Design and Production of a Help Tool for Quick, Easy and Innovative Prototyping

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Abstract: This paper describes a new tool developed in the IPSI laboratory (ENP of Oran) named (3 In 1). The latter was adopted as a powerful, easy and innovative tool and made available to the designer more features. Our rapid prototyping tool, which from a Computer-Aided Design file, corresponding to an object, allows you to quickly and easily visualize and generate a physical part on one of the lab printers. The validation was successfully completed .what makes (3 In 1) the first universal tool used ,aims to improve the field of prototyping in Algeria based on 3D printers available in the lab and trying to pass creative ideas, imaginary to the real realization. In the context of the globalization of increasingly competitive markets and increasing reactivity on the part of companies, a company wishing to maintain and / or acquire new market shares must ; control costs ; improve product and study quality ; reduce development time (design and delivery) .To meet these critical success criteria, companies need to adapt their design process and al so take into account the emergence of new technologies. In this way, it becomes crucial for companies to have the tools to quickly materialize the products under development, in order to facilitate the design and realization of all the different technical solutions chosen. This is the area of rapid prototyping research at the IPSI Laboratory.

Keywords: CAD, Prototyping, Technology, Rapid prototyping

Introduction and the Origin of Rapid Prototyping

Rapid prototyping is a technique for making solid objects from a digital model. The first CNC (Computer Numerical Control) machines were built in the 1950s. These were mainly towers and milling machines, but they were intended for production, not for prototyping. As this type of machine evolved, the G-Code was invented in the 1960s: a standardized language for operating digital machines. This language will later be used with RepRaps (Rapid Prototyper Replication or Rapid Replication Designer). It is a team made up of Alain Le Méhauté (Alcatel), Olivier de Witte (Cilas) and Jean-Claude André CNRS (National Centre for Scientific Research) who patented the first 3D printing process in 1984 : stereolithography. Little convinced of the value of this technique Alcatel and Cilas will quickly abandon these patents. In the second half of the eighties appeared the first commercial stereo Lithography machine, the process was patented by Chuck Hull and disseminated by his company 3D Systems. It is a system of photo-polymerization of a resin using lasers. Unlike traditional machine tools, this type of machine constructs objects by adding matter and not by shrinkage (it is additive manufacturing).You can therefore make an object directly from a 3D model, without any concern for the path of the tool, without mold, and thus create (relatively) quickly complex shapes that are impossible to make otherwise.

The STL (Stereo Lithography) format is created for this purpose. It is a 3D file format that describes the surface of an object, and is currently the standard used in 3D printing.

At the same time, Stratasys filed a patent on the FDM (Fused Deposition Modeling) process, which consists of building an object from molten plastic and extruded in successive layers.

This process is used by a Rep Rap under the name of (FFF : Fuse Filament Fabrication). Since then, various other processes have emerged, such as SLS (Selective Laser Sintering), which consists of polymerizing a powder in successive layers with a laser, or SLA (Stereolithography Apparatus) using photo-polymerizing resin sensitive to ultrasound. All these systems used by companies remain rather expensive (in machines, as in consumables), and have therefore remained inaccessible to the general public. It was not until 2005 and the RepRap project hat this technology was widely disseminated

Definition of Rapid Prototyping

Rapid manufacturing, or rapid prototyping, is a combination of processes and technologies for manufacturing parts by removing or adding layer-by-layer material. However, there are several methods of rapid prototyping. From a computer-aided design (CAD) model, it is possible to realize all types of parts, especially those with complex architectures.

The work piece is produced by machining, depositing, polymerizing or melting successive layers of organic, mineral or metallic raw material. It is thus possible to produce parts in routine materials such as plastic, ceramic or metal.

Rapid prototyping incorporates three key concepts: time, cost and form complexity.
- **Time:** the objective of rapid prototyping is to quickly realize the models, in order to reduce the time of product development.
- **Cost:** rapid prototyping allows prototypes to be made without the need for expensive tools, while guaranteeing the performance of the final product. It is therefore possible to explore the different variants of the product underdevelopment in order to select the most appropriate solution.
- **Complexity of forms:** machines operating by adding matter are capable of making extremely complex forms (inclusion, cavity, torsion, etc.).., unachievable by processes such as machining for example.

3D printing

3D printing is an additive production technique developed for rapid prototyping. Its goal is to quickly and easily generate a physical part. Different materials can be used, more generally ABS plastic, PLA plastic, and metal, but also wax, or even plaster.

The applications of 3D printing are varied, but in all cases aim at the concrete visualization of projects, or checking of ergonomics of parts.

The general principle is quite similar to that of a conventional 2D printer, that is, from a model created on a computer and giving a physical, concrete representation of it. From a CAD file, 3D printing allows the user to produce a part (through a software that cuts it into slices) by depositing or solidifying the material layer by layer, which makes it possible to obtain a physical part in 3D. The printing time, which varies depending on the volume of the work piece and the printing speeds, is a few hours.

The operation of the 3D printer

From the beginning, 3D printing can seem very complicated. But when you're experienced enough, it's all the easier to assemble parts mechanically. First of all, it is necessary to understand the principle of identical operation for any type of printer. This principle consists in creating, step by step, an object as if one were building a building with several floors. This principle is more commonly known as " layer by layer ".3 D printing consists of the deposition of molten material, selective laser filtering which will allow the object to be assembled and finally the solidification of the material thanks to UV lights.

To achieve this objective, the first step is to model the object to be realized on a CAD tool. This CAD tool is a software program that will make it possible to materialize the object in a printable format. A final step will be to transfer the file to the printer and promote its materialization. File transfer can be done in several ways: Wi-Fi, Bluetooth, or USB if necessary. Once the transfer is complete, the creation process can be initiated.

The press suite is taken care of by the machine itself. It is responsible for super imposing several layers of the material used until the desired result is achieved.

Les outils utilisés : (Logiciel CAD-Slic3r-G. code-Arduino)

Our 3D printer will be driven by several free software programs, capable of printing parts based on PLA and ABS wire coils. In what follows, We will present the various tools that we needed to use and their functionalities from the creation to the actual impression of apiece.
For this, we will use the following tools:

CAD software

A 3D CAD software, which will allow us to make the desired part in 3D and then save it in STL format for use afterwards.

STL

Short for Stereolythography, a 3D file format used for printing and working with most 3D modeling or printing software.

Slic3r

This software allows to convert SLT file to G-code. The G-code is a text-based language that is generated on the basis of a 3D model. These instructions are sent to our printer who will interpret these lines and execute them. The G-code instructions program by the coordinates X, Y and Z. These are points in the 3D space that the print head will move with some advance that will be adjustable.

Slic3r al so cuts the model into horizontal slices to calculate the amount of material to be extruded.

G-Code

Code used by most digital machines that gives the instructions they need to use (coordinates, travel speeds, tool parameters,..).

Operation of the application (3 In 1)

The use of the software (3 In 1) is to view the parts, generate the Rolling G-code and print with the 3D machine. It is a simple and efficient interface which facilitates USB connection to the 3D printer. This part is devoted to the design and realization of our work, thatis, the implementation of a rapid product development process. To do this, we will introduce and make available to the IPSI (ENPO) (a 3in1 software) of rapid prototyping.

Rapid prototyping techniques, which rapidly lead to design validation models, make a major contribution to mechanical production. Because of this, our goal is to improve these techniques by developing an application that will allow many users to view and print files from 3D modeling.
We will start with the presentation of the *functioning of the application*
Figure 1 represents the main interface of our application , it contains design tools, prototyping, help and a work history.
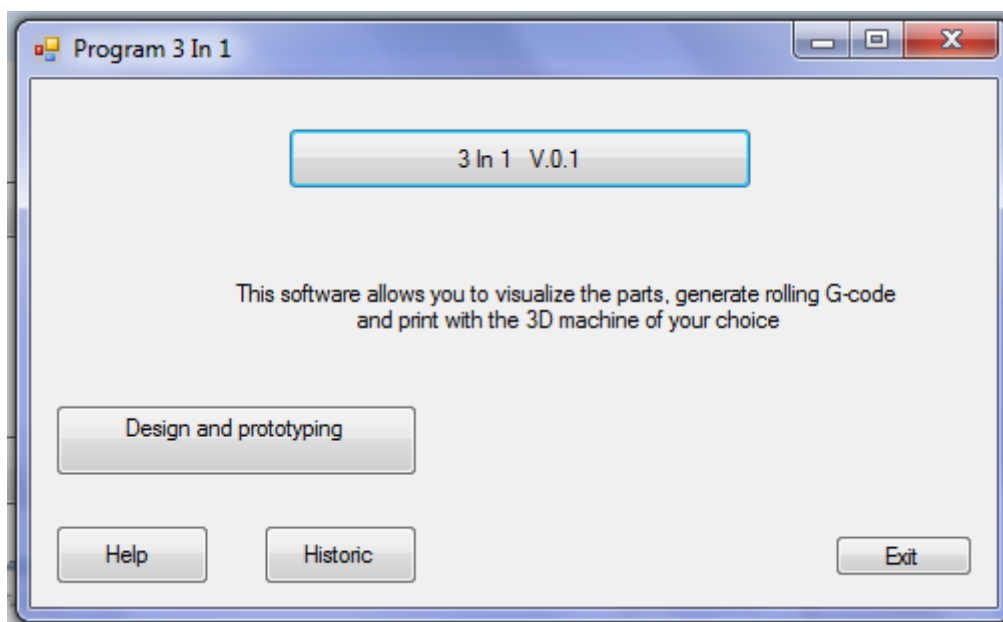
Figure 1. The main interface of the project 3 In 1

We can use our Software (3 In 1) to print our models and we will see that it is graphically more user friendly and offers more control options with visualization of formats STL and G-code.

- Open the file first .STL on the main software interface (3 In 1) by clicking on the ***design and prototyping*** button in Figure 1, we obtain the ***interface 2*** (See Figure 2).
- For this ***interface 2*** (figure2), it was preferred to set up a single window, making it easier for the user to follow the Three steps recommended for carrying out his work.
- The first step, we will see that we can select the settings and saved profiles that we would like for printing by clicking on the button ***open the DAO file***
- The second step, choosing the printer by clicking on the ***Choose 3D printer button.***
- The third step after selecting the STL file and selecting the printer, by clicking on the button ***g-code*** which will automatically generate the file g-code.
- Once we have a generated g-code format, we can print the piece we want by clicking on the ***print button***, this is the fourth step and the printer starts to print our work.
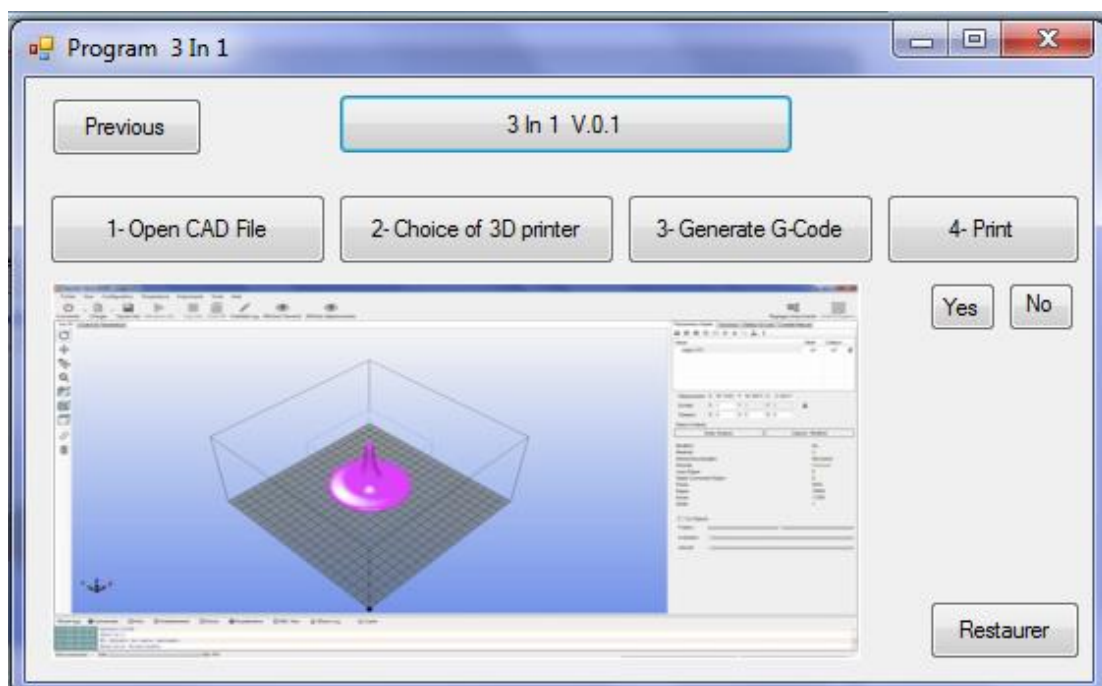

Figure 2. Design and prototyping Interface in step 3

The IPSI laboratory has solved one of the major problems for users, namely the import of files .STL, G-Code generation and direct printing of the part after choosing the 3D printer on the same software 3 In 1.

Conclusion and Outlook

Despite these seemingly temporary limitations, research is making great strides in the area of additive manufacturing, new materials, new models, new uses and new software ...etc. eachmonthbringsexcitingadvancesthatreallysuggestthatthistechnology (3D printing) can soon be used on a large scale.

Whether you are a designer or SME manager, a passionate amateur or an expert in CAD, 3D printing is a technique that is becoming impossible to do without.

A new generation of manufactured objects, designed by professional designers and made possible by end-user data, can be created: e-objects .These new digital objects, manufactured on demand with 3D printing technology, adapt to the needs of the end user and announce this wonderful world to suit every man, where mass production is giving way to mass customization.

Through this research work, we had the chance to discover this wonderful world of rapid prototyping and to make our contribution by developing and producing a tool (3in1) for end users, namely the researchers of the IPSI laboratory (ENP of Oran). An easy, simple and innovative tool, you just need to install the application (3en1) for more features, so this will give us the right to create, as we have the chance to challenge the prices of other parts that we will be able to buy from the Algerian market and reprint them using the imported printer, in order to reduce its price to 40% and to have an Algerian product that would give every Algerian customer the opportunity to benefit from the product exhibited and to increase the number of purchases, hence the interest to manufacture this type of machinery locally. Finally, as a major perspective for our work, we cite the realization of other Algerian products.

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