The production process of hardware

ONSITE VISITS 2023-CHINA

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INTRODUCTION

Hardware trims and accessories are essential parts of the leather goods components. Within ECCO Leather Goods Unit, these items are outsourced from China. The hardware is usually designed at the ELU's design department in the Netherlands. To bring these designs to life, a 3d printer (Formlab 3L SLA printer), is deployed at the Atelier, dedicated solely to prototyping.

Once the 3D design is finished, the corresponding 3D files (STEP format) will be sent to suppliers for high-volume production. Notably, the entire production process is carried out in on-site in China, to gain a comprehensive understanding of the production process and techniques, two on-site visits were scheduled in Guangdong Province during week 20 of 2023, spanning from May 16th to May 19th. The chosen suppliers for these visits were Kenuo and Shiwang.

Kenuo, established in 1993, and Shiwang, founded in 2004, are both manufacturers that offer end-to-end services. This includes Design & Engineering, Molding & Electroplating plants, Quality Control & Packaging, and Customer Services, among others. These visits aim to provide insights into the intricate processes and capabilities of these esteemed suppliers.

According to China's regulations governing the central processing of industrial pollution, particularly concerning water, metal, and plastics, it's notable that the factory and its electroplating plant are situated in separate locations.

This report is structured as below:

1. The first part describes types of the materials (metals & plastics) that can be used for CNC machines and possible surface finishing.
2. The second section focuses on the process of creating a hardware piece, from application to die-casting process, and lastly electro-plating process.
3. The last section critically reviewed the process and draw implications and limitations for ELU.

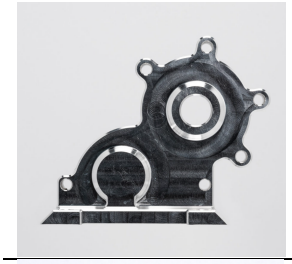
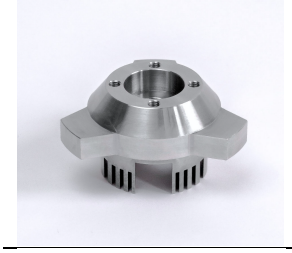
1. MATERIAL TYPES AND FINISHING SURFACE

This chapter describes the material types that can be used for CNC machines. To produce a hardware piece (trim or belt buckle), the first step is to define the material and its prototyping/manufacturing method.

For accessories with ELU, metals and plastics are the most relevant and will be discussed in this section.

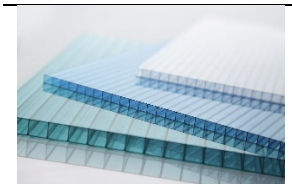
1.1 Metal materials

Metal can be used for both manufacturing and prototypes for low-to-medium production. **Aluminum 6061** is by far the most used material. Below are the most used types of metal at ELU during the prototyping phase.

	**Aluminum (铝)** - Natural protection against corrosion - High thermal and electrical conductivity - **Light weighted**
	**Stainless Steel (不锈钢)** - Against corrosion - High strength and ductility - Can be **Welded** and polished.
	**Alloy Steel (zinc) 合金类** - Improved hardness - Price – friendly - **Low-chemical resistance**
	**Brass (铜)** - Excellent machinability - **Golden Appearance** - **Weldable**

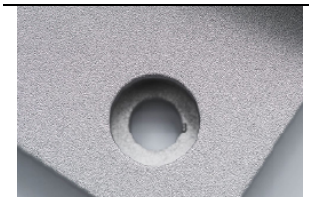
1.2 Plastics materials

Plastics are lightweight materials and are often used for their chemical resistance and electrical insulation properties, Plastics are commonly CNC machined for prototyping purposes before the injection molding. Below are the plastic materials that could be used in the future at ELU.

	**ABS (ABS 树脂)** - Good resistance to heat and chemical. - Smooth surface and electro-plating possibilities - **Light weighted**
	**Nylon (尼龙)-Polyamide** - Excellent chemical resistance - High strength - Good Machinability
	**PC (聚碳酸酯)** - **Transparent** - **Low anti-friction** - **Excellent chemical and heat resistance**

1.3 Finishing

Surface finishing is applied after CNC, and it serves to change the appearance, surface smoothness, hardness, and chemical resistance. Below is a quick summary of the most common finishes for CNC.

	**Electro-plating（电镀)** Widely used and most common surface finishing	Pros: 1. Corrosion resistance 2. Decorative finishes (color, shiny and colorful finishing) 3. Compatible with all metals 4. for all size Cons: 1. Environmental impact 2. Highly energy consumption 3. High cost and waste generation 4. Limited thickness.
	**Powder Coating (喷塑)** Protective polymer paint, available in many colors	Pro: 1. Corrosion resistance 2. Compatible with all metal 3. Environmental benefits 4. Efficiency and variety of finishes Cons: 1. Not suitable for small pieces 2. Limited thickness and heat sensitivity
	**Bead blasting (喷砂处理)** Adds a uniform matt or satin surface, removing all tool marks.	Pro: 1. Remove tool marks. 2. Matte or satin finish 3. Low-cost surface finish Con: 1. Critical surfaces or features, like holes can be masked. 2. Not for small sizes

Anodizing (阳极氧化) Adds a thin, hard, non-conductive ceramic coating on the surface. of aluminium parts parts can be dyed producing a smooth aesthetically pleasing surface.	Pro: - Excellent corrosion resistance - Enhanced hardness - Non-conductive coating - Environmental benefits - Can be colored to any Pantone tone. Cons: - High cost - Limited to Aluminum and its alloys

1.4 Other types of finishing:

Engraving and silk screening are both commonly used methods to add text or textures.

- Engraving

Engraving involves physically removing materials from metal, this method can achieve both shallow and deep markings or textures. However, once it is engraved, it becomes permanent. It is also time-consuming and costly.

- Silk screening

Silk screening is an inexpensive way to print text or logos on the metals, multiple layers and colors can be applied, without physically removing any materials.

Silk screening is generally more cost-effective, faster than engraving, make it suitable for high-volume production, but it is NOT suitable for high-friction or harsh environmental conditions.

2.PRODUCT PROCESS

The part showcases a holistic overview of the production process, both factories follow the same process: 1) Designing & Engineering 2) Making molds 3) Die-casting & Post-processing 4) Plating & QC & Packaging.

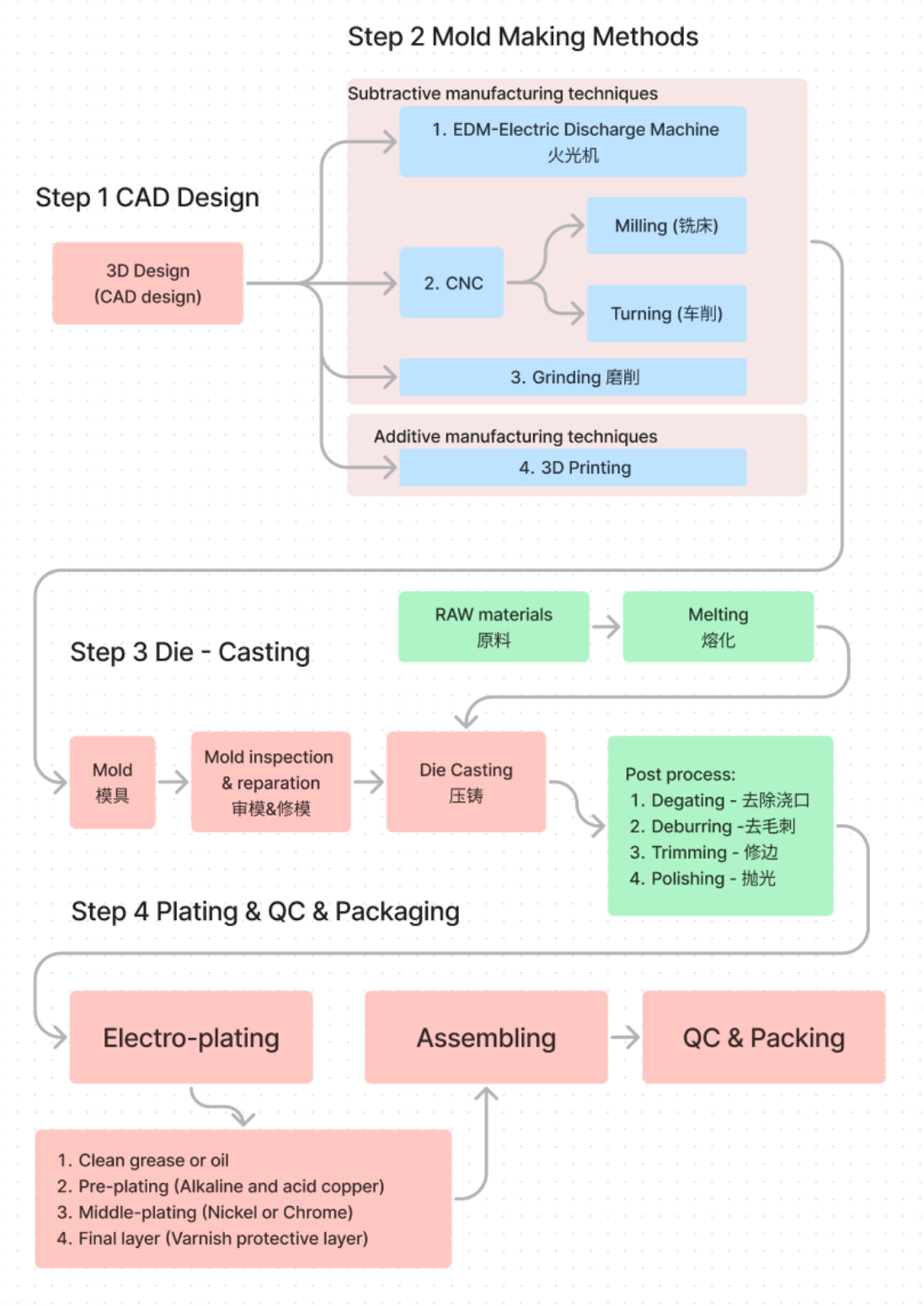


Figure 1: The work process

2.1 Step 1&2: 3D design and Mold making

Commonly used are: 1) EDM; 2) CNC milling or lathe; 3) Grinding; 4) 3D printing.

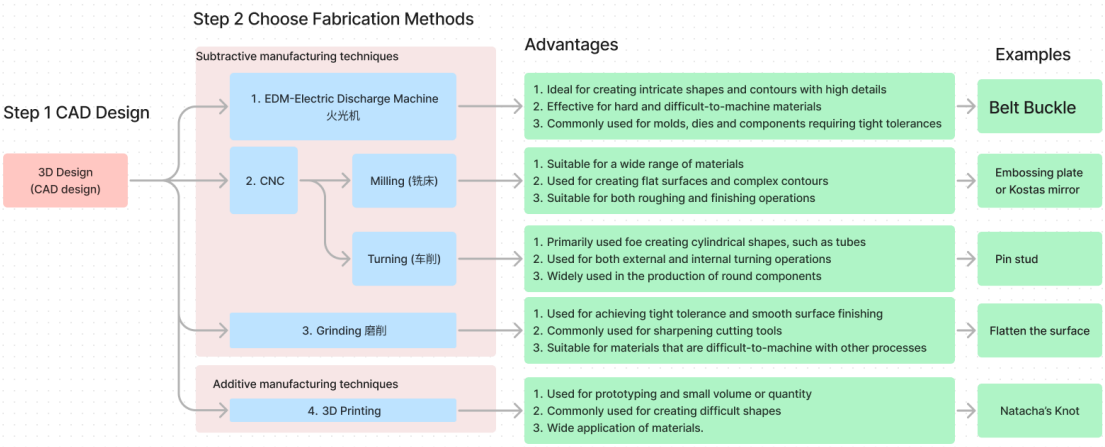


Figure 2: The molding fabrication methods, advantages and examples

EDM-Electric Discharge Machine

EDM utilizes electrical discharges or sparks to precisely remove material from a workpiece. This method is particularly effective for machining materials that are difficult to machine with CNC methods due to their hardness or other properties.

- The consistency of the machining process is crucial for molding production. Mold requires higher details, smaller size, and hard materials, it is better to choose EDM, on the other hand, EDM is relatively affordable than CNC machines.
- However, the finishing quality (smoothness) of CNC is better than EDM, therefore, there is always a step needed, the inspection by technicians.

Figure 3&4: EDM machine and mold inspection process

CNC milling/turning

Engineers or 3d designers create 3d models by using CAD (Computer-aided design) programs. However, the 3D model cannot be processed by a CNC machine directly, a conversion is therefore needed. This process is called CAM (Computer-aided manufacturing) programming, requiring CAM programmers to perform several tasks, including defining tool paths, cutting speed, and other parameters.

CNC machine is a high-speed and -precision subtractive manufacturing technology. The process typically begins with a solid block of materials and using a variety of sharp rotating tools, removes materials to achieve the required final shape.

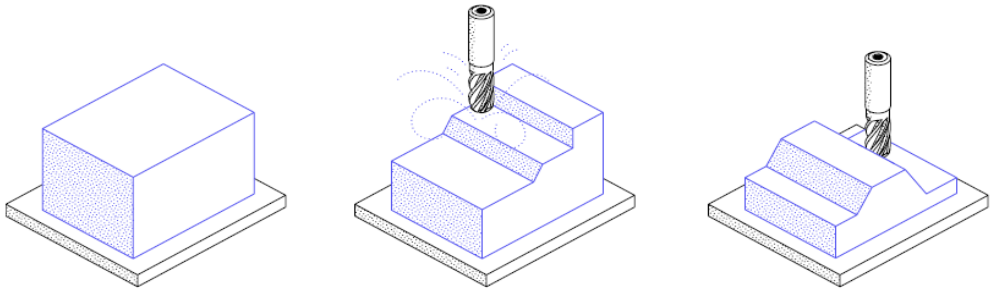
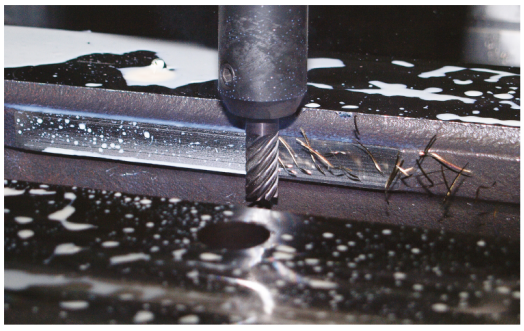


Figure 5, CNC concept

- There are various types of CNC machines, the most used principles are milling and turning (lathe). The most significant difference between turning and milling is the movement of the workpiece and tooling. In turning, the workpiece (usually cylindrical shape) rotates, and the cutting tool does not, in milling, the cutting tool moves and rotates while the workpieces (block shape) remain fixed (Gensun, 2020).



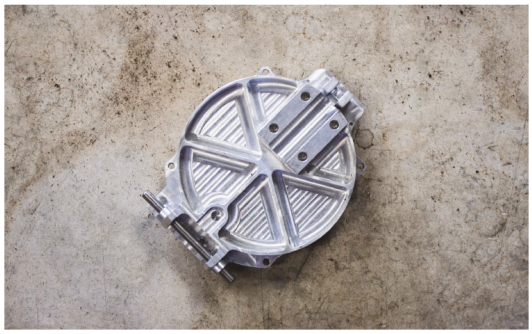


Figure 6, CNC milling, and a "machined" piece.

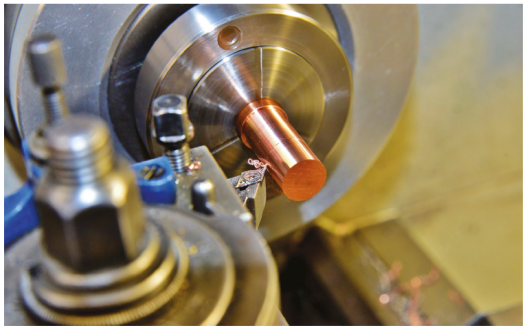


Figure 7, CNC lathe or turning, and a "machined" piece.

Figure 8, CNC machine used at factory.

2.2 Die casting & post-process

The main difference between molding and casting is the use of material in the process.

Molding, or injection-molding, focuses **on plastics, polymers, TPU, or rubber**. This method is used for shoe sole production at R&I, the headquarter in DK. The mold is usually produced by using a CNC machine.

Figure 9, injection molding example, at the headquarter in Denmark, Bredebro Ecco

Casting, or die-casting typically involves **metal** under extreme force. The hardware produced for ELU, for instance, the rings, belt buckles, eyelets, and bag frames.

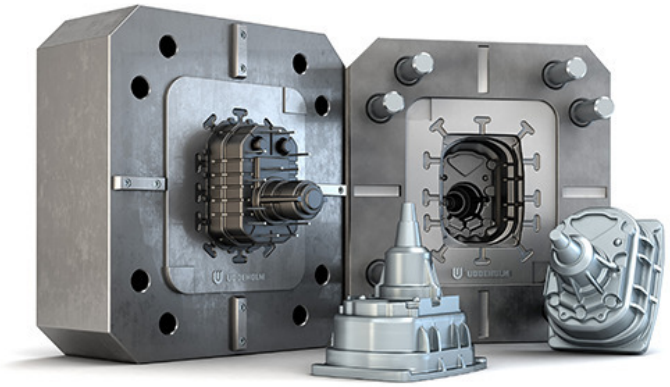


Figure 10, die-casting mold example.

The entire process from raw materials to ready-for-electroplating

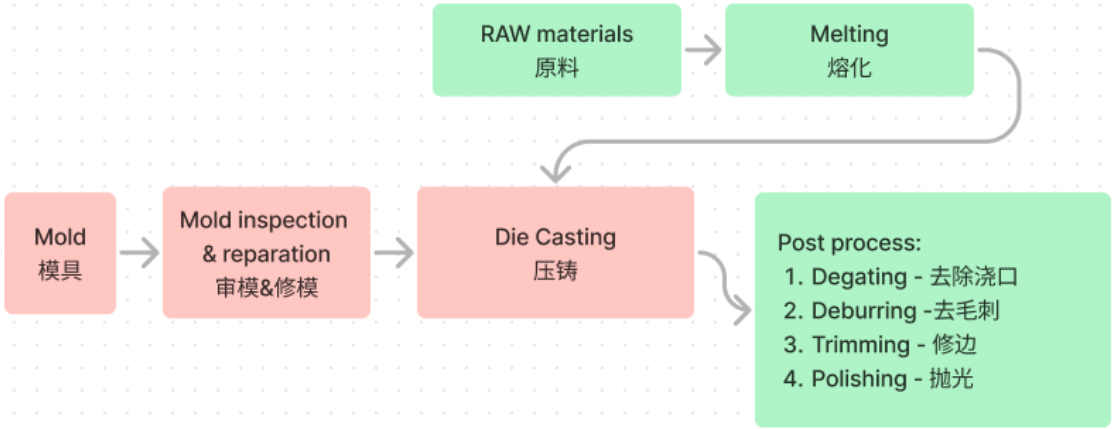


Figure 11, the die casting, and post process

Die Casting Machine

Figure 12, die-casting machine at factory plant

Post process:

1. Degating: remove the excess material, often referred to as gates from a molded.

Figure 13, degating, removing the leftover materials.

2. Deburring & trimming: remove burrs or sharp edges.

Figure 14, deburring, and trimming

3. Polishing

Figure 15, polishing the raw piece to increase smoothness.

2.3 Electro-Plating

After completing the post-process steps (raw pieces come out of the die-casting machine), they are ready to be shipped to the electro-plating factory. Electro-plating is the decorative process, where the raw pieces will be given different colors, and textures to enhance the aesthetics or surface hardness/smoothness and so on.

- The first step is to **clean the grease or oil**, and then hang every individual piece on the hanger. Each hanger is customized, and specially tailored based on the design of the raw piece.

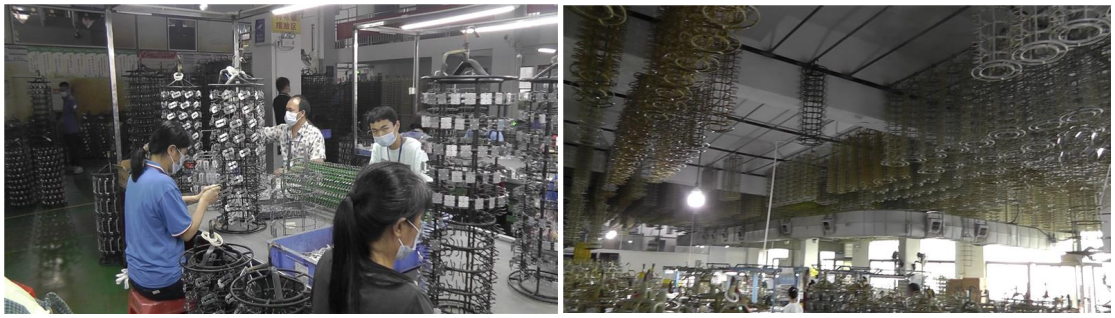


Figure 16, hanging and cleaning.

- The second step is **Pre-plating** TWO layers of **copper** as the base coat because copper has good conductivity and adhesion properties. Copper also has good leveling properties which ensure a smooth and uniform surface. Gold and silver have similar properties but are more expensive.
    - FIRST LAYER: Alkaline copper plating(碱铜), the reaction time is faster, and adds a thicker layer of copper, ensuring an even surface
    - SECOND LAYER: Acid copper platting (酸铜), the reaction time is slower, this adds a more smooth and refined surface, making it shiny and metallic.

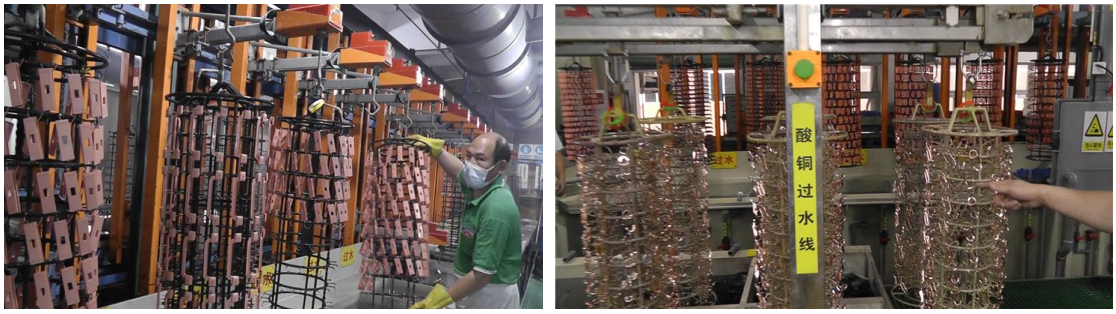


Figure 17, Alkaline finishing vs Acid finishing

- The third step, based on the requirement of the client, technicians will decide what will be the finishing colors and materials (Nickel or Chrome).
- The final layer will be a protective layer to ensure safety and anti-frication.

3 Implications & Limitations

Mold design and production require a large investment in equipment and technology. The investment in electroplating plants, in particular, requires not only skilled engineers and technicians, but also a reliable and steady supply of water, electricity and qualified metal materials. Furthermore, China has a strong infrastructure and logistical advantages to arrange shipments on time.

The fact that the clothing production chain can be transferred to South Asia on a large scale, while the metal and mold development has remained in China, is also explained by this. It is not only because of China's policy support and mature experience in this industry, but also because mold development replies on experienced technicians and engineers, as well as the factory facilities.

From a sustainable perspective, both suppliers adhere China's regulation on centrally-process waste pollution, by establishing their electro-plating plants in a designated area. This helps to minimize the potential pollution. However, electro-plating plants are notorious for their polluted wastewater, necessitating the requirement for suppliers to update their qualifications and certifications in line with relevant regulations.

Kenuo stands out in its utilization of renewable energy by installing solar panels on the roofs of its factories. Their clients also at a higher level in brand positioning, including Coach, Jimmy Choo, Marc Jacobs, and Kate Spade. Their expertise lies in belt buckles, but during their last visit to the Netherlands, they demonstrated their capability in making bag accessories as well.

SW is more competitive in terms of price and development cost. And we have been working with SW for almost 3 years, their customer services and product quality are also decent, but the factory environment and hardware facilities need to be improved.