$S/2...2/3S$
7	Line for section marking		$S...1,5S$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

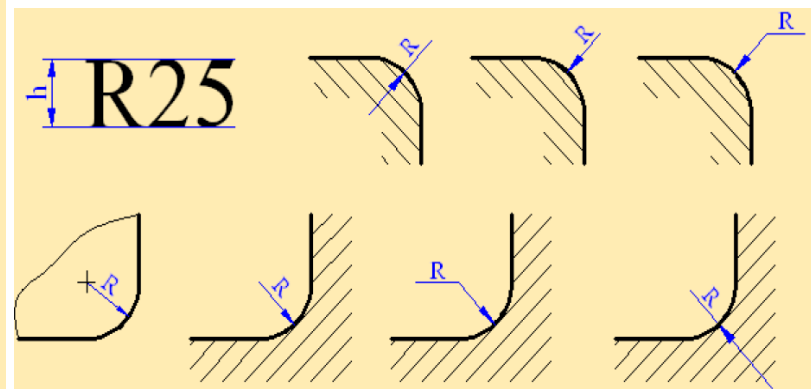
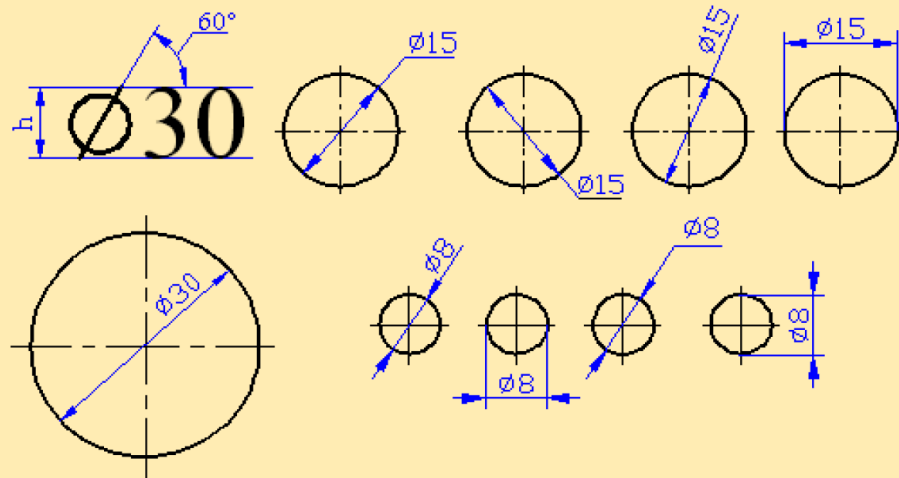
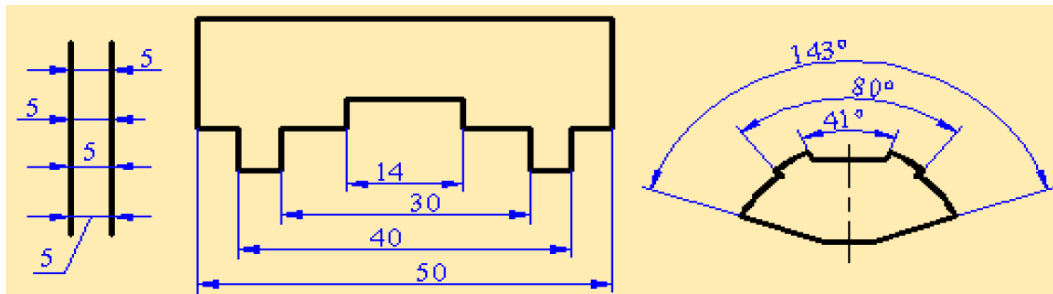


- 3 Общие допуски формы и расположения по ГОСТ 30893.2-К.

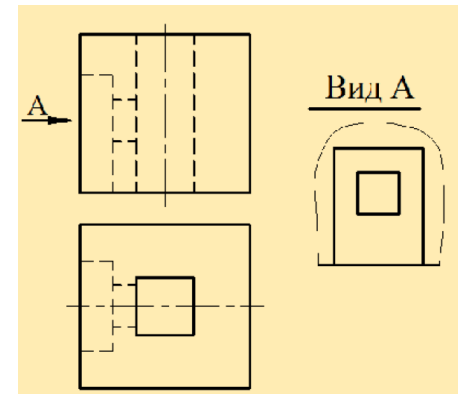
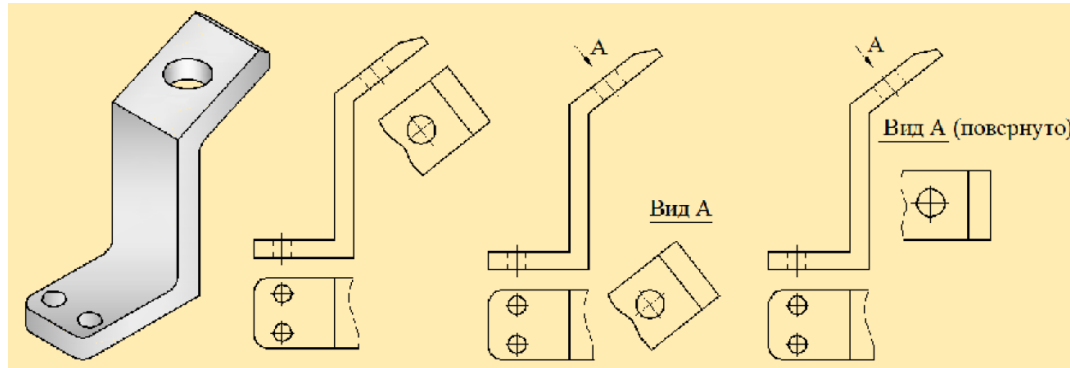
Standards



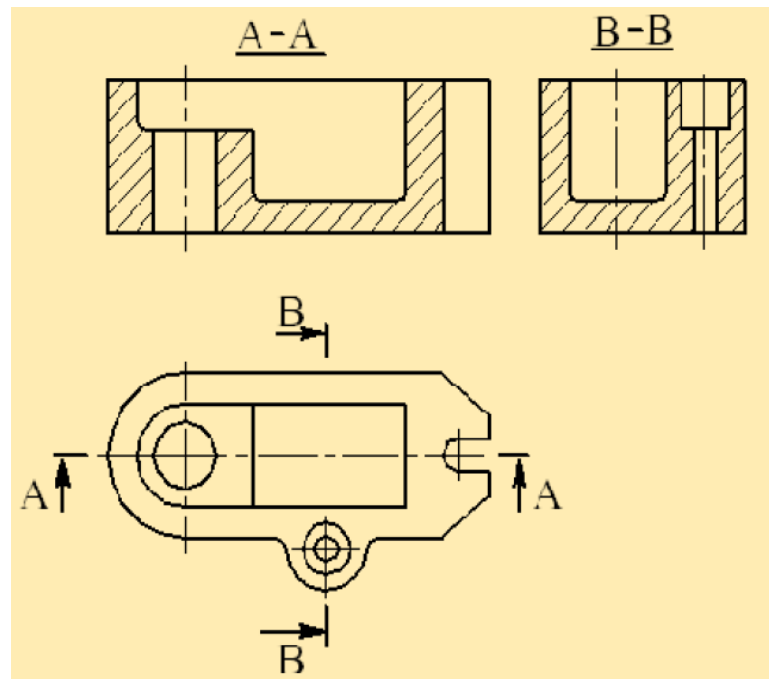
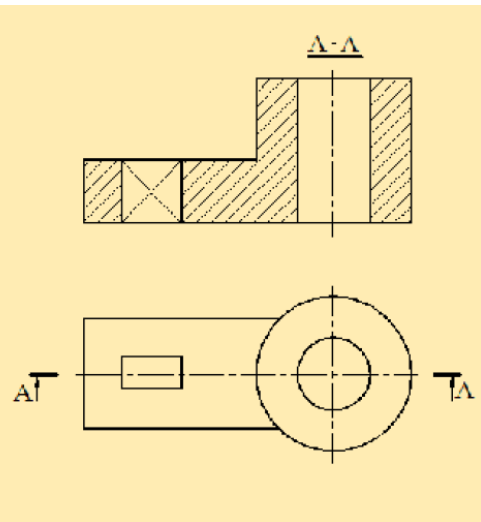
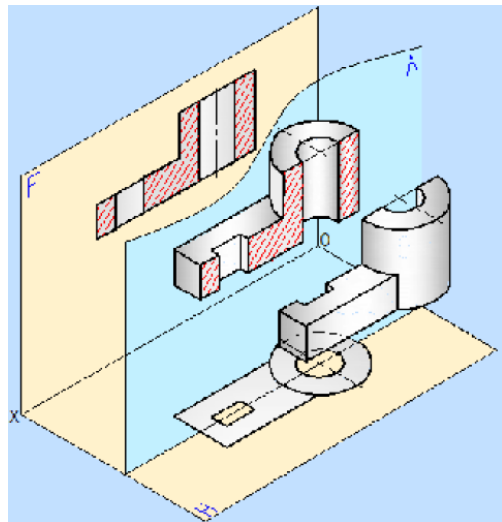
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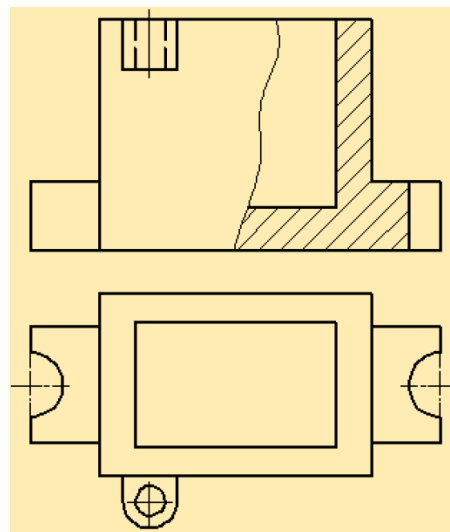
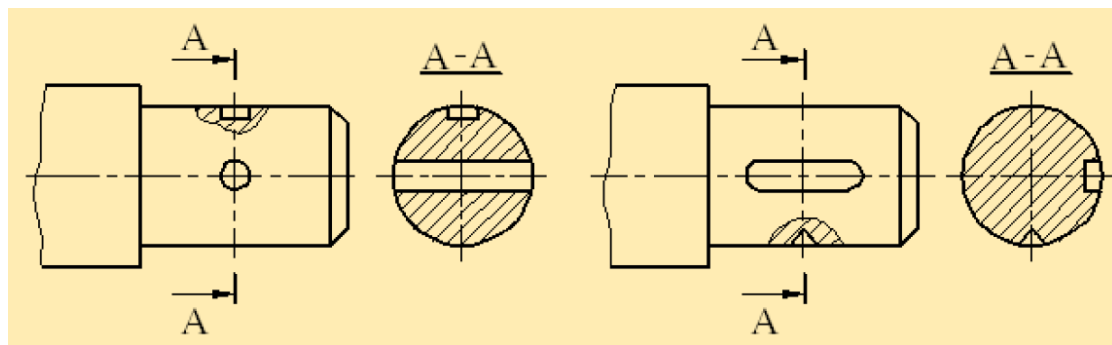
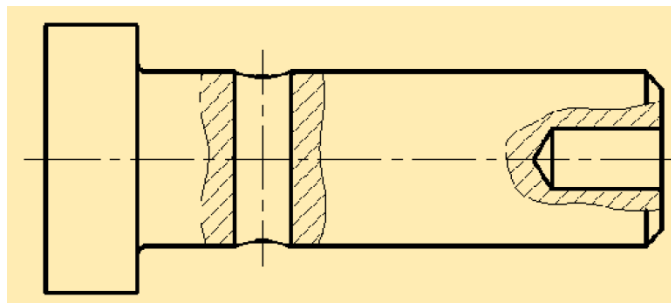
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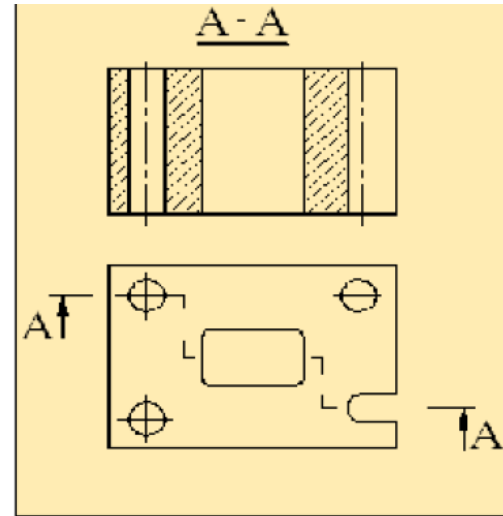
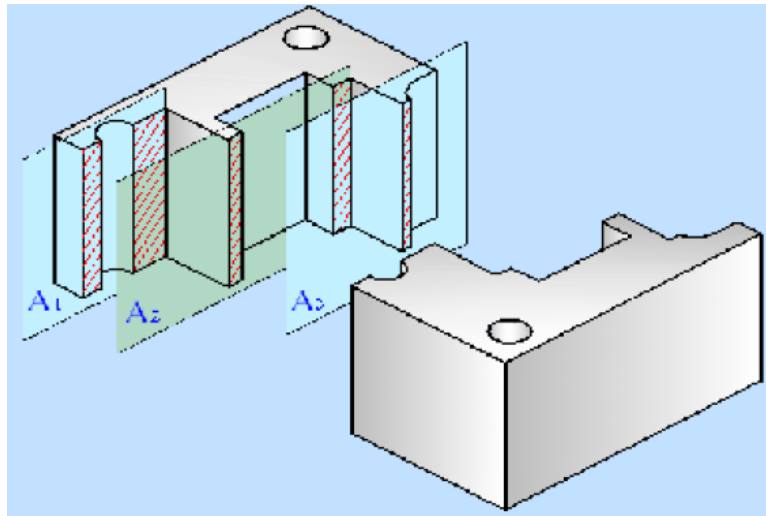
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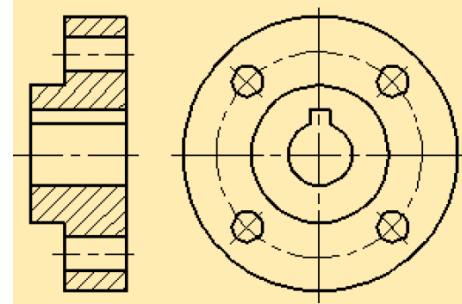
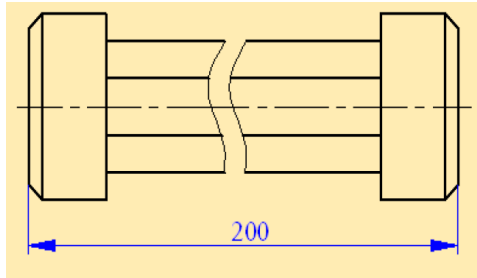
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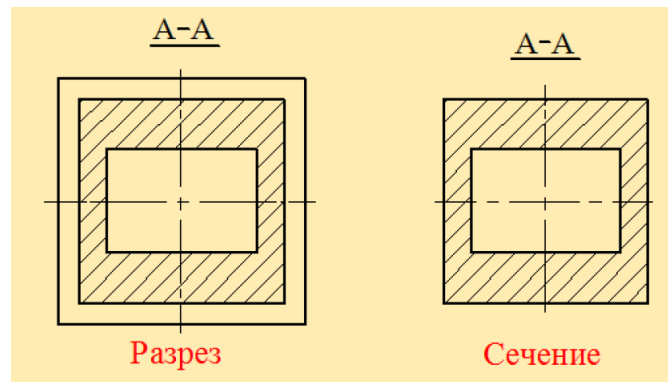
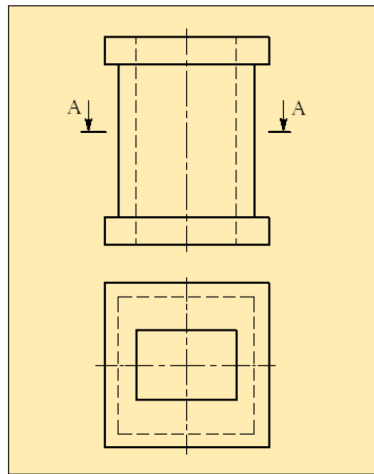
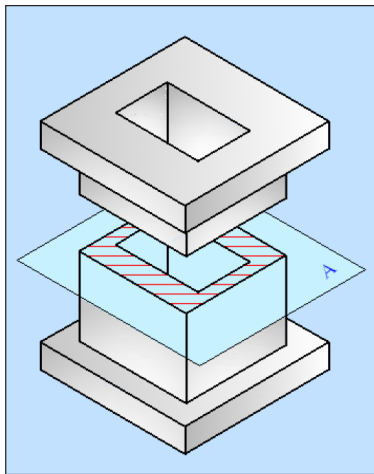
Standards



Standards



Standards



Reference material



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

Deserve “A” grade!

– Oleg Bulichev

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📍 @Lupasic

🏠 Room 414