DESIGN OF PLAQUES FOR MUSIC FESTIVAL AND APPLICATION OF CO_2 LASER FOR CREATION OF ACRYLIC GRAPHIC PRODUCTS

Petra Tanović[1] Aleksandar Kulauzov[2] Anita Petrović Gegić[3]

Abstract: The design of industrial products plays an important role in the business of a company, because good design often depends on the success of a company or a certain event. Plaque design for music festivals plays a key role in the visual identity of the festival. The plaque must be recognizable worldwide, adapted to the event and users, and easily portable. When making plaques, lasers are successfully used for cutting materials. The paper explains the design of the plaque, the way it is made and the application of the CO_2 laser for making a plaque for a music festival.

Key words: industrial design, graphic technologies, plaques, lasers.

1. INTRODUCTION

Industrial design is more and more prevalent nowadays, and lasers are becoming an increasingly modern way of using and processing various products. Laser cutting devices have become very popular in the past few years. The advent of laser cutters made it possible to create detailed models. Laser cutting is also a common production process for cutting large-format plates or technical materials. The materials that are most used for the production of graphic products and are cut with a laser are Plexiglas, acrylic, plastic and metal. The mentioned materials are of very high quality. Devices with a laser are most widely used in the automotive industry, the printing industry, and the serial production of various items. The characteristics of laser cutting and engraving are precision and processing speed. The lasers used in machines are improved every day and thus their capabilities and capabilities are improved for much more demanding processes. Lasers are used in various types of industry, including in the graphic industry for the production of various products or product models. The paper shows the application of the CO_2 laser for the production of a plaque for a music festival. It can be said that the plaques of some events often represent the visual identity of the event. Visual identity represents the identity of the business, which is present on all products, documents, websites, social networks, etc. The design of industrial products must ensure that the items are practical and useful. Whether it is musical equipment, souvenirs or other products, the design must be intuitive, ergonomic and user-friendly.

The design of the plaque often contributes to the visual identity of the festival. Recognizable shapes, colors and materials help create a visual brand. Uniquely designed musical instruments or plaques can become symbols of the festival and become recognizable around the world. Plaques are symbols of recognition and respect for artists and organizers. A well-thought-out plaque design can create a lasting memory of the festival and its events. Plaques are often displayed in the winners' rooms, so their design must be aesthetically appealing and in line with the style of the festival. An innovative plaque design can further enhance the festival's reputation and attract media and public attention.

[1]Phd, The Higher Education Technical School of Professional Studies in Novi Sad, Novi Sad, Školska 1, email: tanovic@vtsns.edu.rs

[2]graphic designer, Enterijer Janković, Novi Sad, Primorska 88, email: kalauzov.aleksandar@gmail.com

[3]Phd, The Higher Education Technical School of Professional Studies in Novi Sad, Novi Sad, Školska 1, email: petrovic.a@vtsns.edu.rs

2. DESINGN AND MANUFACTURE OF A PLAQUE USING A CO_2 LASER

2.1. Lasers in graphic technology

Laser marking is a contactless printing method. This printing method offers advantages over other technologies. It includes the very quality and durability of marking, with the minimum amount of material used. The line of industrial lasers includes CO_2, Fiber and UV laser sources of different powers. They achieve good print quality on any substrate and also cover a wide range of applications. All the mentioned lasers also have very wide possibilities of upgrading accessories such as lenses, which maximally improve the performance of the laser itself and its quality. It is important to note that laser printing has a great advantage due to precise printing without deviation [1].

Figure 1 – CO_2 laser [2]

A laser beam is a high-powered beam of energy that is focused on a single position at the point being cut. In CO_2 laser cutting, the laser beam is part of the infrared light spectrum and is invisible to the human eye. At the beginning of the cut, the laser beam travels from the laser resonator and is directed by the mirrors towards the nozzles. After passing through the nozzle, the laser beam hits the material to be cut and after some time penetrates through it, which starts the cutting. Focusing the laser beam is possible using special mirrors located in the head of the laser cutter. By focusing the laser beam on a small area of the material, the surface is heated up to the point where melting begins.

During laser cutting, the laser head moves a certain distance. This distance is very important for the speed, but also the quality of the cut. The thickness of the laser beam is less than 0.3 mm. The cutting process begins by focusing the laser beam on the surface of the material to be cut. The surface on which the laser beam is focused is very small and can amount to $0.025mm^2$ [3].

2.2. Materials for making plaques

A laser can cut and engrave on a variety of materials, but it works best on the following materials: acrylic, metal, glass, plastic sheets, leather, paper, textiles and wood. With laser cutting, components can be produced without contact and thus without material wear. Acrylic does not need to be reprocessed because the laser cut edges remain crystal clear.

Transparent acrylic was used to make the final plaque of the music festival. Gold-colored engraving plastic was also used to make the medal. The plexiglass used is 5mm and 15mm thick, while the engraving plastic is 2mm. These materials are very resistant and attractive, so they are used for shaping and making plaques and decorative plaques because they provide great flexibility during work. Acrylic is the generic name for polymethyl methacrylate, a thermoplastic material used in many industries.

Polymethyl methacrylate, better known in our country as Klirite or Plexiglas, is acrylic sheets. Plates can be transparent or colored. One of the important chemical properties of this material is that acrylic has a high level of light transmission depending on its color spectrum. This material has natural UV protection, which makes it suitable for making products that are exposed to sunlight.

A large selection of plates, neutral, iridescent, white, translucent and transparent, with a glossy or matte surface, offer a great possibility of applying acrylic for different purposes and needs of designers [4].

Acrylic sheets are produced as extruded and cast, and each production process has different technical parameters. Acrylic sheets are most often used for advertising materials. They are used for lamps, shelves and background lighting of panels. Acrylic is also used in architecture. It is used as a decoration of various glazing stands, it is even used as a partition wall. It is known that acrylic is also used in the automotive industry for headlights, front and rear lights, and is also used in the aviation industry. Acrylic also has a special use for the walls of car washes, solariums, and is also used for the walls of greenhouses and winter gardens [4].

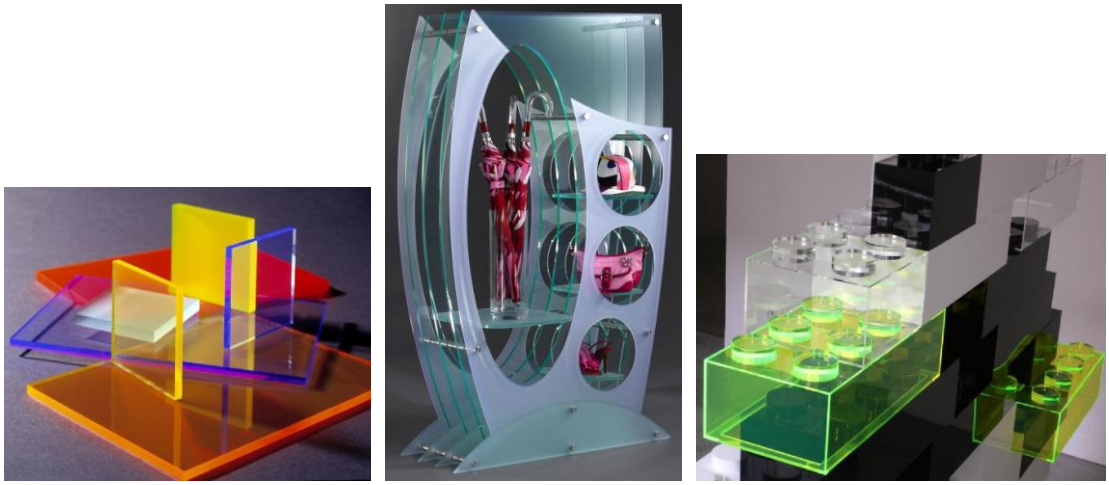

Figure 2 – Acrylic objects [4]

Acrylic has many advantages compared to other materials of the same purpose. It is used all over the world and has a certificate for use in the food industry. One of the important advantages is that it is easy to process both mechanically and thermally. It is very resistant to UV rays and various atmospheric influences. It is highly resistant to corrosive chemicals and has a high transparency of up to 92%, which makes it one of the most transparent materials. Its advantage is that it can be easily recycled and reused. [4].

For the production of the plaque, 2mm gold-colored engraving plastic was used. The medal on the plaque is made of engraving plastic. The appearance of engraver plastic is very reminiscent of a metal surface. By all its characteristics, it makes a better choice than the metal itself. This type of material is perfect for outdoor use because it is waterproof and does not react to climatic factors, which makes it a very rewarding material. Engraving plastic changes color under the influence of external conditions and factors. It is long-lasting and does not change its properties even after more than 10 years. It also differs from metal in that it is lighter. Engraving plastics are used in various branches of industry. The most famous use is in the production of advertisements for companies, then for the production of inventory plates, signs for houses and for the production of identification plates, then for cups and plaques.

2.3. Design and production of the plaque

Before starting the design and production of the plaque for the client, it is important to have a conversation with the client, in order to find out the purpose of the product and the wishes of the client. Once the conceptual solution is found, the sketching and design of the plaque begins. Practical work is complex and detailed processing that follows the process of making a product from the beginning of creation to the final finished product. The process consists of coming up with ideas for how the final product can look, what material it is made of, and what its purpose is. Considering that it is a music festival, the research is directed towards some symbols that are

connected with that theme. The conceptual solution for this project is the treble clef, the first symbol that tunes into musical culture.

The idea begins to be realized by sketching symbols on paper. Roughly sketched work is then presented to the client.

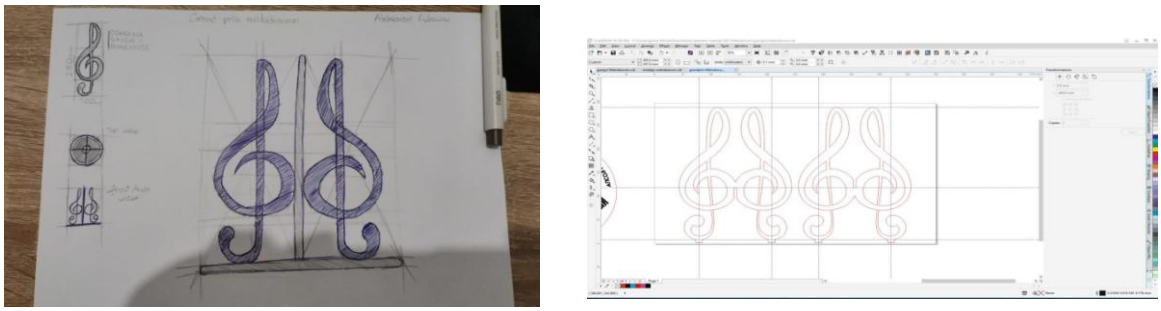

Figure 3 - Sketch of conceptual solution on paper and computer

Vector graphics programs, Adobe Illustrator and CorelDRAW were used to digitize the sketch. The idea of the plaque is violin keys, which intersect in four parts. They are located on a stand that is laser engraved on the machine. The treble clef and stand were drawn in CorelDRAW using the pencil and curve tools. The idea of the plaque is that there are violin keys on the stand.

Figure 4 - Drawing the plinth *Figure 5 - The final look of the vector side projection*

Preparation for laser cutting must be precise so that the work is done as well as possible. It is necessary to color each cutting line in RGB red color of parameters 255,0,0. The laser scans each line when it is colored with the code 255,0,0.

Transparent acrylic of 5 mm is used and based on its characteristics, the power, speed and frequency of the laser is adjusted. To achieve a better cutting quality, it is necessary to do a couple of tests. Laser power is set to 42%, speed to 0.2 and frequency to 2000 Hz.

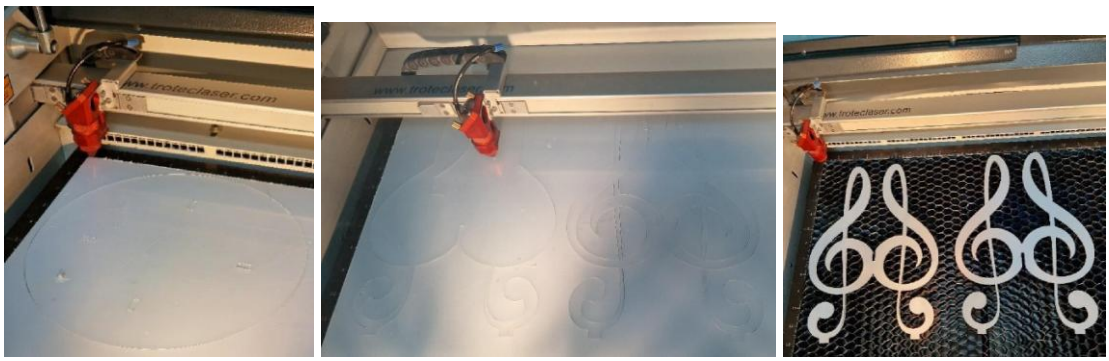

Figure 6 - Laser cutting of stands and violin keys

For the production of the plaque, in addition to cutting the stand and violin keys, it also includes the engraving of other elements: the logo of the event, the date of the event and the logo of the host of the event. It was considered that these elements would be printed with UV technology, but due to the material from which the plaque is made, laser engraving turned out to be more accurate and better. The setting of the engraving laser consists of the following items: power 20%, speed 6.1 and frequency 1000 Hz. The laser needs to be assigned the RGB black color of parameters 0,0,0. in order to recognize which fields he is engraving.

After the cutting and engraving process, it is necessary to clean all elements from the dust created by the laser during engraving. These elements are joined with acrylic glue, which is transparent and does not change the appearance of the final product.

Before cutting and engraving, it is necessary to choose the types of acrylic and engraving plastic that will be used for the project. After consultation with the client, it was decided that 15 mm thick acrylic, which is transparent, will be used for the final production of the stand. 15mm matte black acrylic is used for the sub-base. For the medal, 2 mm thick gold-colored engraving plastic was used. 5 mm thick transparent acrylic was used to make the notes. The laser must first be calibrated and set the correct path of movement. By setting these parameters, the program starts working.

After the successful completion of acrylic cutting, engraving follows. Laser engraving is a longer and more complex process than cutting itself. It takes 30 minutes to laser engrave the base, while the laser engraves the decorative medal in a total of about 20 minutes.

The decorative medal is engraved on a gold-colored engraver's plastic to make it look as realistic as possible. This acrylic has a thickness of 2mm. For a better shine and screening, it is necessary to clean the engraving plastic after engraving both surfaces. A natural bristle brush and particle cleaner are used for cleaning. The cleaning process must be repeated several times until the desired shine effect is achieved.

Figure 7 - Engraved base and final plaque

After finishing the laser cutting and engraving of the plaque parts on the machine, the parts are cleaned and ready to assemble the product. The polishing process is very important, because the high gloss of acrylic is of great importance in the appearance of the product.

3. CONCLUSION

Industrial design is more and more common nowadays. Lasers are increasingly used as a way of processing and manufacturing various products. The advantage of the laser is in precise and fast production. Laser processing significantly speeds up the production process itself, which contributes to faster serial production of a certain product. It is believed that in the near future, laser processing and engraving will become dominant in industrial product design and will be used even more. When researching the market, it is very important to first carefully examine all existing possibilities and benefits, and only then proceed to product development. Specifically in this project of making a plaque for the "Melodium" Grand Prix competition, the challenge was to find the right conceptual solution for the client, make a good design and finally make the plaque. In the future, lasers will be increasingly applied in various branches of industry due to the precision and speed of production.

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