

# The Study to the Theory of Human-Machine-Integration in Product Design

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**Abstract.** The paper puts forward a design concept named Human-Machine-Integration which refers to the shape of the product designed according to the location and contact type when the product is used. It considers the double properties of function and aesthetics to product and makes the designer combine the formal principle with Human-Machine Engineering theory together to mould the product shape conforming to the easy-to-user principle with the consideration of form beauty at the same time. It regards the man - machine – environment as a whole body and has practical significance to the system design of the product. When a product is designed according to Human-Machine-Integration theory, contact parts form and contact area and the harmonious relationship between forms of contact parts and overall product should be considered. And the Convex-concave match of product part and body part should be complement with each other and tolerant match of product part is contacted with the human body part. At the same time, the purpose of form should be fully considered. Correspondence, Integrity, Systematicness and Independence are four characteristics of Human-Machine-Integration design.

## 1. Introduction

The generation of artificiality accompanied with the creation and extension of the form. The process of shape extension is also the process of searching for good shape[1]. In this course, the form is gradually combined with the user and use status according with the development of Human-Machine Engineering. And it shows the practical value besides the aesthetic value[2]. The first property of form is materiality determinate that its function to the objects is moulding. The double properties of function and aesthetics to product make the designer combine the formal principle with Human-Machine Engineering theory to mould the product shape conforming to the easy-to-user principle with the consideration of form beauty at the same time.

Form-Fit means close match to others between shapes[3]. The Form-Fit design is finding the corresponding relationship between shapes such as up and down, left and right, positive and negative according to the basic function requirement among shapes.

It is from the collinear and conformal theory in Graphics. That means two shaped have common edge line when shapes are combined[4]. The method of shared shape reflects the meaning of Form-Fit[5]. As to the 3D product's performance, collinear and conformal became coplanar and shared body. Corresponding relationships between each other make products or different parts of product to join each other and become the new whole one. The research object of this article is Human-Machine-Integration theory which refers to the shape of the product designed according to the location and contact type when used. The product form is designed to considerate the corresponding relationship

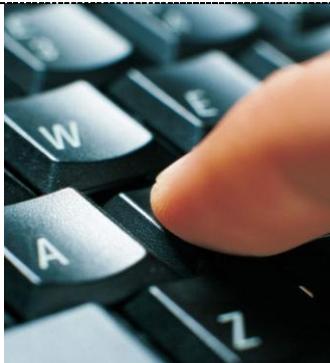


between touch location and operating type such as pressing ,gripping , dialing , pulling , treading , sitting. Then the form of product is designed to adapt to the human body and make the product form to convey semantic and guide function.

**2. The type of Human-Machine-Integration**

According to the corresponding relationship with each other, Human-Machine-Integration can be divided into surface correspondence and body correspondence. When the operation location to the body is one surface, the product surface is designed to be a complementary form with the contact surface. The design of various buttons is the most common example. Body correspondence means one part of the body and part of the product or a product that is both inclusive or accommodate. The whole or part of product can be held by one part of body, or the product has certain instruction space to accommodate certain part of body. This indicative modelling language has semantic role. Human-Machine-Integration can also be divided into internal and external correspondence according to the space position relations. Internal correspondence refers to the internal part of product can accommodate certain part of the body. While external correspondence refers to the operation area is located outside of the product.

For example as Fig.1 shows in the picture, computer’s button is the part with surface contact is very frequent. So the keys are designed as slightly concave shape to make the user to put fingers forward the trend of completion. Left and right surfaces of the mouse can also be seen as the representative to match each finger with product as Fig.2 shows. The cavity in two sides can accommodate for the thumb, ring finger and little finger. Also the model makes the mouse to be an aesthetic shape. Hand shape should be fully considered when design handheld tools.

	<p><b>Figure 1.</b> This figure shows the design of computer keyboard. The keyboard is designed based on the shape of human finger. And it indicates the method of application with its shape.</p>
	<p><b>Figure 2.</b> Mouse is the product that the designer should take more ergonomics factor into account. Frequent operation makes its shape must cater human hand.</p>

### 3. The significance of Human-Machine-Integration form

According to the Gestalt theory on psychology, an open graphic has the trend of completing good form. People will close or fill a graphic vacancy to complete a whole body. When the surface or body of product has open property, their own gestalt trend will make users to fill the vacancy so as to achieve the effect of man-machine integration.. Product forms act as the instruction to indicate the operation behaviour of people and prevent improper operation aiming at more reasonable, safer and more comfortable operation. Direct experience and indirect experience work together, through a series of reinforcement, to form fixed good use habits and form the correct behaviour patterns. Finally the purpose of the comfortable and safe operation can be achieved.

Let's come to the model evolution of Video Game Controller. Controller is the main place of human-computer interaction for operators to operate games. It is controlled by the operator's hands. Fig.3 shows that the initial shape of Video Game Controller is a rectangle, without considering the hand's interaction with the controller. With the human comfort research, the controller's appearance has changed a lot to prominent dual handle. It is suitable for both hands gradually and it is becoming more and more humanized as the new type controller in Fig.4.



**Figure 3.** The model evolution of Video Game Controller.



**Figure 4.** This is the new type Video Game Controller which is suitable for both hands. Based on Human-Machine-Integration theory, the controller is designed to fit the shape of hand and gain the success of performance.

### 4. Design key points and main characteristics

Human-Machine-Integration theory is about the product shape fits the human body, and it is a form design pattern combined form beauty and function value. The research of Human-Machine-Integration theory will help us broaden our design vision and strengthen our ability to create new form. The product's specific function and operating status must be deeply understood when track to the Human-Machine-Integration design. And the basis point is the interaction between the user and the product.

#### 4.1. Design key points

Human-Machine-Integration form design's key points are as follows:

- The designer must comprehensively consider contact parts form and contact area and the harmonious relationship between forms of contact parts and overall product. Then the model of product is finally determined. The system is composed of this three. Any one's change will affect the other two parties and will ultimately affect the Human-Machine-Integration form of the product.
- The Human-Machine-Integration form include the Convex-concave match of product part and body part to complement each other and tolerance match of product part is contacted with the human body part to accommodate each other. The type of Human-Machine-Integration should be ensured according to the different operating state. Then the corresponding design is carried on.
- When design the overall form based on Human-Machine-Integration theory , the purpose of form should be fully considered. The designer needs to combine specific function with the corresponding aesthetic form to make a systematic design.

#### *4.2. Main characteristics*

Therefore, the main characteristics of Human-Machine-Integration design are listed as the following: Correspondence, Integrity, Systematicness and Independence.

- Correspondence can also be called as' coordination. It is refers to the corresponding relationship to each other between human and machine such as concavo-convex relationship, embedded relationship, tolerance relationship, etc. This is the most basic morphological characteristics of Human-Machine-Integration. A product with good Human-Machine-Integration form has good human-machine interaction relationship and high cooperation degree.
- Integrity includes two aspects. The one is that as a product with good Human-Machine-Integration design, the conjunction part and contact parts of users should correspond to each other to get a whole. At the same time conjunction part is a part of the entire product, and the products including conjunction parts is a whole.
- Systematicness means Human-Machine-Integration design is not the design that separately considers function value, but the synthesis combined with function value and aesthetic value. It's a systematic design.
- Independence refers to the fit part has its own function and form characteristics, so it is relatively independent individual. Finally all individuals are unified in the whole product.

#### **5. Design cases**

Product is created to improve the human life. Design from the perspective of Human-Machine-Integration can guide the design of industrial products and seek for solutions and design ideas for products. It's a new product design thought to look for embodiment of Human-Machine-Integration in various sorts of modelling form and interaction of product and user and to apply into practical design. There are some practical design cases by my students as follow in Fig.5, Fig. 6 and Fig. 7.

	<p><b>Figure 5.</b> The picture shows the design of walking aid 's handrail. Walking aid is designed for disadvantaged groups to help them walk. The handrail is the part that the hand holds the walking aid. According to the Human-Machine-Integration theory, the shape of handrail is designed as picture shows.</p>
	<p><b>Figure6.</b> The design is for fingerprint identifier. The user put his or her thumb on the interactive surface of fingerprint identifier, and then the identifier give the result. The place where the thumb contacts the interactive surface is designed with correspondence to the shape of thumb to give a sign to use the machine.</p>
	<p><b>Figure 7.</b> Child amblyscope is the product that cures children amblyopia which is more and more common among children nowadays. The part that put the face on is designed in cooperation with child's face and eyes. So it is easy for child to judge how to find the place before the medical instrument.</p>

**6. Appendices**

Human-Machine-Integration design concept fully considers the function value and use condition of the product. It regards the man - machine – environment as a whole body instead of only considering the product itself. The traditional Chinese design thought that implement is used by people and it is an extension of the human body also embodies the design concept of Human-Machine-Integration. Form is the carrier of function. Human-Machine-Integration design concept extends the morphological function to the operation process of product and deepen the function of the form. So it has certain practical significance to the system design of the product.

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