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Design of Automotive engine components by cad software; Autodesk Inventor and Solidworks; a comparative study

Talal Ibrahem Almudhaf
Automotive section solidworks certified associate (CSWA)

ABSTRACT:
Technical drawing is the act and discipline of composing drawings that visually communicate how something functions or is constructed. The drafting process is largely accelerated through the use of CAD software. In this paper, I will compare between the most famous 3D Modelling CAD softwares. Regarding to the specific of the profile of students going through training, the selection of 3D CAD Software is reduced to the most usually used in this field: Autodesk Inventor and SolidWorks.
Inventor is a computer-modelling program from Autodesk that can be used to create 3D models parts. Inventor is one of the most popular programs for drafting three-dimensional design and it is commonly used in solid modeling like SolidWorks. SolidWorks is a computer-aided design (CAD) software which runs on Microsoft Windows. SolidWorks published by Dassault Systems. Both softwares appoints a parametric feature for model creation. It means designers create models using engineering shapes, such as cams, holes and slots more than using geometric terms.
Keywords: Automotive, Engine,Design, Autodesk Inventor, SolidWorks,2D, 3D, Modelling.

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I. INTRODUCTION

Computer Aided Design (CAD) is a program which helps users to create Stereolithographic (STL) files. It helps in designing, analyzing and optimizing 3D models. This software helps in designing ideas and visualizing the concepts through realistic renderings. They also imitate the showing of the design in the real world. SolidWorks and Inventor are famous software used in this research to design of required shape and dimensions.

1.1 History of CAD

In 1883 Charles Barbage developed an idea for the computer. The establishment of CAD returns to the early 1940s when the mathematical description of the curves was developed. In 1963, Ivan Sutherland developed the theoretical basis for CAD drawings in his doctorate. Thesis entitled "sketch pad" Showed that graphical entities can be interactively selected on a computer screen using a stylus (light pen). This was the beginning of interactive computer graphics in engineering where she gave birth to the development of techniques to perform images in digital form. During the seventeenth of the last century, commercial

applications of CAD started in 2D drafting. CAD of 2D drawing consists of arcs, lines and so on wireframe graphical models.

In 1964 the first commercial CAD system was produced by IBM. There have been many changes since then, with the advanced of powerful computers, it is possible now to do all sketches using CAD with 2D graphics, 3D modelling, complex engineering analysis, manufacturing and production. The New technologies are permanently created, making this process faster, more multilateral and powerful.

In the beginning of CAD innovating, its systems were run only on mainframes of computer systems Due to memory size requirements for figures, links, and storage of drawing entities. Improvements in the development of computers have made greater memory and greater capabilities possible, allowing CAD systems to upgrade from the mainframe to the microcomputer, then the workstations, desktops, and laptops. Three-dimensional wireframe models have advanced in the late 1960s. Although this has been remarkable advance in 2D CAD systems, it required many practical properties such as surfaces of solid and physical entities. So, three-dimensional surface modeling techniques shown up in the early 1970s. Surface models are basically wireframe models to be completed by encasement body faces, but hollow. The real objects are solid materials, although some may have bores. By the mid-1970s, CAD systems with solid modelling have appeared. The development of 3D solid model abilities brought the engineering analysis of graphical models to the computer screen as technical graphics. Higher processing speeds and smaller

sizes of computers with larger memories have made a strong configuration in CAD applications today. Parametric modeling based on parameters and features seems to be improved rapidly. The advancement of automatic technical drawing generation and dimension have improved rapidly.

1.2 Advantages of CAD

(1) Detailed drawings can be composed more quickly and making modifications so efficient more than modifying drawings manually.
(2) CAD allows many views of the same body and 3D graphic views, which grants the best Visualisation of sketches and drawings.
(3) Templates, symbols and designs can be stored for easy retrieval and reuse.
(4) More accurate drawings by using the computer.
(5) Drawings and sketches became more easily filed,
restored and transmitted on disks.
(6) Rapid Design Analysis, also testing and Simulation Possible.
(7)When we do the organ implant -In medicine field- the Volumetric imaging data is first processed and constructed to acquire the three-dimensional shape and size of the organ or site, which is then imported into CAD program like SolidWorks or Inventor to design the human organs implant.

II. INVENTOR:

After AutoCAD and MDT, the American company Autodesk introduced Inventor, a three-dimensional solid simulation software with 17 core patents in 1999. It has intelligent help, a simple and intuitive design environment, rapid assembly display, adaptive assembly, and assistance. Collaborative design, easy to learn and easy to use, etc., have been favored by the majority of engineering designers. Inventor is mainly composed of parts modeling, component assembly, sheet metal, welding, view expression, and engineering drawings. It is a relatively complete and interrelated 3D design system. Inventor integrates the advantages of parametric and variable technology, innovatively proposes adaptive technology, and builds adaptive components based on adaptive technology to overcome the shortcomings of poor variability of other purely parameterized 3D solid simulation software. It can be said that the adaptive technology is a new breakthrough in the field of CAD since the birth of parametric feature modeling technology.

2.1 Learning curve rate / Ease of use

Bachelors of the Faculties of Mechanical Engineering had some training in Inventor. Inventor is considerably more ganglion - Unlike SolidWorks - and 40 hours studying is necessary to complete 2D drawing, and 30 hours training to complete 3D drawing. This reveal those 50 hours of practice are necessary; starting with 2D first before 3D modeling. Among the trained students, we have students with previous experience in using Inventor. Interestingly, students without more experience mastered the program faster than students with previous practical experience.

2.2 Inventor Features:

Application of Inventor in the teaching of points, lines, and areas Just like learning phonetic symbols and letters first when learning English, mastering the projection of points, lines, and areas is the basis and prerequisite for learning the subsequent content of engineering graphics. The projection rules of various position points, lines, and surfaces and their relative positional relationships are the focus and difficulty of this part of the teaching. You can make full use of the parameterization function of Inventor software to make models. You can get Stereoscopic views of various position points, lines, and surfaces, and their associated projections, for students to observe visually and visually, and to accelerate the understanding and mastery of projection laws. The methods used in the model making process are: ① using the automatic projection of the space object on each projection surface to achieve the association between the object and its projection; ② using the derivative and size parameter references to achieve the association with the stereogram; ③ using multiple document windows to achieve You can observe the change of the projected unfolded image in real time with the spatial position of the object. Taking the straight line model established in Figure 1 as an example, this model can be used to: ① Adjust the coordinate values of points A and B at the two ends of the straight line in the fx parameter table (such as Xa, Ya, Za and Xb, Yb, Zb), you can get the stereograms and projections of straight lines at various positions; ② By referencing the coordinate parameters in the stereograms to the projection unfolding diagram, the projected unfolding diagrams can be updated in association with the stereogram; ③ By changing the projection plane, spatial straight lines, and The color characteristics of the projection make the whole model image realistic.

III. SOLIDWORKS:

SolidWorks founded in the late of nineteenth of the last century by Jon Hirschtick who spent the $1 million he made when he was a member of the MIT Blackjack Team to establish

the company. Hirschtick then enroll a team of designers and engineers who shove off with the aim of creating three-dimensional CAD software. It was designed to be affordable, accessible and workable on Windows. Later on, SolidWorks was released in November 1995. It was the first considerable modeller for Windows. This considered to be an enormous step in the posterior evolution of CAD. In spite of Inventor had been released earlier, SolidWorks create something new to the board—3D modelling. Thus, 3D CAD became the Corner stone of the 1990s. During months, SolidWorks developed the way engineers brought their creations to life.

3.1 Learning curve rate / Ease of use

Students classify SolidWorks as easy to use, which was harmonious for adopting from both 2D and 3D CAD. A higher level of satisfaction and Greater ease-of-use are illustrative of more powerful a software design tool. Students were also able to create and manage larger and more complex projects with increased confidence as much time as needed for a smaller project in their previous systems. They were able to design products as easily as they had imagined, while before designs were compromised because of the CAD system. They were also able to produce useful graphics within two weeks. All changes are instantly reflected in the parts and assemblies.

3.2 SolidWorks Features:

SolidWorks program supports the import of data in the DWG and DXF formats addition to Inventor blocks, facilitating the creation of 3D models from 2D data. SolidWorks has adorable tools to hasten design and build 3D models including a tool called Design Clipart that lets you to drop and drag drawing views from DWG files into SolidWorks software models, and another operation called View Follding can help for automate the building of a 3D model by control and manipulating the views of imported 2D drawing. As well as, SolidWorks supports the import of 2D ―blocks‖ from Inventor as the basis for sketching new 3D features in SolidWorks program. 3D CAD functionality is known for SolidWorks, SolidWorks also helps designers to sketch 2D accurately. SolidWorks models In fact, typically start life as 2D drawings and sketches. Then, users can extrude their products into 3D using a number of available stuff and tools. SolidWorks has aimed to be more than a simple drafting application. As mentioned before, the software has included simulation tools, allowing designers to test their parts by simulating conditions of real world. Those tools contain computational (calculations) fluid dynamics (CFD) tools, the ability to imitate and simulate heat transfer, fluid flux, and fluid forces, and life cycle assessment (LCA) countenances and features. Besides, the software includes robust rendering features, which help users to see realistic photos of the parts they inspire; we will show the reality for both software at the comparison part of that thesis. SolidWorks has other tools represent extensive arsenal include Product data management (PDM) packages, and a range of electrical solutions that make it simple to create schematics and circuit data accurately. With such a wide range of different countenances, it leads to know that SolidWorks has designers and users across numerous and abundant industries. At first, this includes a numerous of businesses in commercial industries that depend on SolidWorks for their daily operations. Here, Key sectors include automotive industries and the aerospace, including major clients such as ―The National Railroad Passenger Corporation‖ (Amtrak) and ―British multinational defence, security and aerospace company‖ BAE Systems.

SolidWorks uses both traditional industries, such as construction, oil and gas, and emerging sectors, including robotics and alternative energy. With too much on offer, a range of SolidWorks packages are available to meet diversity of industry requirement, there are little of the bundled features for each version of SolidWorks:

1. 3D CAD: theclassic solid modelling program that allows designers to inspire and createparts rapidly, drawings and assemblies.
2. Simulation: a wide range of options for designers who looking to build products faster with less waste.
3. PDM: to enable teams to cooperate more effectively when creating new parts; to help all members to access securely to documents and files.
4. CAM (Computer-aided manufacturing): This is resolution for any work looking to merge design and manufacturing processes.
5. Electrical Design: where packages that make it fast to create electrical plans and schematics and combine them within mechanical designs and three dimensional modelsall while decreasing the need for physical modelling and prototyping.
6. Visualization: originate photos of projects which realistic, comprising both static and animated or moveable content.
7. 3D Experience: work with teamwork in a cooperative milieu to build new parts.

IV. CRITERIA FOR COMPARING AND CONTRASTING BOTH APPLICATIONS:

As discussed before, these comparing will be done with the usage of certain parameters or standards to create clear pathways which will make

understanding what each program application has to offer. Here are the chosen criteria:

1. Industry: It is very important to use the specific industry of CAD software, due to the fact that CAD applications are usually developed with some industries in mind.
2. File types: Various file types that the application supports are also a standard that should be considered if the user intends to use CAD mercantile. This is because the user may be asked to send projects in specific formats to different clients.
3. Functionality: Where, different types of tools and features used in drawing and modeling will be debated in conjunction with the way that the task is made simple for designers. Those standards will go in depth to cover all the features of both CAD applications such as architectonic features, electrical design and modeling.
4. Learning curve: To learn how to apply CAD couldn't be seen as an easy task, but features embedded in specific design applications make this mission too hard. This standard will try to cover learning curves related to each.

4.1 Comparing Inventor and SolidWorks

First, the comparison will explain the general characteristics of each of the applications using our criteria.

A. Industry

SolidWorks and Inventor have many likeness and industrial sectors are applied for each. Inventor is mostly built for construction and architectural design but its 3D modeling capacities also make it a perfect tool for engineering design. SolidWorks also does these roles and it can be used to design 2D architectonic designs and other construction projects and drafts while using 3D modeling in the engineering society to design three-dimensional mechanical parts. Finally, all CAD software can be used by almost anyone to draft or use public characters.

B. File Types

Autodesk constantly at the top of the pyramid design for decades will be valuable when saving files. Inventor DWG and Inventor DXF formats have been used as an industrial location for standard industrial file types, but both SolidWorks and Inventor support the use of various file types on their interface. These file types include: DWG, DWF, DWT, DWS, DXF, SAT, PLT.

C. Functionality

As mentioned before, CAD software are perfect tools for creating two-dimensional creating and drawing 3D models. Those CAD software applications are engineering tools for driving and come equipped with a variety of tools to accomplish design tasks. User interfaces from both applications are also very axiomatic and are simply created for basic design tasks for designers. The use of customizable command lines and shortcuts as auxiliary tools is another likeness that is shared together because they are designed for axiomatic task. The function of customizable command lines and shortcuts as auxiliary tools is another similarity that is shared together because they are designed for axiomatic work. Inventor and SolidWorks, used to assemble parts, simulate designs, estimate costs, and provide authentication and presentation models based on what the user wants to achieve. Finally, capabilities of cloud storage are combined into both software to help designers to save and share drawings easily.

D. Learning Curve

The learning process associated with each CAD application cannot simply be compared to how well a person can draw on each platform, but how easy it is to use these programs to handle hard tasks or projects. In this context, the learning curve liege the accuracy of two-dimensional graphics using either Inventor or SolidWorks is very sharp for first-time users, but it is very easy for everyone with some computer-aided design expertise. This is certainly the most important way both applications are similar and can be said that have the ability to create similar design projects. It was said that the differences between each of the software applications are what makes them all prominent and those Differentiated features must play a more effective role in the user's choice of design software when choosing.

4.2 Contrasting Inventor and SolidWorks:

A. Industry

Even if program can generally be used as design applications in many industries, the truth still stays that both software have been improved for some industry sectors. For Inventor; construction, architectonic design, automotive industries, and education are unrivaled developed and employed to serve it; it comes withcomprehensive features to support design projects which mentioned above. Furthermore, for a larger number of users , SolidWorks is designed , and can be reversed through the drawing , drafting and modeling countenance that the user shall find on his interface . Local métiers include use : aviation, rapid prototyping, computer design, electronics, biomedicine, energy, and technology building.

B. File Types

As noted and mentioned before, Autodesk products have determined the speed of using DXF and DWG files in CAD, but with the emergence of different software of design applications that showcase their file formats, the value of an interface that supports the use of each type of file is important for users. So, for Inventor, it supports the following files: ACIS SAT, ACIS, HOOPS META FILE, HPGL / PLT, JPEG, IGS, IGES, Parasolid, XT, PROE, PDF, STL, STEP.

While, the various file types that support SolidWorks are very bounded, where Inventor already employs most of the files it prop. About file support, SolidWorks works with the most common files which most CAD applications and includes: PDF, DWG, DXF, and SLD. For that, Inventor considered to be in the front where the user can import the designs, regardless of their formatting in their worksheet, to save or edit in a different format.

C. Functionality

Although both applications share many similarities in many aspects, some major differences are common. SolidWorks and Inventor have a lot of variances that will be shown in details here because the ability of CAD applications to work is the most significant part of their employ. Cooperation aspects: Inventor is accommodated to support the conversion of 2D drafts into 3D models, while SolidWorks does not have the ability to handle the file conversion. And so, while models of Inventor can be used with a 3D printer conjunctionally, models of SolidWorks are commonly loaded into a sectioning program before being used in 3D printing.Advanced Profiles of Modeling: It is important to remember that Inventor is basically a two- dimensional drawing application unlike SolidWorks Before discuss in depth the contrast features between both software. So, SolidWorks came with many advanced aspects and features that make 3D modeling easy and simplified for each user of CAD.Some of the advanced features of SolidWorks include: the ability to create organic shapes, flat surfaces, the creation of radiation-free surfaces, healing or coherent models, facial replacement, stylize shapes, surface filling and conduction analyze; thickness analysis; symmetry analysis; Gaussian analysis, gradient and many more advanced functions. Furthermore, Inventor is not prepared to deal with these creations or analyzes, but for those seeking for an Autodesk product it can be a look at the Inventor is worth it. Architectural Profiles and Features: On the one hand, architectural draft features contained in both programs, is the case of the opposite of what happened in the "argument on advanced modeling features". Inventor is mostly an architectonic design program whereas SolidWorks is not; it is tied up with extensive aspects and features to deal with such layouts.

Through Inventor, layouts and designs involving landscape, alignment of walls and stairs, merging survey design and results of doors, walls, and windows into floor layout can be easily achieved. On the other hand, while SolidWorks can be used to design building components and structures, they do not come with tools for drafting and documenting basic architectural structures. Characteristics of electrical design: Designers also benefit from CAD to draft more advanced schematics, electrical systems and circuits as analyze how they work finally. SolidWorks was fully stuffed to handle electrical design tasks whereas Inventor is very finite in this denomination. Design of Sheet Metal: working on Metal projects depends to a certain extent of CAD. This is due to the fact that CAD provides realistic simulation tools and tools help users to draw layouts for the situation and also experiment with new connotations. For SolidWorks, infer bending allowance can be calculated, handle placement sketches, flat display switches, use modulation tools, bend tables, weld table also. When working with metal sheeting and structure.

Inventor unfortunately lacks all of these aspects because of its status only. Therefore, another look at Inventor should be seen as an option for Autodesk to deal with metal work, those hell bent on endure with their Inventor expertise.

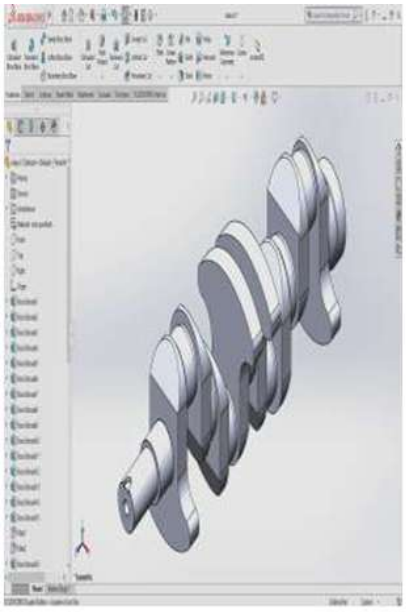
D. Learning Curve

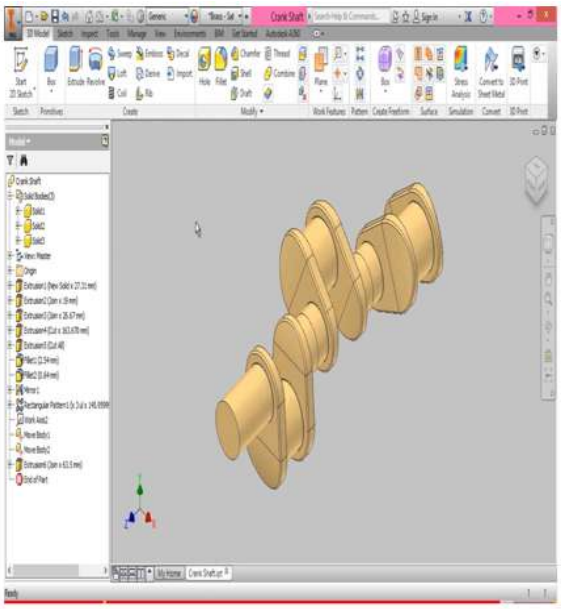
We have discussed-previously- the likeness between the ease of use associated with each application. With regard to the disparities between the learning curve, it is important to distinguish that SolidWorks comes with both integrated training features and training programs that help us easily identify the use of its own interface as a modeling workspace and layouts. Inventor also comes with training programs, without training features incorporated with workspace. Although, this does not make obstruction for students' training. There are many online materials to help us find way around Inventor to learn the perfect places to take advantage of the comprehensive features.Finally, cost aspects of both CAD program wouldn't considered to be cheap, both costing over $ 1,000, making it hard for the many student to obtain. Autodesk and Dassault, Understanding these difficulties, have made "educational version" for teachers and "student versions" for student of all their CAD software free of charge for registered

teachers and students who are looking for an advanced software application to work with.

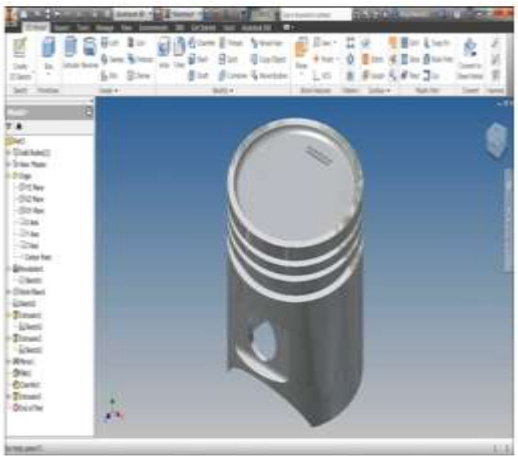
4.3 Application of the softwares in Reality:

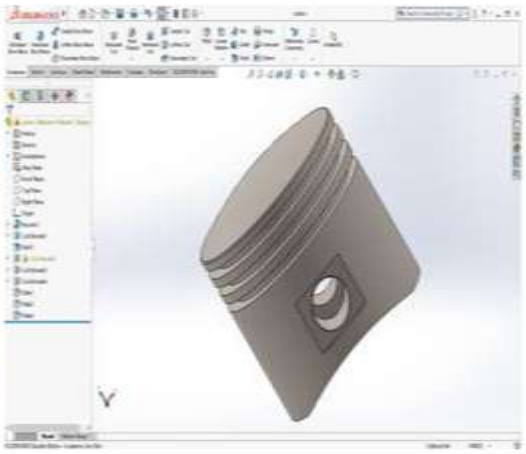
There are some differences in reality between Inventor and SolidWorks, in the next pages some Drafts for Automotive parts done by the researcher with both Programs show those differences.



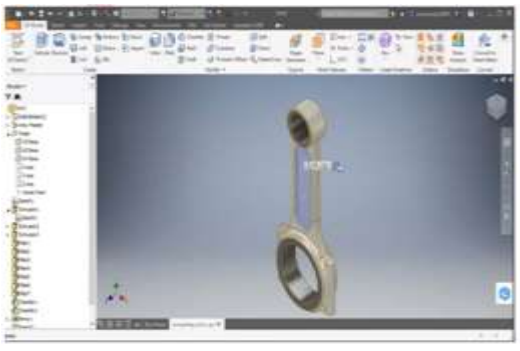


(1) Screenshot of Designing Crankshaft by SolidWorks. (2) Screenshot of Designing Crankshaft by Inventor.





(3) Screenshot of Designing Piston by Inventor. (4) Screenshot of Designing Piston by SolidWorks.



(5) Screenshot of Designing connecting rod by Inventor. (6) Screenshot of connecting rodbySolidWorks.

V. CONCLUSIONS

Finally, the thesis put the next table to conclude the comparisons between the twosoftwares:

	SolidWorks	**Autodesk Inventor**
1	3D solid modeling	3D solid modeling
2	Windows only	Windows and Mac (on a Windows partition)
3	User-friendly—can be picked up quickly	Has a much steeper learning curve
4	Perceptual license or subscription basis	Monthly/1 year/3 year subscription basis
5	No student licenses	Free Autodesk Inventor licensing for students
6	Predominantly used in aerospace, automotives, construction, consumer product industries	Used in engineering automotive and construction industries
7	Not suitable for architecture	Has the option to export to Revit to make architectural drawings.
8	Large online community, complete with tutorials and resources.	Smaller online presence—with tutorials and resources—which can hinder learning.
9	Comes with sheet metal design tools	Has specialist tools like electrical harnessing.
10	Integrated CAM process	Printed circuit board interoperability.
11	Collaborate on designs with the 3DEXPERIENCE platform	View designs online with Autodesk Viewer.

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