

DEVELOPING 3D AWARENESS WHEN TEACHING TECHNICAL DRAFTING

Abstract: This paper details a new method of developing 3D awareness when teaching technical drafting. The latest advancements in technology allow us to develop 3D parts in a virtual environment relatively easy. Allowing students to see the 2D part they are drawing in a 3D presentation may allow them to better understand the concepts of spatiality and planes of view.

Keywords: engineering graphics education, spatial perception, technical drafting, 3D modeling.

1. INTRODUCTION

Technical drafting has evolved over the years implementing new technologies into developing new shapes and improving existing engineering concepts. The international language of engineers has seen a large boost with the latest advances in computer science with the invention and continuous improvement of computer aided design and CAX technologies.

In recent years had there not been a bigger problem in teaching technical drafting then trying to develop a 3D visualization of a 2D part drawing in the minds of students. Various instruments have been used throughout time like bringing the part to be drawn in the classroom or making mockups of assemblies for ease of spatial comprehension of the respective part.

2. INTRODUCING 3D PARTS THROUGH PDF DOCUMENTS

Dassault Systèmes and also Autodesk, the company behind AutoCAD and Inventor, has implemented an option to allow developers to easily share their work with their clients without the need for the clients to have Autodesk software installed on their computers.

This very option could help teachers a lot when teaching traditional technical drafting to students by giving them access to 3D models of the parts they are working on so that they could better understand the shapes and how rules apply in technical drafting.

When it comes to drafting, schools may not be able to give every individual student physical parts to study at home but they are now able to give them access to 3D models and they can study them at their discretion.

Teachers may now model 3D parts for their students as simple or as complex as they want at no extra cost.

3. HOW TO APPLY THE 3D PDF METHOD

The process is easy and straightforward so long as the teacher masters a software package that can export to 3D PDF.

Furthermore, the teaching method is useful for students, not only in the first year of study but also for the following years when they will actually learn about computer aided design.

The basic steps to giving students access to parts is as follows:

- Design the part in Inventor or other software package;
- Export it as 3D pdf;
- Send the pdf to the students.

By doing so the student is able to open the part in a simple pdf interface using an application he already has installed on his computer for other school work.

To start off we provided the students with the following simple (Figure 1) part in order for them to study it and determine its shape and component geometry.

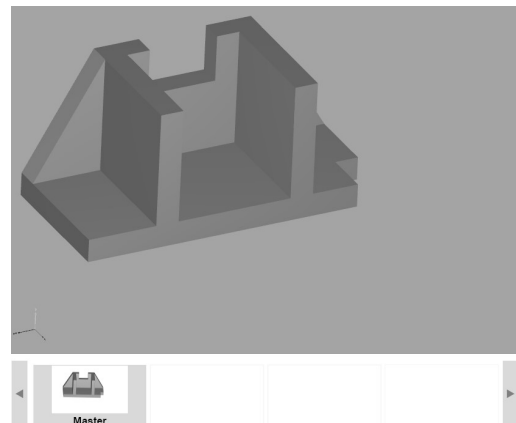


Fig. 1 Simple part in 3D pdf format.

After being given this part prior to the lab they had to draw the main projection on a classical A3 format sheet during the lab. They were given explanations on how the drawing is done and shown an example at the blackboard (Figure 2).

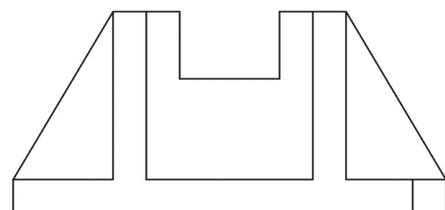


Fig. 2 Drafting example of the main projection for a simple part[1].

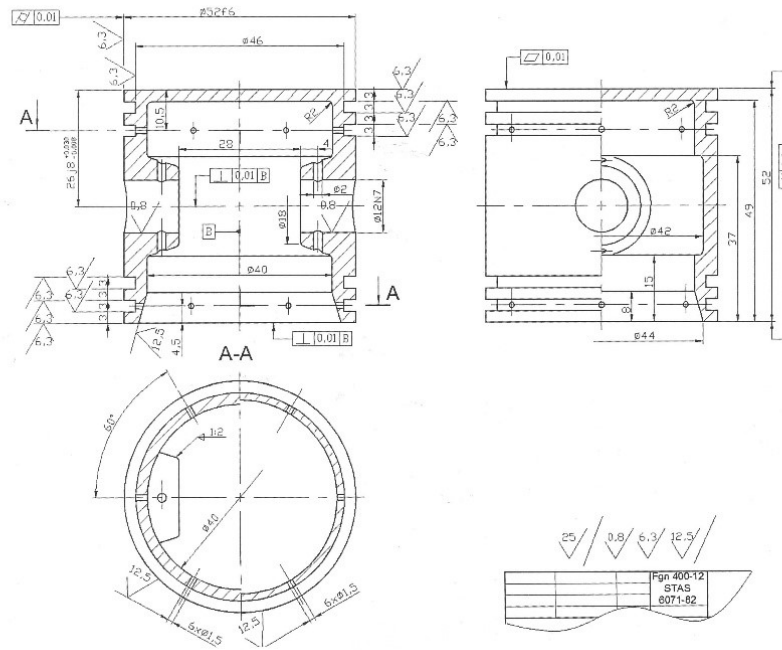


Fig. 3 Piston in a triple orthogonal projection [2].

The drawing above (Figure 3) depicts a technical representation of a piston in a traditional manner. This is the drawing that the students are expected to do in a lab session as first year undergraduate students in an engineering degree.

Below is a 3D modelled piston that was exported from Inventor .ipt format to 3D pdf format (Figures 4 and 5) to be given to students.

The student is able to rotate the part and see all shapes in detail. They can zoom and pan through the part and examine it from different angles as if they had it in a physical format.

When it comes to sections that student has an option to see the sectioned part as it is in real life if the teacher provides a sectioned part in the same document as is in this case where we can see at the lower part of the figures where students can toggle between normal and sectioned view.



Fig. 4 3D pdf of piston.



Fig. 5 3D pdf section view of piston.

4. HOW TO EXPORT TO THE 3D PDF FORMAT

In order to create the 3D pdf the teacher has to model the part and afterwards needs to follow these steps to export the file to 3D pdf[3]:

- In an assembly or part file, click File ► Export ► 3D PDF fig. 6;
- In the Publish 3D PDF dialog box, select model properties to include in the 3D PDF. fig. 7;
- Select design view representations of the model to include in the 3D PDF. fig. 8;
- Set the Visualization Quality. Visualization Quality controls quality of mesh used to display model views in the output 3D PDF file. fig. 9;
- If appropriate, change the 3D PDF template file.fig. 10;
- Click Publish;

- Repeat process for multiple parts.

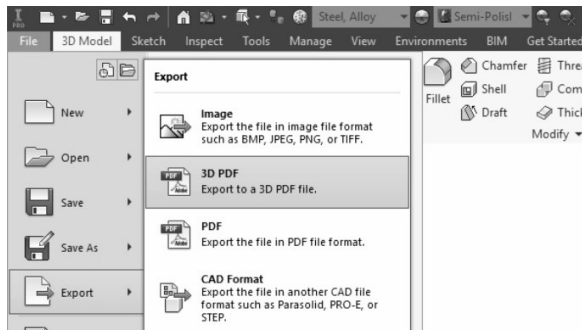


Fig. 6 Step 1 export as 3D pdf in Autodesk Inventor.

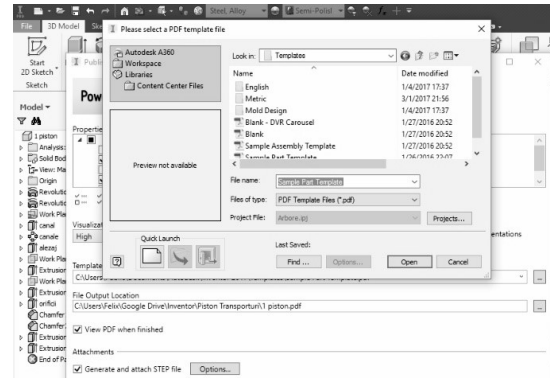


Fig. 10 Selecting a template.

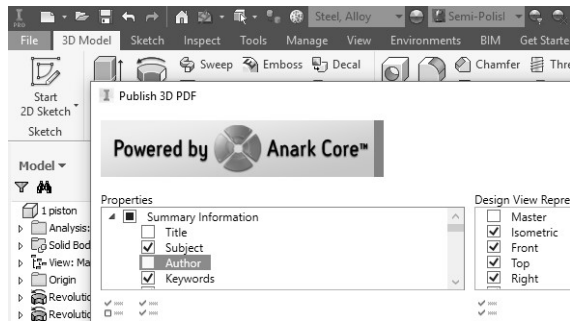


Fig. 8 Step 3 Selecting the design view.

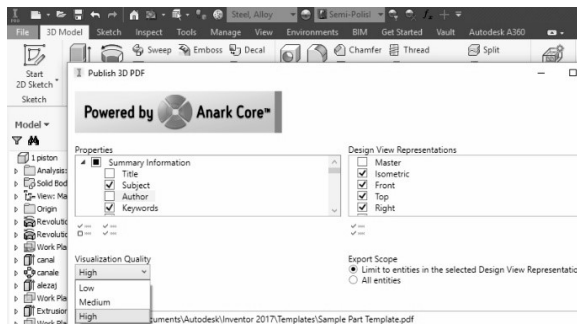


Fig. 9 Step 4 set the visualization quality.

As best practice, it is better to change the background color to white as some students may feel the need to print the 3D model and keep it in a paper format in different angles, if the model is of a dark material on a dark background the students may find it hard to use the educational instrument and find it useless as they can't see everything.

The method is a team effort so both teacher and student must try their best to work with the new technique so that the desired effect is achieved.

The next table, displaying the steps that need to be taken for the technique to work, is as seen below and made in respect to both what is needed to be done by teacher and student (Table 1).

Some students may find the 3D part useful and use the 3D pdf while others may be reluctant and try to avoid it especially if the number of steps to use it is too big.

Table 1
Tasks to be done by teacher and student in order for the method to have the best results

No.	Teacher	Student
1.	Designs part	Pan
2.	Exports as 3D PDF	Zoom in to see details
3.	Provides PDF to students	Rotate to see the part on all sides
4.	Evaluates results of method	Cycle through views

The 3D pdf even allows for a standard STEP file to be attached to it and can be opened in a 3D modeling environment if the student desires to add to it or modify the part. This is useful when the teacher wants to provide an option for the student to edit the part but does not need to model the part in the same program that the student uses to open it.

Downsides

Among its many upsides we have determined a few disadvantages to the method in question. The application has its limitations such as

- Not being able to display more than one section plane at a time;
- Some renders are a bit off from the original 3D model;
- Mobile access is not fully available; in some cases the file opens but displays nothing

There is a continuous interest in this kind of technology and efforts are made to improve it in the foreseeable future.

5. CASE STUDY: RATE OF RESPONSE TO THE TEACHING METHOD

We have started using this method in the classroom for a group of undergraduate students in the first year at engineering school.

The first part was very simple and had only basic shapes as is the part in figure 2 in the form displayed in figure 1.

As they finished the part we started giving them more complex geometry leading to full parts like the piston in figure 3 in the form shown in figure 4 and 5.

Before each lab, the students received the 3D modelled parts via email and were encouraged to study the shapes that form the part.

Students that were taught using this method have responded in different ways in the classroom and as expected some had problems with opening the documents while others were indifferent to the whole idea.

Most of them liked this method and said they wouldn't have really grasped the situation if it wasn't for the 3D models that they received for the lab beforehand.

The students' response rates are presented in table 2 and illustrated as a chart in figure 11.

As time passes we intend to use this method more especially with parts that we don't have physically in the lab but can model in 3D based on drawings or measurements done in the field.

Table 2

Rate of response from the students		
No	Result	Amount
1	Satisfied	50%
2	Whatever	30%
3	Unable to use	20%
4	Unsatisfied	0%

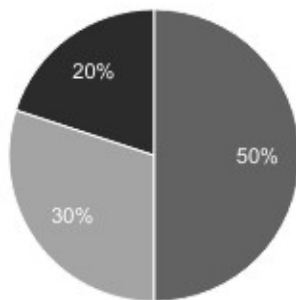


Fig. 11 Response to teaching method [4].

6. CONCLUSION

Using this teaching technique and providing access to 3D models for students when learning about traditional technical drafting is a great way to enhance development of students' perception of 3D space and spatial awareness.

Teachers can offer students more examples of part design by providing them access to a larger number of parts that can be presented to them on their own time and thus have a bigger knowledge base to aid them in future projects.

The complexity of the drawings can go far beyond what is available in the lab and can incorporate both renders from drawings found in books and from measurements on parts done in the field.

Simplifying the method to a few steps goes towards a better response rate. The students adopt the method and use it more.

REFERENCES

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- [4] Office support website support.office.com

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