

## MOULDING GRACE DESIGN OF MACHINE TOOLS APPEARANCE MODELLING DESIGN

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### Abstract

Machine tool has been evolved for thousands of years from the birth of the first one to the wide application of numerical control machine tool. It has been experienced from the beginning in simple function with man powered to the development in implementing multi function with machine power, and to the emerging of the numerical control machine tool. And their application fields are more and more extensive; their process precisions are even higher. The materials which are used to consist of the machine tool were developed from wood, iron, steel and alloy, nonmetal material with the properties of much lighter, preferable mechanical performances, and to pay more attention on materials by environmental protection and sustainable. The exterior appearance model of the machine tool were designed from the beginning in tousy appearance and without any protection parts to employ diversity and individuation designing style with streamline idea, modernism idea and post-modernism. The exterior color of the machine tool were varied from the early in wood manner without color to black, grey, and to now meet the customer mental needs which are put into pairs with Multi-color. Individuation, diversification and emotion are more reflected in modern color design of the machine tool. It is very important and useful to investigate the development process of machine tool from the construction, consist of materials, exterior appearance, and color design etc., to forecast the development trends of the exterior appearance model of machine tool for the future machine tool design.

### Introduction

#### 1. The birth of machine tool

In 4,000 BC, the beam was placed on two columns, and the rotating awl was hanging on it, then the bowstring was wound round to make the awl rotate for perforating, there came the first drilling device. The

first prototype drilling machine was 'lulu' which made the awl rotate by the flexible bowstring.

In the ancient Egyptian, people made a kind of tool used to turn with the wood rotating around its central axis. The

wood was placed on two columns, and the elastic of the branches was used to make the ropes rolling around the wood, and then the rope was pulled to rotate the wood by foot or hand, while the knife was used to turn. (fig.1 showed) Later, the bow lathe appeared. That was two or three cord rounding around the pulley, and then the cord was placed on elastic bow rod while the bow rod was pushed or pulled to rotate the processed objects for turning.

It has been experienced from the beginning in simple function with man powered to the development in implementing multi function with machine power, and to the emerging of the numerical control machine tool. And their application fields are more and more extensive; their process precisions are even higher. The materials which are used to consist of the machine tool were developed from wood, iron, steel and alloy, nonmetal material with the properties of much lighter, preferable mechanical performances, and to pay more attention on materials by environmental protection and sustainable. The exterior appearance model of the machine tool were designed from the beginning in tousy appearance and without any protection parts to employ diversity and individuation designing style with streamline idea, modernism idea and post-modernism. The exterior color of the machine tool were varied from the early in wood manner without color to black, grey, and to now meet the customer mental needs which are put into pairs with multi-color. Individuation, diversification and emotion are more reflected in modern color design of the machine tool. It is very important and useful to investigate the development process of machine tool from the

construction, consist of materials, exterior appearance, and color design etc., to forecast the development trends of the exterior appearance model of machine tool for the future machine tool design.

## **Proposed method**

The function of the early machine tools which relay on manpower is signal; later, there is the machine tool which relays on power of the generator and motors; then there is the multi-function CNC machine tool that is more extensive application and more accurate. The modern machine tool design reflects human care to human, comfort use, security and agreeableness.

## **Methodology**

### **The Evolution of machine tool function and materials technology**

#### 2.1 The Emergence of the base machine

The development stage of the base machine was from the Middle Ages to the 17th century AD. The support components were already taken shape, while the mobile station which was used to install the work piece and the basic transmission mechanism also appeared. The power used was mainly supported the aid of human or hydraulic. Table 1 shows the evolutionary process of machine from the Middle Ages to the 17th century, including the emergence of the time, the inventor, the name, the types and characteristics of machine tools.

#### 2.2 The initial development of machine tool

In the 18th century AD, the development of machine tool was not very fast, while there appeared signal change. For example, the emergence of bedside box and tool promoted the progress of the machine tool to a certain extent, and the machining

precision was also further improved. The details are shown in table 2.

### 2.3 The rapid development stage after the industrial revolution

The machine tool whose power source changed from the steam to motors were developed greatly because of the first industrial revolution in 18th century 60s and the second industrial revolution in 19th century 70s. In the second half of the 19th century, new tools and new materials also contributed to the impetus for the continued development of machine tool. Since 20th century, the rapid development of the automotive industry and the aircraft industry has promoted the mechanical manufacturing to high-precision, large-scale, special-purpose and automation.

The developments of technology drove the social progress while machine tool also changed obviously since the 18<sup>th</sup> century. The function component of machine tool was mainly made of cast iron and steel because of the evolution of the machine tool from wooden structure to metal structure. And with the development of materials science, new materials were gradually applied to the machine tool, such as, composite materials, engineering plastics, etc., which broke Iron and steel alone EC scene. In 1975, a company of Switzerland firstly used granite materials to alter cast iron applied on machine tool to manufacture the non-moving parts of machine tool, such as bed, column and spindle box, etc.. At the same time, the application of engineering plastics, which was used to manufacture the small parts of smaller force as well as some important parts such as rail and cochlear mother, became gradually greater. Table 3

gave a detailed analysis of evolution of machine tool during this period.

### **3. The evolution of appearance of machine tool**

Because of the imperfection of the function and structure and the simple appearance of machine tool, all the components without appearance protective were exposed at the beginning of generating machine. While in the subsequent development, although the structure and function of the machine tool were made more progress, there was still no big change in the appearance. The single colored machine tool made people feel dull and heavy, because they were only a simple accumulation of the various components and combinations, and lacked of design and aesthetics. The appearance of machine design began to form their own style in the 1930s, which was developed from simply meeting the functional needs, no considering the quality and pleasant appearance and the poor effect of modelling to the emergence of appearance protective, application of color design, volatile materials, and the appearance of the ergonomic.

### **The design period of streamlined machine**

Modernism design style derived from the 20th century, which followed the rationalism, summarizing the objective with geometric forms and simple abstract color. And the geometric shapes of plane and three-dimensional strictly followed the pattern and the geometric form was combined with the new machines to pursue the rigorous and precision of Machinery. The streamlined design features were of modern American style.

The Streamlined machine design which reflected the basic characteristics of the streamlined design with the beauty of simplicity was used all the rage in the 1930s. Firstly, influenced by functionalism, more work were considered on function that abandoned the complicated history decorative style and excluded the superfluous details to form beauty style of machinery and geometric. Secondly, the appearance of machine tool became simple and fluid because of the unified integration of excessive decorative parts. Then, the form design of machine tool was not simple and crude, but an organic to a certain extent to avoid the monotonous and empty. The color design conformed to the pace of the 'gray period', and the dominant color was "black, white, gray, brown series". That reflected the characteristics of cold, mechanical and lack of humanity.

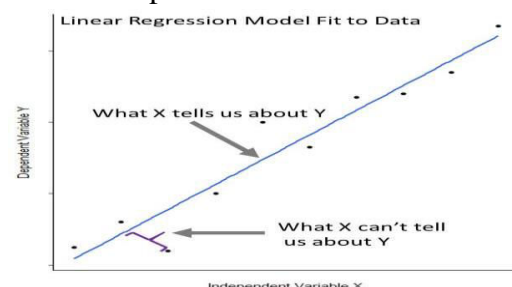
### Modern style period

With the prosperity and development of the modern style, it also generated many new styles and genres. The design of machine tool was developed from the streamlined shape for design principles of envelopment analysis, which made the curve, surfaces and the rounded transition as the keynote. This design gave people the mellow feeling, but also had the bloated effects easily.

The design of machine tool changed when modernist style has gradually become an international trend. The modelling of the square and small round square transition was used in the 1950s, which paid attention to function of product and avoided too rigid and harsh geometric forms. So the modern aesthetic of 'human touch' which reflected unique clear, organized,

lightweight, agile was formed. There was numerical control machine during this period, and the characteristics of these shapes in the design of CNC machine tool were more clearly reflected. That was a CNC lathe, as Fig.11 showed.

Designers began to create the life style of industrial society to create high-quality and excellent design for people, with the prevalence of modern design ideas. Finally, there came the design style of concise and abstract. Straight line thus became the largest design feature of machine tool. The modelling of 'horizontal + vertical line' was used in machine tool which has founder and stable visual effects according to the trend of the times. Fig.12 showed other CNC machine tools whose overall modelling was cuboids, the straight-line, simple and stable, so this fully reflected the characteristics of modelling tool in this period.



### Conclusions

According to looking back, analysis and research on the evolution of the machine tool, the following is concluded: (1) The function of the early machine tools which rely on manpower is signal; later, there is the machine tool which relies on power of the generator and motors; then there is the multi-function CNC machine tool that is more extensive application and more accurate. The modern machine tool design

reflects human care to human, comfort use, security and agreeableness.

(2) Wood is the main structure materials in the beginning, later that is gradually replaced by iron and steel. Then there are more and more non-metallic materials of lightweight and better mechanical properties with stronger environmental protection.

(3) Color of the machine tool is from the nature color to black and gray; gradually, that begins to meet the user's physical and psychological demands. Now, the color design of the machine tool reflects more personality, diversity and emotional characteristic.

(4) The early appearance of the machine tool is simple, and all the components are exposed without appearance protection. Then there comes streamline design, the modern style design and the postmodernism style and so on. The connection of structure and function are combined more perfectly and more meet the requirements of ergonomics. With the design change, new technologies, new techniques, ergonomics and aesthetic are applied. So, the machine tool will gradually become the art in the workshop, rather than production tool and equipment. In a word, machine tool that is of high performance, easy to operate, safe and reliable, intelligent, environmental protection, beautiful and practical will be the main developing direction in the future. The modelling design of machine tool will be developed towards better function, beautiful appearance, more agreeableness, etc. to meet operator's demand of the physiology and psychology.

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