

# Research on Computer Wireless Network Assisted Industrial Design in Human-Computer Interaction

Shide Shao (✉ [furijinwen48036@163.com](mailto:furijinwen48036@163.com))

suqian university

Wei Chang

suqian university

---

## Research

**Keywords:** Human-computer interaction technology, shape design, computer-aided industrial design

**Posted Date:** May 22nd, 2020

**DOI:** <https://doi.org/10.21203/rs.3.rs-30338/v1>

**License:** © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

# Abstract

With the introduction of computer-aided industrial design into industrial design, it has brought huge economic effects to people's production and life. Especially for enterprise companies, computer-aided industrial design has shortened the cycle of enterprise research and development, and at the same time improved the quality of products. However, in the information age, effective and timely communication of information is very important. How to achieve computer-aided industrial design and human error, timely and effective communication has become a research focus and difficulty. At present, the research on computer-aided industrial design of human-computer interaction is limited to the research of interface design and virtual simulation technology, and there are few research and innovations of theoretical methods. This article will explore computer-aided industrial design in human-computer interaction technology. This paper will specifically analyze the user target drive and user behavior driven design methods and give detailed steps and methods of computer-aided industrial design based on human-computer interaction. At the same time, this paper proposes a method of adding form design to man-machine performance in the computer man-machine form design, and then proposes product shape design based on data information. At the same time, based on this, the morphological man-machine design information space is constructed. Experiments show that the design method proposed in this paper has a good performance advantage in computer-aided industrial design of human-computer interaction.

## 1. Introduction

The development of industrial design has gradually turned to the development of computer-aided industrial design. Computer-aided industrial design benefits from the establishment of computer graphics theory and the rapid iteration of computer hardware and software. It is mainly based on digital platform, modern enterprise application computer. Auxiliary industrial design software can greatly shorten the cycle of product development and improve the quality of products[1]. However, with the rapid development of information technology, the performance of computational aided industrial design in human-machine performance is not satisfactory. How to make the computer-aided software of industrial design and users communicate more effectively and clearly in human-machine communication. Development direction and technology hotspots[2]. Human-computer interaction technology is a technology to solve the communication between users and machines or software. Its form and quality are important factors affecting human-computer performance[3]. It is the product of the intersection of computer science and cognitive psychology, and it also absorbs The technical achievements of the disciplines such as linguistics and ergonomics are also attributed to sociology within a certain scope [4]. Human-computer interaction technology can't be separated from two major themes: interface technology and virtual simulation technology. Interface technology is closely related to multimedia technology, communication technology and artificial intelligence technology[5]. It is a fusion of multiple technologies, and virtual simulation technology is also integrated. A large number of computer technologies. Therefore, based on the above analysis, it is meaningful to integrate human-computer interaction technology into computer-

aided industrial design and optimize its human-computer interaction technology to make its man-machine performance better. At the same time, it is also the imperative for computer-aided industrial design development[6]

In the research of computer-aided industrial design human-computer interaction technology, researchers at Zhejiang University have proposed integrated ergonomics simulation analysis method, whose main advantage is to establish static and dynamic analysis of man-machine. Model, but its modeling is too complicated[7]. Researchers at Northwestern Polytechnical University proposed an auxiliary design model based on ergonomic performance evaluation results. The main technology based on it is CAD direct access technology, and the application of this technology in modeling scope There are drawbacks in sex[8].

This paper will specifically analyze the user target drive and user behavior driven design methods and give detailed steps and methods of computer-aided industrial design based on human-computer interaction. At the same time, this paper proposes a method of adding form design to man-machine performance in the computer man-machine form design, and then proposes product shape design based on data information[9]. At the same time, based on this, the morphological man-machine design information space is constructed. Experiments show that the design method proposed in this paper has a good performance advantage in computer-aided industrial design of human-computer interaction. This article will make the following arrangements[10]. In the second section, this paper analyzes the application of human-computer interaction technology in computer-aided industrial design and analyzes the relevant principles. This paper analyzes the optimization strategy of human-machine shape design in the third section, based on The above theory constructs the human-computer design information space. In the fourth section, the design of the model platform applied by the above theory is given and the results and analysis are given. The fifth section will summarize the content of this paper[11].

## **2. Application Of Human-computer Interaction Design In Computer-aided Industrial Design**

### *2.1 Human-computer interaction and computational aided industrial design*

Human-computer interaction technology and computational-assisted industrial design technology are the products of the rapid development of computer technology and information technology. They integrate many disciplines such as artificial intelligence technology, communication technology, and graphics processing technology. The principles will be discussed separately below[12]:

#### 2.1.1 Human-computer interaction technology

Human-computer interaction technology enables products to solve problems in people's daily life quickly and effectively, and at the same time pays more attention to the user's comfortable user experience when using products. It consists of two phases, the input phase and the output phase[13].

Human-computer interaction design must follow three elements, the specific content is as follows:

users: In real life, each individual can become a user of a certain product. The user determines the start and end points of the interaction process, which plays a leading role in the communication between the entire user and the object[14].

medium: In all daily consumer goods, the interface corresponding to human-computer interaction or a fixed object called the interaction behavior bearer is also called medium.

Process: The user applies a purposeful behavior or operation to the medium to achieve the desired purpose of the user. Such an operation process to achieve the goal is called a human-computer interaction process[15].

The process of human-computer interaction can be subdivided into input and output processes. Both humans and machines have many forms of input and output. At the same time, these inputs and outputs are matched one by one according to a certain logic, which is transformed into a variety of interactions. Way, based on this, the way of human-computer interaction can be roughly divided into five types as follows[16]:

#### 1) Action interaction

It is the earliest human-computer interaction mode. The early keyboard typing and remote control of household appliances such as TV sets are such interactive ways. In the information age, the somatosensory interaction mode has become a new action interaction mode, which can recognize human actions. And the expression changes, this is a technological breakthrough in the past simple mechanical interaction.

#### 2) Voice interaction

The voice interaction mode is an artificial intelligence-based interaction mode. In this mode, the user can naturally communicate with the product, and the product is more anthropomorphic, which eliminates the sense of distance between technology and users.

#### 3) Visual interaction

Visual interaction is to understand the command according to the movement of the person's line of sight, and to perform related operations. The main purpose is to use the visual tracking technology to record the change track of the human eye through a large number of special cameras to realize communication with the machine. Representative as Google Glass, as shown in Figure 1:

#### 4) Virtual reality technology

Virtual reality technology is a high-end human-computer interaction technology, which is mainly based on the fusion of augmented reality and real world, which allows users to operate real products, which are 3D

scenes simulated by computer image technology[17].

#### 5) Augmented reality interactive technology

Its integration with the real world is also true and illusory. Its main products, such as training machinery maintenance augmented reality technology, can display the computer-generated image overlay on the mechanical equipment that the user sees. The specific shape is a helmet, user. Any part of the eye that the eye sees, the helmet will identify the part and guide the user through the repair work[18].

#### *2.1.2 Computer Aided Industrial Design*

Computer-aided industrial design is realized based on the digital platform. It integrates scientific thinking with artistic thinking, and integrates science and technology into artistic thinking, making the whole designed product more humanized and scientifically rigorous. Computer-aided industrial design technology mainly includes computer-aided shape design, computer-aided color design, computer-aided human-machine related, computer-aided evaluation design and other related technologies[19].

Computer-aided industrial design is increasingly becoming more and more integrated with CAD technology, and it has become the mainstream of industrial product design. Research on auxiliary industrial design in auxiliary objects, auxiliary strategies and auxiliary methods has also become a hot topic. Figure 2 shows the flow chart of human-machine auxiliary objects in computer-aided industrial design. The current human-machine computer-aided industrial design software is still independent software, and its output is only for designers and requires manual processing by designers to be converted into Auxiliary data for analysis.

The main process of computer-aided industrial design is to combine the efficiency and flexibility of CAD technology with creativity to ensure product design success. There are mature technologies and programmatic design work in the field of human-machine design, which is the advantage of computer-aided industrial design compared to manual design. CAD technology has been able to take over this part of the work, but there are still more scattered design tasks in the field of human-machine design. These design tasks have no unified mode for processing, and basically belong to the step-by-step state, so the computer is in progress. Manual adjustments and data output are required after the auxiliary design, and the manual is still irreplaceable in this process. The principle of product design differs from traditional physical principles, which is a probabilistic principle that derives from the probabilistic nature of the product user and the mode of use.

The key to computer-aided industrial design is to establish a system method that conforms to the characteristics of human-machine design, and specifically becomes the drive design and mapping rule of product form.

#### 2.2 Application of human-computer interaction in computer-aided industrial design

The application of human-computer interaction in industrial design is essentially a design method for people and products and their use behavior. It is not limited to product styling, functions and processes, and more attention is paid to the user experience generated by the product.

The main application method of human-computer interaction technology in computer-aided industrial design is user-centered interaction design method, which is divided into user-driven interaction design method and user behavior-driven interaction design method. The user-centered interaction design is based on the user's experience. During the use of the product, the designer cannot communicate face-to-face with the user. The communication between them can only be carried out through the product. This method can help the designer to accurately locate the user's needs at the beginning of the design, and ensure that the designed product achieves certain effects under the guidance of the user's needs.

The main idea of the user-driven interaction design method is that it believes that the industrial product design should meet the user's expectations. The most critical part is to find the user's target. The user's goal is not a simple superposition of functions or tasks. The necessary conditions for users to achieve their goals are mainly divided into research phase, modeling phase, definition requirement phase, definition framework phase, refinement phase and test modification phase. The definition of the requirements phase is the core part of the human-computer interaction design method, which requires a lot of human effort.

The user behavior-driven interaction design method takes the user's behavior as the first production factor, and does not pay attention to the product in the design process. The focus is on the usage behavior when people use the product. This design method is suitable for product comparison. The complex stage is divided into the user model setting stage, the user model behavior mode analysis stage, the build product prototype stage, the prototype usability test stage, the method iteration and improvement stage, and the design output stage. It is by setting the user model. The analysis of the user model and the establishment of product prototypes can basically solve the problems of interaction behaviors that occur during the user's use, which is beneficial to the designer's design work.

Based on the above analysis, the application steps of human-computer interaction technology in computer-aided industrial design can be as follows: clear requirements, conceptual design, prototype design, usability testing, and design release. The following steps should be followed in the specific design method: Figure 3 corresponds to the concept of simile, behavioral metaphor, functional simile, structural metaphor.

## **3. Methods**

### *3.1 Product form man-machine information*

#### *3.1.1 Morphological role and interaction channel of human-computer interaction industrial products*

The form of the product can be understood in a broad sense as the material characteristics that the product can be directly perceived by the user and obtain information from. According to these characteristics such as color, sound and material and corresponding dynamic features, the function of the product and the user's interaction can be realized. The corresponding schematic diagram is shown in Figure 4.

The form of the product is a medium for completing the product function carrier and human-computer interaction. When the user uses the product, the user obtains the information from the product and performs corresponding operation behavior according to the information, and drives the product to generate the function required by the user, and passes the product form. Feedback verification of functional results.

The human-computer interaction channel of the product is mainly communicated through visual information, sound information, position channel, and digital channel. The "digital channel" is a special channel, which is composed of the digital combination of the above-mentioned channel information. The user "processes" other channel information into digital information and then participates in human-computer interaction as input. Digital channels have been widely used in modern electronic products, becoming an important part of modern product man-machine design and an important basis for constructing human-machine information space. The human-computer interaction channel between its product and the user is shown in Figure 5.

The degree of utilization of the channel is affected by many factors, including the channel itself, as well as technical and economic reasons. In order to study the methods and tools of human-computer interaction design in more depth, it can define the content of human-computer interaction as a flow. The specific classification is as follows:

Table.1 Human-computer interaction flow

Stream category	Streaming content	Form of flow
Physical quantity	Material, energy	Force/tactile/sports
data	Information for accurate measurements	Digital channel
information	Difficult to measure information	Visual channel

Its corresponding role in human-computer interaction is shown in Figure 6.

### 3.1.1 Product shape design based on data information

The generation and development of product form is the result of the combination of internal process and external process. In the internal process, it is divided into four domains: demand domain, functional domain, conceptual domain and morphological domain. Each of the four domains corresponds to a product model. They are demand model, functional model, conceptual model and morphological model.

The goal of human-computer interaction in computer-aided industrial design is to find efficient and reliable auxiliary means to complete the sequential transformation of the four models. The premise of the transformation is that the four models must be clear and operable, and there is a unified structured mathematical model. The morphological design process is shown in Figure 7. The characteristics of the corresponding internal processes are mainly as follows: one-to-many mapping process, evaluation and selection process, and information implantation process.

The external process is a statistically based process based on phenomena. When the factors considered by the internal process are too complicated and difficult to simplify, then the external process is evaluated and judged. The characteristics of the external process are mainly composed of inheritance, mutation and mutation.

In the structure of the product design information space, encoding processing is required, which can perform the following three operations: finding the current position and the target position in the information space of the design problem, finding the best way to the same position from the current position, and finding The information and technical means needed to achieve this optimal approach. Using the degree of abstraction and coding two variables as the two axes of the information space, the corresponding structure of the information space and corresponding line chart of data performance indicatoris shown in Figure 8.

The area division of the man-machine information space and its corresponding histogram of data performance indicator is shown in Figure 9:

Various areas of the information space correspond to different knowledge and information support.

On the product design evaluation model,  $X_{ki}$  and  $P_{ki}$  are respectively the evaluation results and membership degrees of the  $K$ th criterion of the  $i$ -th design, and the corresponding formula should follow Equation 1:

$$\lambda' = \sum_i^{k=1} b^i x^i$$

(1)

The technical reliability factor can be obtained by the reliability theory as shown in Equation 2:

$$x_i = R_i = \prod_{j=1}^n \prod_{k=1}^m R_{jk}$$

(2)

## 4. Experience

Based on the above, the human-computer interaction design of the product form has been elaborated and analyzed. The basics can be summarized as follows: In computer-aided industrial design, human-computer interaction needs to be simplified under the premise of maintaining the basic shape of the product. In a form that can be expressed in a simple manner, the simplified product form can reflect various elements of human-machine design. Based on the above principle, this paper designs a product form man-machine design prototype system, and its corresponding system work flow is shown in Figure 10.

The system first designs the shape and attitude of the object under the measurement data of the object, and then performs parameter calculation to obtain the size data related to the object. After the relevant parameters are determined, the design parameters of the object are associated with the size parameters of the associated related objects, so that the product shape driving design of the object can be realized. Finally, the parameters of the object are obtained according to the drive calculation and modeled to obtain the shape of the object. Using the genetic algorithm, the design program selects the optimal design according to different human-computer interaction postures and selects the scheme for the user to select. This paper is based on the Solidworks modeling system for the prototype design of related objects. Here, taking the mobile phone as an example, the corresponding multi-dimensional design effect diagram is shown in Figure 11.

The corresponding nonlinear and linear prediction results are shown in Figure 12. The corresponding line graph and area map analysis are shown in Figure 13.

The above data is sampled data, and the amount of data collected is 9 groups. The corresponding nonlinear model is compared with the data of the linear model. The proposed shape design has good performance and indicators. It can be seen from the figure that the shape of the object based on the mobile phone can be multi-modular design through the software platform proposed in this paper, and several optimized schemes are selected for the user to select.

## 5. Results And Discussion

This paper analyzes the human-computer interaction design and the principle of computer-aided industrial design and the corresponding fusion application. Based on the application of current human-computer interaction design in computer-aided industrial design, this paper proposes a method of adding morphological design to human-machine performance. A product shape design based on data information is proposed. At the same time, based on this, the morphological man-machine design information space is constructed. Experiments show that the design method proposed in this paper has a good performance advantage in computer-aided industrial design of human-computer interaction.

## List Of Abbreviations

## Declarations

## Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Competing interests

We have no competing interests

**Fund Project:** This article is one of the achievements of Shao Shide's 2019 Industry-University-Research Project "UI Interactive Design and Applied Talent Practice Base Construction" (Project Number: 201901293015)

## References

- [1] Chen R, Hua Q, Ji X, et al. An Interactive Task Analysis Framework and Interactive System Research for Computer Aided Diagnosis[J]. IEEE Access, 2017, PP(99):1-1.
- [2] Hinsien K. Digital Scientific Notations as a Human-Computer Interface in Computer-Aided Research[J]. Peerj Computer Science, 2018, 4(5).
- [3] Chen R, Hua Q, Ji X, et al. An Interactive Task Analysis Framework and Interactive System Research for Computer Aided Diagnosis[J]. IEEE Access, 2017, PP(99):1-1.
- [4] Filippi S, Barattin D. IDGL, an interaction design framework based on systematic innovation and quality function deployment[J]. International Journal on Interactive Design & Manufacturing, 2016, 10(2):119-137.
- [5] Emiris I. Research workshop on algebraic representations in computer-aided design for complex shapes[J]. Acm Communications in Computer Algebra, 2016, 49(4):134-134.
- [6] Feng X, Cai L, Wang W. Sandbox – An Operation Platform for Landscape Architecture Planning and Design Based on Computer Aided Manufacturing and Augmented Reality Technology[J]. Landscape Architecture Frontiers, 2017, 5(2).
- [7] Guo L. A system design method for cloud manufacturing application system[J]. International Journal of Advanced Manufacturing Technology, 2016, 84(1-4):275-289.

- [8] Bezhentsev V M, Tarasova O A, Dmitriev A V, et al. Computer-aided prediction of xenobiotic metabolism in humans[J]. *Russian Chemical Reviews*, 2016, 85(8):854–879.
- [9] Liang D, Wang Y, Li S, et al. Study on Dicyandiamide-Imprinted Polymers with Computer-Aided Design[J]. *International Journal of Molecular Sciences*, 2016, 17(11):1750.
- [10] D. Åkesson, Caitlin Mueller. Using 3D direct manipulation for real-time structural design exploration[J]. *Computer-Aided Design and Applications*, 2018, 15(1):1-10.
- [11] Wang J Q, Fan G Q, Yan F Y, et al. Research on initiative scheduling mode for a physical internet-based manufacturing system[J]. *International Journal of Advanced Manufacturing Technology*, 2016, 84(1-4):47-58.
- [12] Du L, Liu C C, Zhang Y, et al. A Single Layer 3D Touch Sensing System for Mobile Devices Application[J]. *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*, 2018, PP(99):1-1.
- [13] Shafik R A, Yang S, Das A, et al. Learning Transfer-Based Adaptive Energy Minimization in Embedded Systems[J]. *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*, 2016, 35(6):877-890.
- [14] Yu Z, Wang J, Eeckhout L, et al. QIG: Quantifying the Importance and Interaction of GPGPU Architecture Parameters[J]. *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*, 2017, PP(99):1-1.
- [15] Wang S, Wu B, Wu Y. Survey on Perception Enhanced Flow Visualization[J]. *Journal of Computer-Aided Design & Computer Graphics*, 2018, 30(1):30.
- [16] Chiacchio F, D'Urso D, Compagno L, et al. SHyFTA, a Stochastic Hybrid Fault Tree Automaton for the modelling and simulation of dynamic reliability problems[J]. *Expert Systems with Applications An International Journal*, 2016, 47(C):42-57.
- [17] Pantoja R R, Howes M J, Richardson J R, et al. A large-signal physical MESFET model for computer-aided design and its applications[J]. *Microwave Theory & Techniques IEEE Transactions on*, 1989, 37(12):2039-2045.
- [18] Chen X, Lu X, Wei W, et al. Computer-aided design and manufacturing of surgical templates and their clinical applications: a review[J]. *Expert Review of Medical Devices*, 2016, 13(9).
- [19] Decou J M, Timberlake T, Dooley R L, et al. Virtual reality modeling and computer-aided design in pediatric surgery: applications in laparoscopic pyloromyotomy[J]. *Pediatric Surgery International*, 2002, 18(1):72-74.

# Figures



Figure 1

Visual interaction technology and Gesture interaction technology

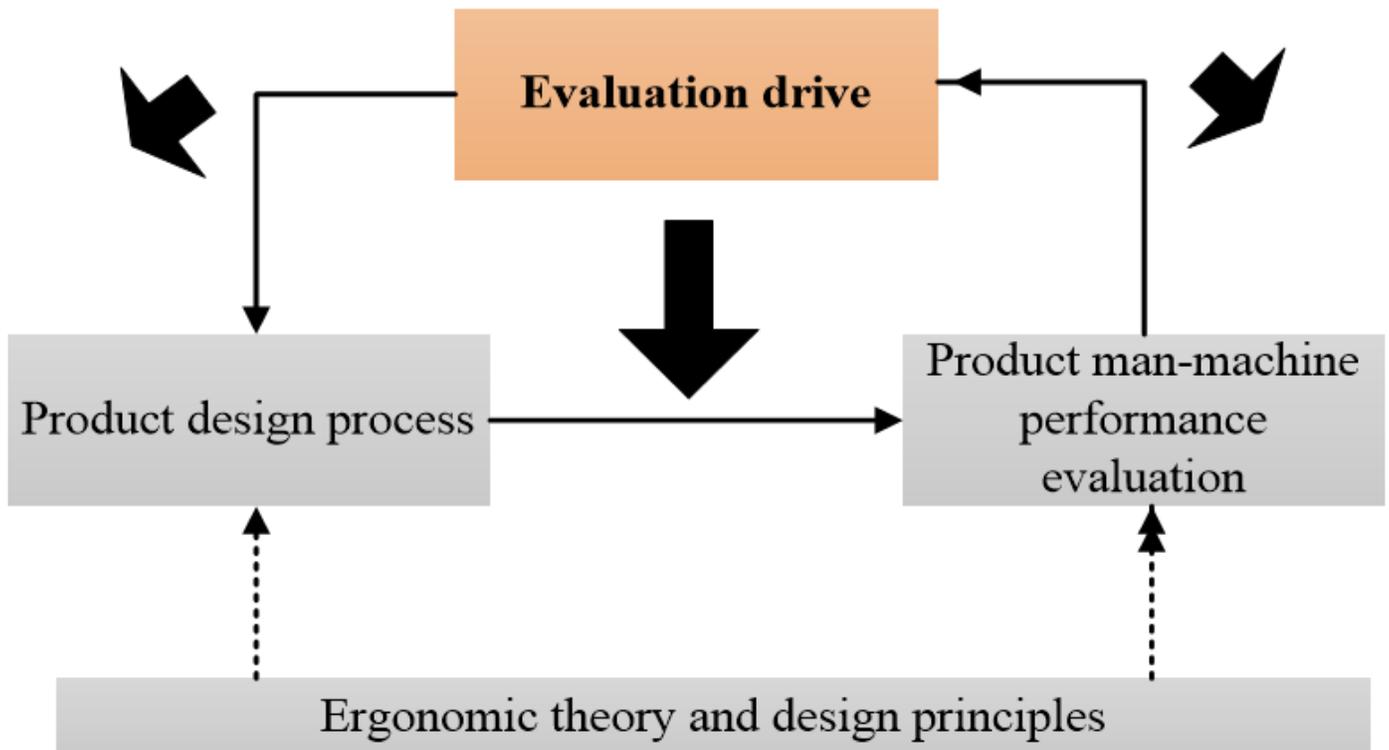


Figure 2

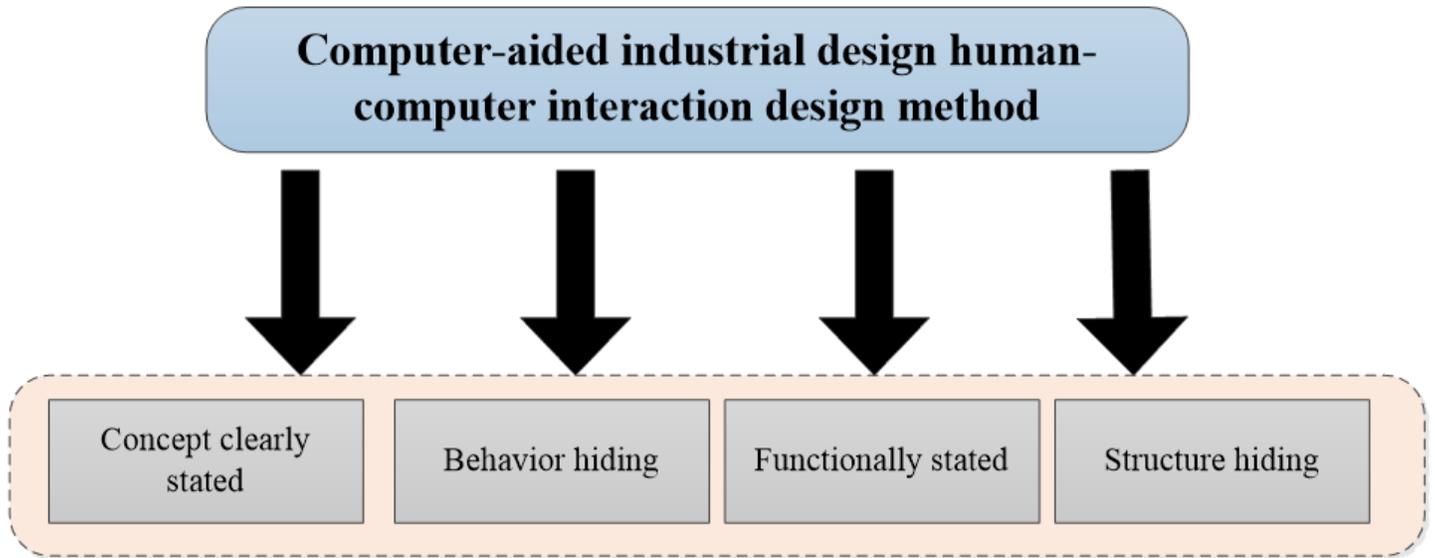


Figure 3

Application method of human-computer interaction technology in computer aided industrial Design

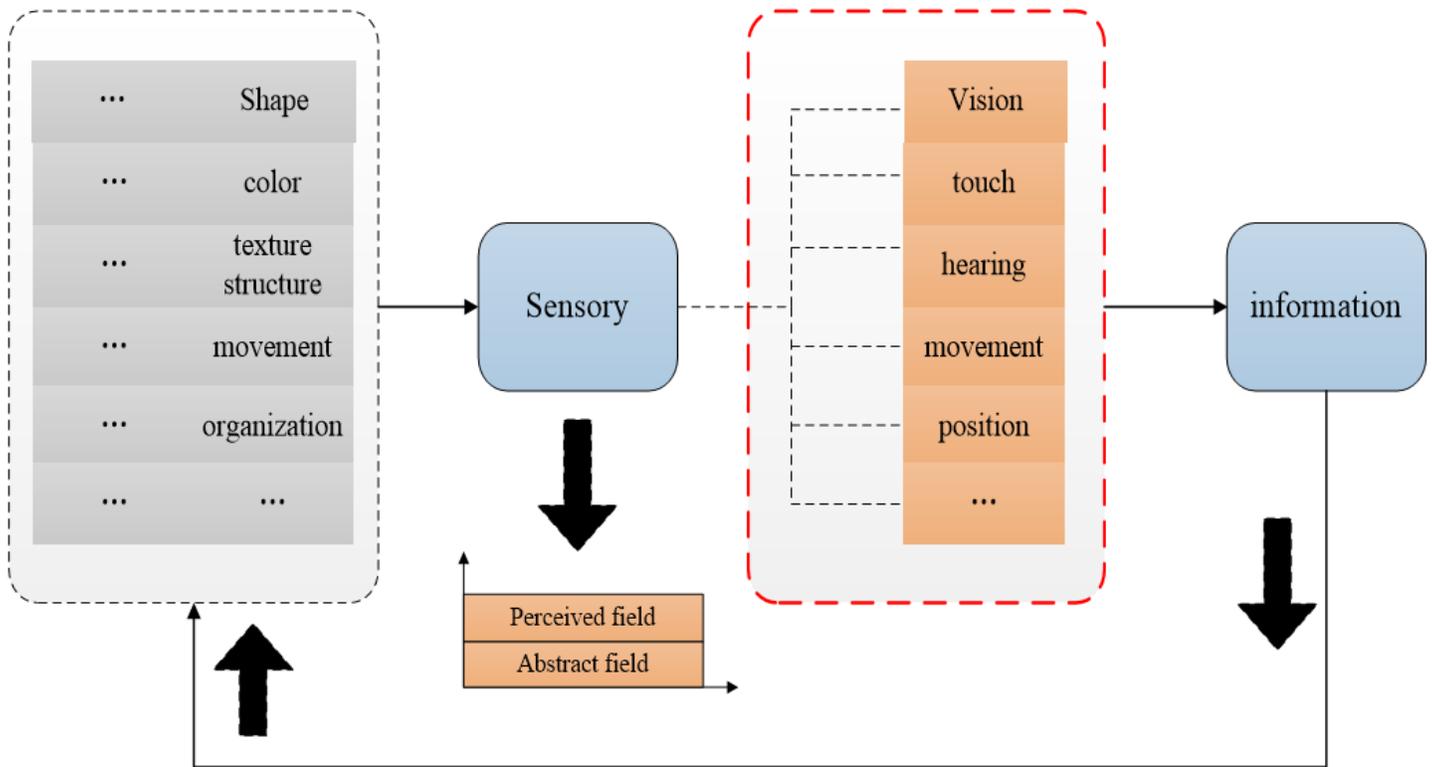
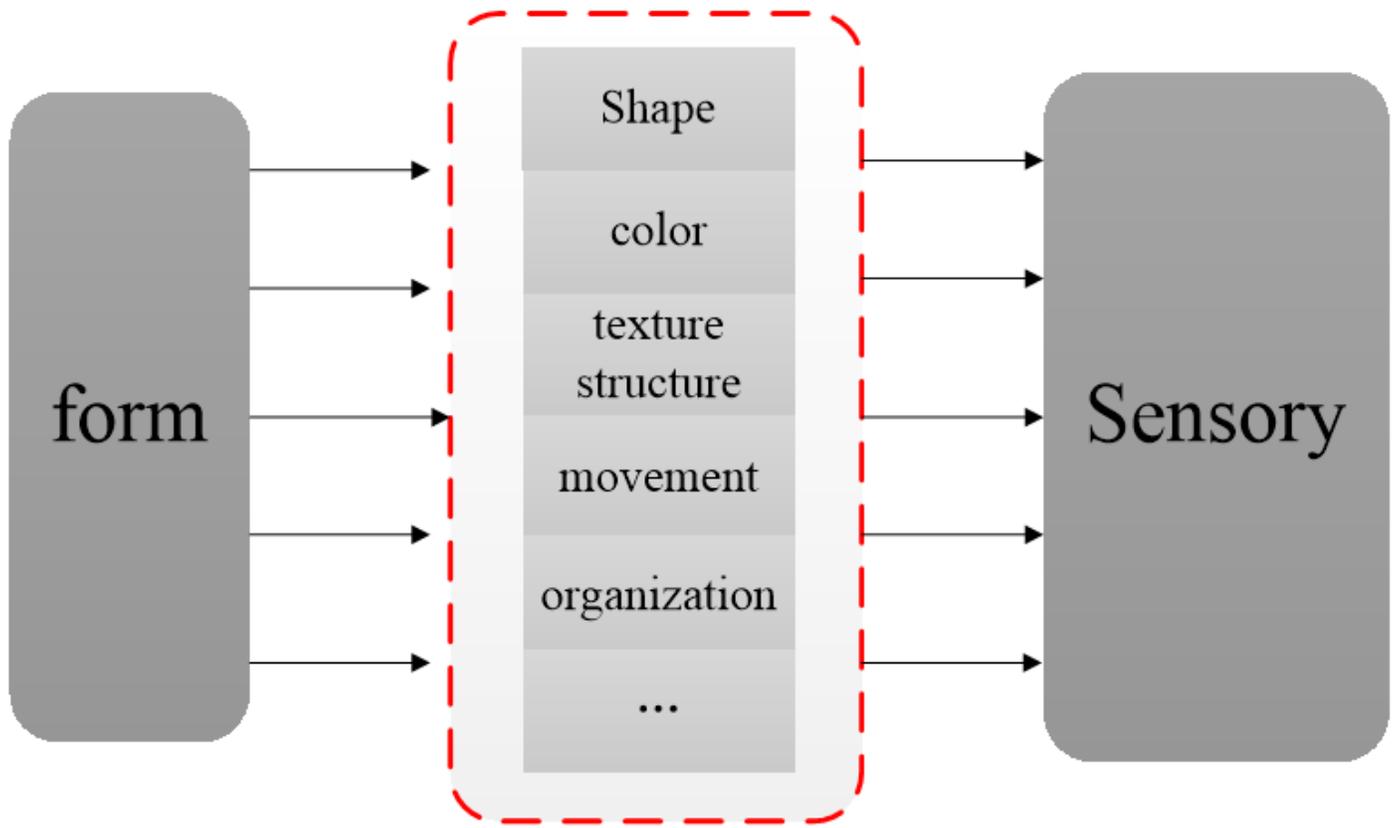


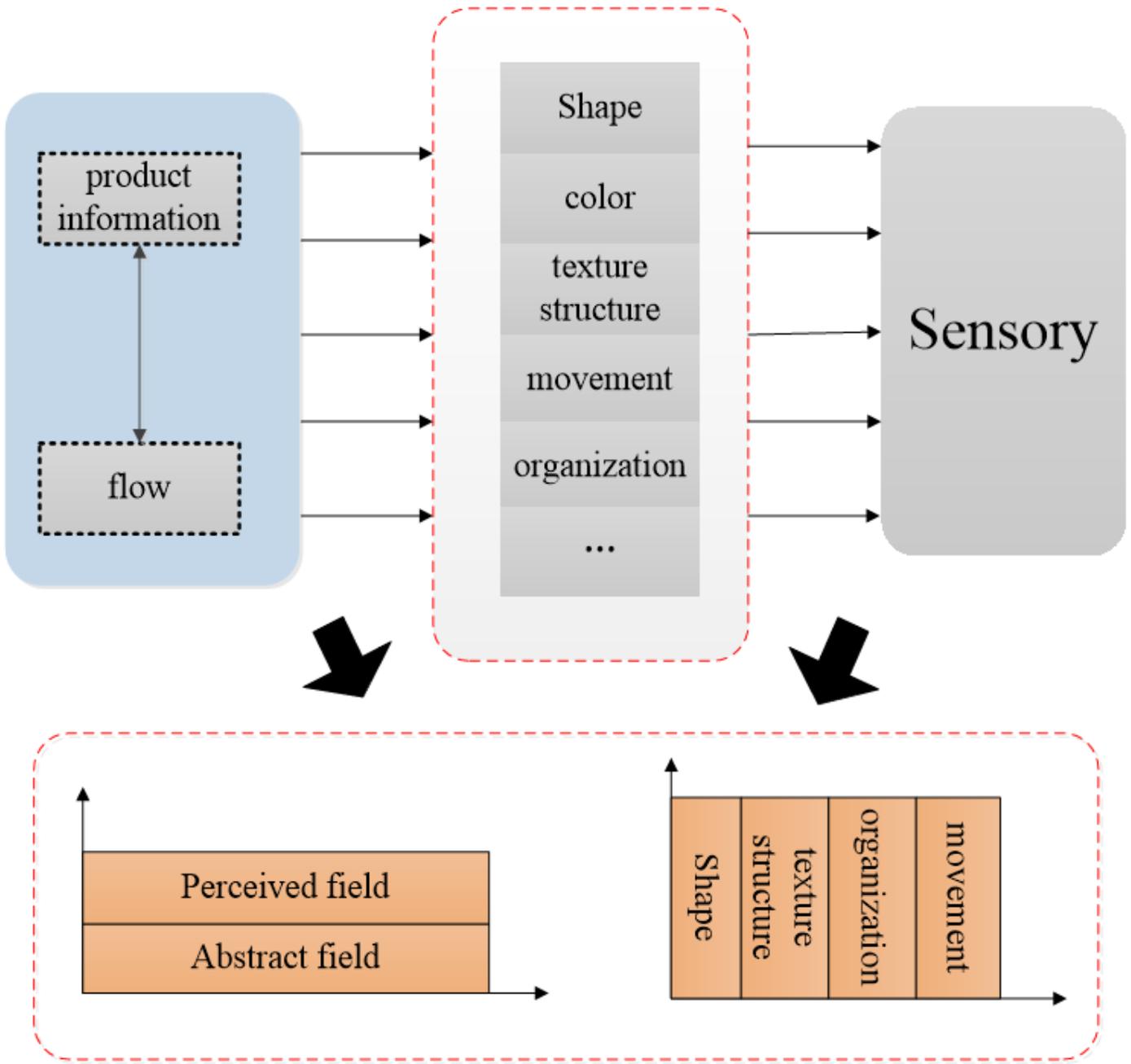
Figure 4

The corresponding schematic diagram



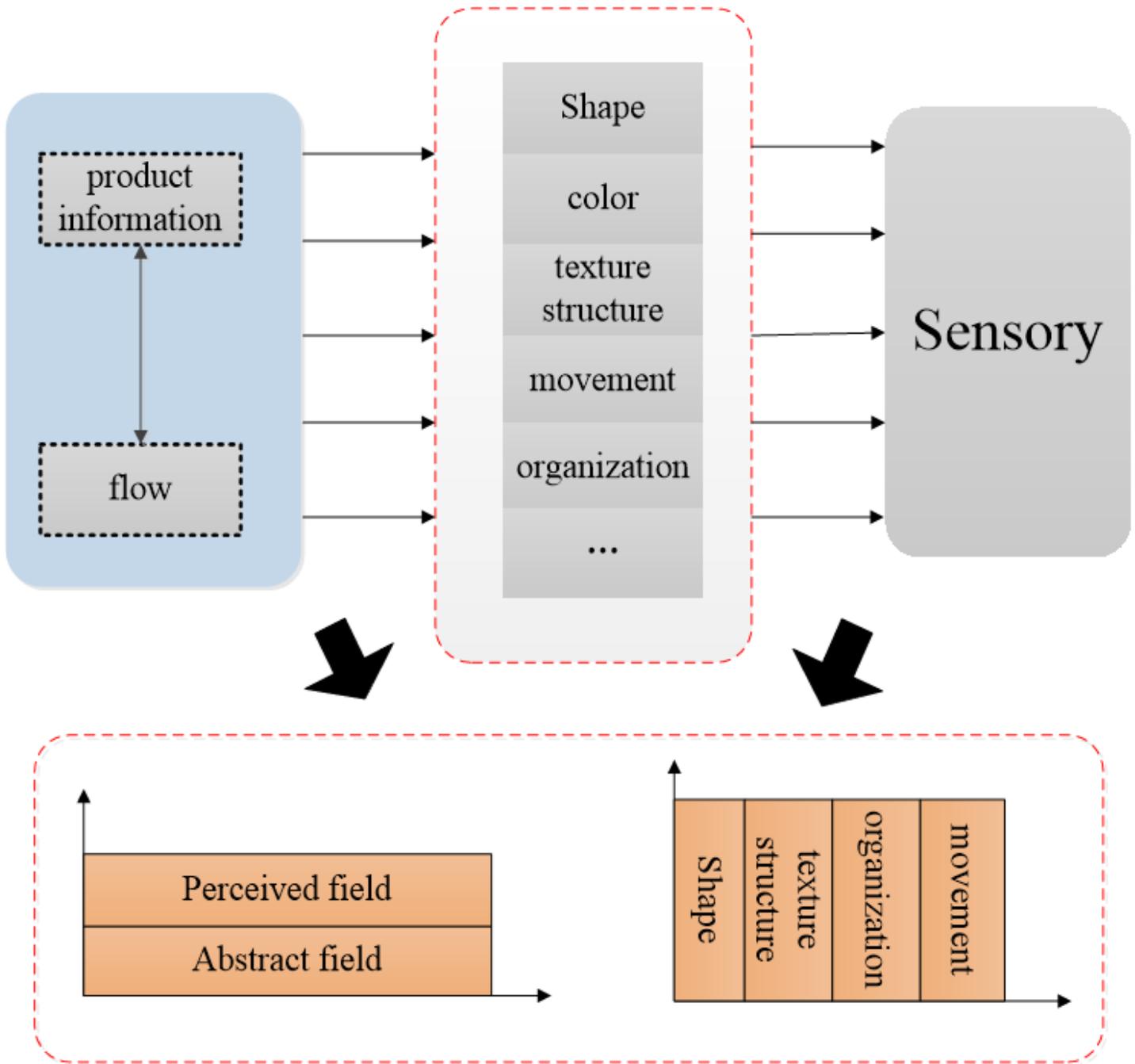
**Figure 5**

The human-computer interaction channel between its product and the user



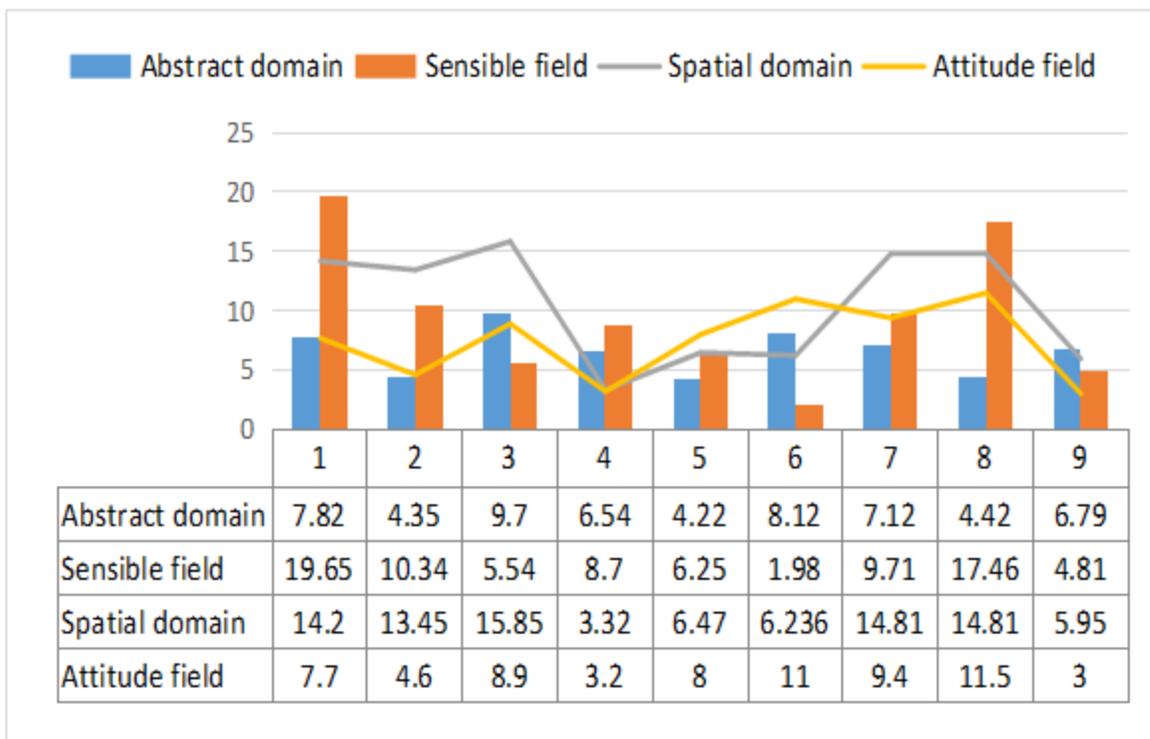
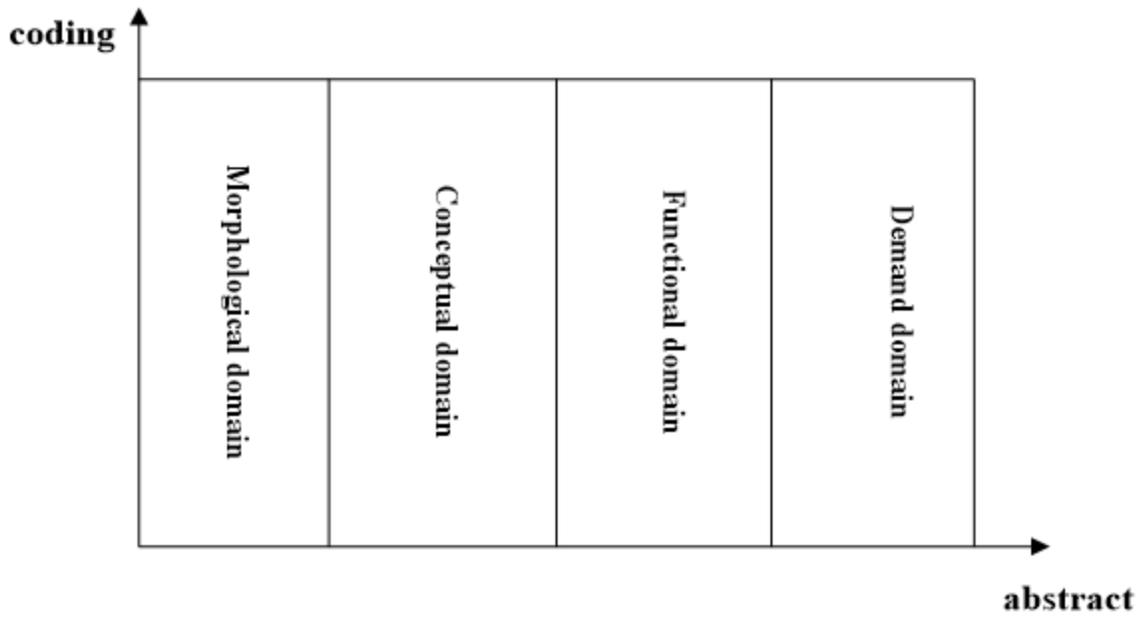
**Figure 6**

Corresponding role in human-computer interaction



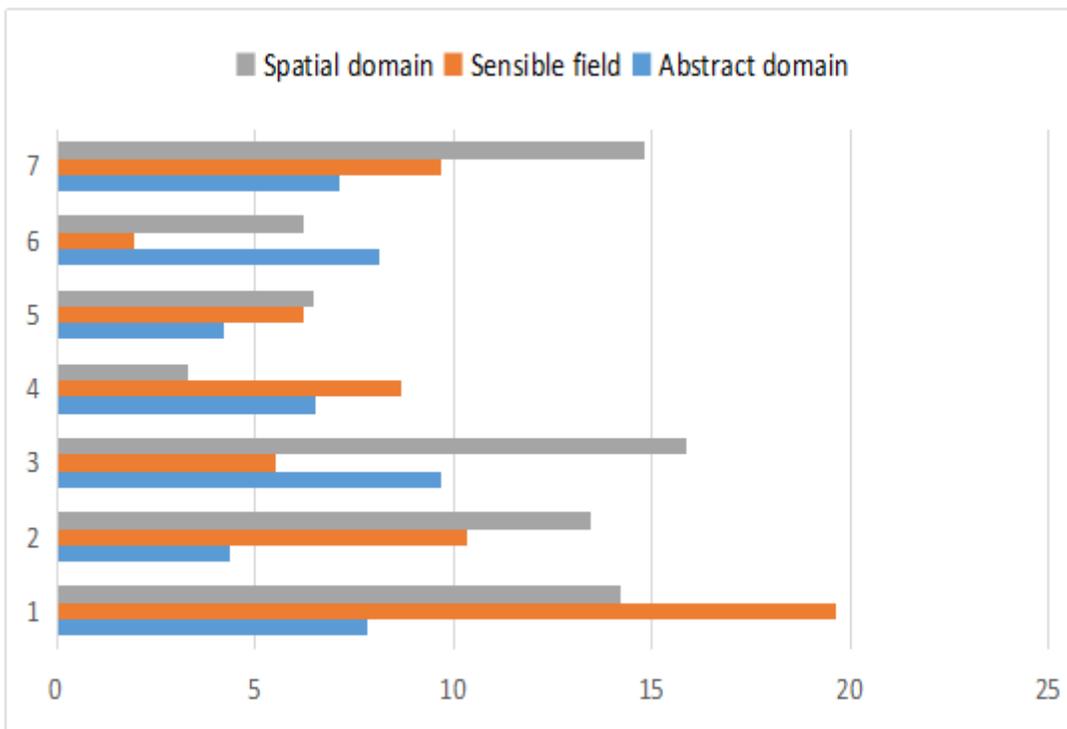
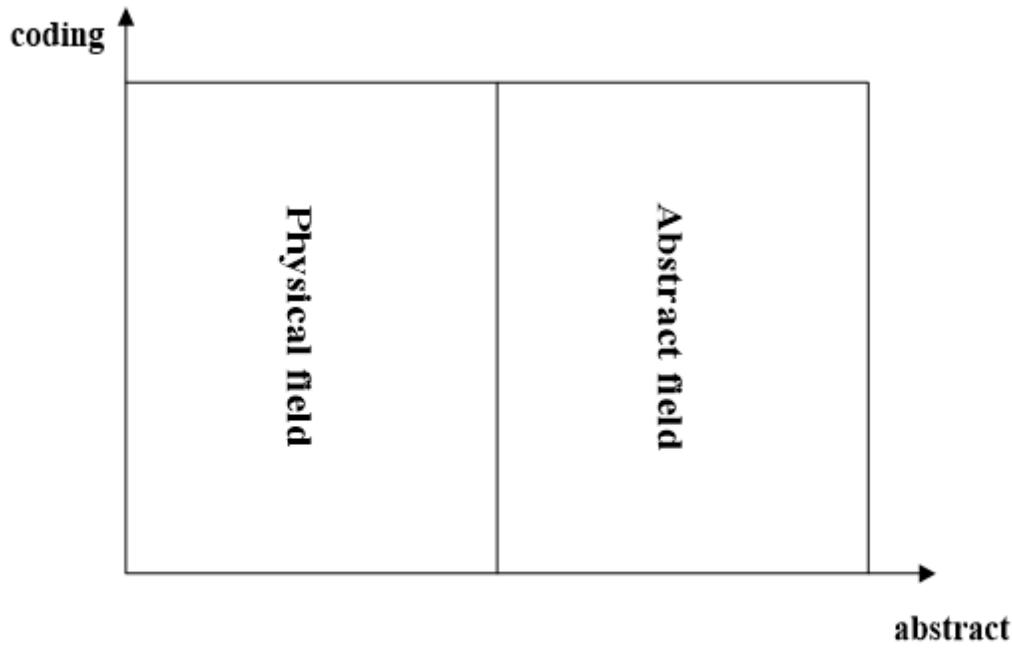
**Figure 7**

The morphological design process



**Figure 8**

The corresponding structure of the information space and corresponding line chart of data



**Figure 9**

The area division of the man-machine information space

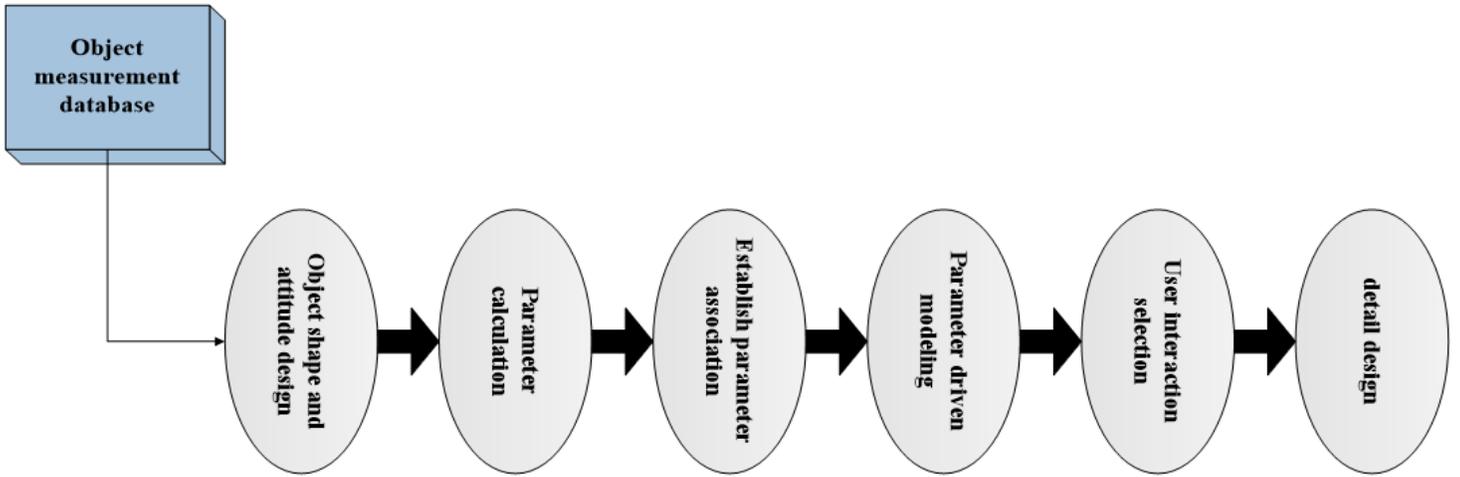


Figure 10

Corresponding system work flow

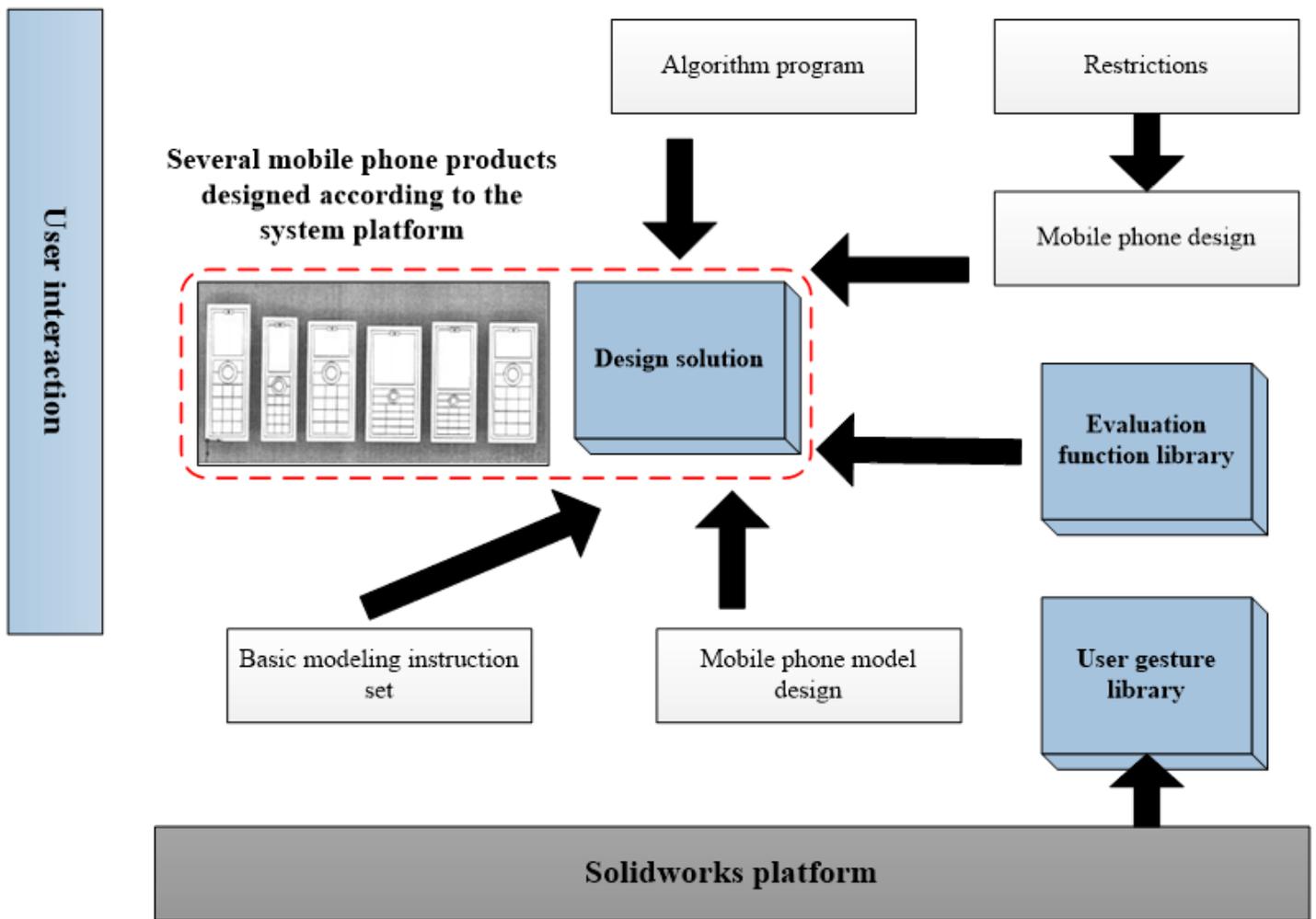


Figure 11

Several mobile phone products designed according to the system platform

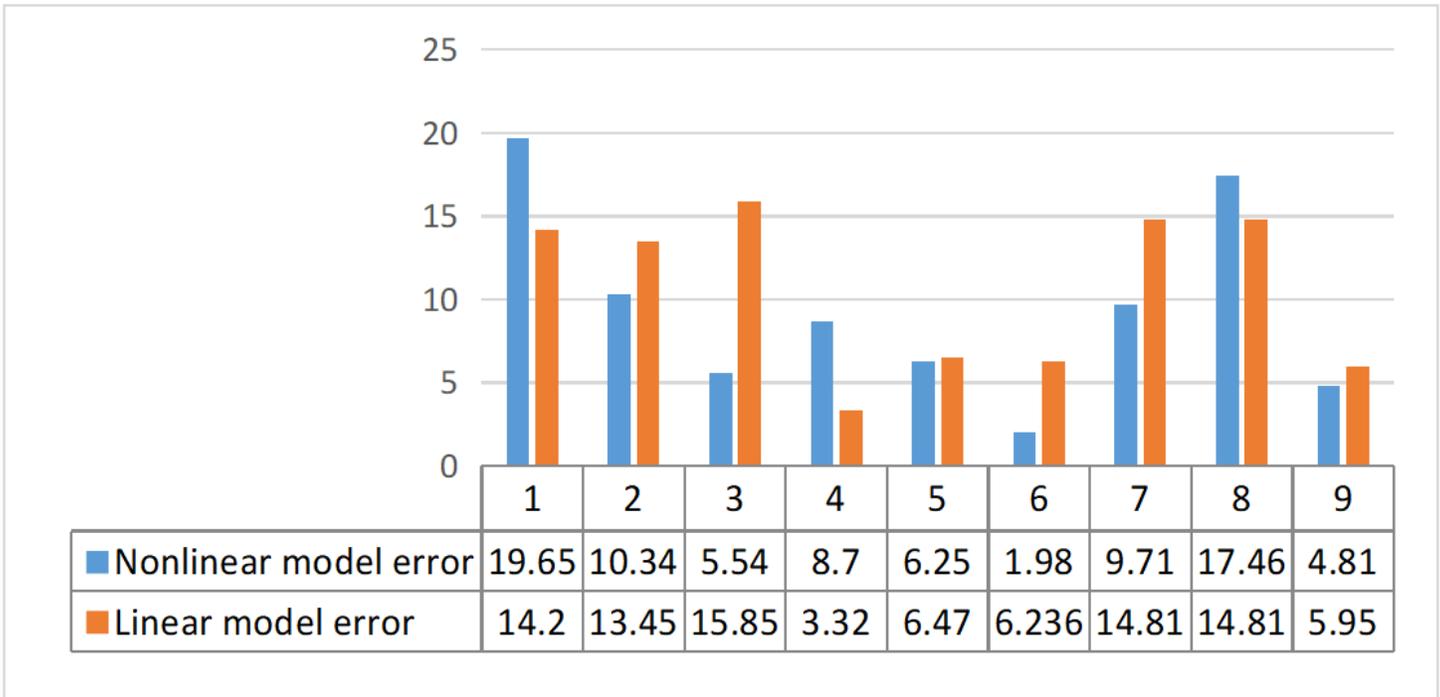


Figure 12

The corresponding nonlinear and linear prediction results

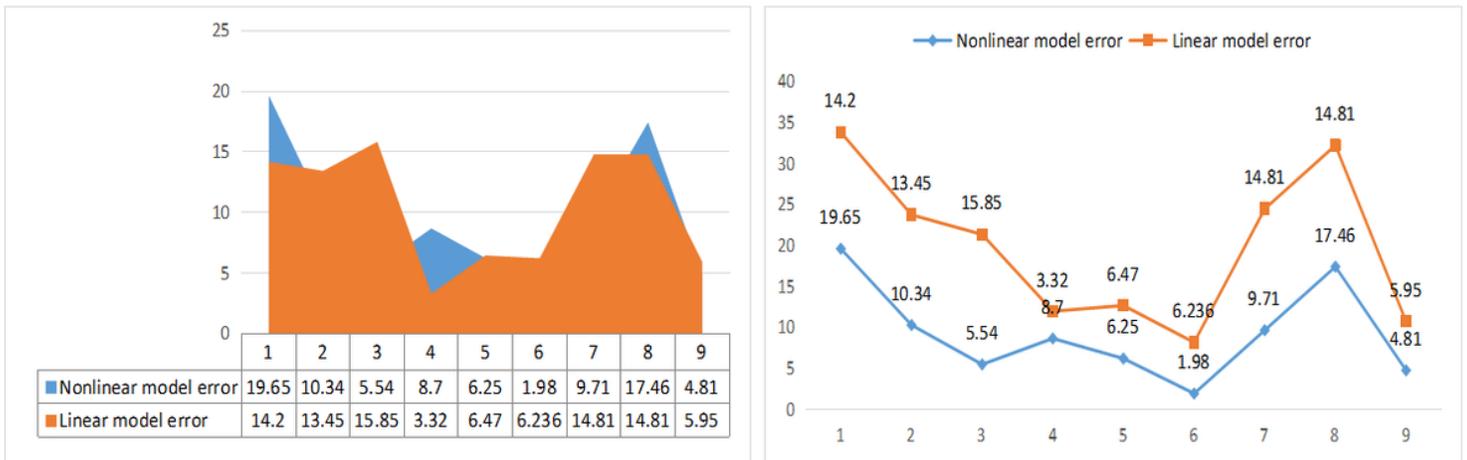


Figure 13

The corresponding line graph and area map analysis