ENGINEERING DRAWING

CVE 101
Civil Engineering Drawing

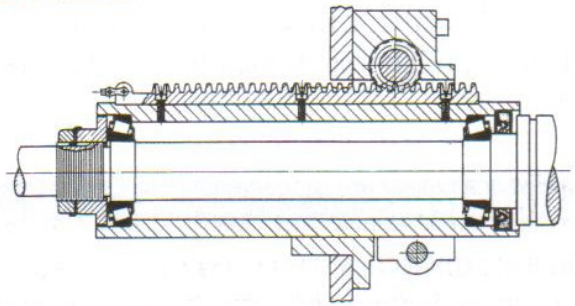
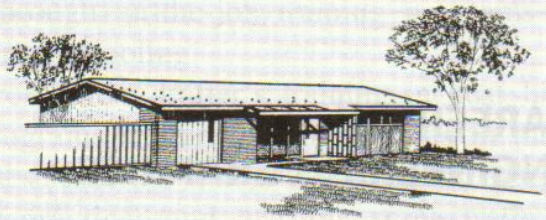
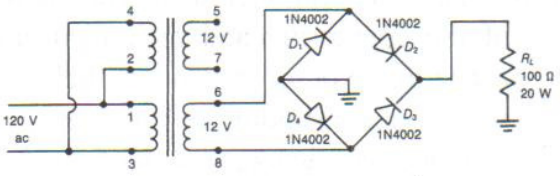
THE LANGUAGE OF INDUSTRY

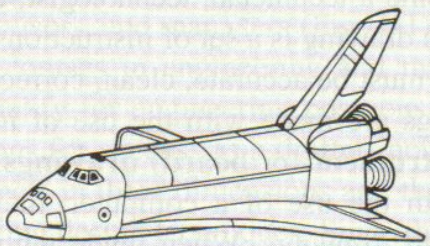
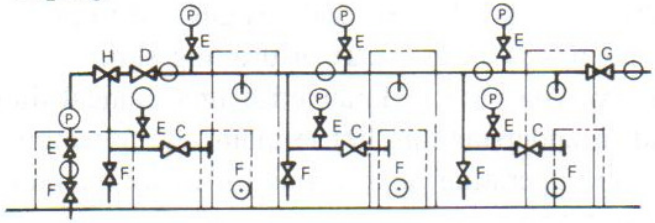
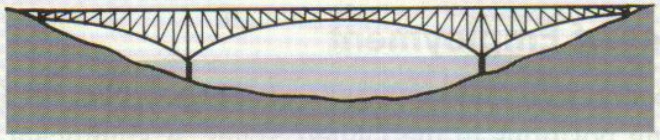
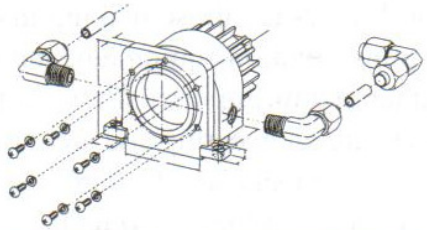
Since earliest times people have used drawings to communicate and record ideas so that they would not be forgotten. **Graphic representation** means dealing with the expression of ideas by lines or marks impressed on a surface. A drawing is a graphic representation of a real thing. **Drafting**, therefore, is a graphic language, because it uses pictures to communicate thoughts and ideas. Because these pictures are understood by people of different nations, drafting is referred to as a *universal language*.

Drawing has developed along two distinct lines, with each form having a different purpose. On the one hand **artistic drawing** is concerned mainly with the expression of real or imagined ideas of a cultural nature. **Technical drawing**, on the other hand, is concerned with the expression of technical ideas or ideas of a practical nature, and it is the communication method used in all branches of technical industry.

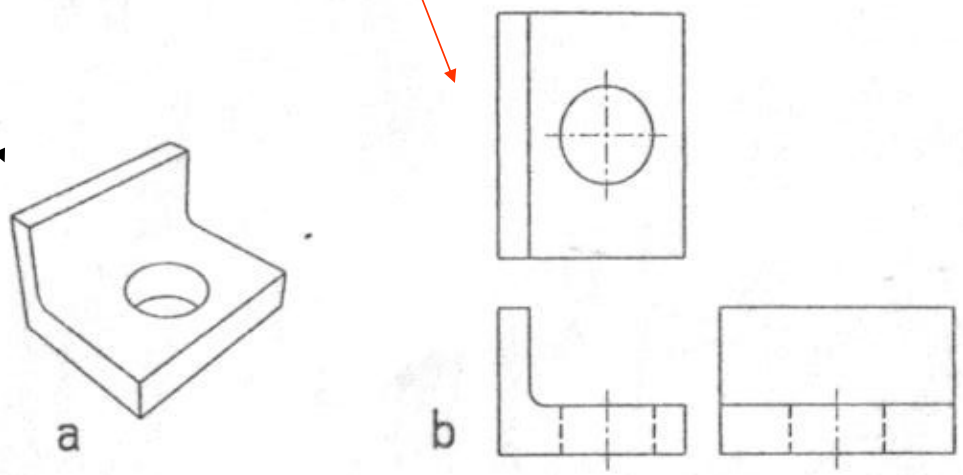
Even highly developed word languages are inadequate for describing the size, shape, texture and relationship of physical objects. For every manufactured object there are drawings that describe its physical shape and size completely and accurately, communicating engineering concepts to manufacturing. For this reason, drafting is called the *language of industry*.

Various fields of drafting.

Typical Branches of Engineering Graphics	Activities	Products	Specialized Areas
Mechanical 	Designing Testing Manufacturing Maintenance Construction	Materials Machines Devices	Power generation Transportation Manufacturing Power services Atomic energy Marine vessels
Architectural 	Planning Designing Supervising	Buildings Environment Landscape	Commercial buildings Residential buildings Institutional buildings Environmental space forms
Electrical 	Designing Developing Supervising Programming	Computers Electronics Power Electrical	Power generation Power application Transportation Illumination Industrial electronics Communications Instrumentation Military electronics

Aerospace 	Planning Designing Testing	Missiles Planes Satellites Rockets	Aerodynamics Structural design Instrumentation Propulsion systems Materials Reliability testing Production methods
Piping 	Designing Testing Manufacturing Maintenance Construction	Buildings Hydraulics Pneumatics Pipe lines	Liquid transportation Manufacturing Power services Hydraulics Pneumatics
Structural 	Planning Designing Manufacturing Construction	Materials Buildings Machines Vehicles Bridges	Structural designs Buildings Planes Ships Automobiles Bridges
Technical illustration 	Promotion Designing Illustrating	Catalogs Magazines Displays	New products Assembly instructions Presentations community projects Renewal programs

The Industrial Revolution brought with it the need to tie more closely the concept of a design with the final manufactured product using technical drawing. The perspective drawing of a simple object in Figure a shows pictorially what the object looks like. However, it is difficult to represent accurately dimensions and other details in a perspective drawing. *Orthographic projections*, developed in 1528 by German artist Albrecht Dürer, accomplish this quite well. An orthographic projection typically shows three views of an object. Each view shows a different side of the object (sav the front, top, and side). An example of an orthographic projection is shown in Figure



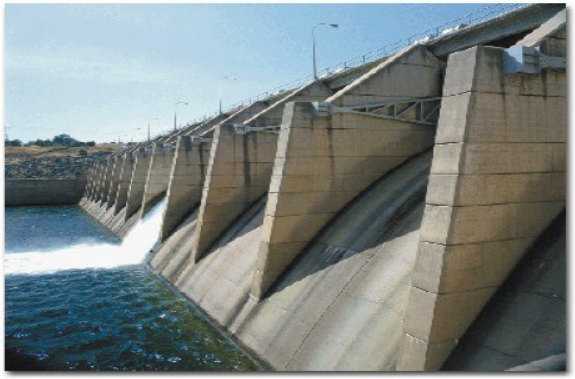
CIVIL ENGINEERING

Buildings

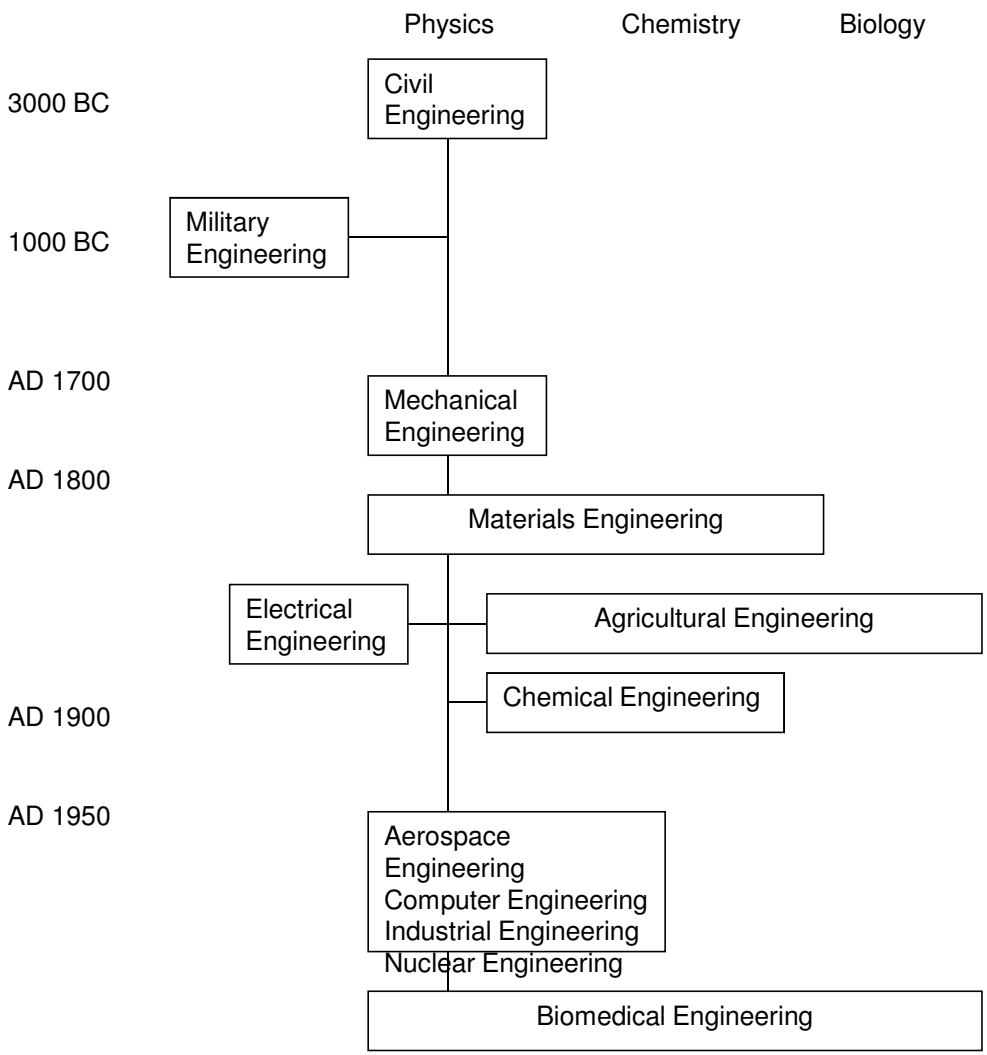
Flyovers

Cannel

Dams



Bridge over waters

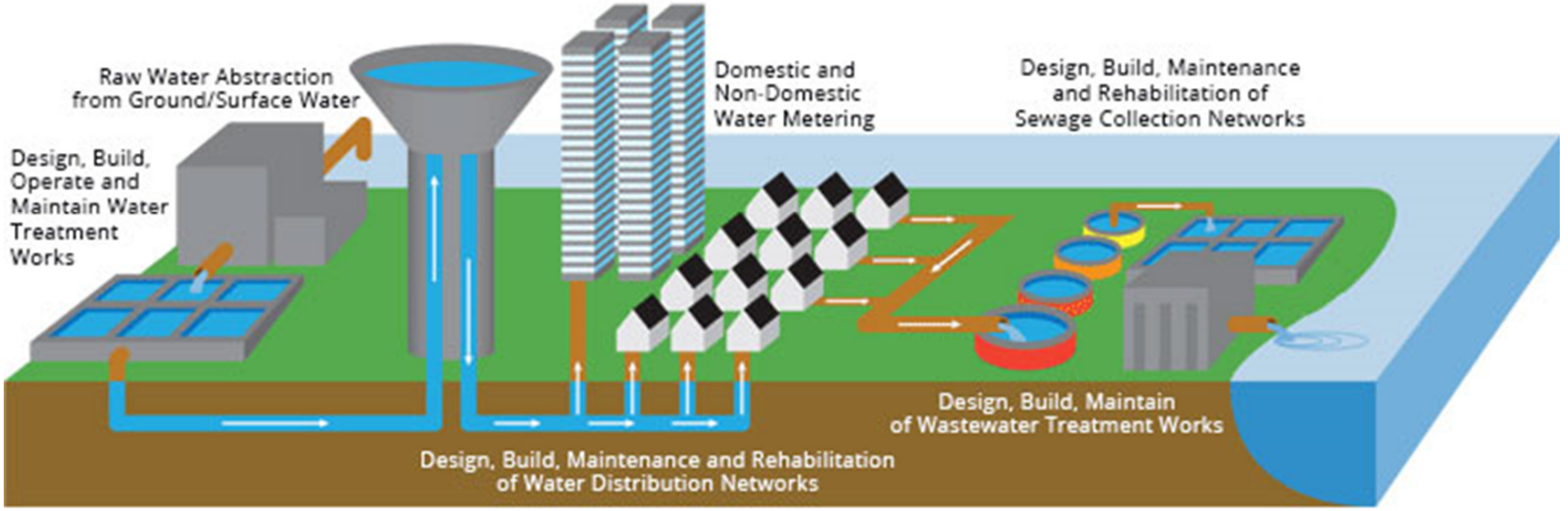


Birth of engineering disciplines

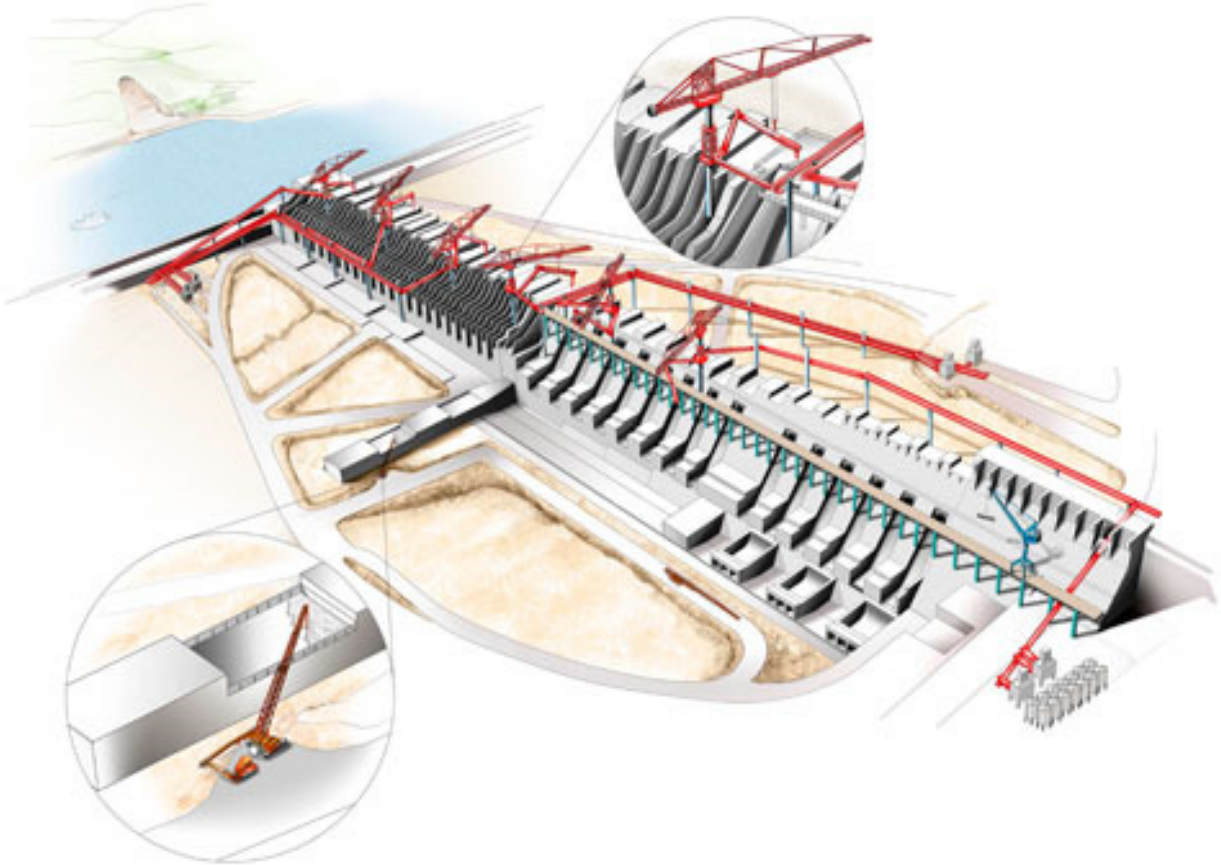
Civil Engineering: Civil engineering is generally considered the oldest engineering discipline-its works trace back to the Egyptian pyramids and before. Many of the skills possessed by civil engineers (e.g., building walls, bridges, roads) are extremely useful in warfare, so these engineers worked on both military and civilian projects.

Civil engineers are responsible for constructing large-scale projects such as roads, buildings, airports, dams, bridges, harbors, canals, water systems, and sewage systems.

Water Supply and Sewage Treatment




JUDY 30/3a



CAD

The introduction of the computer revolutionized engineering graphics. Pioneers in computer-aided engineering graphics envisioned the computer as a tool to replace paper and pencil drafting with a system that is more automated, efficient, and accurate. The first demonstration of a computer-based drafting tool was a system called SKETCHPAD developed at the Massachusetts Institute of Technology in 1963 by Ivan Sutherland. The system used a monochrome monitor with a light pen for input from the user. The following year IBM commercialized computer-aided drafting.

During the 1970s, computer-aided drafting blossomed as the technology changed from scientific endeavor to an economically indispensable industrial tool for design. Commands for geometry generators to create commonly occurring shapes were added. Functions were added to control the viewing of the drawing geometry. Modifiers such as rotate, delete, and mirror were implemented. Commands could be accessed by typing on the keyboard or by using a mouse. Perhaps most importantly, three-dimensional modeling techniques became a key part of engineering graphics software.

The company behind AutoCAD, Autodesk was founded in 1982 by John Walker. AutoCAD is a commercial computer-aided design (CAD) and drafting software application. Developed and marketed by Autodesk, AutoCAD was first released in **December 1982** as a desktop app running on microcomputers with internal graphics controllers.

By the 1980s, computer-aided drafting became fully developed in the marketplace as a standard tool in industry. In addition, the current technology of solids modeling came about. Solids models represent objects in the virtual environment of the computer just as they exist in reality, having a volume as well as surfaces and edges. The introduction of Pro/ENGINEER® in 1988 and SolidWorks® in the 1990s revolutionized computer-aided design and drafting. Today solids modeling remains the state-of-the-art technology.

What we have been referring to as computer-aided drafting is usually termed *CAD*, an acronym for Computer Aided Design, Computer Aided Drafting, or Computer Aided Design and Drafting. Originally the term Computer Aided Design included any technique that uses computers in the design process including drafting, stress analysis, and motion analysis. But over the last 35 years CAD has come to refer more specifically to Computer Aided Design and Drafting. Computer Aided Engineering (CAE) is used to refer to the broader range of computer-related design tools.

The use of CAD has had a great impact on the design process. For example, a part may be modified several times to meet the design specification or to mate with another part. Before the advent of CAD, these modifications were very tedious, time-consuming, and prone to error. However, CAD has made it possible to make these changes relatively easily and quickly. The connectivity of computers using local area networks then makes the revised electronic drawings available to a team of engineers at an instant. This is crucial as engineering systems become more complex and operational requirements become more stringent. For example, a modern jet aircraft has several million individual parts that must all fit together and perform safely for several decades.

Although CAD had a great impact on making the design process speedier and more accurate, the capabilities of the first few generations of CAD were still limited. Early CAD systems only provided a means of automating the drafting process to create orthographic engineering drawings. The designer or engineer would simply generate a line on the computer screen rather than drawing the line on paper. Current computer graphics software such as "paint" or "draw" programs for personal computers work this way. As CAD became more sophisticated, it helped automate the drafting process based on the "intelligence" of the software. CAD software lacking such intelligence required an engineer to draw a pair of parallel lines an exact distance apart by specifying coordinates of the endpoints of the lines. More advanced generations of CAD software permitted an engineer to draw approximately parallel lines using a mouse. Then the engineer would specify a particular distance between the lines and that the lines should be parallel. The CAD software then automatically placed these lines the specified distance apart and made them parallel. However, the major problem with the early generations of CAD software was that the designer or engineer was simply creating two-dimensional orthographic views of a three-dimensional part using a computer instead of a pencil and paper. From these two-dimensional views, the engineer still needed to reconstruct the mind's eye view of the three-dimensional image in the same way as if the drawings were created by hand.

The current generation of CAD software has had a very profound effect on the design process, because it is now possible to create a virtual prototype of a part or assembly on a computer.

Rather than translating a three-dimensional image from the mind's eye to a two-dimensional orthographic projection of the object, current CAD software starts with generating a three-dimensional virtual model of the object directly on the computer. This virtual model can be rotated so that it can be viewed from different angles. Several parts can be virtually assembled on the computer to make sure that they fit together. The assembled parts can be viewed as an assembly or in an exploded view. All of this is done in a virtual environment on the computer before the two-dimensional orthographic engineering drawings are even produced. It is still usually necessary to produce the orthographic engineering drawings. But these drawings only to serve as a standard means of engineering graphics communication, rather than as a tedious, time-consuming task necessary to proceed with the design process.

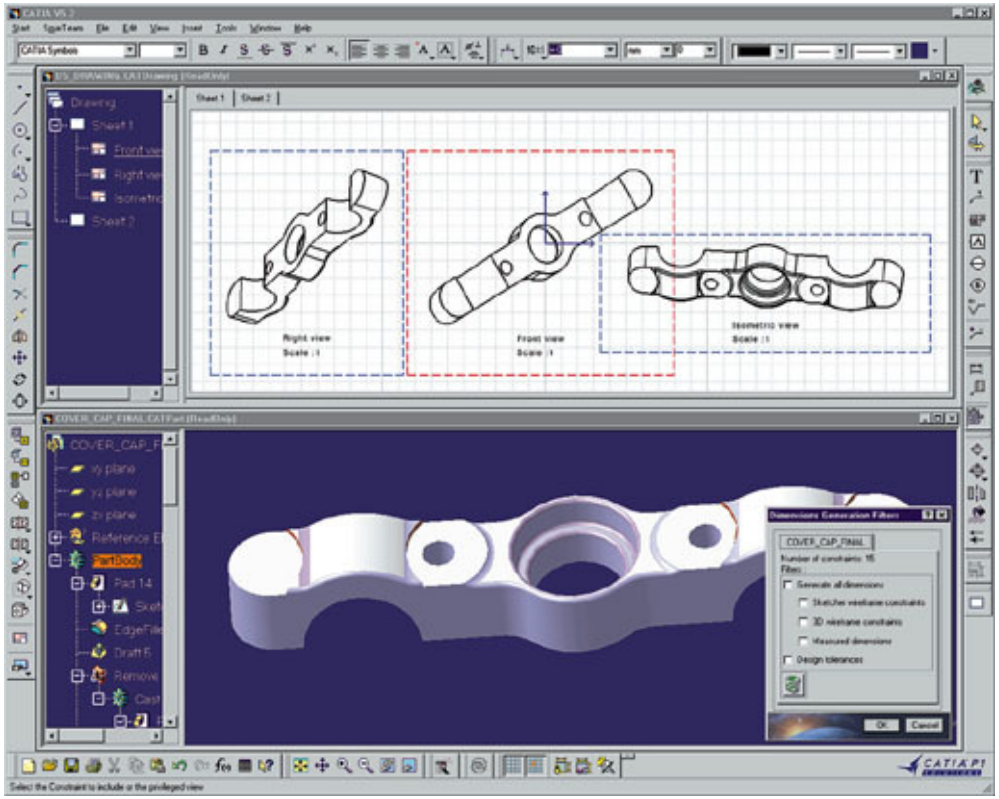
What Happened to Pencil and Paper Drawings?

CAD drawings have already replaced pencil and paper drawings. Through the 1970s and even into the 1980s many engineering and design facilities consisted of rows and rows of drafting tables with a designer or engineer hunched over a drawing on each table. Engineering colleges and universities required a full-year course in "engineering drafting" or "graphics communication" for all engineering students. Many of these students purchased a set of drawing instruments along with their first semester textbooks. They spent endless hours practicing lettering and drawing perfect circles.

Now nearly all of the drafting tables and drafting courses have been replaced by CAD. One can still find a drafting table here and there, but it is not for creating engineering drawings. Most often it is used for displaying a large CAD drawing to designers and engineers. They can make notes on the drawing or freehand sketch modifications on the drawing. The pencil is still an ideal means for generating ideas and quickly conveying those ideas to others. But eventually, all of the pencil markings are used as the basis for modifying the CAD drawing.

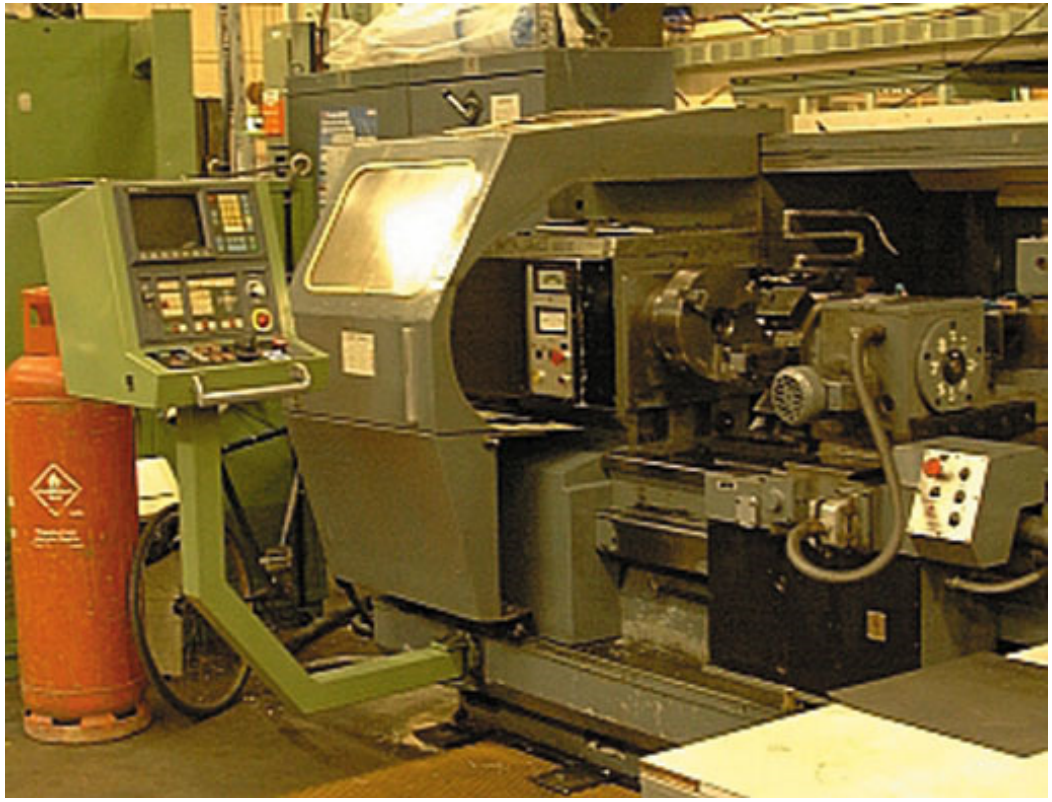
In some companies with traditional products that have not changed for decades (like a spoon or a chair), pencil and paper drawings are gradually being converted into electronic form. In some cases, the original drawing is simply scanned to create an electronic version. The scanned drawing cannot be modified, but the electronic version takes much less storage space than a hard copy. In other cases, the original pencil and paper drawings are being systematically converted to CAD drawings, so that they can be modified if necessary. In any case, though, the pencil and paper drawing is now just a part of the history of engineering.

COMPUTER-AIDED DESIGN



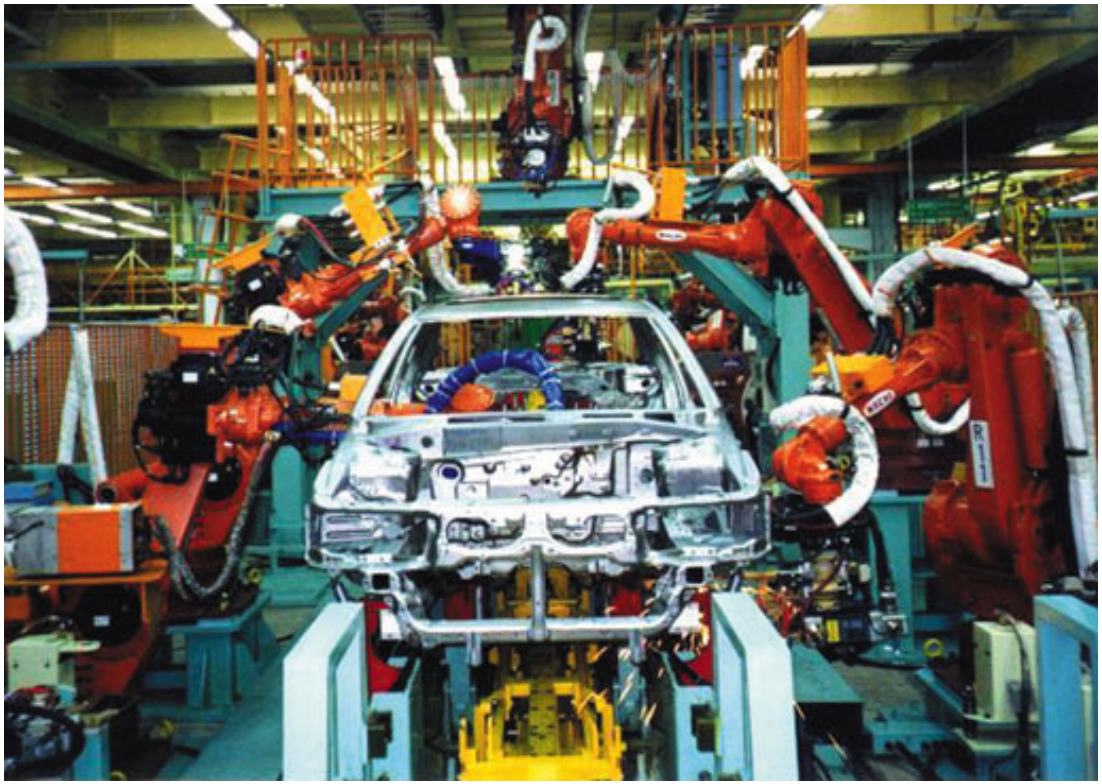
COMPUTER-AIDED DESIGN

(CNC) COMPUTER NUMERICAL CONTROL

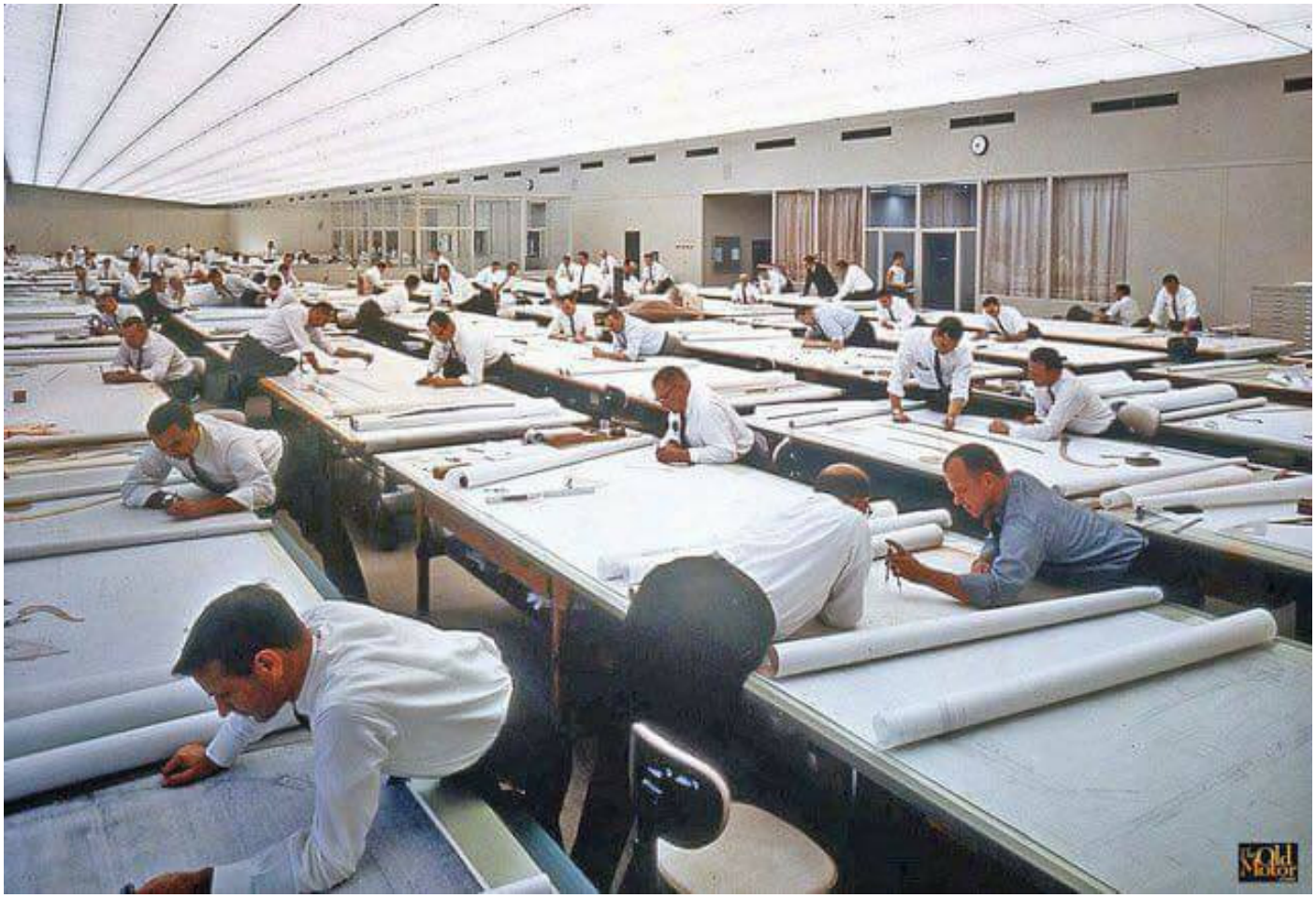


COMPUTER-AIDED DESIGN

(CAM) ROBOTICS

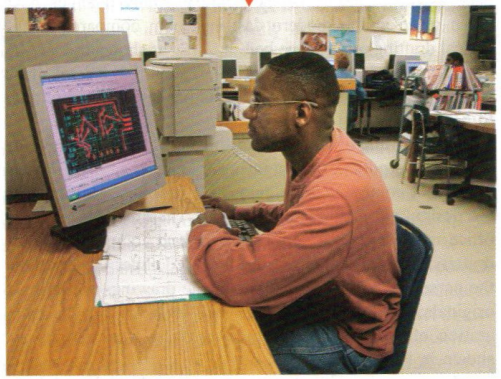


Life without AutoCAD!



(A) THE DRAFTING OFFICE AT THE TURN OF THE CENTURY.

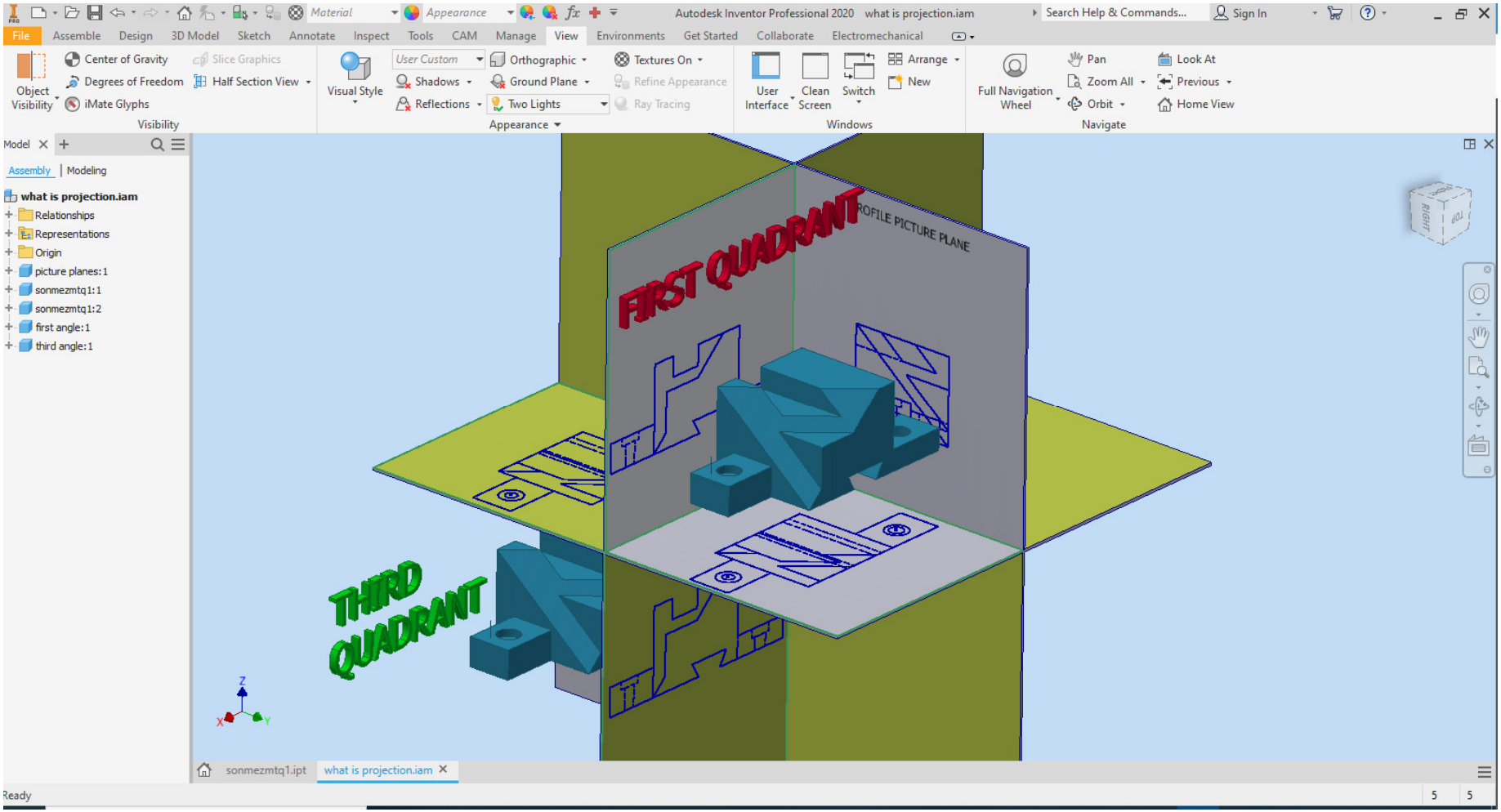
(B) BOARD DRAFTING OFFICE UP TO 1970.



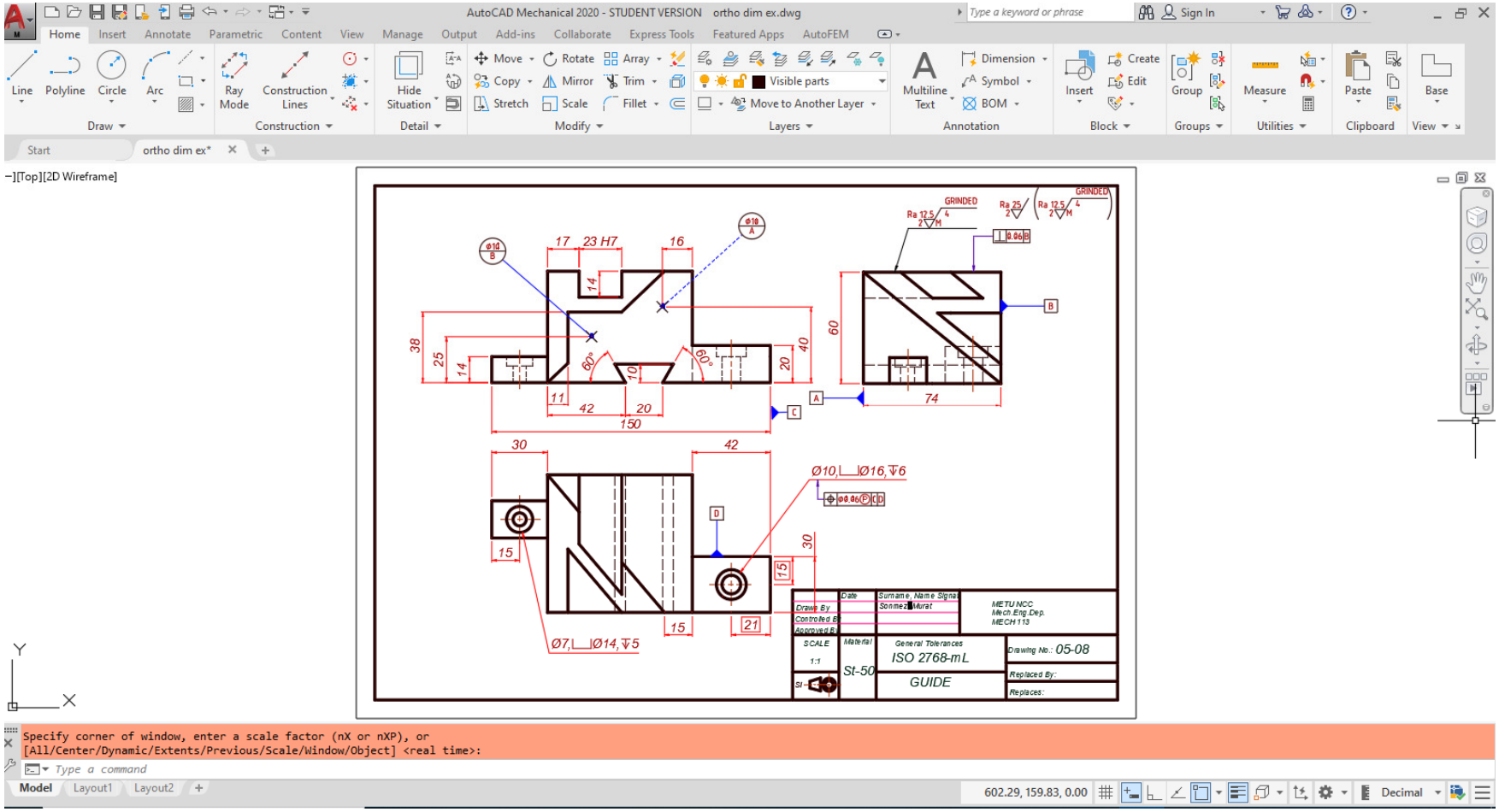
(C) TODAY'S DRAFTING OFFICE.

Evolution of the drafting office.

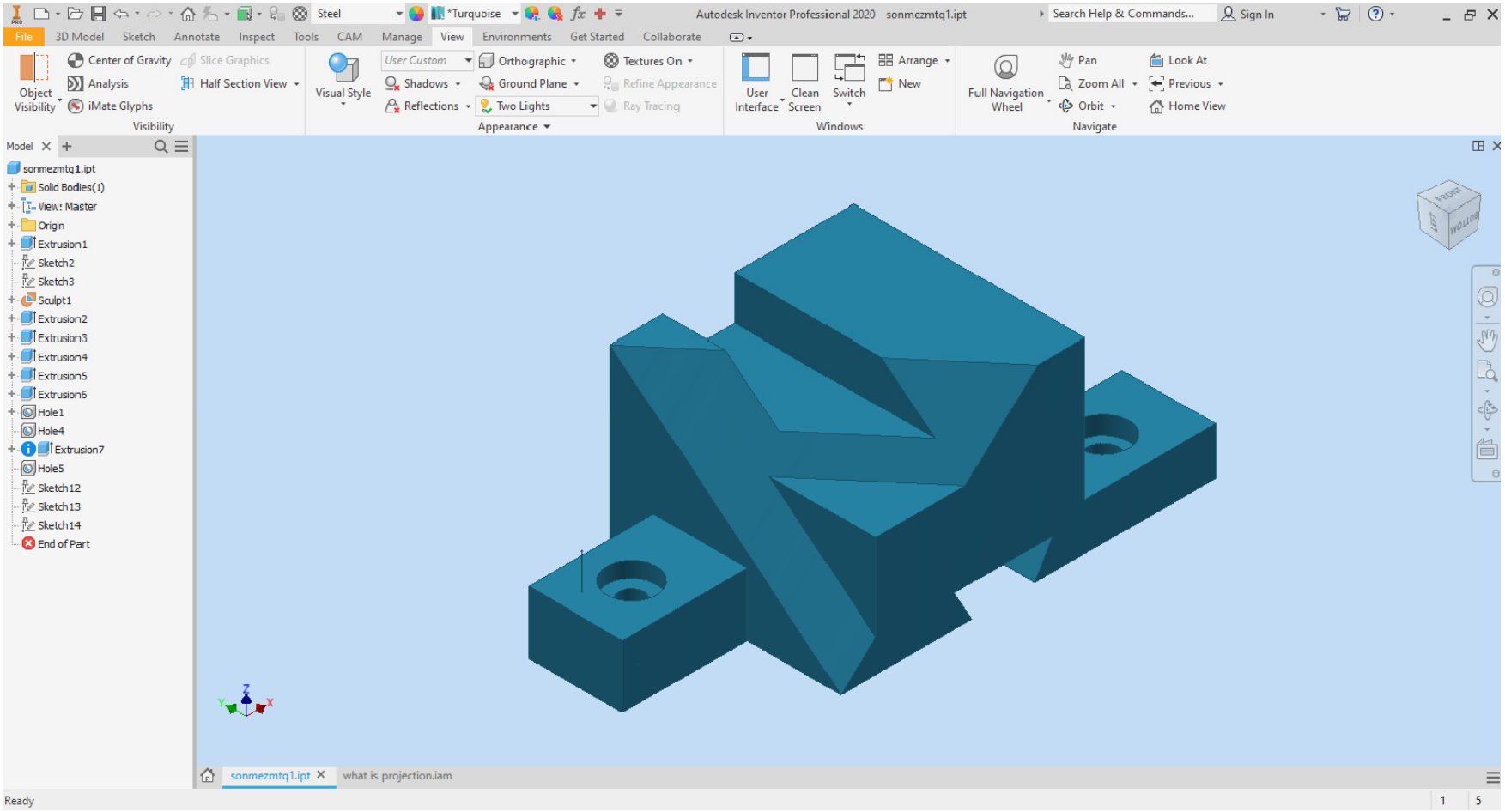
Engineering Drawing v.s. Solid Modelling



Reading and writing an engineering drawing require education/ learning



Solid Model:
Reading does not require education/ learning
Model Creation: Require education/ learning

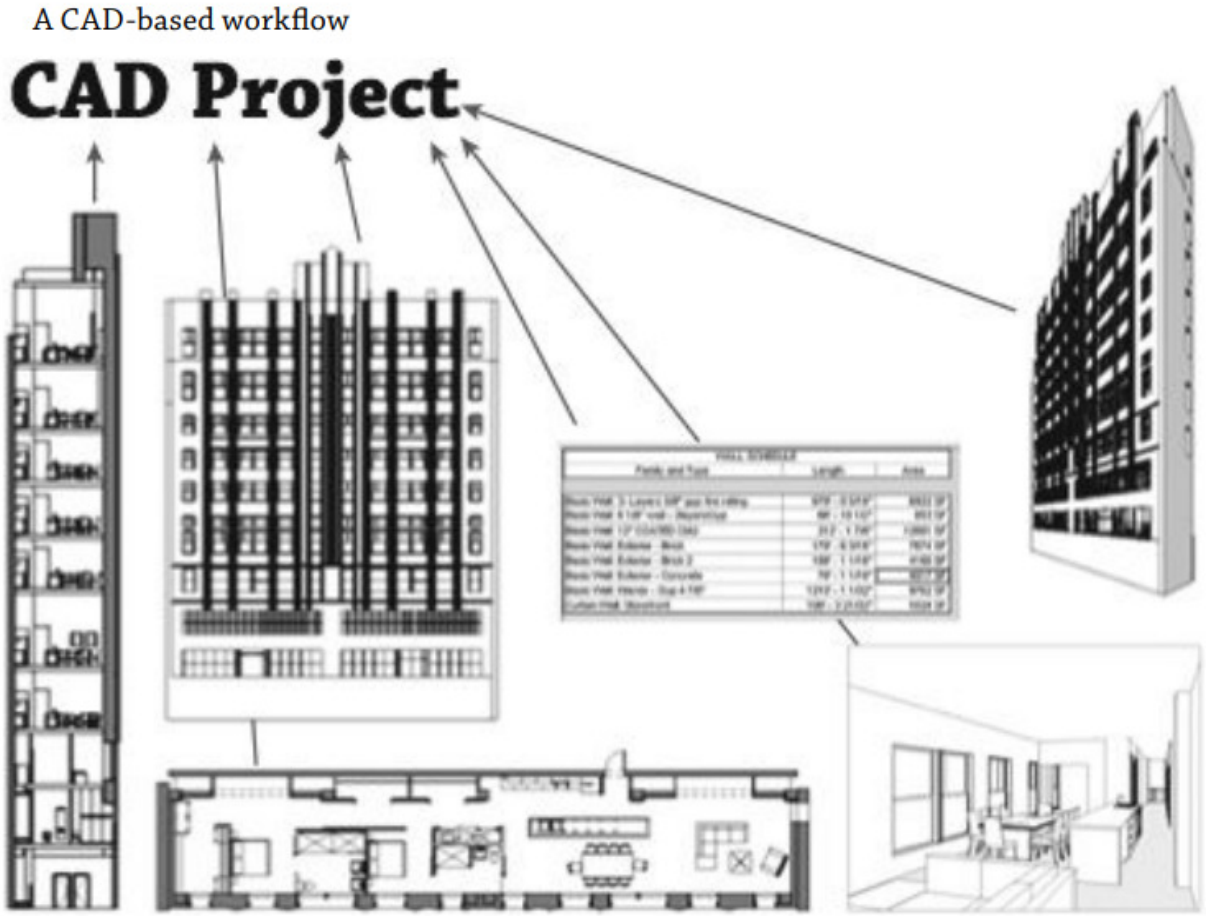


CAD-based system v.s. BIM-based system

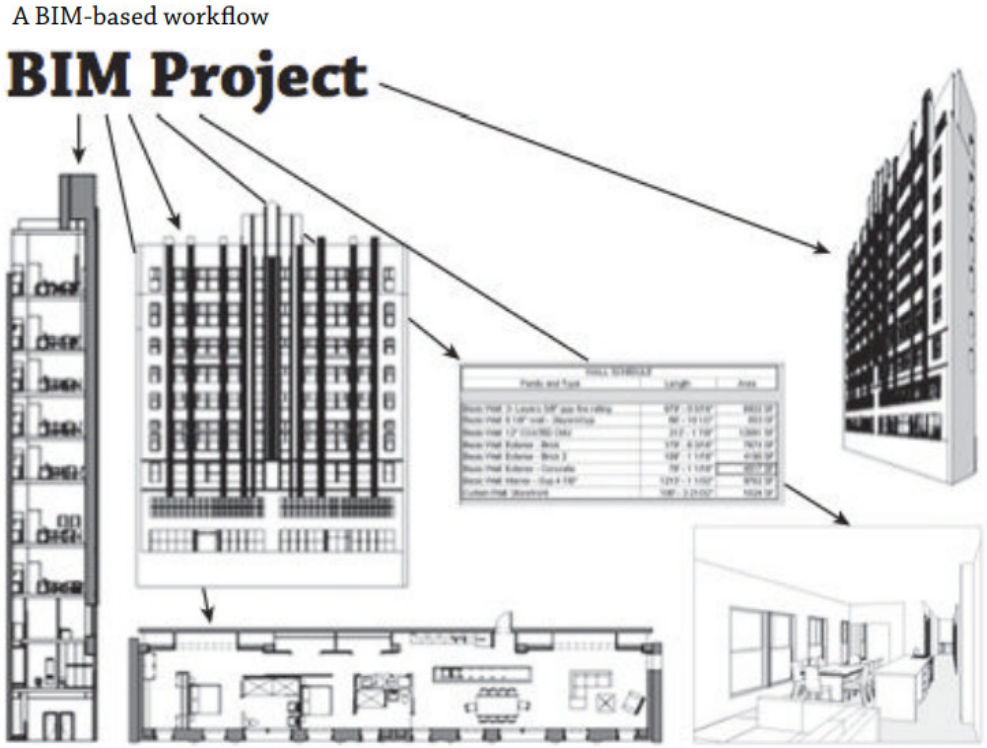
BIM- Building Information Modeling

Autodesk REVIT

In a traditional CAD-based workflow each view is drawn seperately with no inherent relationship between drawings. Plans, elevations, sections, schedules, tables, are created not related. Any changes are to be coordinated and files are to be updated manually.

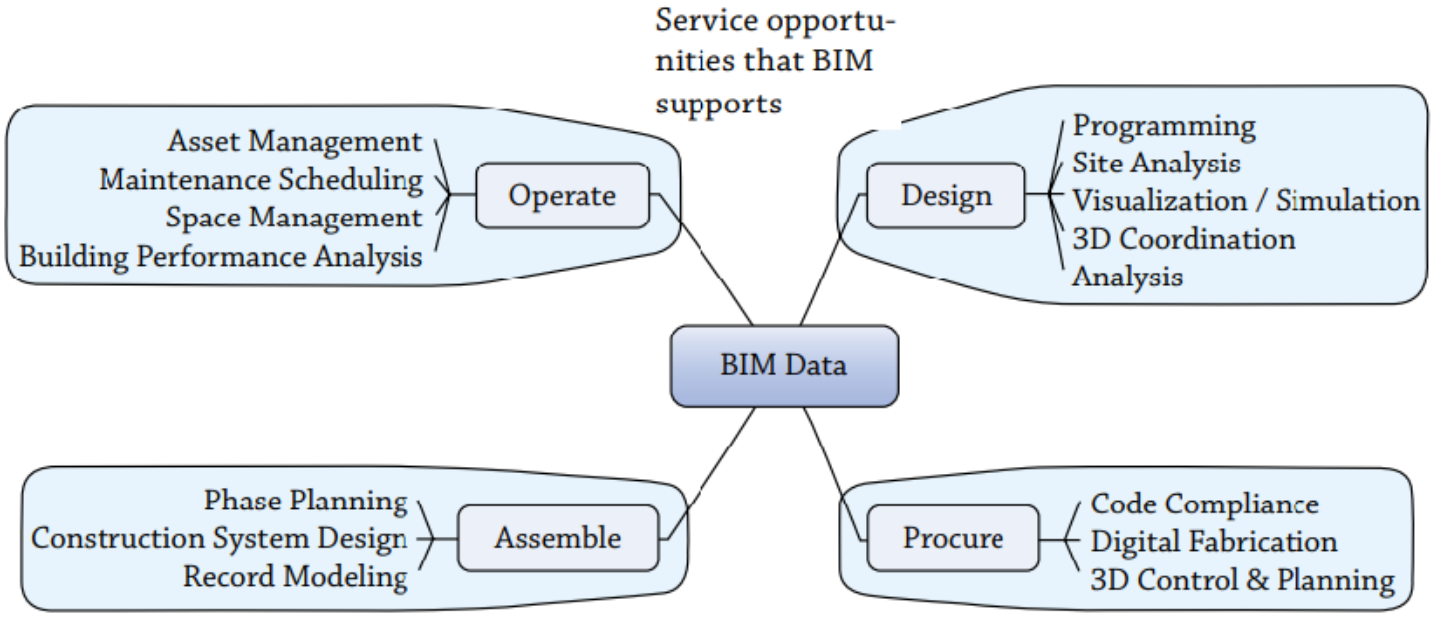


In a BIM-based workflow, the team creates a 3D parametric model and uses this model to generate the drawings necessary for documentation. Plans, sections, elevations, schedules, and perspectives are all by-products of creating a building information model. This enhanced representation methodology not only allows for a highly coordinated documentation but also provides the basic model geometry necessary for analysis, such as daylighting studies, energy usage simulation, engineering calculations, and so on.



BIM as a Single Source Model

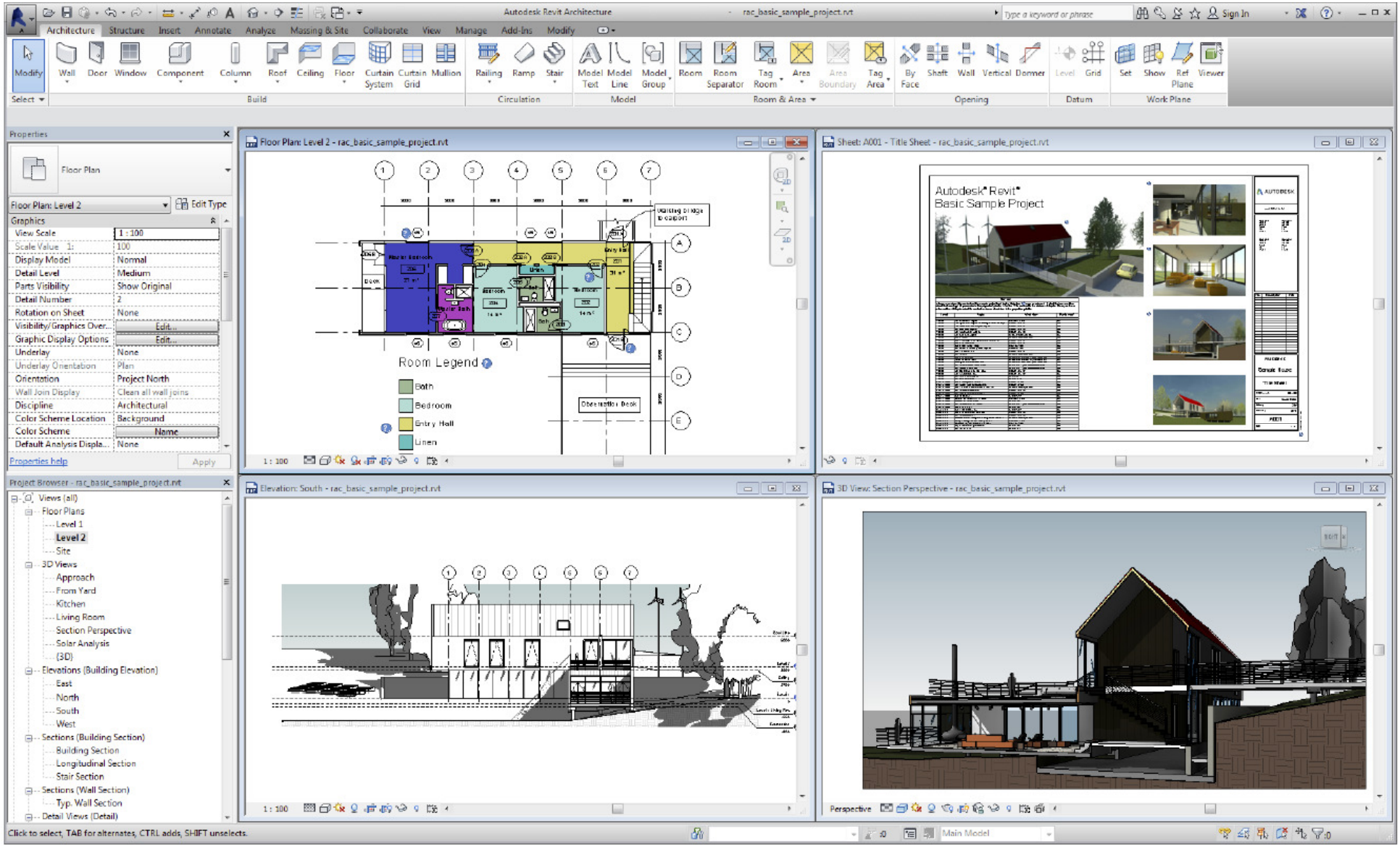
In the early 2000s if you wanted to create a rendering, a physical model, a daylighting model, an energy model, and an animation, you would have had to create five separate models and use five different pieces of software. There was no ability to reuse model geometry and data between model uses. One of the key uses of BIM is the opportunity to repurpose the model for a variety of visualizations. This not only allows you to not have to re-create geometry between uses, but it also ensures you're using the most current information in each visualization because it all comes from the same source. As the capacity of cloud rendering and analysis grows, the feedback will no longer need to process locally and you'll be able to receive feedback faster.



What Is Revit?

Autodesk® Revit® software is a BIM application that utilizes a parametric 3D model to generate plans, sections, elevations, perspectives, details, and schedules—all of the necessary instruments to document the design of a building. Drawings created using Revit are not a collection of 2D lines and shapes that are interpreted to represent a building; they are live views extracted from what is essentially a virtual building model. This model consists of a compilation of intelligent components that contain not only physical attributes but also functional behavior familiar in architectural design, engineering, and construction. Elements in Revit are managed and manipulated through a hierarchy of parameters. These elements share a level of bidirectional associativity—if the elements are changed in one place within the model, those changes are visible in all the other views. If you move a door in a plan, that door is moved in all of the elevations, sections, perspectives, and so on in which it is visible. In addition, all of the properties and information about each element are stored within the elements themselves, which means that most annotation is merely applied to any view and is transient in nature. When contrasted with traditional CAD tools that store element information only in the annotation, Revit gives you the opportunity to more easily extract, report, and organize your project data for collaboration with others.

The first version of Revit was launched in 2000 by Revit Technology Corporation, and its name is a contraction of “revise-it”. Revit aimed to go beyond simple drafting, allowing smart building models to be created in a computer. Autodesk purchased Revit Technology Corporation in 2002, after realizing the potential of the software package.


Autodesk Revit Architecture
rac_basic_sample_project.rvt
Architecture
Structure
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Modify
Properties
Floor Plan
Floor Plan: Level 2
Edit Type
Graphics
View Scale
1 : 100
Display Model
Normal
Detail Level
Medium
Parts Visibility
Show Original
Rotation on Sheet
None
Underlay
None
Orientation
Project North
Discipline
Architectural
Color Scheme Location
Background
Color Scheme
Name
Properties help
Apply
Project Browser - rac_basic_sample_project.rvt
Views (all)
Floor Plans
Level 1
Level 2
Site
3D Views
Approach
From Yard
Kitchen
Living Room
Section Perspective
Solar Analysis
{3D}
Elevations (Building Elevation)
East
North
South
West
Sections (Building Section)
Building Section
Longitudinal Section
Stair Section
Sections (Wall Section)
Typ. Wall Section
Detail Views (Detail)
Floor Plan: Level 2 - rac_basic_sample_project.rvt
Room Legend
Bath
Bedroom
Entry Hall
Linen
Sheet: A001 - Title Sheet - rac_basic_sample_project.rvt
Autodesk® Revit®
Basic Sample Project
Elevation: South - rac_basic_sample_project.rvt
3D View: Section Perspective - rac_basic_sample_project.rvt
Perspective
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model

When is AutoCAD Recommendable?

AutoCAD is effective when working with renovations and upgrades in existing buildings, constructed before the advent of BIM and where the original construction plans were also drafted in AutoCAD. The software offers excellent compatibility among versions from different years, so working with files from an earlier version is not an issue. Property managers and engineering firms often have large databases of AutoCAD files (DWG format), and creating Revit models for all these projects can involve a significant number of man-hours that are better used in new projects.

The 2017 version of AutoCAD offers enhanced integration with PDF files, which is a very useful feature when the existing project plans are not available in DWG format. AutoCAD 2017 can import PDF files and convert them to DWG, correctly distinguishing between line work and text. The 2017 edition also supports cloud-based view sharing, and these can be viewed by other team members in the web app, without having to install anything. Another innovative feature of AutoCAD 2017 is 3D-printing compatibility, which greatly simplifies prototype creation.

Revit Overview

Revit is a much more powerful software package, capable of creating a 3D model of a project, which includes the physical properties and interactions of building components. For example, if you have several views of a mechanical system and introduce a change in one of them, the change is reflected on the actual model and all other views are updated accordingly. This is one of the key strengths of Revit, allowing project documents to be completed much faster.

Revit also eliminates the complexity of managing upgrades, since all design teams are working simultaneously on the same building model. For example, if a change to the plumbing layout causes overlap with HVAC installations, Revit can immediately detect this and generate an error message. Managing changes in Revit is much simpler, since one modification is immediately reflected on all existing views; in AutoCAD, changes often force all teams to update their work manually.

Revit is also a very powerful tool when calculating material lists or preparing project bids. Since it contains all key information regarding technical specifications and pricing, it can generate cost schedules automatically.

The main limitation when using Revit is that the building model must follow a set of rules, and this rigidity also applies for 2D view and drafts. When working exclusively with precise line work, AutoCAD offers greater flexibility.

When is Revit Recommendable?

Since Revit is a BIM tool, it can be extremely powerful when planning, designing, constructing and operating new buildings. Even after the project has been completed, Revit simplifies maintenance and future upgrades.

The benefits of using Revit become more evident as the project scale grows. When designing with AutoCAD alone, an architectural design change may involve updating dozens of 2D plans, while in Revit they are updated automatically and engineering teams can focus on optimizing building systems. Building layout modifications and location conflicts are managed automatically in the background by Revit.