**Scientific visualization** (also spelled **scientific visualization**) is an interdisciplinary branch of science according to Friendly (2008) "primarily concerned with the visualization of three-dimensional phenomena (architectural, meteorological, medical, biological, etc.), where the emphasis is on realistic renderings of volumes, surfaces, illumination sources, and so forth, perhaps with a dynamic (time) component". It is also considered a branch of computer science that is a subset of computer graphics. The purpose of scientific visualization is to graphically illustrate scientific data to enable scientists to understand, illustrate, and glean insight from their data.

Scientific visualization using computer graphics gained in popularity as graphics matured. Primary applications were scalar fields and vector fields from computer simulations and also measured data. The primary methods for visualizing two-dimensional (2D) scalar fields are color mapping and drawing [contour lines](http://en.wikipedia.org/wiki/Contour_line). 2D vector fields are visualized using [glyphs](http://en.wikipedia.org/wiki/Glyph_%28data_visualization%29) and [streamlines](http://en.wikipedia.org/wiki/Streamlines,_streaklines,_and_pathlines) or [line integral convolution](http://en.wikipedia.org/wiki/Line_integral_convolution) methods. 2D tensor fields are often resolved to a vector field by using one of the two eigenvectors to represent the tensor each point in the field and then visualized using vector field visualization methods.

For 3D scalar fields the primary methods are [volume rendering](http://en.wikipedia.org/wiki/Volume_rendering) and [isosurfaces](http://en.wikipedia.org/wiki/Marching_cubes). Methods for visualizing vector fields include glyphs (graphical icons) such as arrows, [streamlines and streaklines](http://en.wikipedia.org/wiki/Streamlines,_streaklines,_and_pathlines), particle tracing, [line integral convolution](http://en.wikipedia.org/wiki/Line_integral_convolution) (LIC) and topological methods. Later, visualization techniques such as hyperstreamlines[[5]](http://en.wikipedia.org/wiki/Scientific_visualization" \l "cite_note-5) were developed to visualize 2D and 3D tensor fields.

**Computer-aided design** (**CAD**) is the use of [computer](http://en.wikipedia.org/wiki/Computer) systems to assist in the creation, modification, analysis, or optimization of a [design](http://en.wikipedia.org/wiki/Design).[[1]](http://en.wikipedia.org/wiki/Computer-aided_design#cite_note-1) CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing.[[2]](http://en.wikipedia.org/wiki/Computer-aided_design#cite_note-2) CAD output is often in the [form of electronic files](http://en.wikipedia.org/wiki/List_of_file_formats#Computer-aided) for print, machining, or other manufacturing operations.

Computer-aided design is used in many fields. Its use in designing electronic systems is known as [electronic design automation](http://en.wikipedia.org/wiki/Electronic_design_automation), or **EDA**. In mechanical design it is known as mechanical design automation (**MDA**) or **computer-aided drafting** (**CAD**), which includes the process of creating a [technical drawing](http://en.wikipedia.org/wiki/Technical_drawing) with the use of computer software.[[3]](http://en.wikipedia.org/wiki/Computer-aided_design#cite_note-3)

CAD software for mechanical design uses either vector-based graphics to depict the objects of traditional drafting, or may also produce [raster graphics](http://en.wikipedia.org/wiki/Raster_graphics) showing the overall appearance of designed objects. However, it involves more than just shapes. As in the manual [drafting](http://en.wiktionary.org/wiki/drafting) of [technical](http://en.wikipedia.org/wiki/Technical_drawing) and [engineering drawings](http://en.wikipedia.org/wiki/Engineering_drawing), the output of CAD must convey information, such as materials, processes, [dimensions](http://en.wikipedia.org/wiki/Dimension), and [tolerances](http://en.wikipedia.org/wiki/Engineering_tolerance), according to application-specific conventions.

CAD may be used to design curves and figures in [two-dimensional](http://en.wikipedia.org/wiki/2D_computer_graphics) (2D) space; or curves, surfaces, and solids in [three-dimensional](http://en.wikipedia.org/wiki/3D_computer_graphics) (3D) space.[[4]](http://en.wikipedia.org/wiki/Computer-aided_design#cite_note-4)

CAD is an important [industrial art](http://en.wikipedia.org/wiki/Industrial_arts) extensively used in many applications, including automotive, shipbuilding, and aerospace industries, industrial and architectural design, [prosthetics](http://en.wikipedia.org/wiki/Prosthesis), and many more. CAD is also widely used to produce [computer animation](http://en.wikipedia.org/wiki/Computer_animation) for [special effects](http://en.wikipedia.org/wiki/Special_effect) in movies, [advertising](http://en.wikipedia.org/wiki/Advertising) and technical manuals, often called DCC [digital content creation](http://en.wikipedia.org/wiki/Digital_content_creation). The modern ubiquity and power of computers means that even perfume bottles and shampoo dispensers are designed using techniques unheard of by engineers of the 1960s. Because of its enormous economic importance, CAD has been a major driving force for research in [computational geometry](http://en.wikipedia.org/wiki/Computational_geometry), [computer graphics](http://en.wikipedia.org/wiki/Computer_graphics) (both hardware and software), and discrete differential geometry.[[5]](http://en.wikipedia.org/wiki/Computer-aided_design#cite_note-5)

**Virtual reality** (**VR**), sometimes referred to as **immersive multimedia**, is a [computer-simulated](http://en.wikipedia.org/wiki/Computer_simulation) environment that can simulate physical presence in places in the real world or imagined worlds. Virtual reality can recreate sensory experiences, including [virtual taste](http://en.wikipedia.org/wiki/Virtual_taste), [sight](http://en.wikipedia.org/wiki/Head-mounted_display), smell, sound, [touch](http://en.wikipedia.org/wiki/Haptic_technology), etc.

Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special [stereoscopic displays](http://en.wikipedia.org/wiki/Stereoscopy), but some simulations include additional sensory information, such as sound through speakers or headphones. Some advanced, [haptic](http://en.wikipedia.org/wiki/Haptic_technology) systems now include tactile information, generally known as force feedback in medical, gaming and military applications. Furthermore, virtual reality covers remote communication environments which provide virtual presence of users with the concepts of [telepresence](http://en.wikipedia.org/wiki/Telepresence) and [telexistence](http://en.wikipedia.org/wiki/Telexistence) or a [virtual artifact](http://en.wikipedia.org/wiki/Virtual_artifact) (VA) either through the use of standard input devices such as a keyboard and mouse, or through [multimodal](http://en.wikipedia.org/wiki/Multimodal_interaction) devices such as a [wired glove](http://en.wikipedia.org/wiki/Wired_glove), the Polhemus, and [omnidirectional treadmills](http://en.wikipedia.org/wiki/Omnidirectional_treadmill). The simulated environment can be similar to the real world in order to create a [lifelike experience](http://en.wikipedia.org/wiki/Lifelike_experience)—for example, in simulations for pilot or combat training—or it can differ significantly from reality, such as in VR games. In practice, it is currently very difficult to create a high-fidelity virtual reality experience, because of technical limitations on processing power, image resolution, and communication bandwidth. However, the technology's proponents hope that such limitations will be overcome as processor, imaging, and data communication technologies become more powerful and cost-effective over time.

GAMES

A variety of [computer graphic](http://en.wikipedia.org/wiki/Computer_graphics) techniques have been used to display [video game](http://en.wikipedia.org/wiki/Video_game) content throughout the [history of video games](http://en.wikipedia.org/wiki/History_of_video_games). The predominance of individual techniques have evolved over time, primarily due to [hardware](http://en.wikipedia.org/wiki/Graphics_hardware) advances and restrictions such as the processing power of [central](http://en.wikipedia.org/wiki/Central_processing_unit) or [graphics processing units](http://en.wikipedia.org/wiki/Graphics_processing_unit).

Some of the earliest video games were **text games** or **text-based games** that used [text characters](http://en.wikipedia.org/wiki/Character_set) instead of [bitmapped](http://en.wikipedia.org/wiki/Bitmap) or [vector](http://en.wikipedia.org/wiki/Vector_game) graphics. Examples include [MUDs](http://en.wikipedia.org/wiki/MUD) (*Multi-User Dungeons*), where players could read or view depictions of rooms, objects, other players, and actions performed in the virtual world; and [roguelikes](http://en.wikipedia.org/wiki/Roguelike), a sub-genre of [role-playing video games](http://en.wikipedia.org/wiki/Role-playing_game_%28video_games%29) featuring many monsters, items, and environmental effects, as well as an emphasis on [randomization](http://en.wikipedia.org/wiki/Procedural_generation), replayability and [permanent death](http://en.wikipedia.org/wiki/Permanent_death)

**Vector game** can also refer to a [video game](http://en.wikipedia.org/wiki/Video_game) that uses a [vector graphics display](http://en.wikipedia.org/wiki/Vector_monitor) capable of projecting images using an electron beam to draw images instead of with [pixels](http://en.wikipedia.org/wiki/Pixel), much like a [laser show](http://en.wikipedia.org/wiki/Laser_lighting_display). Many early [arcade games](http://en.wikipedia.org/wiki/Arcade_games) used such displays, as they were capable of displaying more detailed images than [raster displays](http://en.wikipedia.org/wiki/Raster_graphics) on the hardware available at that time

In [computing](http://en.wikipedia.org/wiki/Computing), a **graphical user interface** (**GUI**,[[1]](http://en.wikipedia.org/wiki/Graphical_user_interface#cite_note-1) sometimes pronounced "gooey")[[2]](http://en.wikipedia.org/wiki/Graphical_user_interface#cite_note-2) is a type of [interface](http://en.wikipedia.org/wiki/User_interface) that allows [users](http://en.wikipedia.org/wiki/User_%28computing%29) to [interact with electronic devices](http://en.wikipedia.org/wiki/Human%E2%80%93computer_interaction) through graphical [icons](http://en.wikipedia.org/wiki/Icon_%28computing%29) and visual indicators such as [secondary notation](http://en.wikipedia.org/wiki/Secondary_notation), as opposed to [text-based interfaces](http://en.wikipedia.org/wiki/Text-based_user_interface), typed command labels or text navigation. GUIs were introduced in reaction to the perceived steep [learning curve](http://en.wikipedia.org/wiki/Learning_curve) of [command-line interfaces](http://en.wikipedia.org/wiki/Command-line_interface) (CLIs),[[3]](http://en.wikipedia.org/wiki/Graphical_user_interface#cite_note-computerhope.com-3)[[4][4]](http://en.wikipedia.org/wiki/Graphical_user_interface#cite_note-blogs.technet.com-4) which require commands to be typed on the [keyboard](http://en.wikipedia.org/wiki/Computer_keyboard).

**COMPUTER AIDED DESIGN**

A major use of computer graphics is in design processes, particularly for engineering and architectural systems. For some design applications; objects are first displayed in a wireframe outline form that shows the overall sham and internal features of objects.

Software packages for CAD applications typically provide the designer with a multi-window environment. Each window can show enlarged sections or different views of objects. Standard shapes for electrical, electronic, and logic circuits are often supplied by the design package. The connections between the components have been mad automatically.

* Animations are often used in CAD applications.
* Real-time animations using wire frame displays are useful for testing performance of a vehicle.
* Wire frame models allow the designer to see the interior parts of the vehicle during motion.
* When object designs are complete, realistic lighting models and surface rendering are applied.
* Manufacturing process of object can also be controlled through CAD.
* Interactive graphics methods are used to layout the buildings.
* Three-dimensional interior layouts and lighting also provided.
* With virtual-reality systems, the designers can go for a simulated walk inside the building.

**EDUCATION AND TRAINING**

* Computer-generated models of physical, financial and economic systems are often used as educational aids.
* For some training applications, special systems are designed.
* Eg. Training of ship captains, aircraft pilots etc.,
* Some simulators have no video screens, but most simulators provide graphics screen for visual operation. Some of them provide only the control panel.

**IMAGE PROCESSING**

* Computer graphics is used to create a picture.
* Image processing applies techniques to modify or interpret existing pictures.
* To apply image processing methods, the image must be digitized first.
* Medical applications also make extensive use of image processing techniques for picture enhancements, simulations of operations, etc.

**GRAPHICAL USER INTERFACE**

* Nowadays software packages provide graphics user interface (GUI) for the user to work easily.
* A major component in GUI is a window.
* Multiple windows can be opened at a time.
* To activate any one of the window, the user needs just to check on that window.
* Menus and icons are used for fast selection of processing operations.
* Icons are used as shortcut to perform functions. The advantages of icons are which takes less screen space.
* And some other interfaces like text box, buttons, and list are also used.

**Computer-Aided Design**

Computer-aided design (CAD) is the use of computer technology for the design of objects, real or virtual. The design of geometric models for object shapes, in particular, is often called computer-aided geometric design (CAGD).

CAD may be used to design curves and figures in two-dimensional ("2D") space; or curves, surfaces, or solids in three-dimensional ("3D") objects. CAD is also widely used to produce computer animation for special effects in movies, advertising, technical manuals.

CAD is used in the design of tools and machinery and in the drafting and design of all types of buildings, from small residential types (houses) to the largest commercial and industrial structures (hospitals and factories). CAD is mainly used for detailed engineering of 3D models and/or 2D drawings of physical components, but it is also used throughout the engineering process from conceptual design and layout of products, through strength and dynamic analysis of assemblies to definition of manufacturing methods of components. CAD has become an especially important technology within the scope of computer-aided technologies, with benefits such as lower product development costs and a greatly shortened design cycle. CAD enables designers to lay out and develop work on screen, print it out and save it for future editing, saving time on their drawings.

**Scientific Visualization**

Scientific visualization ia a branch of science, concerned with the visualization of three dimensional phenomena, such as architectural, meteorological, medical, biological systems. The emphasis is on realistic rendering of volumes, surfaces, illumination sources, and so forth, perhaps with a dynamic (time) component. Scientific visualization focuses on the use of computer graphics to create visual images which aid in understanding of complex, often massive numerical representation of scientific concepts or results.

**Virtual Reality**

Virtual reality (VR) is a technology which allows a user to interact with a computer-simulated environment. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special or stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Some advanced, haptic systems now include tactile information, generally known as force feedback, in medical and gaming applications. Users can interact with a virtual environment or a virtual artifact (VA) either through the use of standard input devices such as a keyboard and mouse, or through multimodal devices such as a wired glove, the Polhemus boom arm, and omnidirectional treadmill. The simulated environment can be similar to the real world, for example, simulations for pilot or combat training, or it can differ significantly from reality, as in VR games. In practice, it is currently very difficult to create a high-fidelity virtual reality experience, due largely to technical limitations on processing power, image resolution and communication bandwidth. However, those limitations are expected to eventually be overcome as processor, imaging and data communication technologies become more powerful and cost-effective over time.

Virtual Reality is often used to describe a wide variety of applications, commonly associated with its immersive, highly visual, 3D environments. The development of CAD software, graphics hardware acceleration, head mounted displays, database gloves and miniaturization have helped popularize the notion.

A **computer simulation** is a [simulation](http://en.wikipedia.org/wiki/Simulation), run on a single computer, or a network of computers, to reproduce behavior of a [system](http://en.wikipedia.org/wiki/System). The simulation uses an abstract [model](http://en.wikipedia.org/wiki/Model_%28abstract%29) (a **computer model**, or a **computational model**) to simulate the system. Computer simulations have become a useful part of [mathematical modeling](http://en.wikipedia.org/wiki/Mathematical_model) of many natural systems in [physics](http://en.wikipedia.org/wiki/Physics) ([computational physics](http://en.wikipedia.org/wiki/Computational_physics)), [astrophysics](http://en.wikipedia.org/wiki/Astrophysics), [chemistry](http://en.wikipedia.org/wiki/Chemistry) and [biology](http://en.wikipedia.org/wiki/Biology), human systems in [economics](http://en.wikipedia.org/wiki/Economics), [psychology](http://en.wikipedia.org/wiki/Psychology), [social science](http://en.wikipedia.org/wiki/Social_science), and [engineering](http://en.wikipedia.org/wiki/Engineering). Simulation of a system is represented as the running of the system's model. It can be used to explore and gain new insights into new [technology](http://en.wikipedia.org/wiki/Technology) and to estimate the performance of systems too complex for [analytical solutions](http://en.wikipedia.org/wiki/Analytical_solution).

**Aerospace Industry**

Aircraft designer use computers to simulate the airflow over the wings. The air patterns around the wings are displayed on the graphics monitor. The patterns of the shock waves around the aircraft give the designer an idea about the area that may create unwanted turbulence.

**Cartography**

Computer graphics is used to produce accurate and schematic representation of geographical and other natural phenomena from measurement data. Examples include ' geographic maps, relief maps, exploration maps for drilling and mining, oceanographic charts, a weather maps, contour maps and population density maps. Eg google map/google earth