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A NEW CONCEPT STYLE PRINTER: SOLAR POWER PRINTING

Abstract: *When discussing a new product, it is essential to consider the needs and desires of the intended audience for the product design. As a result, engineering systems are constantly evolving to achieve a higher degree of ideality. The process of designing new products involves a continuous search for solutions and requires designers to uphold high standards in their thinking abilities. Design itself is a form of thinking and action that encompasses various activities, including visualization, creative thinking, user empathy, and reasoning from function to form. The objective of designing a new product is to comprehend and impact the world around us by creating products that fulfill people's needs and desires. The purpose of this article is to present an innovative design for a printer. Our contribution is to provide a brief overview of a uniquely designed solar printer. To accomplish the goals of this article, a thorough review of existing literature in the field was conducted. The primary aim of this research is to emphasize the significance of a printer that can be used throughout a lifetime.*

Key words: *Design, solar, innovation, new idea, printer.*

1. INTRODUCTION

The sun is the key to our lives, and a sunny day makes us all happier. It's also great for making a multitude of photographic prints [1, 2]. Over the years, many different approaches have been designed to harness the power of the sun to create prints, but none have been as complex as a system that can even print using sunlight [2-4]. Apparently, it's not just people who can tan. Paper is a material that can also be „tanned". The concept of this project is to propose a printer that can print on any paper by „tanning" them in the sun. More precisely, it can print using solar energy and refraction [2]. If you regularly use printers, you are likely familiar with how annoying they can be. Ink cartridges need to be replaced frequently and sometimes don't connect properly to the computer. Then there's the issue of noise and energy consumption, although it's not excessively high [5]. All these problems led us to think of a concept that would eliminate these inconveniences.

The design we have come up with is revolutionary and has a futuristic appearance. It incorporates several excellent features that make printing much more convenient [6]. This solar-powered printer uses the „tanning" process to print on paper instead of using ordinary ink cartridges [5]. By utilizing thermal energy from the sun, this compact printer can print on paper in an environmentally friendly manner. As long as the sun shines brightly, we anticipate that this printer will do its job. Additionally, using recycled paper could further enhance the sustainability of the entire solar-powered printing process [7].

The Solar Printer is a portable, solar-powered printer that doesn't require ink. This eliminates the need for an electrical connection, making it suitable for use in various locations, such as offices or cash machines [8-10]. Furthermore, since it doesn't use ink and relies on a solar-powered printing mechanism to burn the text onto the paper, there is no need to purchase ink cartridges, which significantly reduces the operating costs of the printer [9]. The „tanning" mechanism of this printer utilizes a refractive glass to capture sunlight and focus it on a thermal coil that prints the desired text onto the paper [10].

2. CONTEXT OF RESEARCH STUDY

Most of us tend to consider printed materials as having our own meaning, but imagine today's life if the printing press had never been invented [11]. We would not have books, magazines, or newspapers. Postcards, flyers, pamphlets, and posters would not exist. Printing allows us to share large amounts of information quickly and in large numbers [12]. In fact, it is so significant that it has come to be known as one of the most important inventions of our time. It has drastically changed the way society has evolved [10].

Printers are sold cheaply, as opposed to the price of the cartridges, which are very expensive. The business model of many printer companies is to sell printers at a low cost and then, with a captive client, sell the compatible ink cartridges at a high profit margin [11-12]. The printer acts almost as a loss leader for the profitable aspect of the business – selling ink and replacements.

Thus, the most important factor that led to the idea of the solar printer is the economic cost of ink used for printing [9]. A solar-powered printing mechanism that burns text on paper completely eliminates the need to purchase ink cartridges, which significantly reduces the cost of operating a printer [11].

The development of solar energy has reached a peak in which everyone recognizes its importance and functionality, bringing many benefits. However, until now, no one has heard of the use of solar energy in the case of a printer, particularly as a substitute for ink cartridges [9-12]. The idea we started with was to eliminate expensive technology and introduce a simple and easy-to-understand technology aimed at reducing the costs of production and resource utilization [11]. Therefore, instead of further developing printer

technology and ink cartridges, we have chosen to explore new technology that utilizes solar energy for both power generation and as a replacement material for ink [8].

3. BACKGROUND

Solar energy is radiant light charged by heat from the Sun, which is harnessed using a variety of technologies, including solar energy for electricity generation, solar thermal energy (such as solar water heating), and solar architecture [2]. It is a crucial source of renewable energy, and its technologies can be broadly categorized as active solar or passive solar, depending on how they capture, distribute, or convert solar energy [11-12].

Active solar techniques involve the use of photovoltaic systems, concentrated solar power, and solar water heating to harness energy [10]. Passive solar techniques, on the other hand, utilize strategies such as orienting buildings towards the Sun, selecting materials with favorable thermal mass or light scattering properties, and designing spaces that facilitate natural air circulation. While research in the field primarily focuses on the current applications of solar energy, specialized studies in this area can also serve as the foundation for the operational principles of the printer we have conceived [3] (Figure 1). Furthermore, the marketing of the product can drive research in the field towards broader advancements in this domain [2].

Printers fall under the category of output peripherals, designed to transfer computer information onto paper or other forms of physical media, such as documents, images, graphics files, emails, and articles. Printers can be classified based on various criteria, including their purpose (printing/imprinting), speed, printing process, maximum paper dimensions, and other factors [5-7].

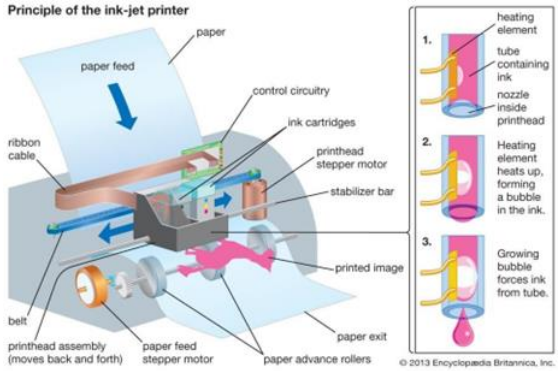

Figure 1 Principle of the ink-jet printer [3].

To reproduce text or illustrations, inkjet printers place very small ink droplets (with a diameter of 50-60 microns) on the page. Some inkjet printers can only print in black ink, while others can print in both black and colored ink, which are stored in cartridges [8]. Although inkjet printer cartridges need to be replaced periodically, inkjet printers are relatively inexpensive. Some inkjet printers can reproduce high-quality images and detailed illustrations [6].

Ottmar Mergenthaler's invention of the linotype machine in 1886 is considered the biggest advancement in printing since the development of movable type 400 years earlier [3].

4. THE PURPOSE OF OUR PRODUCT

The concept we started with is a simple one: solar energy, without harming the environment and without the need for adapters [6]. We have connected the requirements of regular commercial printer users to a portable and lightweight solution that can be easily transported to different locations. This solution eliminates the need for cables and dependence on electricity while also reducing the cost of ink used by printers. Additionally, it helps tackle environmental pollution caused by the consumption of cartridges [4].

5. PRODUCT PRESENTATION

Nowadays, black and white printing is used in a proportion of 80%, suggesting that we live 80% of our lives in black and white [11]. The concept behind the solar printer, SOLRUM, is to use the energy of nature to bring color into our lives. The idea is based on the principle of a paper burning experiment using a magnifying glass.

In this experiment, solar energy is stored through the light refractive process, which allows for „engraving" with thermal paper light [9]. The solar energy is utilized to operate the printer's components and power the battery, enabling the system to function independently even in the absence of light [11-12].

In the design of the final product, we have chosen to create two printer variants, both utilizing the same operating principle of solar power, without the need for ink or electricity consumption [9]. This printing mechanism uses a refractive glass to capture sunlight and focus it on a thermal coil, which prints the desired text on the paper. Additionally, both product variants are portable, providing significant ease of use [6].

The fact that the printer doesn't require ink cartridges and relies on a solar-powered printing mechanism eliminates the need to purchase ink cartridges, thereby significantly reducing operating costs. Consequently, ink cartridges no longer need to be frequently replaced, allowing for continuous use of the printer as solar energy doesn't incur any additional expenses [9].

In addition, it is known that a toner of ink is required to purify the residual ink from a cartridge. The indiscriminate printing we engage in today ultimately leads to environmental pollution [10]. Therefore, the elimination of ink-filled cartridges and their polluting components would help prevent continuous pollution of the environment we live in [12].

Both printers were modeled using the Autodesk Inventor Professional 2022 program, which is used to model the elements, subassemblies, and structures of this paper. The program offers multiple advantages, such as modeling areas with complex geometry, modeling of assemblies and component subassemblies, and the ability to verify the accuracy of models at relatively high speeds. Furthermore, this printer model variant also includes a digital dial for operating the printer, along

with Bluetooth specifications that allow control from a phone, computer, or laptop (Figure 2).

Figure 2 First model proposed of the ink-jet printer.

The first version of the SOLRUM PRINTER printer model is presented in Figure 3.

Figure 3 First model proposed of the ink-jet printer.

The difference between the two product models lies in the ergonomic form preferred by the customers. The first version of the Solrum Printer is equipped with a support for vertical positioning, which can be folded to enable horizontal printing on a support surface [3]. The second version of the SOLRUM PRINTER printer model is shown in Figure 4.

Figure 4 Second model proposed of the ink-jet printer.

The second model variant can only be placed on a horizontal surface due to its simpler design, which also results in a lower cost of the printer. As the paper is inserted into the printer, it heats up and prepares to begin the printing process. The movable end, positioned on top of the product to aid light refraction, moves back and forth in an alternating motion, „enrolling" the paper (Figure 5). Then the paper is released.

In terms of pure power, a laptop consumes about 60W of peak power, and a printer commonly used at home draws around 40-50W at peak power. Therefore, the printer we aim to produce should support a minimum of 200W. This means that solar panels installed on its surface, in the form of refractory glass, should generate a power output of 200W, which could take between 2-3 hours of solar charging [3].

Figure 5 The operating system.

Regarding potential shortcomings, we have considered the possibility of implementing systems capable of managing overvoltage. By purchasing a single 60-cell photovoltaic module, we can generate the required energy for the printer's operation at an extremely low cost [5]. Furthermore, in the product design, we will integrate a battery to store additional power units for later use. This makes the printer feasible for any kind of company or personal use, as it does not need to rely solely on daylight for operation [3].

The battery we have in mind will have a storage capacity equivalent to 4-5 hours of active use. This feature positions the device as a large-scale solution for any field that requires low-cost printing.

The anticipated results include fulfilling the operational requirements under all conditions, offering feasibility for adoption in rural communities without access to the power grid. Printers powered by affordable photovoltaic solar systems have great potential to reduce poverty by creating jobs, as well as ensuring a constant supply of essential products to isolated communities [9].

System sizing was performed to obtain a system capable of powering the printer whenever the photovoltaic modules receive sufficient illumination. However, the system should also be able to direct excess power to charge the battery whenever the total power supplied by the photovoltaic modules exceeds the power required for printing. The battery used is a pack of rechargeable Li-ion polymer batteries (14.8 V, 20 Ah) that includes an overload protection circuit, enabling it to function as a backup/energy reserve during low-light conditions [10].

Converters connected between the solar module, battery, and printer must adjust the output voltage to match the printer's requirements. Since the system should be able to print while being charged, photovoltaic modules with a rated power of at least 48 W are necessary to meet the printer's requirements and direct excess power to charge the battery when the printer is not operating at maximum power [3].

As most photovoltaic modules on the market, valued at 50 W or more, have a rated voltage of at least 20 V, converters are required to adjust the decreasing voltage of the photovoltaic module to meet the printer's requirements [6]. The materials used in these types of printers are still under investigation because a material

that combines strength and rigidity with resistance to climatic conditions, while also being lightweight and suitable for incorporating solar panels and batteries, has not been identified yet. The choice of material will determine the available color range as the paint layers will be applied to it.

6. THE LIMITS OF THE PROPOSED PROJECT

The advantages of the product, as we have mentioned throughout the article, are innumerable. It reduces costs when buying and using, is an environmentally friendly device that harnesses power from nature, and does not require ink containers. The control is easy, it weighs significantly less than current products, and it boasts a new ergonomic design that sparks interest among customers accustomed to using regular commercial printers. However, we cannot deny that the product currently has some significant drawbacks. The printing principle used by the printer prevents us from being able to print colored images. Additionally, the fact that it relies on lighting as the primary source of energy can be a disadvantage for customers who require continuous operation.

7. CONCLUSIONS AND FUTURE WORK

This paper proposes a 3D solar printer system with low, simple, and mobile costs. The system consists of an autonomous photovoltaic battery/power supply system integrated with a medium to very small printer that does not use ink cartridges but is based on the principle of thermal heating. This allows it to reproduce images/texts received externally from other devices to which they are connected.

The chosen design can be considered a significant improvement over ordinary printers in terms of portability, mobility, size, and weight. The innovations presented in this project are of general importance for all printing operators, as they now have the opportunity to transport their printing systems wherever they want without relying on electricity from the grid. This also has far-reaching implications for the adoption of printing technology in rural communities without access to the power grid, enabling distributed production.

Printers powered by optimized and accessible solar systems have great potential to reduce the market costs of current products and demonstrate that we can achieve remarkable results while protecting the environment through innovative ideas. The focus should be on sustainability and environmental protection rather than material benefit.

The diversity of the printer market is vast, making it challenging to introduce something truly innovative. However, a thorough analysis of people's printing needs leads to the development of products with increasingly unconventional forms and more functions aimed at making our work and life easier.

This paper is intended to showcase a unique design. For further work, we propose to discuss the operating principle of the proposed printers.

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