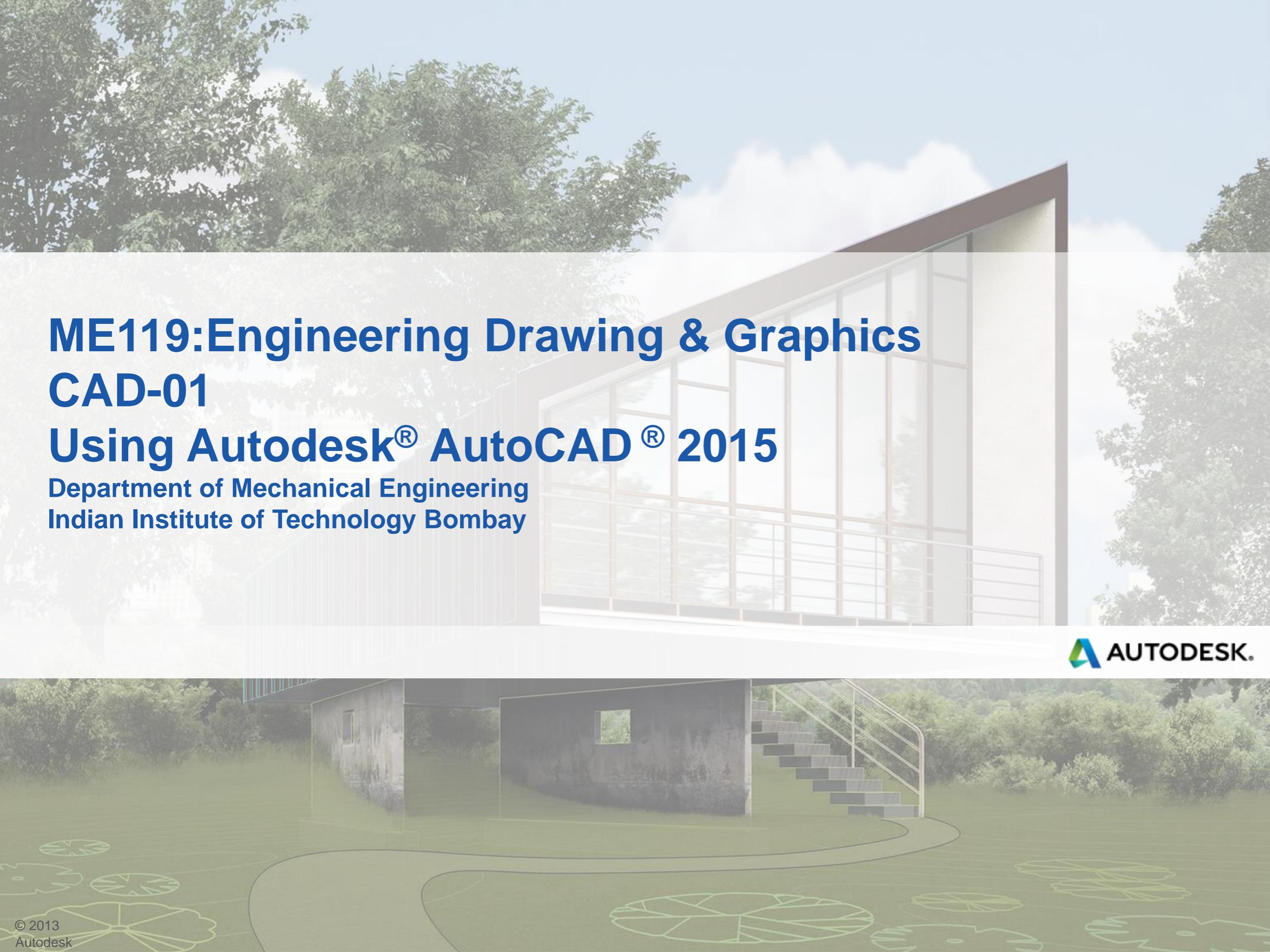


ME119:Engineering Drawing & Graphics

CAD-01

Using Autodesk® AutoCAD® 2015

**Department of Mechanical Engineering
Indian Institute of Technology Bombay**



ITEM	QTY	PART NUMBER
4	1	Wheel Holder - Lowr Guide
		Wheels
9	2	Side Wheel
11	2	Wheel
18	2	SideWheel Bolts
18.1	1	Unbrako - 1 1/2 x 10
18.2	2	ANSI B18.22.1 - 1 1/2 - Regular - Type B
18.3	1	ANSI B18.2.2 - 1 1/2 - 6
19	1	Frame - V2
19.1	1	Frame, Section
19.2	1	Base, Lower Wheel
19.3	1	Wheels

The Autodesk vision is to help people imagine, design, and create a better world.

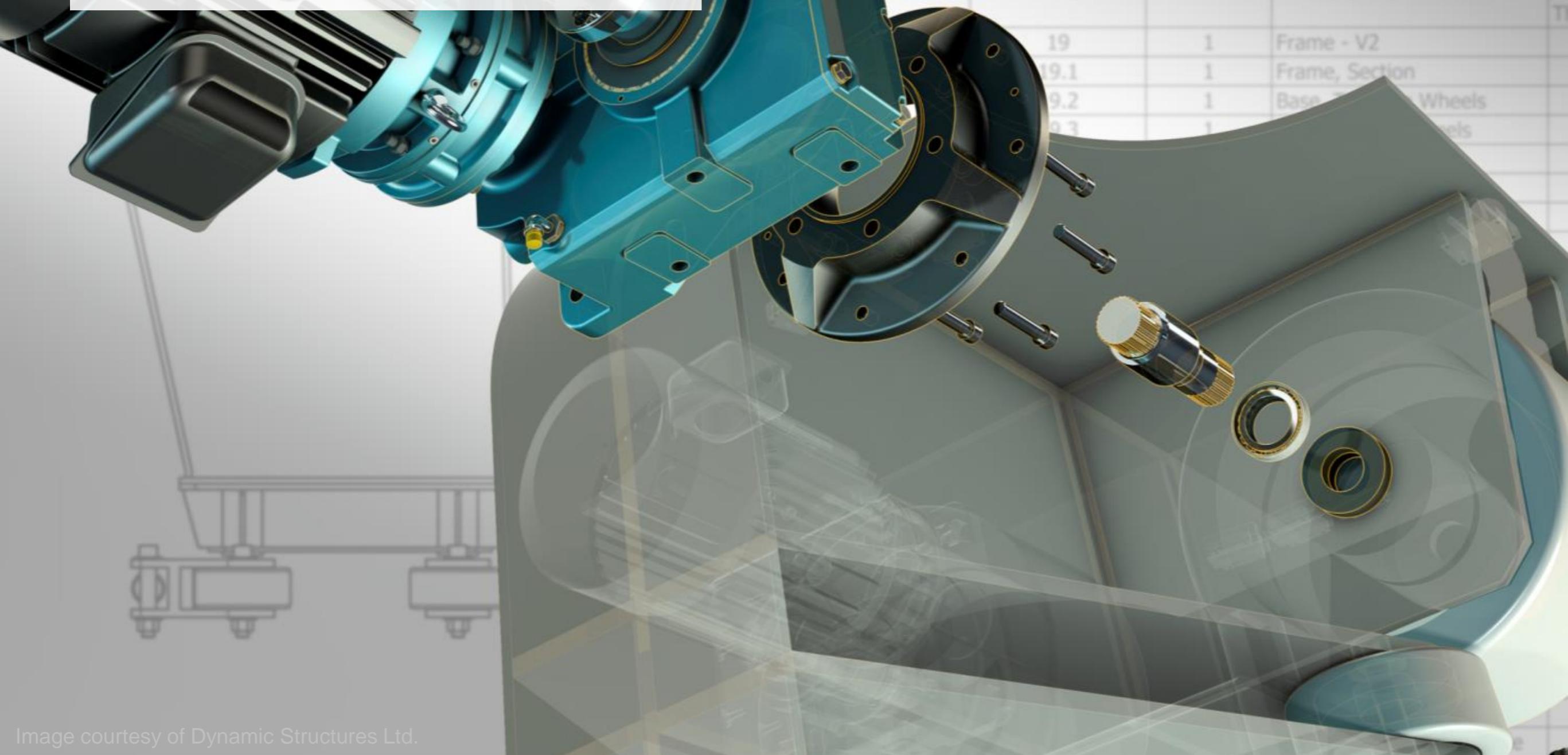


Image courtesy of Dynamic Structures Ltd.

Autodesk started more than 30 years ago, with 16 employees and one software title.

Today more than 100 million designers, engineers, architects, creative artists, students, and hobbyists use Autodesk software and apps to unlock their creativity, build better products, and address important challenges impacting the world.



Looking toward the future

Supported by a firm financial foundation, thousands of software developers, and \$500 million in annual R&D investments, Autodesk continues to develop innovative software and solutions, including:

- Autodesk® 360 cloud-based framework
- Autodesk suites and services
- Integrated tools and streamlined workflows



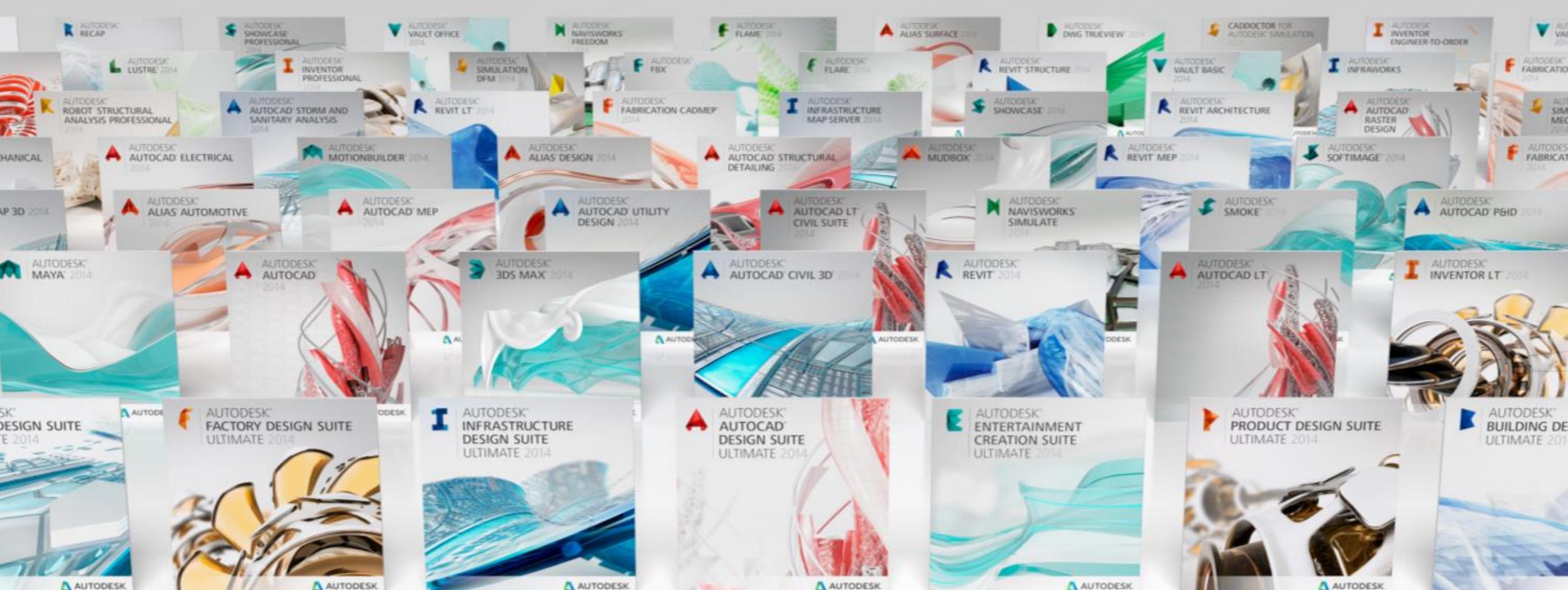
What we do: data-driven design

Based on data-driven design technology from Autodesk, processes have emerged that enable our customers to design in more efficient, more sustainable ways:

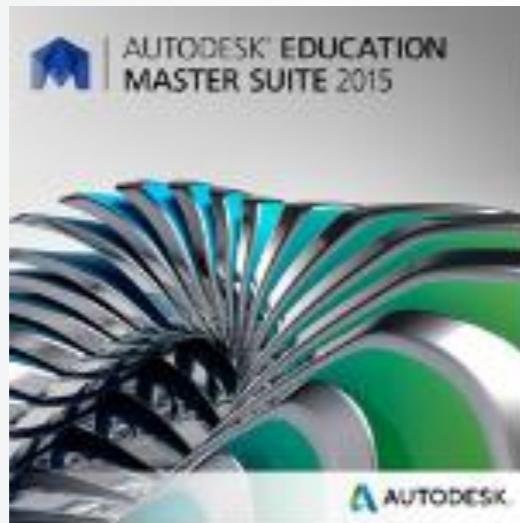
- Digital Prototyping (DP)....Manufacturing
- Building Information Modeling (BIM)....Civil & Architecture
- Digital Entertainment Creation (DEC)...Media & Entertainment
- Design visualization....Rendering

Image courtesy of Marin Bikes

Supported by the breadth and depth of a leader



Autodesk Education Master Suite 2015

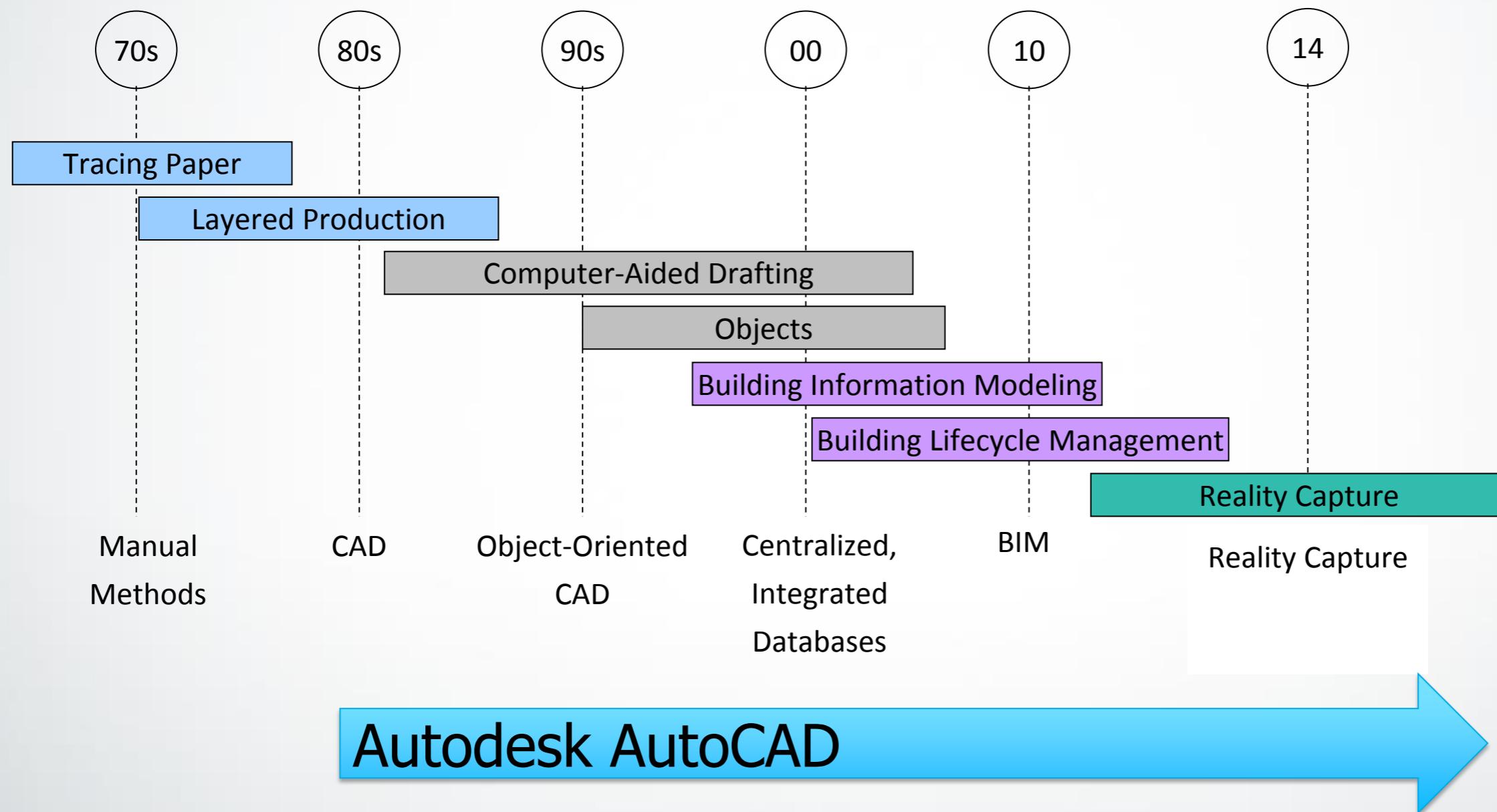


Autodesk® AutoCAD®
Autodesk® Mechanical
Autodesk® Inventor Professional
Autodesk® ReCap™
Autodesk® Navisworks® Simulate
Autodesk® Revit®
Autodesk® Alias Design
Autodesk® AutoCAD® Civil 3D®
Autodesk® InfraWorks™
Autodesk® 3ds Max® Design
Autodesk® Navisworks® Manage
Autodesk® Robot® Structural Analysis Professional
Autodesk® Vault Basic
Rail Layout and Bridge Module
Roads and Highways Module for InfraWorks™
Many more.....

Free Software Available to Students at

www.autodesk.com/education

History: Methods of Production

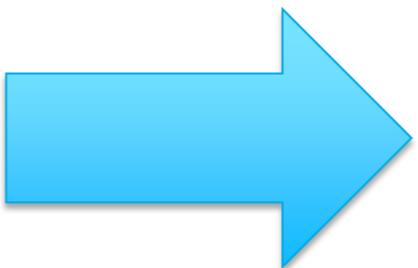


CAD Based Workflow



AUTOCAD

30 years of Continuous Innovation



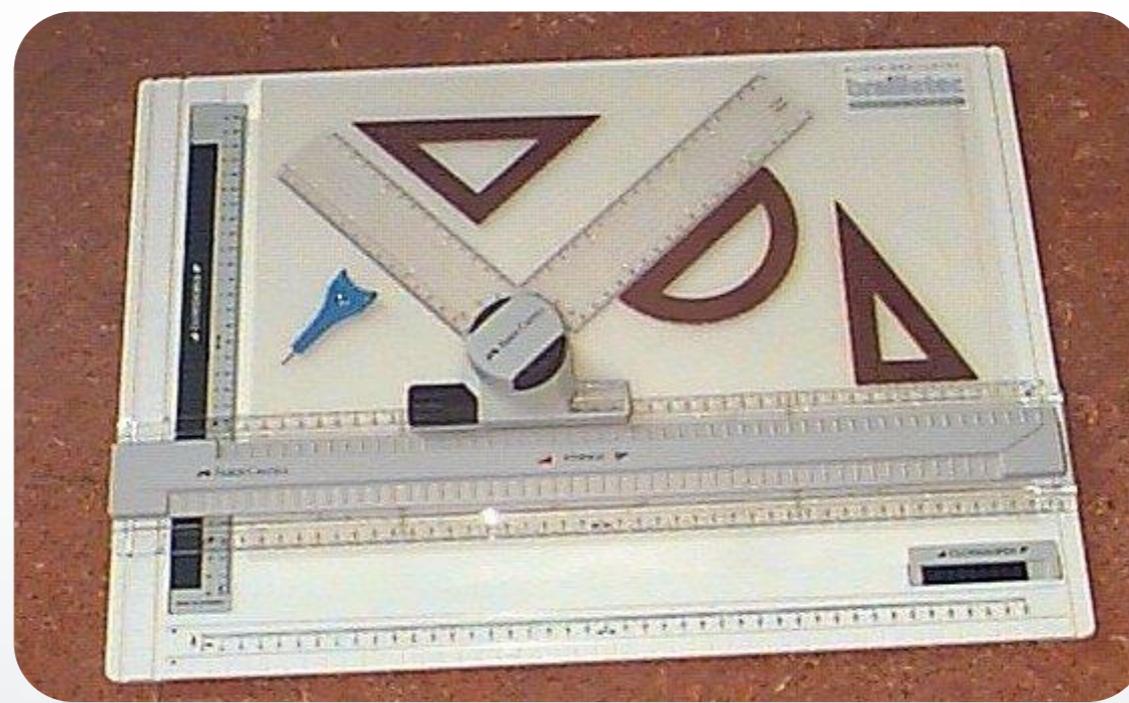
AUTODESK.



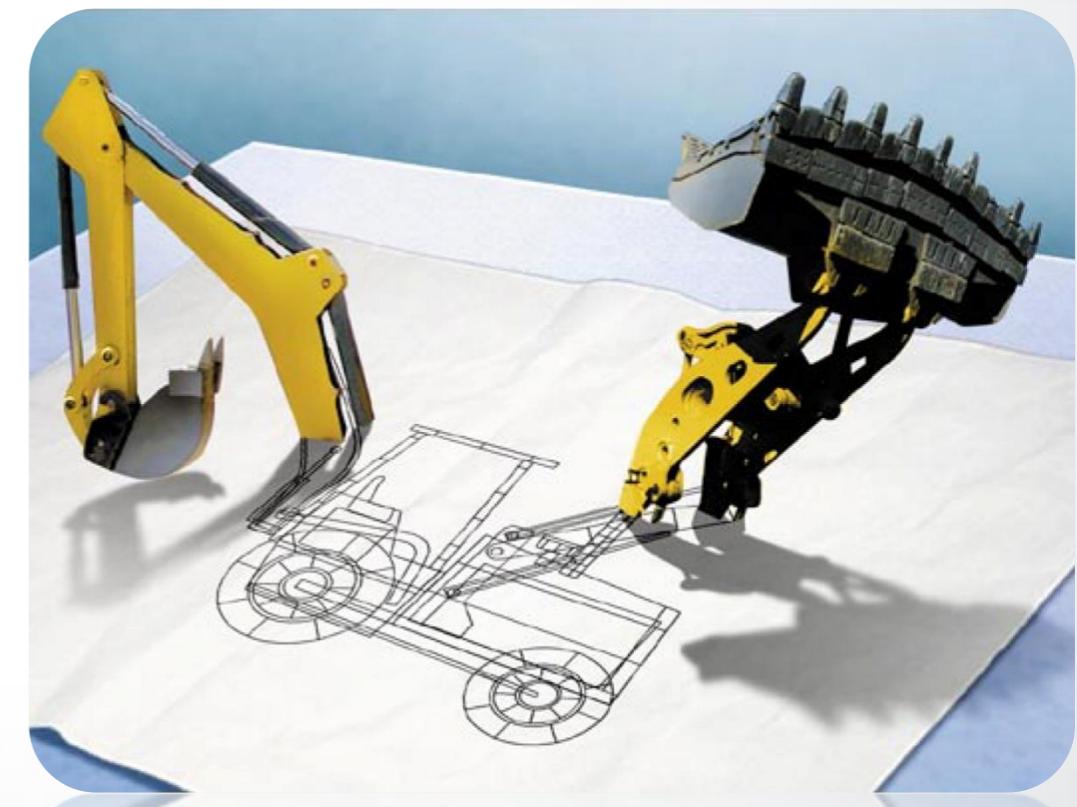
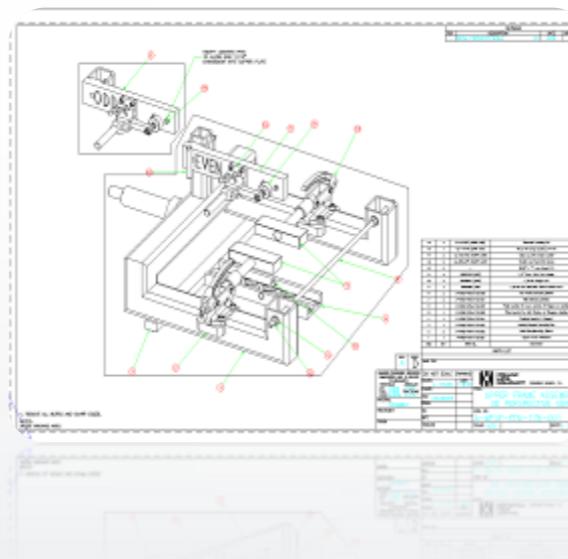
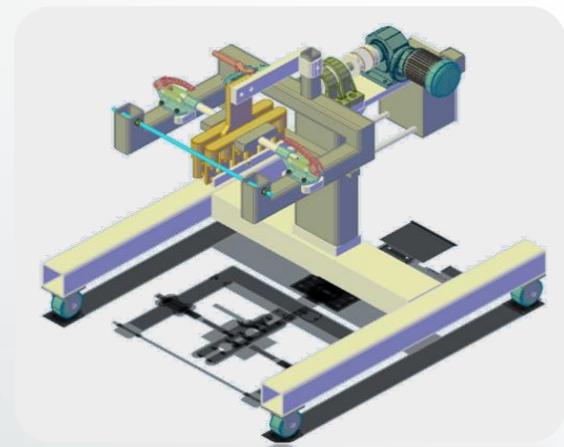
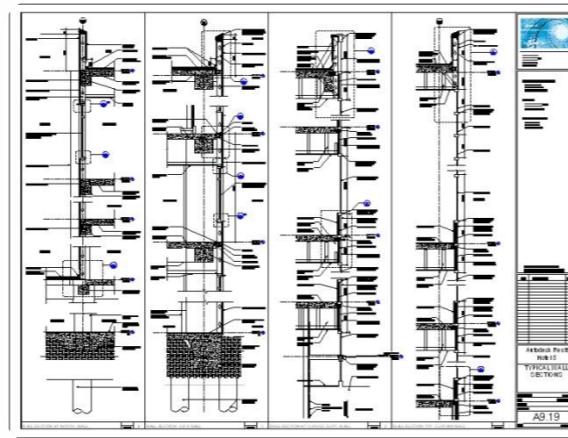
Evolution of Design

First Level of Automation

Mini drafter and drafting machine

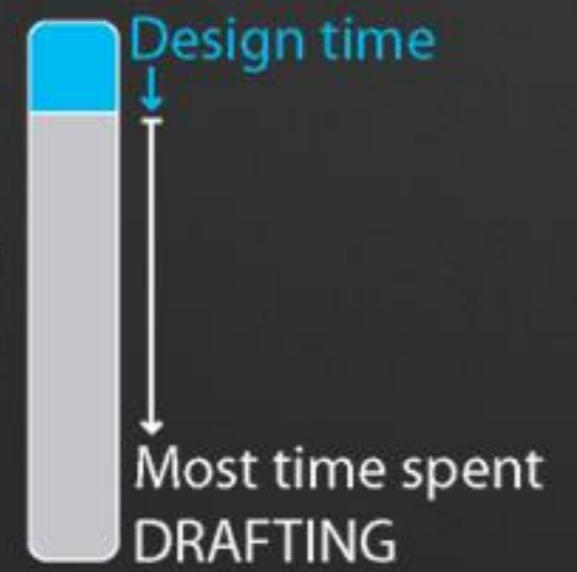


Automation of drafting led to CAD

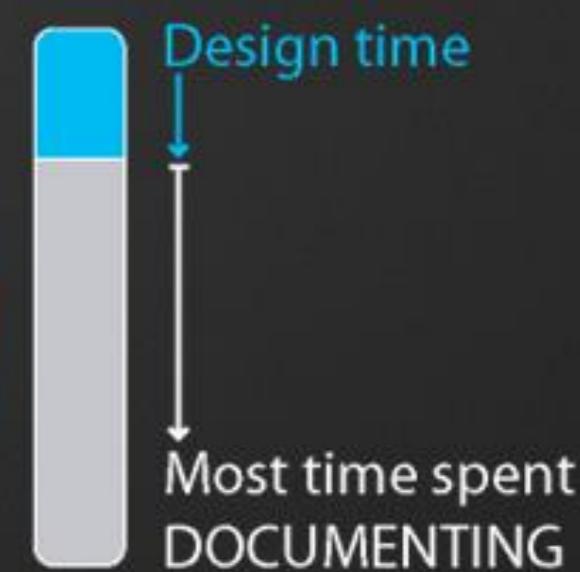


Evolution of Design

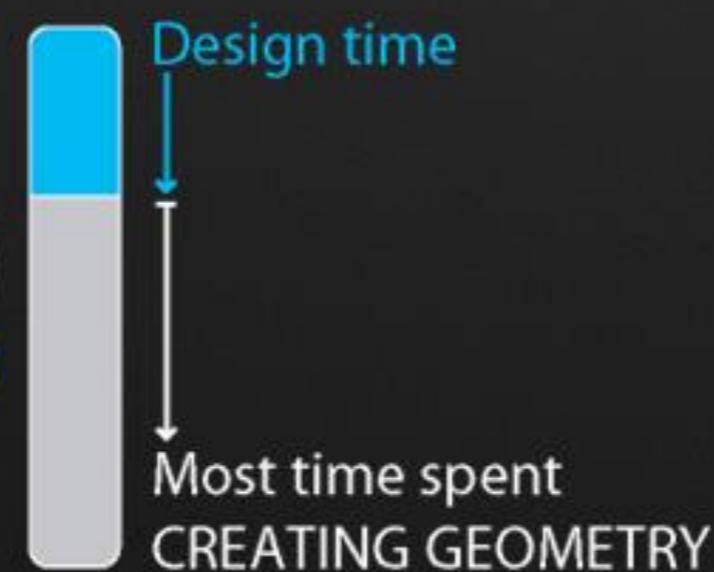
Pen and Paper



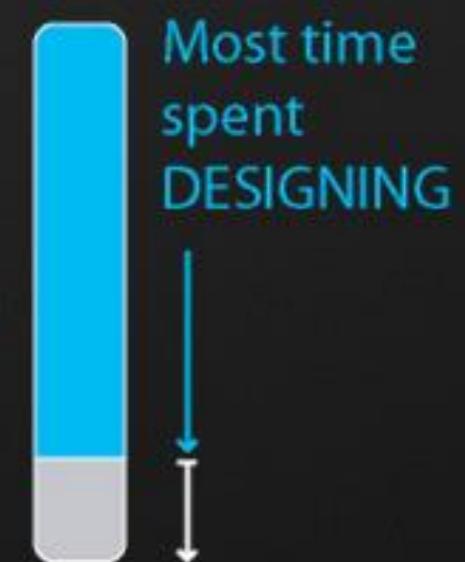
2D CAD



3D CAD (Solids and Parametrics)



Autodesk Functional Design

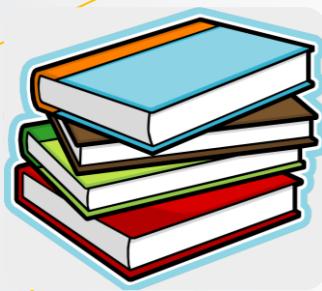




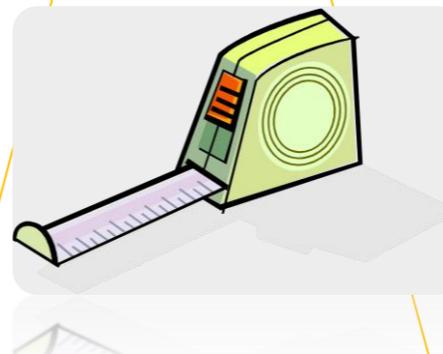
Engineering Drawing

Engineering Drawing

Chapters



STANDARDS



UNITS



DRAFTING TOOLS



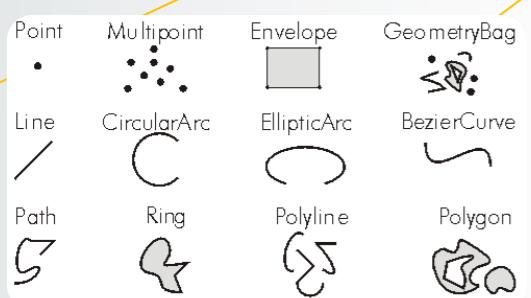
SHEETS & BORDERS



SCALE

Engineering Drawing

Chapters



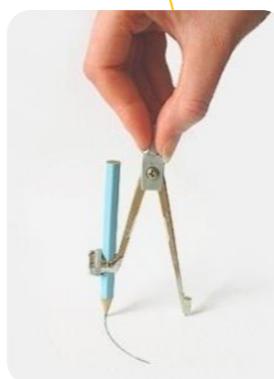
GEOMETRY

ABCDEFGHIJKLMNOPQRSTUVWXYZ
TUVWXYZ 12345678910
abcdefghijklmnopqrstuvwxyz

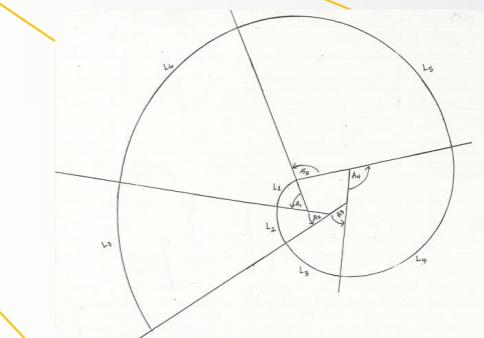
CLEAR LETTERING CAN BE PRODUCED AS EASILY
AND AS SWIFTLY AS SCRATCHY LETTERS BY
USING THE CORRECT TECHNIQUES.

A DRAFTSMAN WILL
NEVER LETTER
WITHOUT GUIDELINES

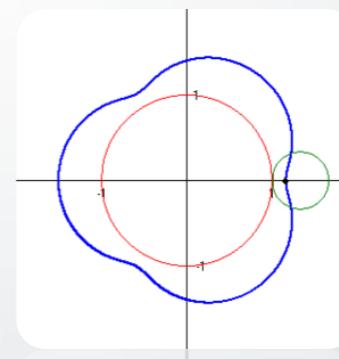
LETTERS & DIMENSIONING



GEOMETRY CONSTRUCTION



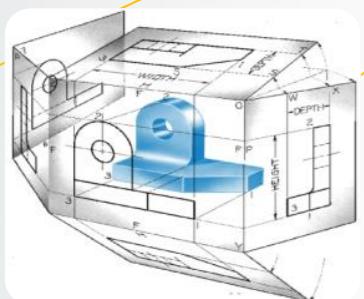
CURVES



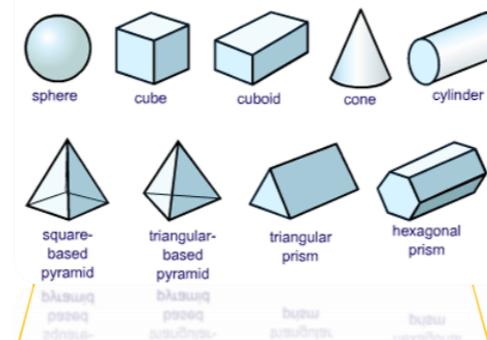
LOCI OF POINTS

Engineering Drawing

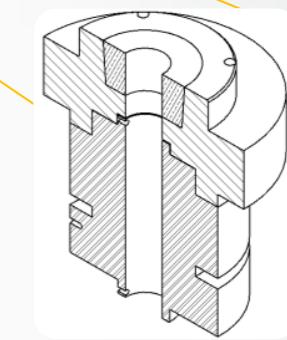
Chapters



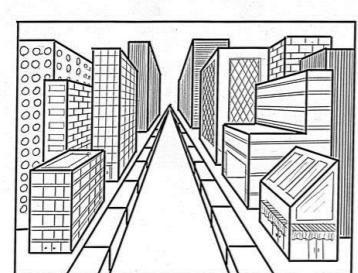
ORTHOGRAPHIC



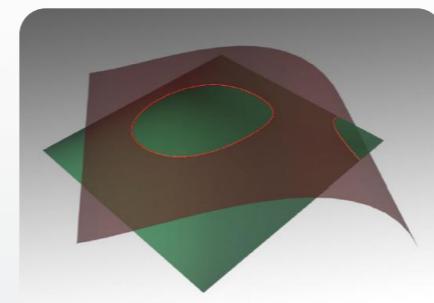
PROJECTION OF ENTITIES



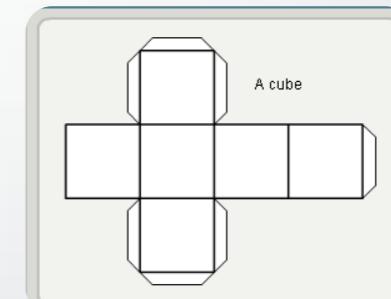
SECTION



PERSPECTIVE



INTERSECTION



DEVELOPMENT



Drafting Tools

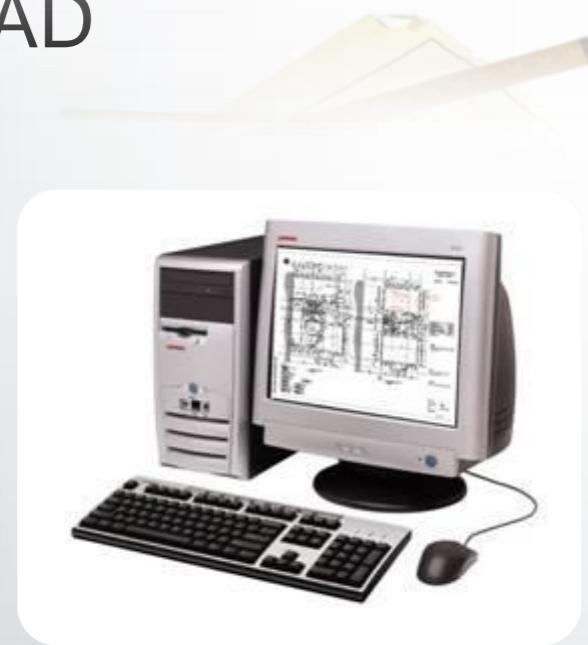
Tools

Theory

- History

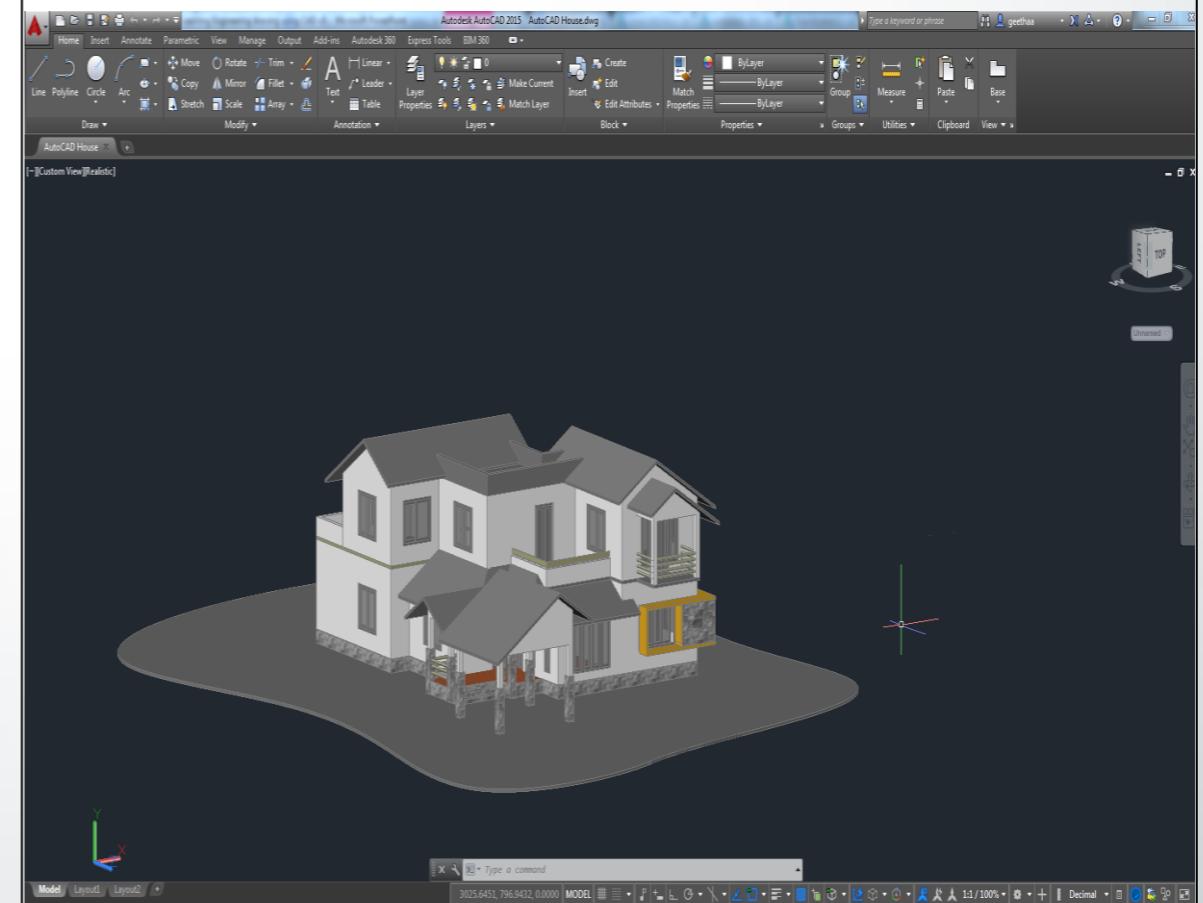


- CAD

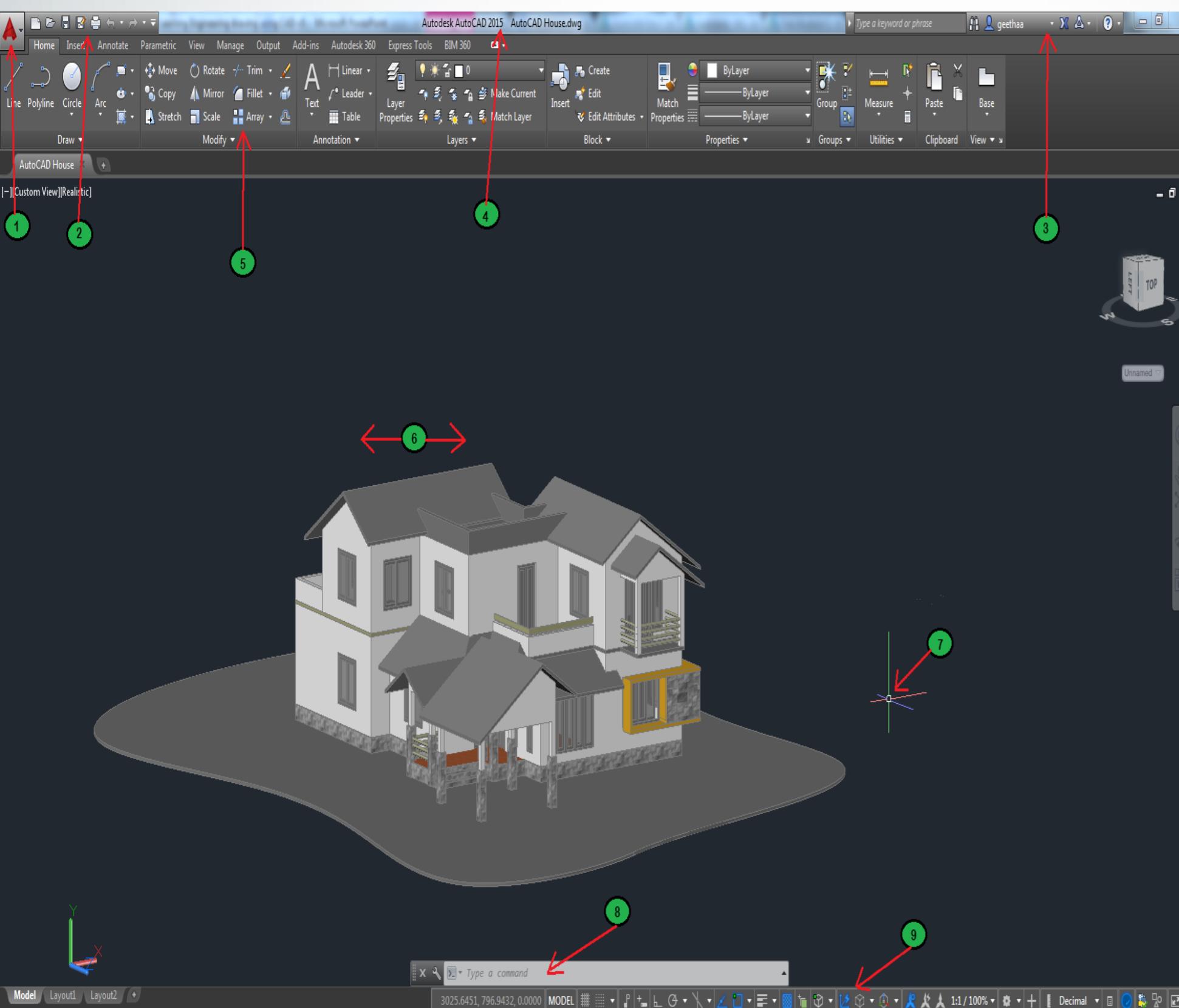


Practical

- User Interface
- Mouse Interaction
- Shortcut keys



User Interface

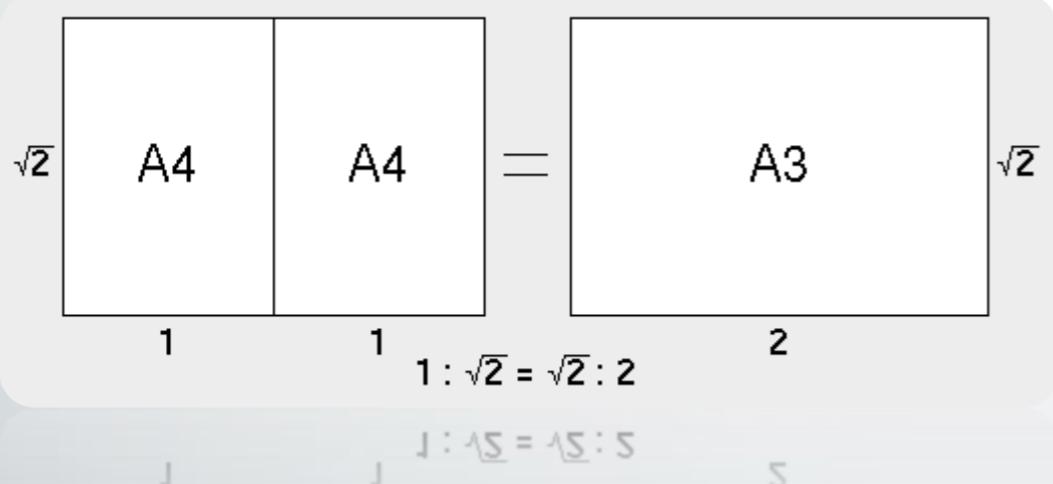


- 1 Menu Browser
- 2 Quick Access
- 3 Toolbar
- 4 Info Center
- 5 Title Bar
- 6 Ribbon
- 7 Drawing Area
- 8 Cross Hairs
- 9 Command Window
- 10 Status Bar

Sheet sizes

Theory

Sheet Designation	Trimmed Size (mm)	Untrimmed Size (mm)
A0	841 X1189	880 X1230
A1	594 X 841	625 X 880
A2	420 X 594	450 X 625
A3	297 X 420	330 X 450
A4	210 X 297	240 X330
A5	147 X210	165 X 240



Practical

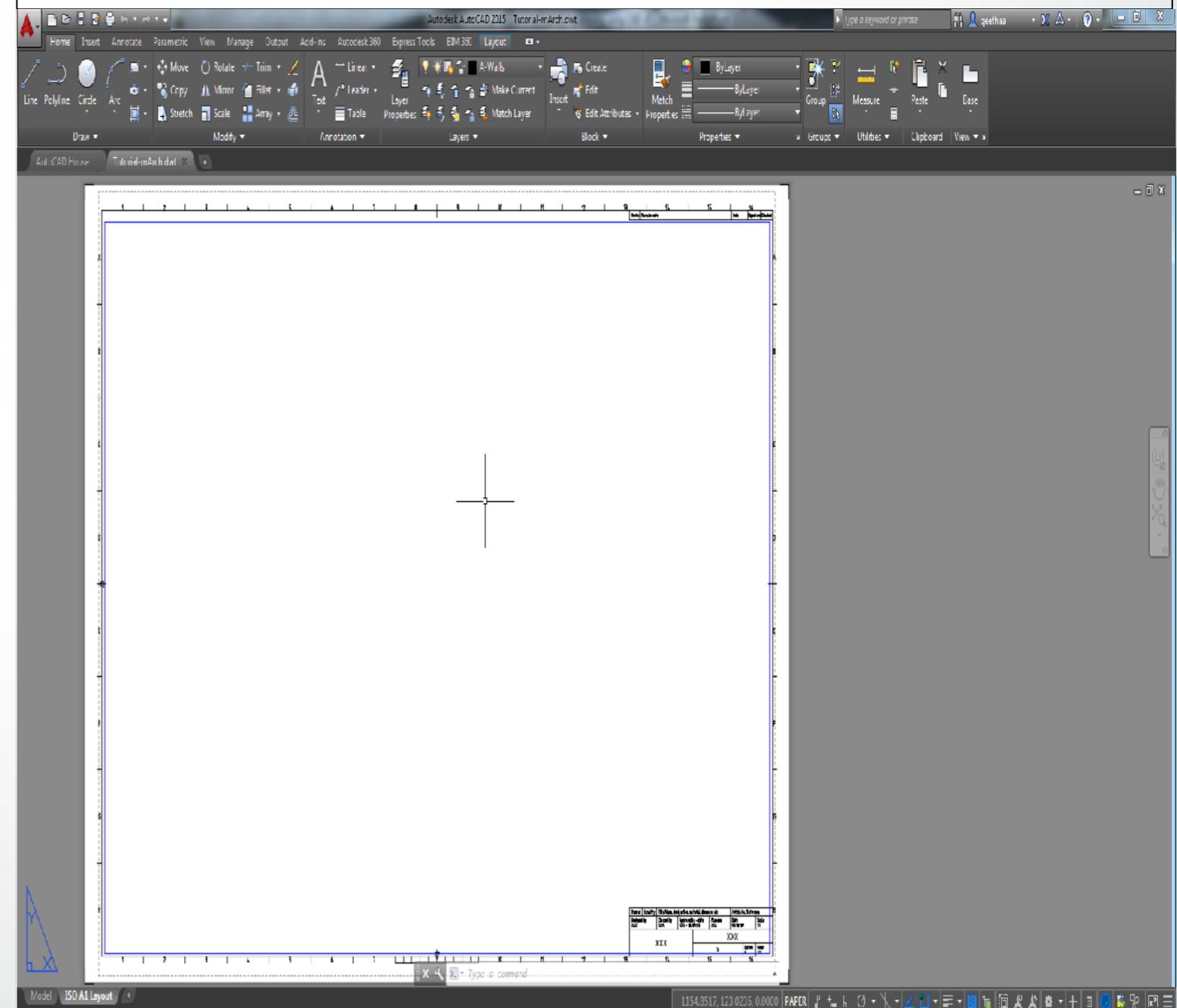
LIMITS

Border and Title block

Theory

- Border
- Grids
- Title Block
- Revision Table
- Parts List

Practical



Scale

Theory

1	Reducing scales	1:2	1:5	1:10
		1:20	1:50	1:100
		1:200	1:500	1:1000
		1:2000	1:5000	1:50000
2	Enlarged scales	50:1	20:1	10:1
		5:1	2:1	
3	Full size scale			1:1

Practical

- Units
- Precision

Freehand sketching

- Freehand sketching is used in engineering graphics to quickly communicate your ideas or designs.
- Drawing instruments and CAD are not always available, especially during field work.
- Freehand sketching is not sloppy sketching! Sketches need to be interpreted by others in team.
- Digital sketching



Geometry

Theory	Practical
<ul style="list-style-type: none">■ Types of lines and its representation■ Line thickness■ Arcs■ Circles■ Ellipse	<ul style="list-style-type: none">■ Absolute co-ordinate system■ Relative co-ordinate system■ Polar co-ordinate system■ Direct distance entry■ Line/Linetype■ Colors/Layer■ Trim/Extend■ Arc/Circle■ Fillet/Chamfer■ Xline■ Ray■ Point■ Ptype

Geometric Construction

Theory	Practical
<ul style="list-style-type: none">■ Bisecting a line■ Perpendiculars■ Parallel lines■ Divide a line■ Bisect an angle■ Trisect an angle■ Find center of an arc■ Equilateral triangle■ Square■ Regular polygons■ Tangents■ Inscribed Circles	<ul style="list-style-type: none">■ OSNAP■ OFFSET■ ARRAY■ RECTANGLE■ POLYGON■ DIVIDE■ MEASURE■ PDMODE■ CIRCLE

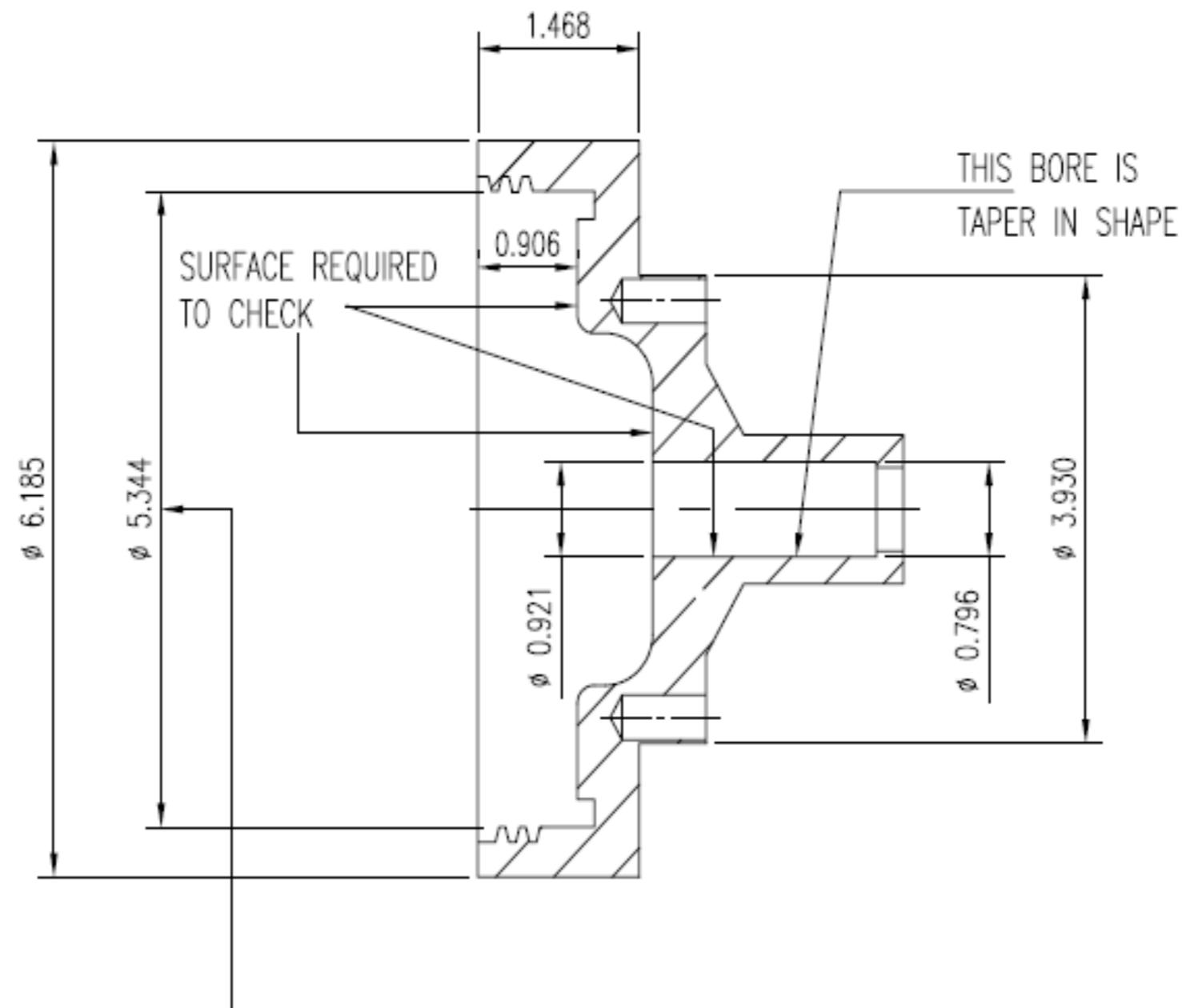
Curves

Theory	Practical
<ul style="list-style-type: none">■ Conic sections■ Cycloidal curves■ Involute■ Evolutes■ Spirals■ helix	<ul style="list-style-type: none">■ Draw & Edit■ Spiral (Helix)

Lettering & Dimensions

Theory	Practical
<ul style="list-style-type: none">▪ Lettering & Sizes based on sheet▪ Dimension placing system<ul style="list-style-type: none">▪ Aligned▪ Unidirectional▪ Types of dimensions<ul style="list-style-type: none">▪ Horizontal, Vertical, Aligned▪ Chain, Parallel▪ Diameter, Radius▪ Angular▪ Ordinate▪ Arrow heads (1:3)▪ Size of dimension text based on sheet sizes▪ Best practices of dimensioning	<ul style="list-style-type: none">▪ DIMENSION▪ DIMENSION STYLES▪ DIMENSION VARIABLES▪ TEXT▪ TEXT STYLE▪ COLORS▪ LAYER

EXERCISE



PLEASE NOTE THAT YOU HAVE TO SUGGEST US
A SUITABLE PROBE FOR DIA 5.344 AND 4.501.

-:NOTE:-

1) ALL DIMENSIONS ARE IN INCHES.

REV.	DETAILS	DATE
	DO NOT SCALE IF IN DOUBT ASK.	

GEOMETRIC LIMITS UNLESS OTHERWISE SPECIFIED.			DIMENSION LIMITS UNLESS OTHERWISE SPECIFIED.			TITLE	DRN.	DIXIT	DATE
L	MACHINED	OTHER	DIMENSIONS	M.M. INCHES	UP TO 380 UP TO 15	380-760 15-30	760-1140 30-45	11/09/12	
I	PARALLELISM								
<input type="checkbox"/>	FLATNESS	1/BFEET 0.025/25 MM.	0	M.M. INCHES	± 1	± 25	± 25		
-	STRAIGHTNESS	3/300 MM.	0.0		± 0.05	± 0.1	± 0.1		
L	ANGULARITY	$\pm 1/2$	$\pm 1^{\circ}$	0.0	M.M. INCHES	± 0.4	± 0.8	± 1.2	
				0.00		± 0.015	± 0.03	± 0.045	
O	CONCENTRICITY	1/2 (TOTAL) OF REQUIRED TOLERANCE	0.00	M.M. INCHES	± 0.13	± 0.26	± 0.40		
			0.000		± 0.005	± 0.010	± 0.015		
REMOVE BURRS AND SHARP CORNERS			FRACTION		$\pm 1/32$	$\pm 1/16$	$\pm 1/8$		

PENNWALT
LIMITED

BOWL BOTTOM

This document is the property of, and the work of Pennwalt Limited.
It is loaned in confidence and must be returned on demand. Any
use detrimental to the interests of Pennwalt Limited is prohibited.
It must NOT be loaned, copied or reproduced without their permission.

CK'D. ART

APPD. VDC

DRG. NO. R

SCALE 0 : 0

SHT. NO. 1 OF 1

Autodesk AutoCAD

Basics

- **Menu:** Ribbon menu, pull down menu and icons
- **Icons:** Grouped and often floating
- **Regions:** menu regions, graphic regions, command prompt
- **Keys:** There are some hot keys which improve your productivity.

Autodesk AutoCAD

Function Keys

F1: Help

F2: Flip Screen between graphics and text window

F3: Osnap on or off

F5: Isoplane (obsolete)

F7: Toggle "Grid" on or off. You can also type <Ctrl>G

F8: Toggle "Ortho" on or off. You can also type <Ctrl>O

F9: Toggle "Snap" on or off. You can also type <Ctrl>B

Autodesk AutoCAD

General Tips

- Space and enter mean the same.
- Space or enter repeats the previous command. (Caution: Avoid superfluous spaces in script files as decorations or to improve readability!). You can also use arrow keys to pick a previously used command from the stack.
- Selecting objects by window:
“Left to right” → selects only the elements fully inside the rectangle;
“Right to left” → selects even the elements crossing the rectangle.

Autodesk AutoCAD

Fonts

- **Types:** Arial, Time New Roman, Courier New, ...
- **Two groups:**
 - i. Proportionate (Eg. Arial)
 - ii. Uniform (Eg. Courier New)
- Some fonts are simple and some have some decorations at ends (Eg. Arial vs. Times New Roman). Arial-like fonts are recommended for headings and Times New Roman-like fonts are recommended for running text. You need **eye-catching** in the former **pleasant reading for long time** in the latter.
- **Size:** Represented by points.
- **Face:** **Bold**, *italics*, underline, ...

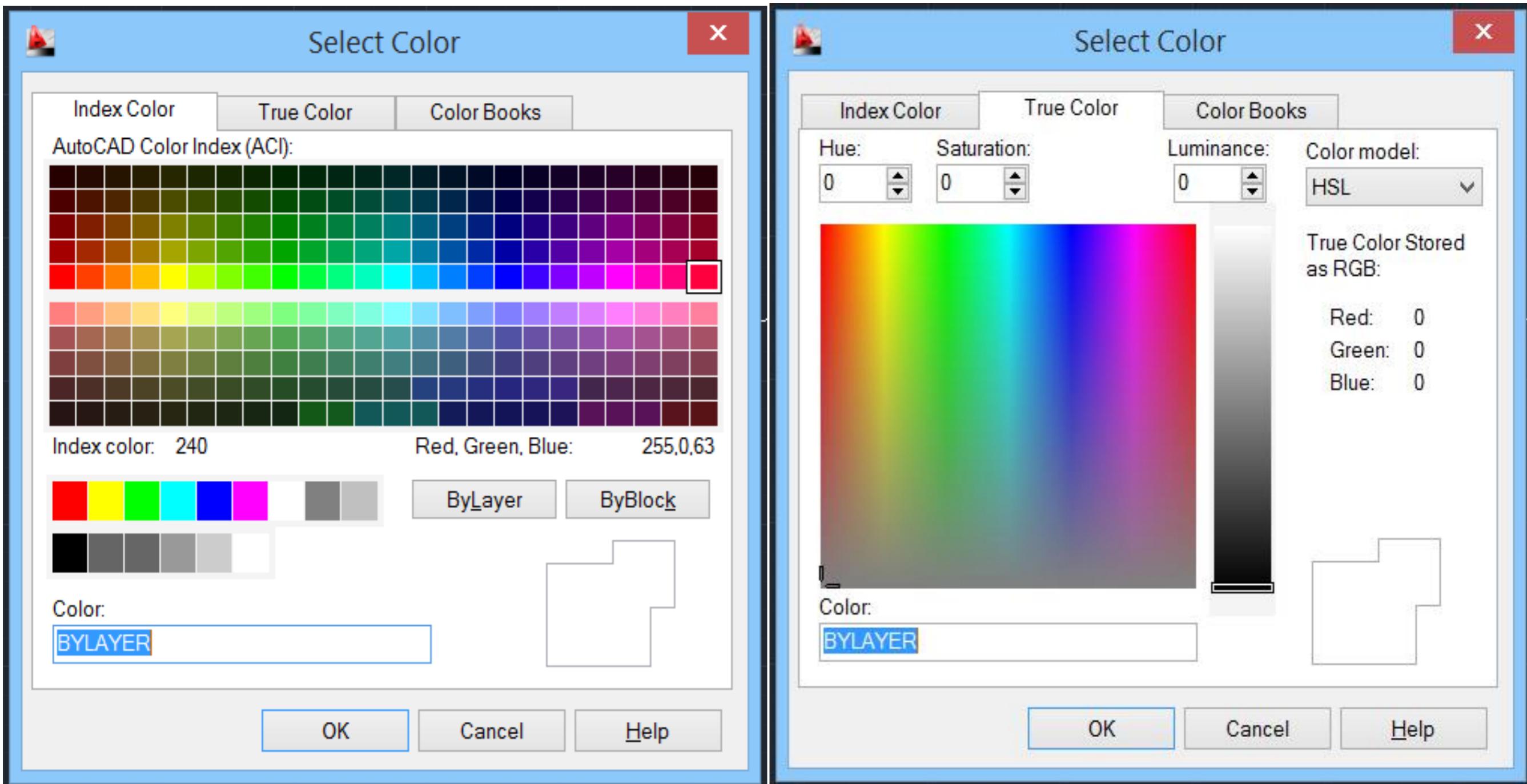
Autodesk AutoCAD

Lines

Linetype	Description
ACAD_ISO02W100	ISO dash _____
ACAD_ISO03W100	ISO dash space _ _ _ _ _
ACAD_ISO04W100	ISO long-dash dot _ _ _ _ _
ACAD_ISO05W100	ISO long-dash double-dot _ _ _ _ _
ACAD_ISO06W100	ISO long-dash triple-dot _ _ _ _ _
ACAD_ISO07W100	ISO dot.....
ACAD_ISO08W100	ISO long-dash short-dash _ _ _ _ _
ACAD_ISO09W100	ISO long-dash double-short-dash _ _ _ _ _
ACAD_ISO10W100	ISO dash dot _ _ _ _ _
ACAD_ISO11W100	ISO double-dash dot _ _ _ _ _
ACAD_ISO12W100	ISO dash double-dot _ _ _ _ _
ACAD_ISO13W100	ISO double-dash double-dot _ _ _ _ _
ACAD_ISO14W100	ISO dash triple-dot _ _ _ _ _
ACAD_ISO15W100	ISO double-dash triple-dot _ _ _ _ _
BATTING	Batting SSSSSSSSSSSSSSSSSSSSSSSSSSS
BORDER	Border _ _ _ _ _

Autodesk AutoCAD

Colors



Autodesk AutoCAD

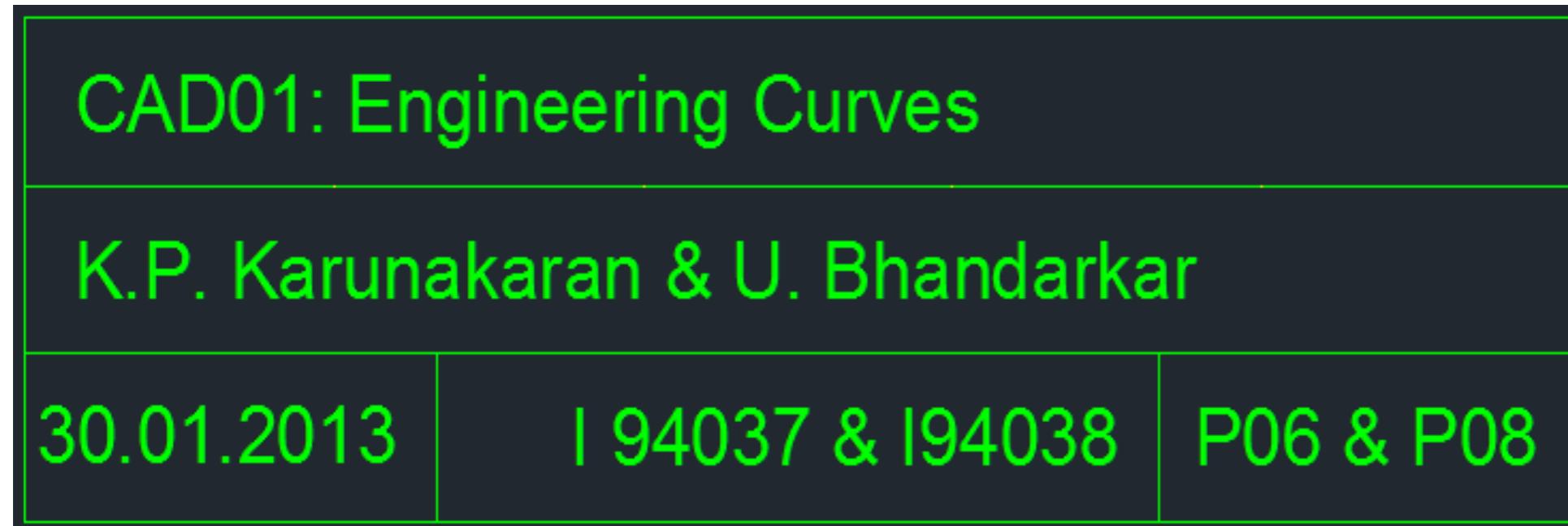
Layers

- Use: Data organization.

Autodesk AutoCAD

Paper, Margins & Name Plate

- Size of sheet is A3 (420 x297).
- Margin of 10mm all around.
- You will work in groups of two. Make the name plate as below.



Border

(for A3)

- Set border as current layer.
- Draw borders using ‘rectangle’:

Outer → 0,0

420, 297

Inner → 10,10

410,287 or @400,277

Note: You can also use offset as it is 10 on all sides.

offset → 10 → click inside

Name Plate

- Draw name plate using ‘pline’:

Outer → Rectangle (click on inner border’s bottom right) (@-150,45)

Inner three lines:

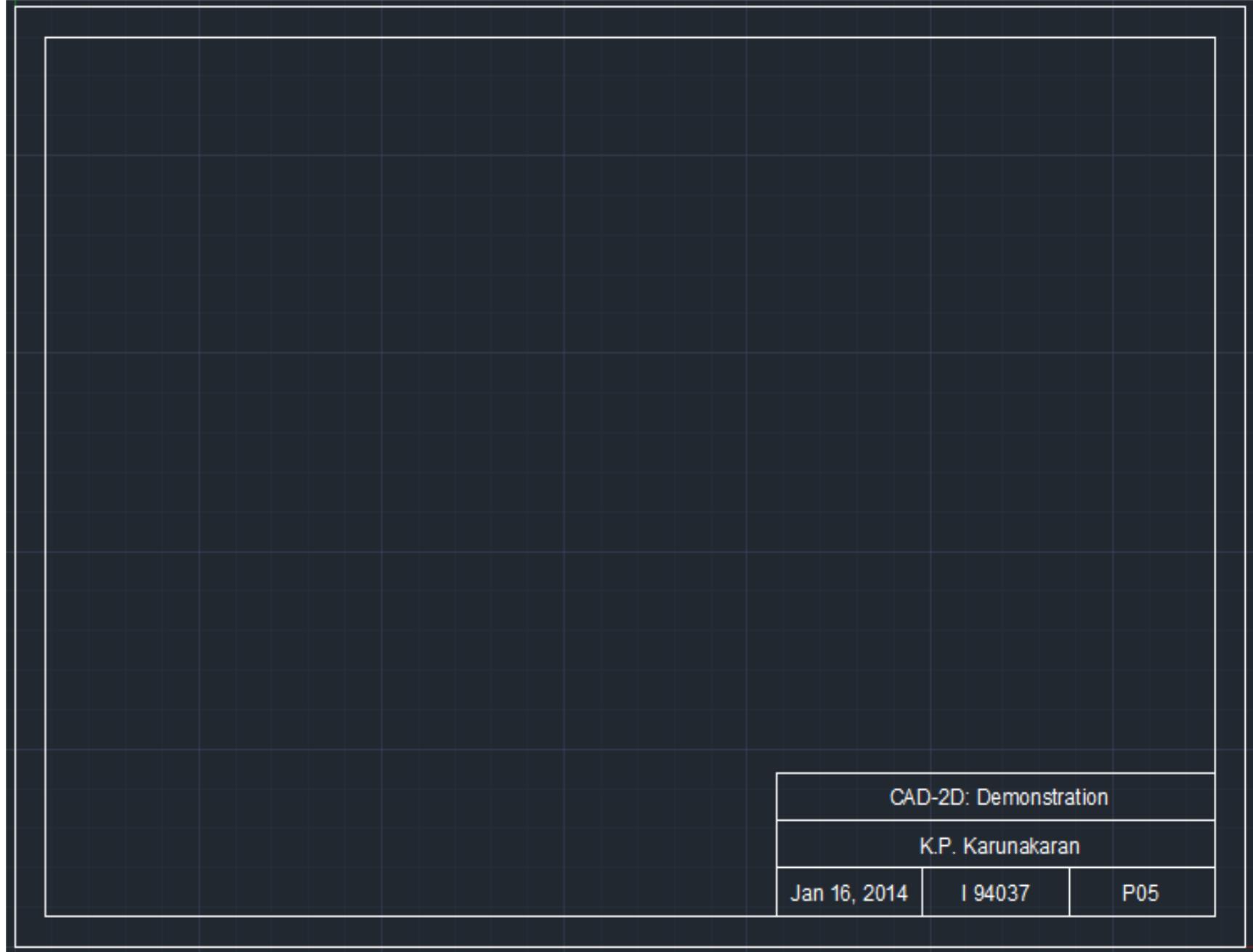
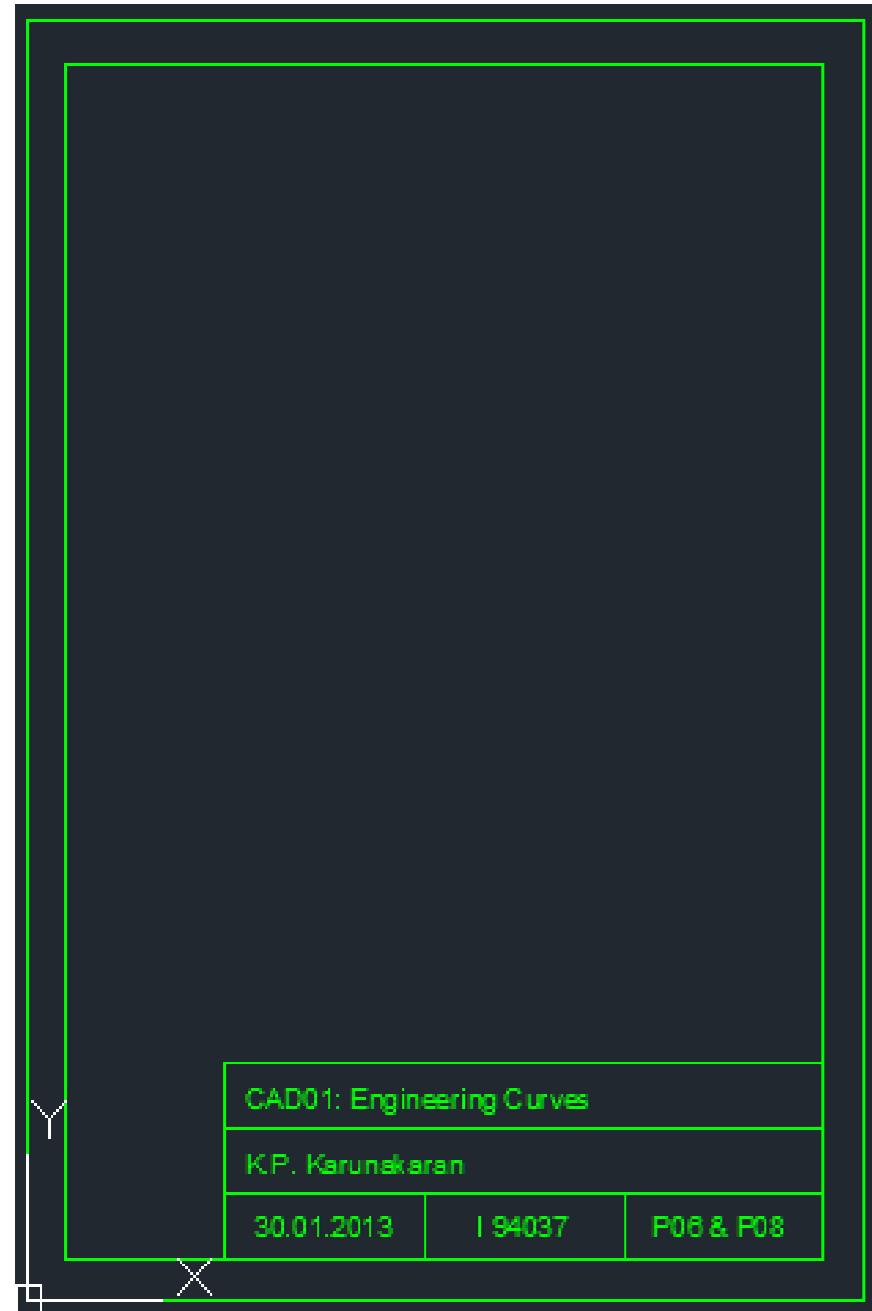
Line → Click on the top line

→ Move it by (0,-15)

→ Copy it by (0,-15)

- Write name:

Name Plate

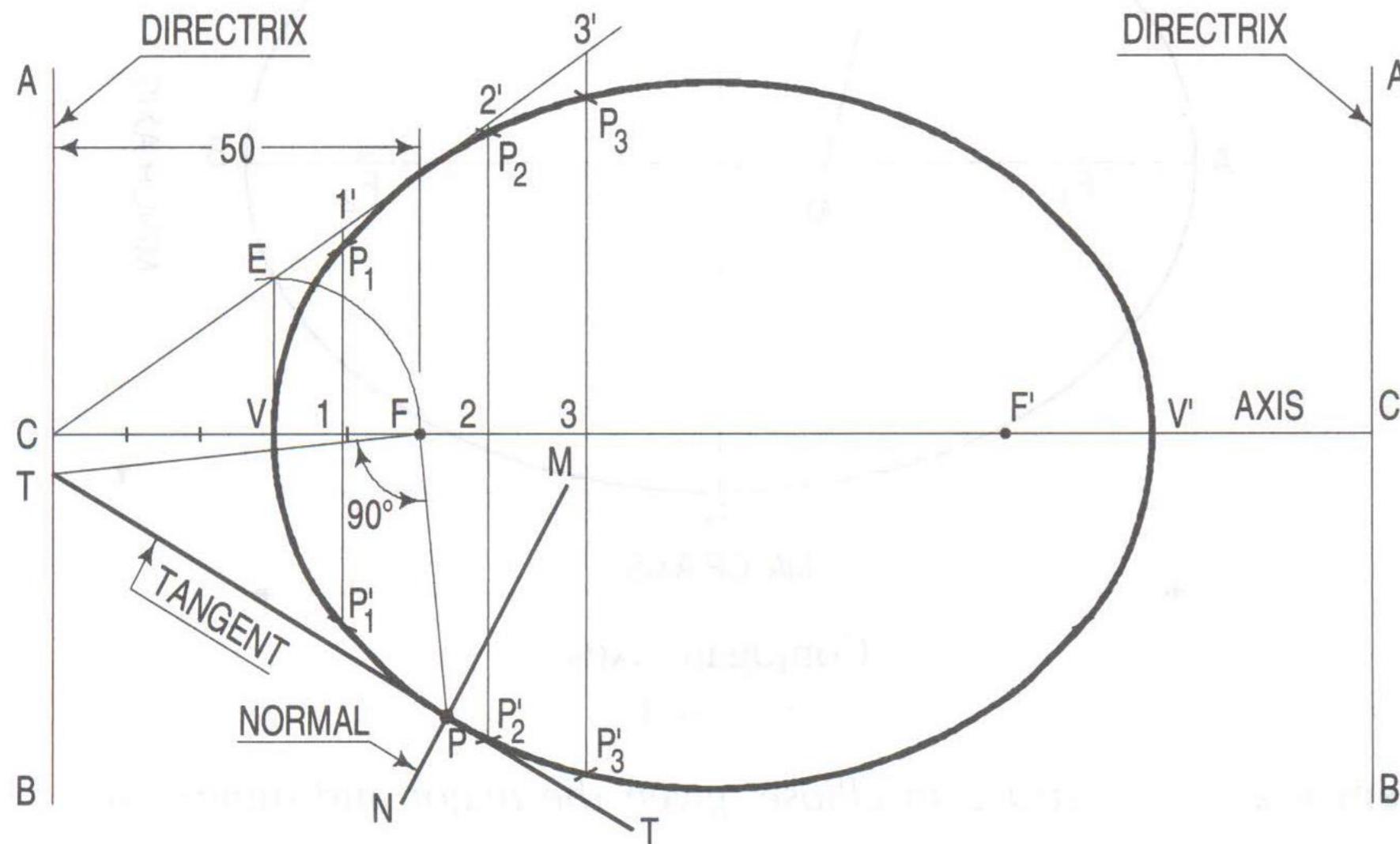


Exercise-1

Problem Statement

Construct an ellipse when the distance of the focus from the directrix is equal to 50mm and its eccentricity is $2/3$.

This is the basic method we have studied.



$$l = \frac{b^2}{\sqrt{a^2 - b^2}} = 50$$

$$e = \frac{\sqrt{a^2 - b^2}}{a} = \frac{2}{3}$$

$$a = \sqrt{\frac{e^2 l^2}{(1 - e^2)^2}}$$

$$b = a \sqrt{(1 - e^2)}$$

$$2a = 120$$

$$2b = 89.4427$$

Exercise-1 ...

Layer management

- Create appropriate layers and set their attributes like color as you feel fit. For example:

border

– Border and name plate

construction

– Construction lines

object

– Object lines

Dimension

– Dimensions

- While drawing, appropriately change the current/active layer and on/off the layers.
- In this exercise, you do not need freeze/thaw. Understand the difference between “on/off” and “freeze/thaw”.

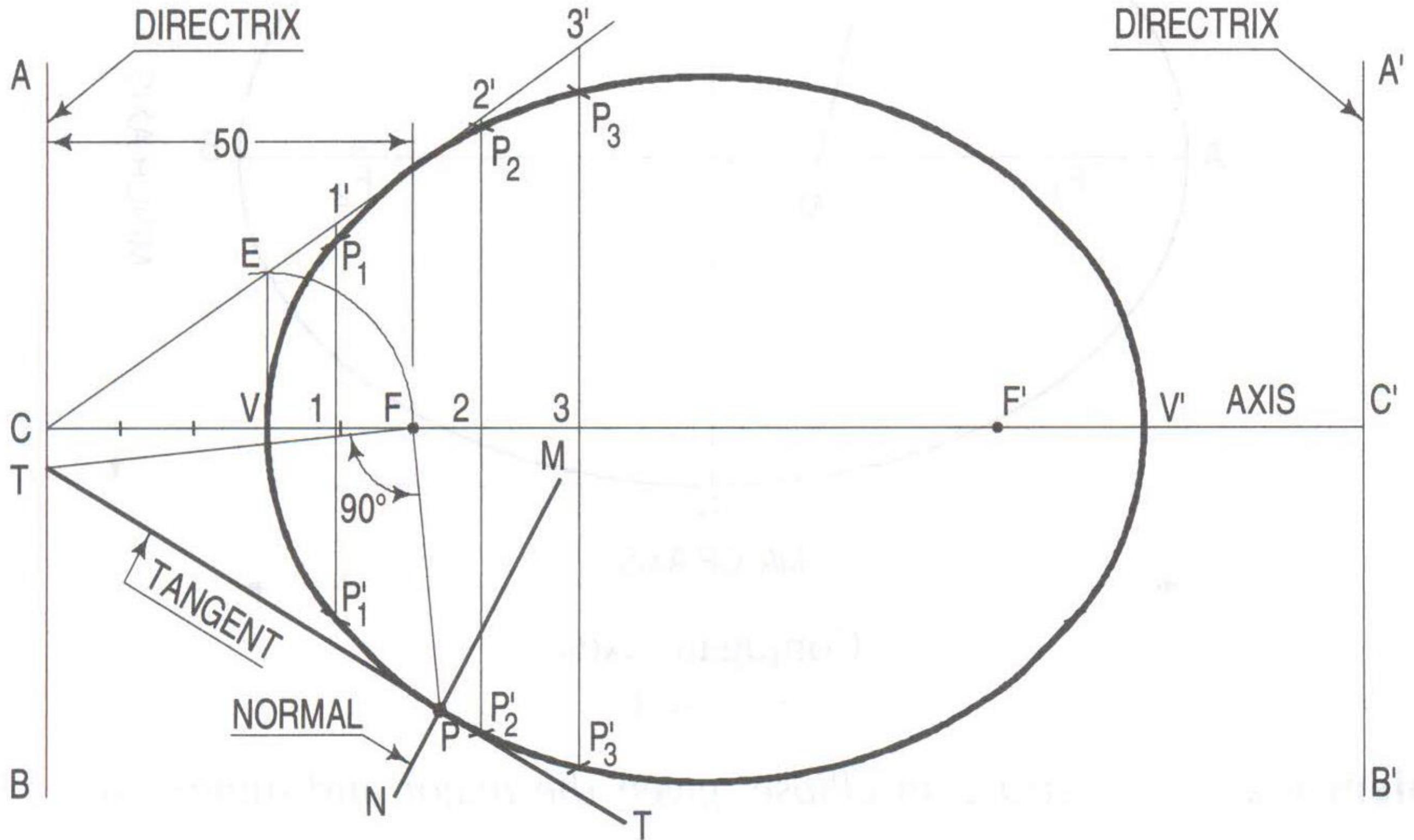
Exercise-1 ...

Some settings

- Dimscale → 25
- Ltscale → 25
- Donut (used for bullets) → (0 ID; 1.5 OD).
- 10 mm spacing.

Exercise-1 ...

Conventional (Manual) Method



Exercise-1 ...

Directrix, focus and angular lines

- Set **construction** as current layer.
- Use infinite vertical line (xline) for directrix.
- Use infinite horizontal line (xline) for CF.
- Copy directrix to (@30,0) and (@50,0); Copy CF to (@20,0).
- Draw the top angular line as a ray.
- Mirror it about CF.
- Create texts C, F, V & E
- Use array to create adequate number of vertical lines of 10mm spacing using VE as the master. Add a few more lines at both ends for getting equi-spaced points.
- Clean up using trim.

Exercise-1 ...

Concentric circles

- Note down the radius values for each vertical line (vertical distance from CF to angular line)
- Using F as centre, draw concentric circles for these radii.

Exercise-1 ...

Marking points of ellipse

- Make **object** as current layer.
- Draw doughnuts (0 ID; 1.5 OD) at the appropriate intersections of the concentric circles and corresponding vertical lines.

Exercise-1 ...

Creating a polyhedral ellipse

- Use polyline to connect all the points of the ellipse. Note that
 - Understand the difference between line and polyline.
 - Polyline is a single entity. It can combine arcs and lines (but this point is not relevant to the present exercise!).
 - Furthermore, it allows you to edit in several ways.
- I suggest you to choose the first point in a shallow (or flatter) part of the ellipse.
- Do not select the last point as first point. Instead, use the option of ‘Close’.

Exercise-1 ...

Smooth ellipse

- Select the polyhedral ellipse and right click on it. From the menu, choose ‘polyline’ option. That gives another series of options. You can use either “curve fit” or “spline fit”. You will hardly notice the difference. However, I recommend “curve fit” for our case. By definition, “curve fit” make the curve pass through all points and “spline fit” will focus on the smoothness and hence may not pass through all points.
- You will also find a similar spline option under ‘draw’. That is not suitable as it will ruin the curve at start and end. Try it to understand. It may also not pass through all points.

Conclusions

- What I have given is one of the possible ways and not the best way. Please explore better ways of doing it. For example, see if there is a command to draw concentric circles of uniformly increasing radii through a single command. In fact, you can easily customize your Autodesk AutoCAD product using LISP/VBA.
- Although all inputs are numbers in principle, some entities such as text, line type and dimension have influence of the dimension being used. Normally, the default settings are biased towards FPS system which the American continue to use. So use 25 for LTScale and DimScale.

Conclusions

- 10 PCs in Drawing Hall may be used during office hours. You may also use your personal PCs.

Exercise-1 ...

Submission

- You will work in groups formed by us. Each group shall have only two students. Each group will submit one assignment only.
- Each group will have a different assignment to avoid copying. It will be uploaded in a day or two.
- Use A3 paper. Choose the printer “DWG to PDF” and print. It will create the pdf file of the drawing. We have a A3 color printer in which you can print through the RAs. Get the printed copy before your submission date. PDF or DWG file will not be evaluated.
- The hardcopy of CAD-2D will be submitted in the Practice Session for Sheet 4.

KEY FEATURES

Important Once

Ribbon

Problem

The current toolbar and menu system is complex and difficult to use:

- Multiple ways to perform a single task
 - Options buried in secondary dialog boxes
 - Commands grouped by function not task
 - Difficult for new users



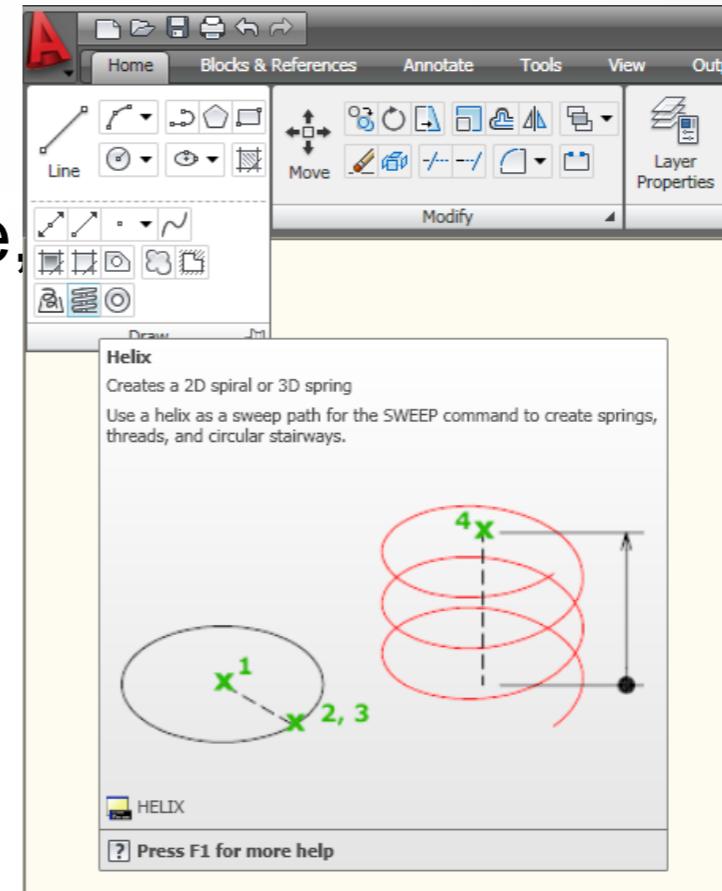
AutoCAD Key Features

Ribbon

Solution

The new ribbon interface gives simple, task-based access to commands:

- Fewer clicks to reach commands
- Commands presented based on task
- Clean modern design
- Easier for new users
- Roll-over help
- Customizable and extensible



Layer Properties Manager

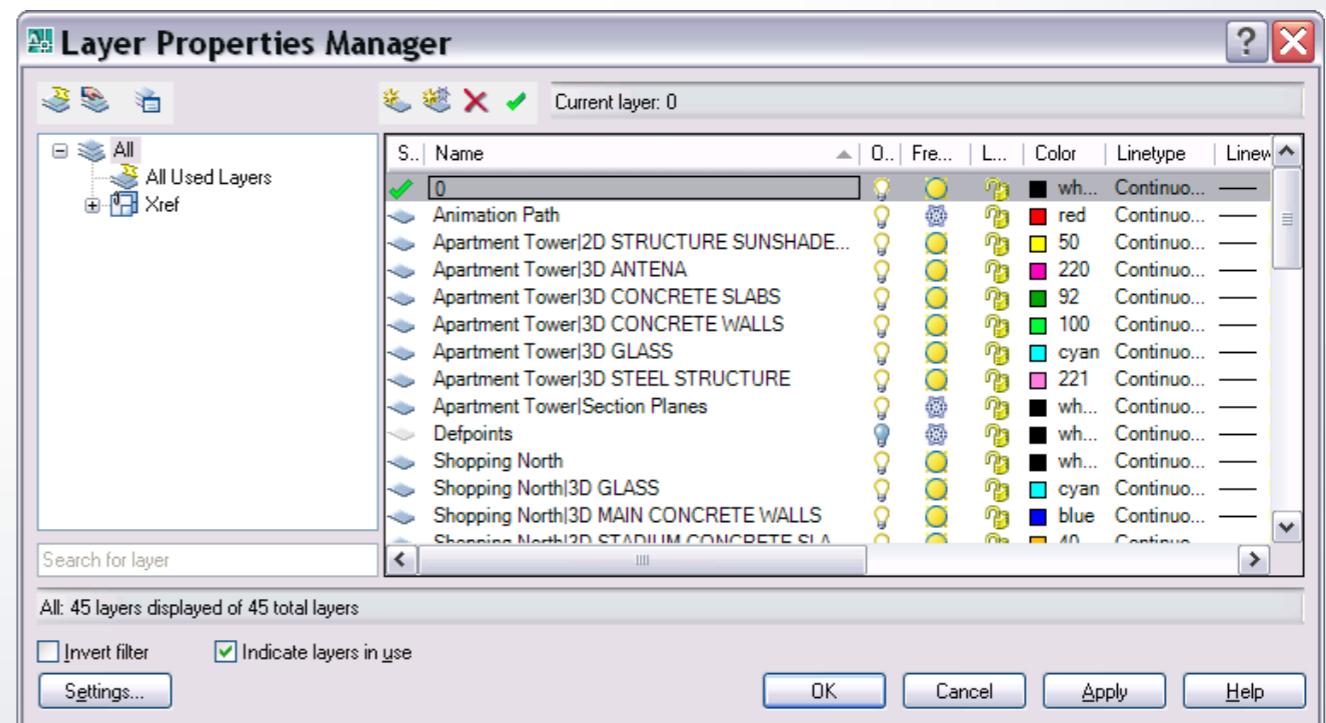
Problem



"THE LAYER LINE THICKNESS DOESN'T WORK TOO WELL IN THIS VIEWPORT"

The current Layer Properties dialog box is not interactive:

- Cannot see changes as they are made
- Cannot run other commands when dialog is active
- Scrolling to review properties hides key information



Layer Properties Manager

Solution

New Layer Properties Manager

- Changes are immediately reflected in the drawing
- Layer manager stays active when running other commands
- Columns can be frozen when scrolling

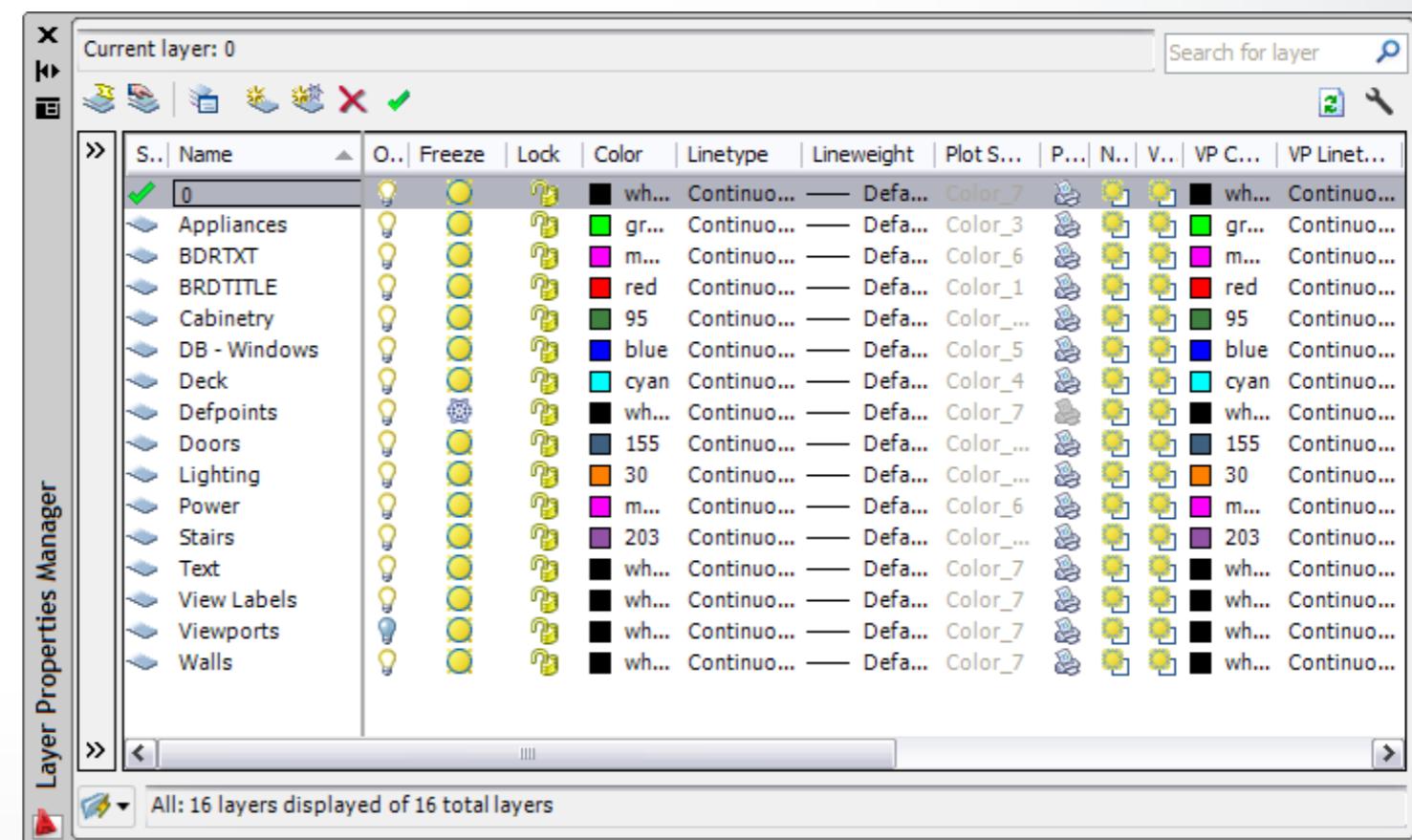


Table & Text enhancements

Problem

Cannot wrap tables or text over multiple columns

- Must manually insert breaks
- Tedious reformatting

Table and text formatting issue

- Limited table styles
- Problems with indents, alignment and line spacing



"Table Enhancements (the link to excel is a must have for us), leader fixes, dimension enhancements, M-Line Attributes and MTEXT improvements are key factors in prompting us to upgrade"

Robert Coutu, CAD Manager, ARUP

Table & Text enhancements

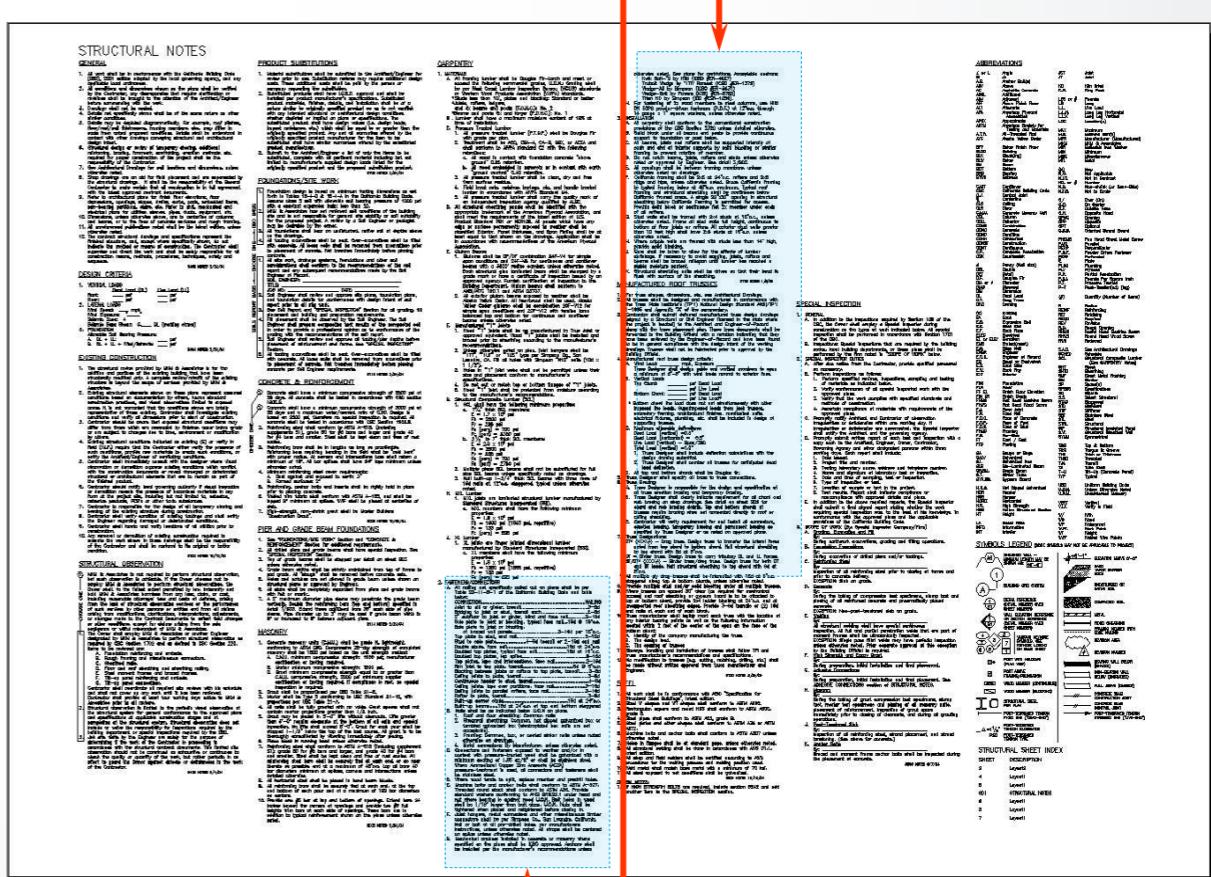
Solution

Tables

- Tables wrap automatically over multiple columns
- Improved table styles
- Variable cell margins for title, header and data cell

MTEXT

- Text wraps automatically over multiple columns
- Tab styles and alignment supported
- Paragraph line spacing control for selected lines



Multiple Leaders

Problem

Customers need to create multiple leaders for a single note

- AutoCAD has limited creation ability for multiple leaders
- Need to align multiple leaders
- Need to edit leaders



RALPH REALISED HIS WISH FOR MULTIPLE LEADERS HAD BEEN MISINTERPRETED

"You guys have obviously been reading wish lists and listening to users."

Lisa Beranacchi, CAD Manager, Schulershooke , Lighting and Theatre Design

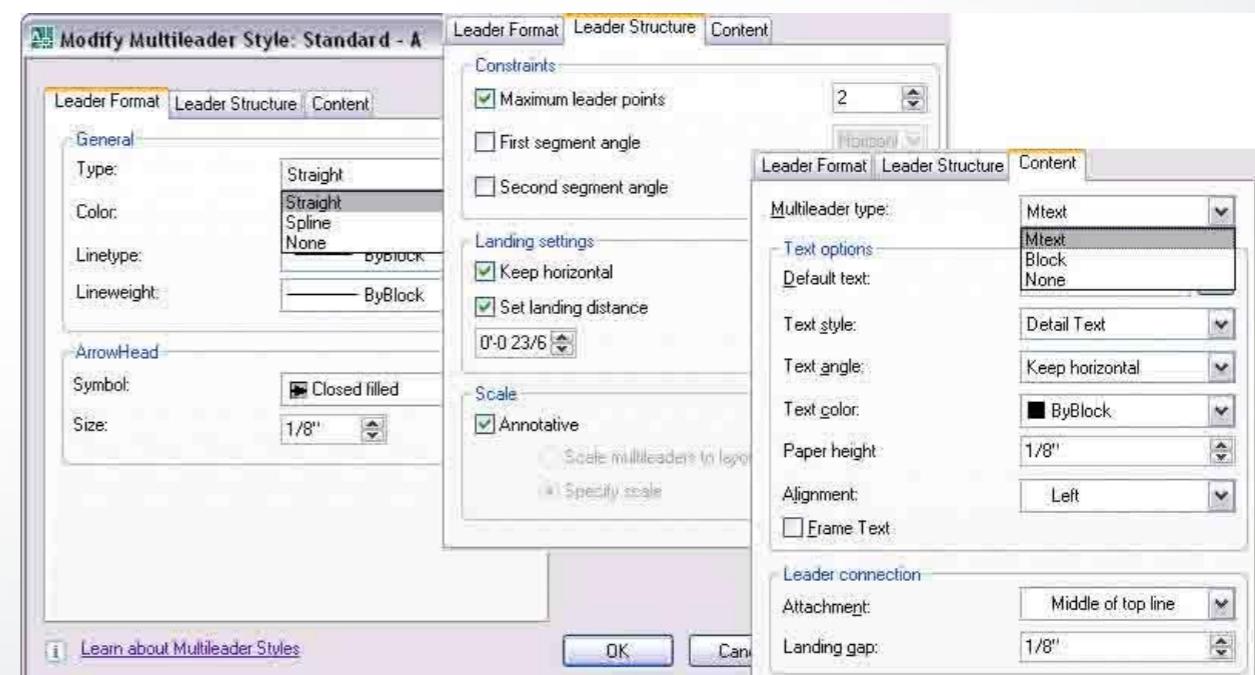
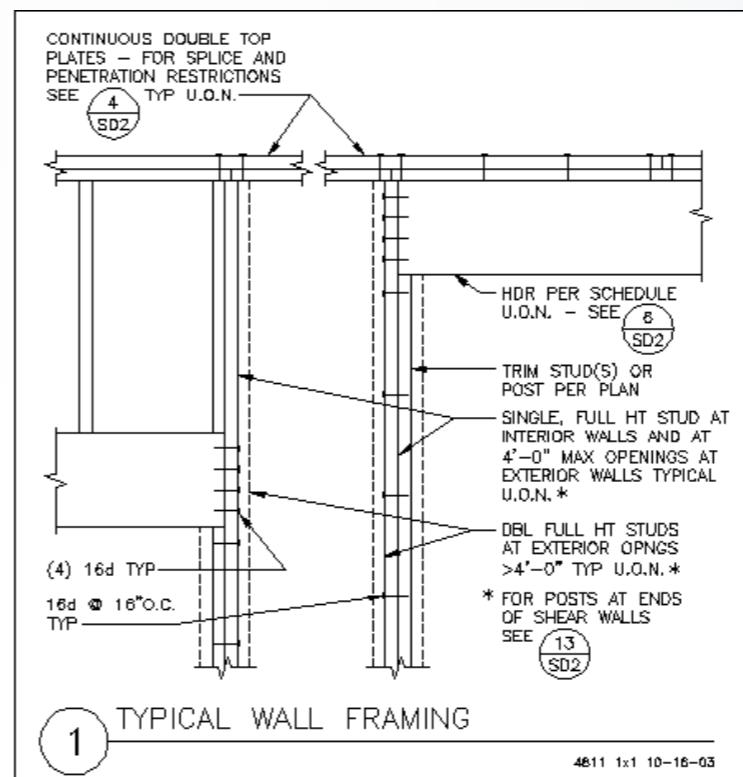
Multiple Leaders

Solution

Automated creation of multiple leaders

- Multiple segments
- Leading or trailing position on text
- Options for placement of leader with respect to text

Automated alignment of notes and leaders as a group



Operating System

Microsoft Windows 8 and 64-Bit Support

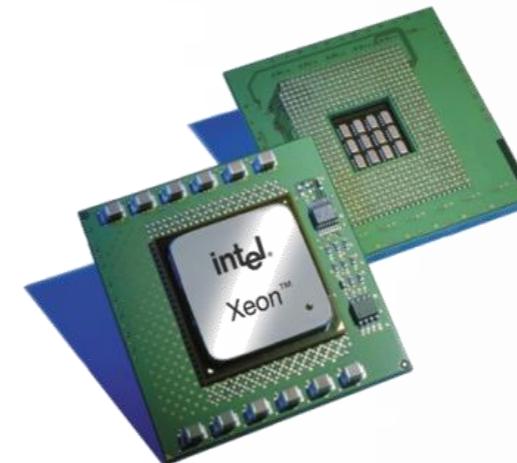
- AutoCAD® and AutoCAD LT® software are “Certified for Windows Vista®”— highest level of Microsoft® Logo Certification

- Multi-core support
- 64-bit support (both AutoCAD and AutoCAD LT):

- Improved performance and stability for large data sets
- Platforms

Intel® EM64T (not Itanium®), AMD® 64

Windows® XP 64, Windows Vista 64,
Windows 7, Windows 8



Design every detail with Autodesk AutoCAD 2015 software

Connect your workflow across integrated desktop,
cloud, and mobile solutions

Customize
your software to fit
your specific
needs

Connect
and streamline your workflow



Design
almost any idea imaginable

Document
your models with detail and
precision

Continuous Autodesk AutoCAD innovation

2010

3D design

- Free-form design
- Surface modeling
- Parametric drawing
- Enhanced documentation

2011

Conceptual design

2012

Design, documentation

- Model documentation
- Associative array

2013

Connected design

- Cloud services
- Model aggregation

2014

Design workflow

- Design feed
- Live maps

2015

Boost productivity

- Refined UI
- Reality capture



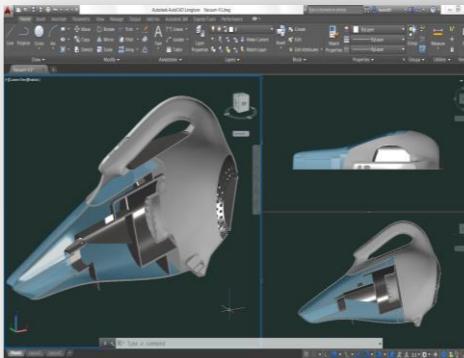
Autodesk® AutoCAD® 2015 software:

- Jumpstarts your design workflow
- Delivers a richer visual experience
- Brings the real world into the AutoCAD canvas

AutoCAD 2015: New features

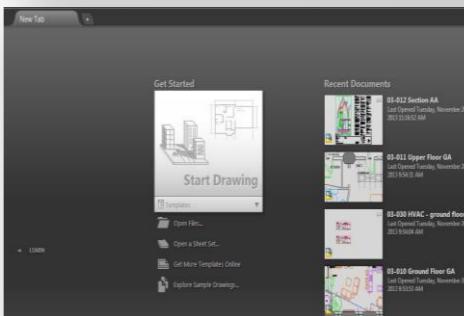
Refined interface

Experience an updated interface that improves functionality and productivity and reduces eye strain.



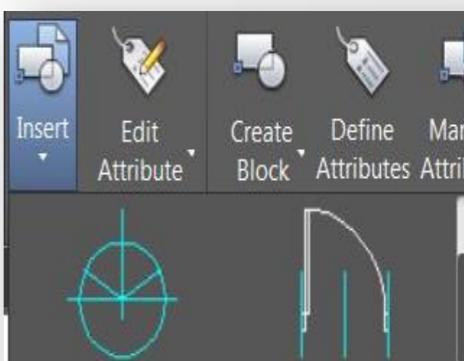
New tab page

Quickly open new and existing drawings and access a selection of content to get you up and running faster.



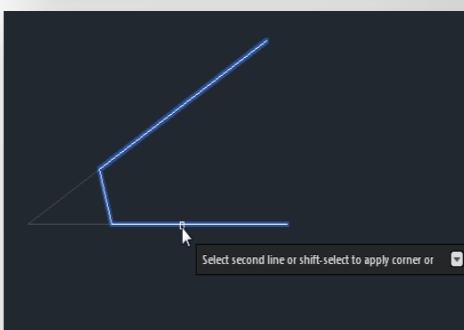
Ribbon galleries

Save time and clicks by visually accessing drawing content directly from the ribbon.



Command preview

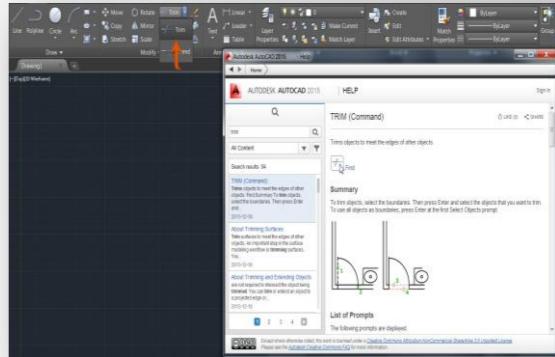
Evaluate potential changes before committing. Extends to more commands such as trim, extend, and match properties.



AutoCAD 2015: Enhancements

Help window

The UI finder shows tool locations directly from the relevant Help content. An animated arrow points you to the tool in the ribbon.



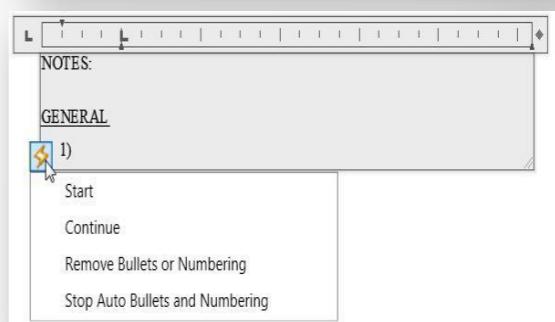
Geographic location

Capture online maps as a static images and print them. Freeze a contextual location so designs won't change even if site maps do.



Productivity tools

Using text within a drawing just got easier! Mtext works more like a word processor, with features like bold, italic, align, and word wrap.



Reality computing

Includes geographic location and new color displays. Improved performance enables denser point cloud display and orienting UCS planes.

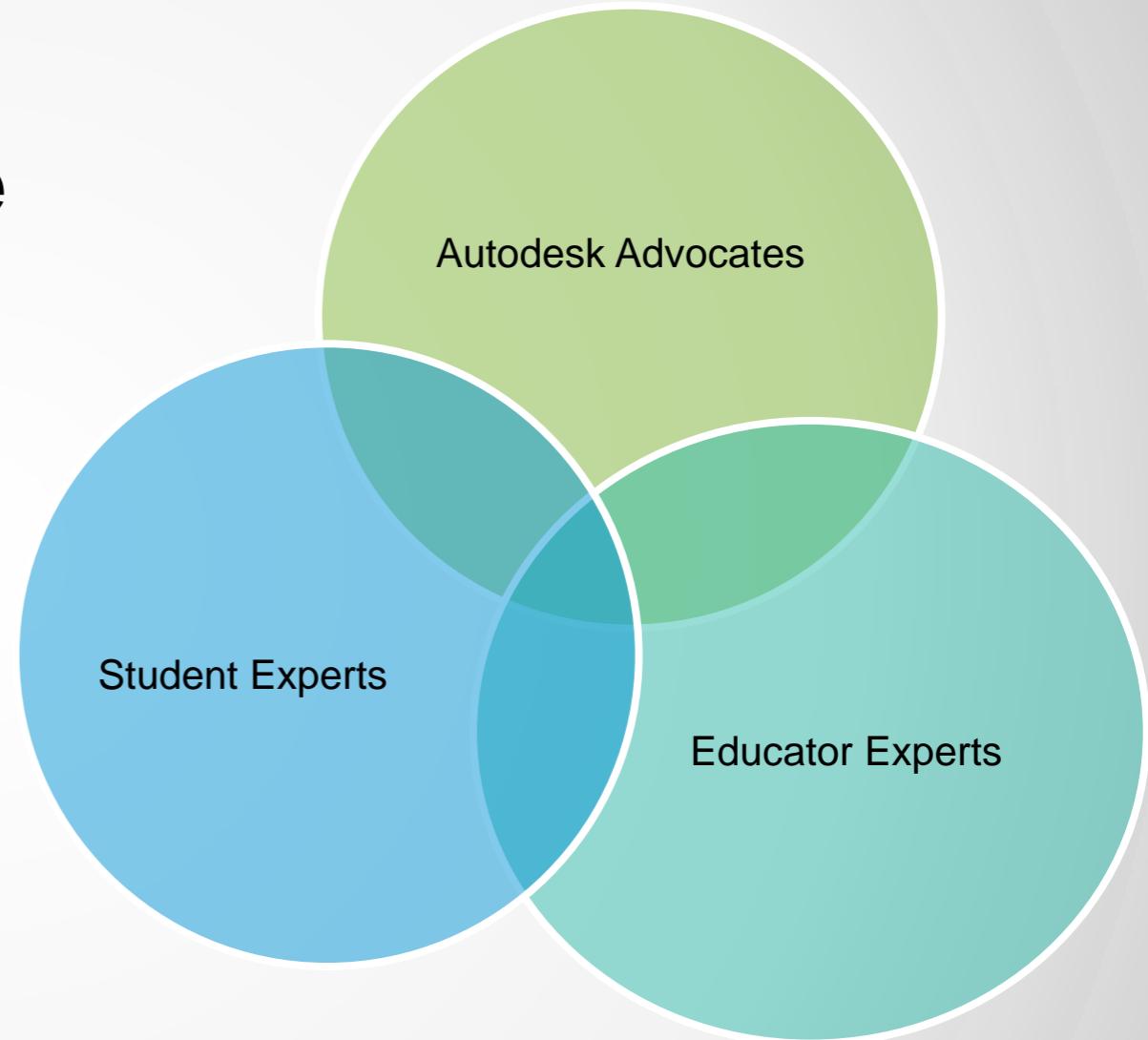


The Experts Program

Autodesk Student Expert

An elite network of passionate educators and students that work closely with Autodesk Education to support their peers on campus

- 900 members from 50 countries
- Community Portal, www.studentexpert.net, with access to networking and forums



Free Software Available to Students at
www.autodesk.com/education



Autodesk Education is committed to preparing the next generation of architects, engineers, and designers.





Autodesk is a registered trademark of Autodesk, Inc., and/or its subsidiaries and/or affiliates in the USA and/or other countries. All other brand names, product names, or trademarks belong to their respective holders. Autodesk reserves the right to alter product offerings and specifications at any time without notice, and is not responsible for typographical or graphical errors that may appear in this document.