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Research Article

Innovative Artistic Design of Nanomaterial Products Based on Intelligent Algorithm

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At present, algorithm technology has achieved very rapid development, and it is more and more widely penetrated and applied in people's production and life. Among them, product design based on intelligent algorithm has also been widely used. This technology plays an important role in promoting product innovation and design and contributes to the improvement and optimization of technology, showing very significant application benefits in the product design and development process of major enterprises. The application of intelligent algorithms in product design can not only make products more in line with customers' usage habits, but also products blessed with intelligent algorithms often have more commercial value. Therefore, in order to enhance the added value of commodities, innovative design of products has become a must. Nanomaterials must have unique properties that are unmatched by general building materials, such as high surface activity, strong oxidation, and superparamagnetic. This article mainly studies design strategies from two aspects, namely the innovation of material properties and application methods, and introduces the properties of nanomaterials, their application status, and the existing problems. And it starts from the application of intelligent technology in nanomaterial products, innovative design, and development prospects, combined with actual cases, to find a feasible way for the development of innovative design and research of nanomaterial products. On this basis, it is proposed that the idea of expanding the design should reunderstand and reposition the product design of nanomaterials and make the design more acceptable to more consumers. New design ideas and methods such as adjusting material properties through intelligent algorithms provide certain assistance and support for the application of intelligent algorithms in product design innovation practice. Some completed application practices are also presented to illustrate the rationality of the application of intelligent algorithms in nanomaterial products. The results show that the crowd search algorithm has the highest optimization degree and has good stability and optimization effect, and its standard deviation is the lowest close to 0.

1. Introduction

Materials are the material basis for human survival and development. In the 1980s, people regarded new materials, information technology, and biotechnology as important symbols of the new technology revolution, and it was considered to be one of the pillars of modern science and technology in the twenty-first century. As an indispensable element in product design, material innovation has formed a preliminary structure and system during the Bauhaus period in Germany. Common materials have many quality defects, which lead to serious constraints in product design. And nanomaterials are completely different. With its excellent material quality, it can play an important and unique role in fields that ordinary materials cannot. Nanomaterials are one of the most important directions for the development of new materials in the twenty-first century. With the development of nanotechnology, the innovation of material properties can not only maintain the basic properties of nanomaterials, but also make up for the deficiencies and shortcomings of their properties to a large extent. In the process of product innovation and design, the initial stage

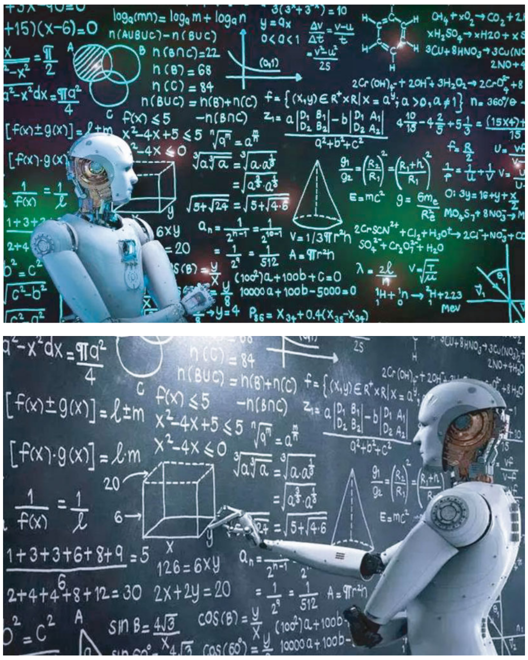


Figure 1: Artificial intelligence optimization algorithm diagram.

focused on divergent thinking and continued to expand outward with the design point as the center, seeking various possible design solutions.

Intelligent algorithm is based on intelligence and performs relatively fast global optimization, which can better simulate the initial design thinking in product innovation design. In the detailed design stage, the main focus is on convergent thinking, fully absorbing the design points of the excellent scheme and thinking in one direction. For the research and development and production of nanomaterial products, the innovation of product design and concept in the product development stage needs to meet people's objective requirements in a true sense, and at the same time, it must be implemented in the production process, so that it can be effectively realized. In this context, it is necessary to keep pace with the times and deeply study the design methods of nanomaterials. This paper makes full use of intelligent algorithm technology to lay a solid foundation for the research and development and innovation of new products, explore its new path for innovative practice, and effectively solve technical problems related to product design.

Based on the intelligent algorithm, the relationship between nanomaterial products and artistic design is discussed, the procedures and ways of applying intelligent algorithm to product innovation design are studied, and several algorithmic product innovation design models are proposed, and the development of an innovative design example system is one of the innovations of this paper.

2. Related Work

For the topic of "intelligent algorithm + nanomaterial products," some scholars have carried out research on it.

Yin got a highly ordered alumina obtained under ultrahigh vacuum (UHV) by NiAl(110) surface oxidation. He

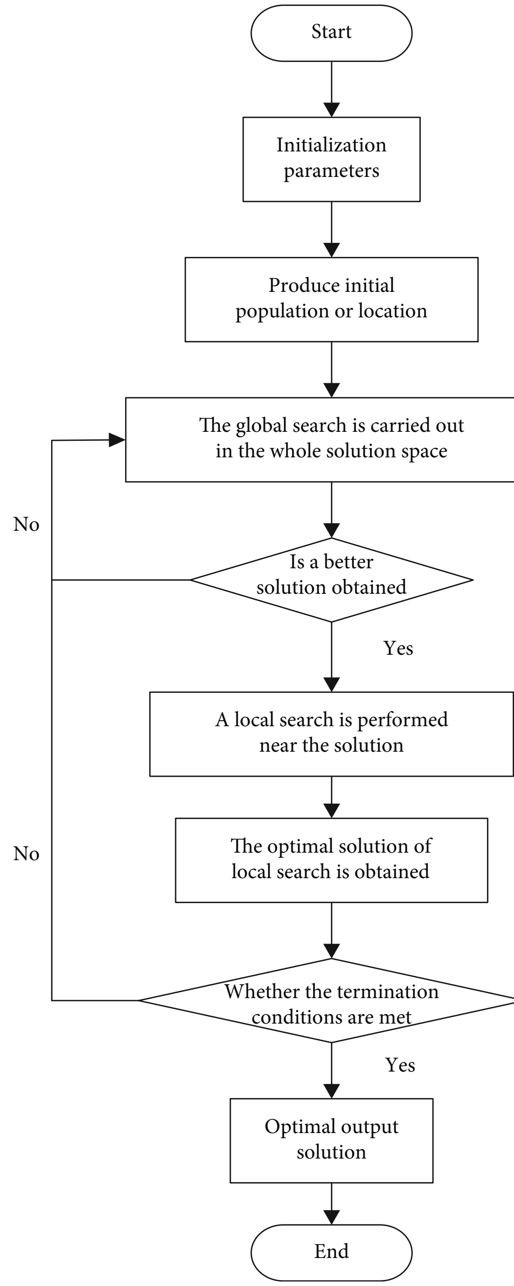


Figure 2: Basic flow chart of intelligent algorithm.

has coordinated UHV-type surface science and real-world experiments with amorphous aluminum oxide obtained by atomic layer deposition on silicon chips. He thoroughly characterized the Pt10 clusters through a combination of experimental techniques and theoretical analysis, showing the highest CO oxidation activity per platinum atom of CO oxidation catalysts. This catalytic system presents a coherent interdisciplinary picture [1].

Shivakumar investigated the 3-nm-thick boron layer in detail by preventing the interaction with the silicon substrate through a thin boron layer grown by chemical vapor deposition at 450°C. It forms the p-anode region of the PureB diode with zero metallurgical junction depth on the *n*-type silicon. Metals are deposited by electron beam-assisted

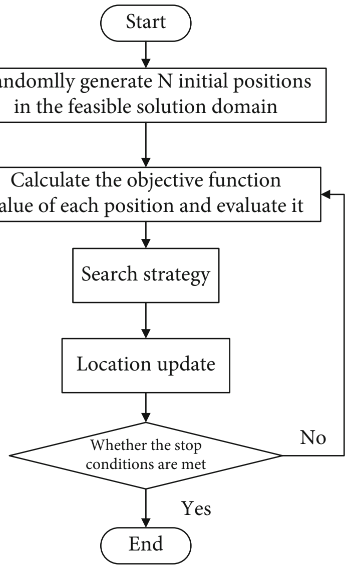


Figure 3: Solving steps of crowd search algorithm.

Table 1: The parameters of genetic algorithm.

Parameter factor	Physical description
Population size	N square grids
Neighbor structure	Moore
Update strategy	Linear scan
Selection operator	Select 2 adjacent positions of the individual
Crossover operator	Single point intersection
Crossover probability	P_c
Mutation operator	Nonuniform variation
Variation probability	P_m
Replacement strategy	Replace if the child is better than the parent
Genetic algebra	≤500
Termination conditions	User interaction experience

physical vapor deposition at room temperature and annealed at temperatures up to 500°C. It was verified by the nearly constant I–V characteristics of the PureB diodes and the microscopic examination of the deposited layers [2].

Agenor examined the interaction between access to finance, product innovation, and labor supply in a two-stage overlapping generational model of endogenous skill distribution and financial market imperfection. An ambitious policy aimed at alleviating the constraints on innovators' access to funding may allow a country to escape this trap by promoting idea generation and improving incentives for investment in skills [3].

Engelman aims to study the impact of intellectual capital on firm absorptive capacity and the impact of intellectual capital on product innovation. He believes that companies mobilize intellectual capital and other intangible assets through dynamic capabilities such as ACAP. He conducted a quantitative study, structural equation modeling, to verify the validity of structural and theoretical models. He found that intellectual capital does affect ACAP. His findings also show that ACAP affects product innovation, but each of its dimensions exhibits different effects [4].

Wang believes that product innovation not only enables organizations to introduce new products to the market, but also challenges organizations to update their technical capabilities. Through a longitudinal study of product introductions in the workstation industry, he found that capability extension reduces the chances of new product survival. In addition, he found that organizational boundaries moderate the negative relationship between capability extension and product survival. He derives the implications of the link between product innovation and capability development [5].

Hui studied the common domain name format of http://www.zol/, processed the data of consumer online reviews of three Huawei Mate phones, explored the correlation between online reviews and phone improvements, and made suggestions for future product improvements. This empirical study showed that changes in mobile phone functional satisfaction are strongly correlated with improvements in mobile phone performance. This research helps companies grasp market demand, understand consumer behavior, and improve the quality and efficiency of product innovation [6].

Bos examines the impact of access to imported intermediate inputs on firm-level product innovation in five developing countries, combining trade data with innovation survey data and developing a method to determine whether new inputs are critical for product innovation. He found evidence that the number of new imported varieties has a significant impact on product innovation that depends on new inputs and provides instructive evidence that this impact comes from access to better quality imported products [7].

3. Intelligent Algorithms, Nanomaterial Products, and Innovative Art Design

3.1. Intelligent Algorithm. Intelligent algorithms are new algorithms based on artificial intelligence. Like most computing, intelligent computing is a kind of natural computing inspired by nature. It first comes from biology; people imitate the evolution process of creatures in nature, thus abstracting such an algorithm [8]. In the process of continuous development, intelligent algorithms are slowly being applied to scientific problems, but these problems are also encountered by people in real life. Over time, people have summarized and summed up a special algorithm and named it intelligent algorithm. Figure 1 shows the AI optimization algorithm diagram.

In fact, the development of intelligent algorithms is far beyond imagination. With the development of time, new ideas of intelligent algorithms have sprung up, and various theories about intelligent algorithms have been proposed, and they have also been improved and updated. But despite this, the basic process of intelligent algorithm has not changed, and its basic process is generally shown in Figure 2. From the frame diagram of the algorithm, it was found that at the beginning of the algorithm operation, it must initialize

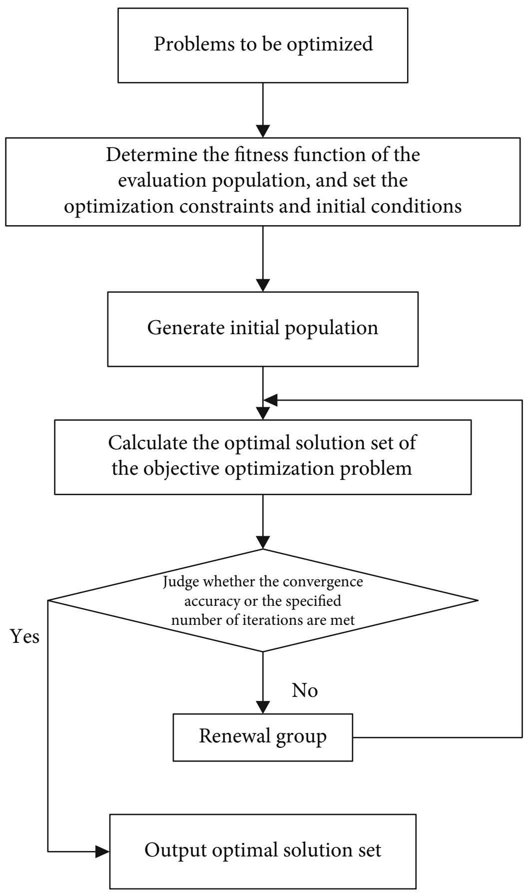


Figure 4: Multivariate optimization flow chart based on genetic algorithm.

Table 2: Convergence performance.

Algorithm	Evolutionary algebra reaching convergence	Number of times to reach convergence
PSO algorithm	68	912
GA algorithm	42	937
SOA algorithm	19	993

all the relevant parameters of the algorithm and then randomly generate a position, that is, the most initial solution [9]. Then, the solution space will generate a different solution according to certain rules; that is, a global search for the solution will be performed until a better solution is judged. According to the different conditions of the solution, the corresponding algorithm will be used to perform a local search near the more optimal solution, so as to further find the optimal solution, until the optimal solution satisfies the termination condition, and the output ends. Otherwise, the algorithm automatically loops and starts to research for the optimal solution [10].

3.1.1. Crowd Search Algorithm. Crowd search algorithm is a heuristic random search algorithm, which draws on human social experience, simulates human search behavior, and regards human self-interest behavior, altruistic behavior, self-organization aggregation behavior, preaction behavior and uncertainty reasoning behavior as advanced intelligence. The body is analyzed and its model is established to calculate the search direction and step size. The crowd search algorithm is a relatively effective search method, and its main working principle is to use the local optimal method. In the search process, the algorithm first finds a continuous spatial position and then judges whether there is an optimal solution based on this position. If the optimal solution is not found at this position, the algorithm will redetermine a continuous space until the optimal solution is finally found. However, the optimal solution generated by the crowd search algorithm is often a local optimal solution, which is far from replacing the global optimal solution [11]. The operation flow of the SOA algorithm is shown in Figure 3.

In the process of searching the space, because the position and the search area are uncertain, the first thing that needs to be done is to determine the relative position of the search target and determine the area according to this position. Its specific function is described as follows:

$$y_i = y_{\max} - \frac{d - U_i}{d - U}(y_{\max} - y_{\min}), i = 1, 2, \cdots, d, \quad (1)$$

$$y_{ij} = \text{rand}\,(y_i, 1), j = 1, 2, \cdots, D. \quad (2)$$

In the above formula, y_i is a position parameter of the objective function value i; y_{ij} is the relative position of the objective function value i of the parameter j; U_i is the specific number of $x_i(t)$ after arranging the overall position in a certain order; D is the actual size of the search space.

According to some conditions about the position in formulas (1) and (2), we can now get the position parameter y_{ij}. According to the above two formulas, the step size formula can be obtained as

$$\beta_{ij} = \chi_{ij} - \sqrt{-\ln\left(y_{ij}\right)}. \quad (3)$$

Among them β_{ij} is a position space constant in j -dimensional space; χ_{ij} is a parameter of the basis function, and the formula for its value is

$$\chi_{ij} = \omega \cdot sab(x_{\min} - x_{\max}), \quad (4)$$

$$\omega = \frac{(R_{\max} - r)}{R_{\max}}. \quad (5)$$

In formula (5), $x_{\max}$ and $x_{\min}$ are the values of the relative position in the process of finding the optimal solution; ω is the weight transformation of the position; r and $R_{\max}$ are, respectively, the number of iterations the algorithm performs in the process of finding the optimal solution.

After the relative position information is obtained, the model is analyzed by estimating the target. In this process, the expected action direction $d_{i,\text{ego}}$, the actual movement direction $d_{i,\text{alt}}$, and the preparation action direction $d_{i,\text{pro}}$ of any i search targets can be obtained. Finally, through the

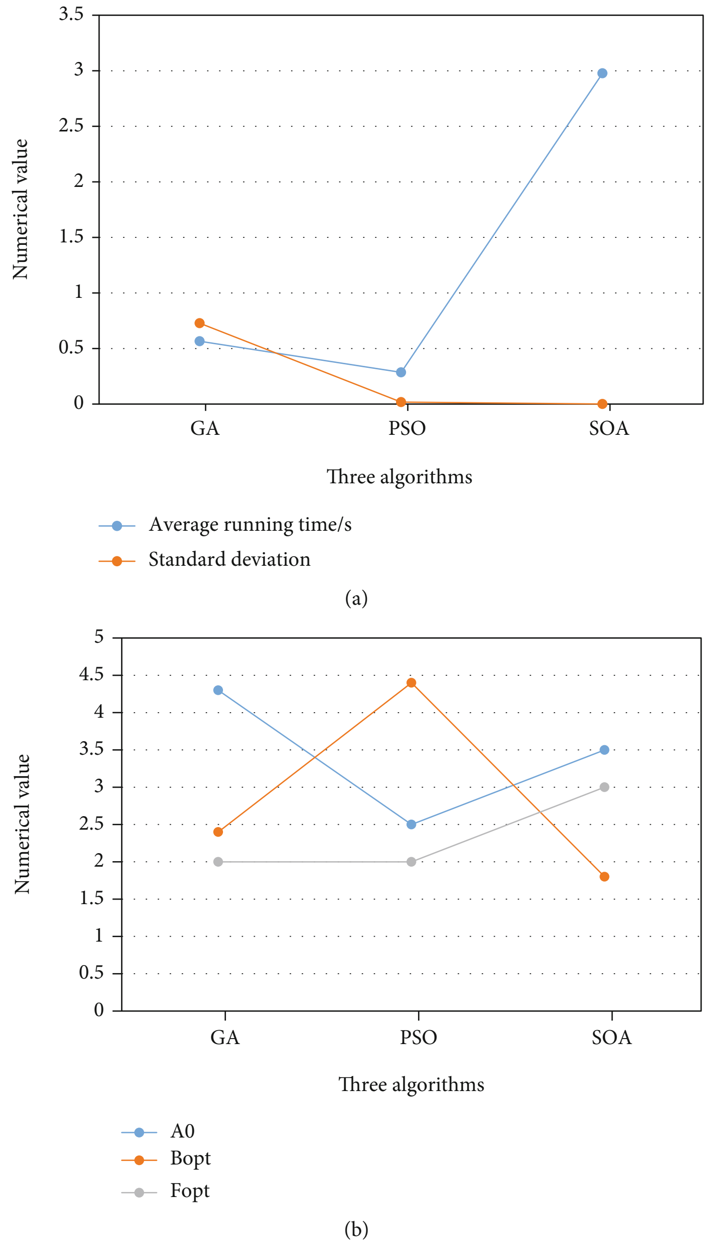


FIGURE 5: Statistical data and optimization results of three algorithms.

calculation of these three, we can get the final search direction.

$$d_{i,\mathrm{ego}}(t) = p_{i,\mathrm{best}} - y_i(t), \tag{6}$$

$$d_{i,\mathrm{alt}}(t) = g_{i,\mathrm{best}} - y_i(t), \tag{7}$$

$$d_{i,\mathrm{pro}}(t) = y_i(t_1) - y_i(t_2), \tag{8}$$

$$d_i(t) = \mathrm{sign}\left(\chi_1 d_{i,\mathrm{ego}} + \chi_2 d_{i,\mathrm{alt}} + \omega d_{i,\mathrm{pro}}\right). \tag{9}$$

In the formula, $t_1, t_2 \in \{t, t-1, t-2\}$; $y_i(t_1)$; $y_i(t_2)$ are the initial positions of $\{y_i(t-2), y_i(t-1), y_i(t)\}$; $g_{i,\mathrm{best}}$ is the relative optimal position in the space where the ith search target is located; $p_{i,\mathrm{best}}$ is the possible target position found by the ith search target; χ_1 and χ_2 are a real number randomly selected in the known interval $[0, 1]$.

The position transformation formula of the target to be searched is

$$\Delta y_{ij}(t+1) = \beta_{ij}(t) d_{ij}(t), \tag{10}$$

$$y_{ij}(t+1) = y_{ij}(t) + \Delta y_{ij}(t+1). \tag{11}$$

3.1.2. Genetic Algorithm. Genetic algorithm is a kind of random search algorithm that is widely used at present. Compared with other algorithms, it can operate directly on configuration parameters, so its operation is particularly simple. The algorithm is based on the typical principles of survival of the fittest. After the parameter configuration of

Figure 6: Nanoproducts.

the first-generation algorithm is generated, it can iterate and evolve continuously and finally produce more and more optimal approximate solutions [12]. The operations of crossover, mutation, and selection of genetic algorithm are carried out in a probabilistic way. The factors of the genetic algorithm are calculated by crossbreeding and mutation in biotechnology.

It is worth mentioning that the genetic algorithm can also realize the direct calculation of the product. In this process, the algorithm continuously evolves through the acquisition of product information. Genetic algorithms can also provide us with an analysis of different parts of the product when we need to do a corresponding analysis of that product. In the iterative process, the genetic algorithm has good convergence and high efficiency. By using the algorithm to simulate the components of the nanomaterial product, we can finally get the shape of the product [13].

But the genetic algorithm cannot solve the problems in dynamic simulation. In order to better demonstrate the dynamic process of product innovation, artistic design, and modeling, particle swarms were introduced to optimize the algorithm to a certain extent. The results show that the performance of the genetic algorithm optimized by particle swarm optimization is significantly better than that of the traditional genetic algorithm.

The reason why the genetic algorithm has such efficient performance is mainly because it uses an iterative calculation method in the process of numerical calculation. Compared with traditional algorithms, traditional iterative processes tend to fall into the loop of local optimization. The genetic-based iteration abandons the drawbacks of the traditional model, so that only the individual with the highest fitness in the global scope is kept as the optimal solution [14]. The relevant parameters of the genetic algorithm are set as shown in Table 1.

The optimization goal of this paper is to find the global optimal solution, so it is necessary for us to make certain improvements to the above algorithm to meet our design of the innovative art of nanomaterial products. The optimization function is as follows:

$$g(x) = \min\left(T_E, H_e\right). \tag{12}$$

Similar to the objective function in most intelligent algorithms, we also introduce an objective function here called the fitness function. After considering the actual value of the fitness function, the fitness function is also adjusted as follows:

$$fit(f(x)) = \frac{1}{g(x)}. \tag{13}$$

The optimization model based on genetic algorithm is shown in Figure 4. Evolutionary rules are the main components of genetic algorithms, which can simulate natural phenomena such as birth, aging, illness, and death and determine the dynamic function of the state at the next moment according to the current state and its neighbors. At the same time, the central states will influence each other and promote the interaction between local populations. Its basic model is

$$If S^t = 1, S^{t+1} = \begin{cases} 1, A_i \leq n \leq B_i, \\ 0, n < A_j, n > B_j. \end{cases} \tag{14}$$

3.1.3. Particle Swarm Optimization Algorithm. Particle swarm optimization (PSO) is an emerging stochastic optimization algorithm that simulates the foraging behavior of birds, which can effectively optimize various functions. This algorithm relies on random processes and uses the concept of fitness value. On the basis of the previous intelligent algorithm, we introduce a new intelligent algorithm, namely particle swarm optimization algorithm. In an era of increasingly abundant data and information, particle swarm optimization algorithms are known for their multidata parallelism and simplicity. The algorithm has few control parameters, and the concept is particularly easy to understand. In actual operation, all particles are governed by two parameters, one determines the position of the particle, and the other determines the initial velocity of the particle. In terms of finding the optimal solution, the algorithm firstly seeks the individual optimal solution and then seeks the global optimal solution on this basis [15]. In the process of finding the solution, the particle needs to continuously change its position and velocity. The formula for its velocity and position is

$$b_{ij}(t+1) = qb_{ij}(t) + c_1 r_1 \left[p_{ij} - x_{ij}(t)\right] + c_2 r_2 \left[p_{jg} - x_{ij}(t)\right], \tag{15}$$

$$x_{ij}(t+1) = x_{ij}(t) + b_{ij}(t+1), (j = 1, 2, \cdots, n). \tag{16}$$

In the formula, q is the inertia weight, and its value is 1.49; c_1 and c_2 are positive learning factors, and its value is 0.5; r_1 and r_2 are random numbers, which are uniformly distributed between 0 and 1.

Table 3: IRTZ theory innovation method system.

Innovative thinking	Nine screen method	IFR method	Villain method	STC operator
Analytical tools	Contradiction analysis	Material field analysis	Function analysis	ARIZ algorithm
Problem solving tools	Invention principle	Separation principle	76 standard solution effect databases	

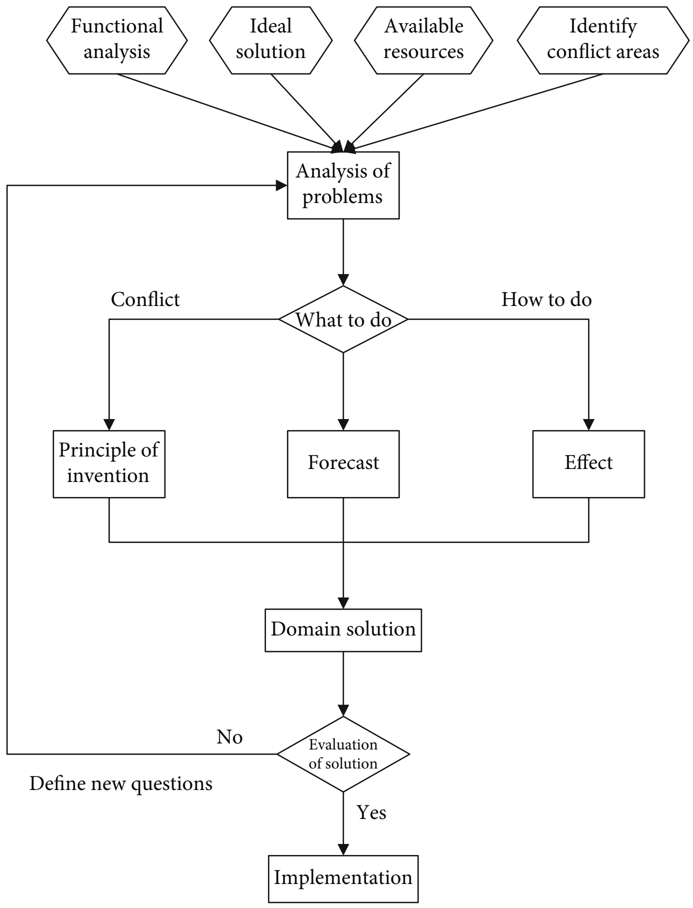


Figure 7: Flow chart of IRTZ.

Table 4: Test parameter setting.

Parameter	Set content
Yield strain	10.8
Breaking strength (GPa)	0.040
Fracture strain	17.4
Stretch feature	Stress-free platform
Yield strength (GPa)	0.453

The design objective function is

$$A_0 = \min \{\max A(\beta_2, f)\}. \quad (17)$$

In addition, the speed update formula is

$$w_{id}^{k+1} + r_1 c_1 \left(p_{id} - z_{id}^{k}\right) = c_2 r_2 \left(p_{dg} - z_{id}^{k}\right) + v w_{id}^{k}. \quad (18)$$

Next, in order to test the stability and adaptability of the performance simulation algorithm, we selected three algorithms, respectively, and let them complete 1000 optimal solution searches alone to test their convergence. The final simulation statistical results are shown in Table 2.

Table 2 shows that in the process of finding the optimal solution for the three algorithms, the final test accuracy of each algorithm is above 90%, which shows that the three algorithms have relatively high efficiency in finding the optimal solution. In terms of convergence, the SOA algorithm has the lowest convergence, less than 2%, which fully demonstrates the superiority of the algorithm.

After calculating the standard deviation and search time of the above results, 15 optimized results were added, and all data were screened as a whole. Figure 5 is the final statistical result. The data analysis shows that the crowd search algorithm is the most optimized among the three algorithms, and the standard deviation is close to 0, which is 0.7 percentage points lower than the GA algorithm. Based on this, we

Table 5: Level 5 vocabulary difference subscale.

Modern	Natural	Plain	Light	Delicate	Soft	Refreshing	Safe	Individual
2	2	2	2	2	2	2	2	2
1	1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0	0
-1	-1	-1	-1	-1	-1	-1	-1	-1
-2	-2	-2	-2	-2	-2	-2	-2	-2
Traditional	Industrial	Gorgeous	Heavy	Rough	Rigid	Sloppy	Dangerous	Ordinary

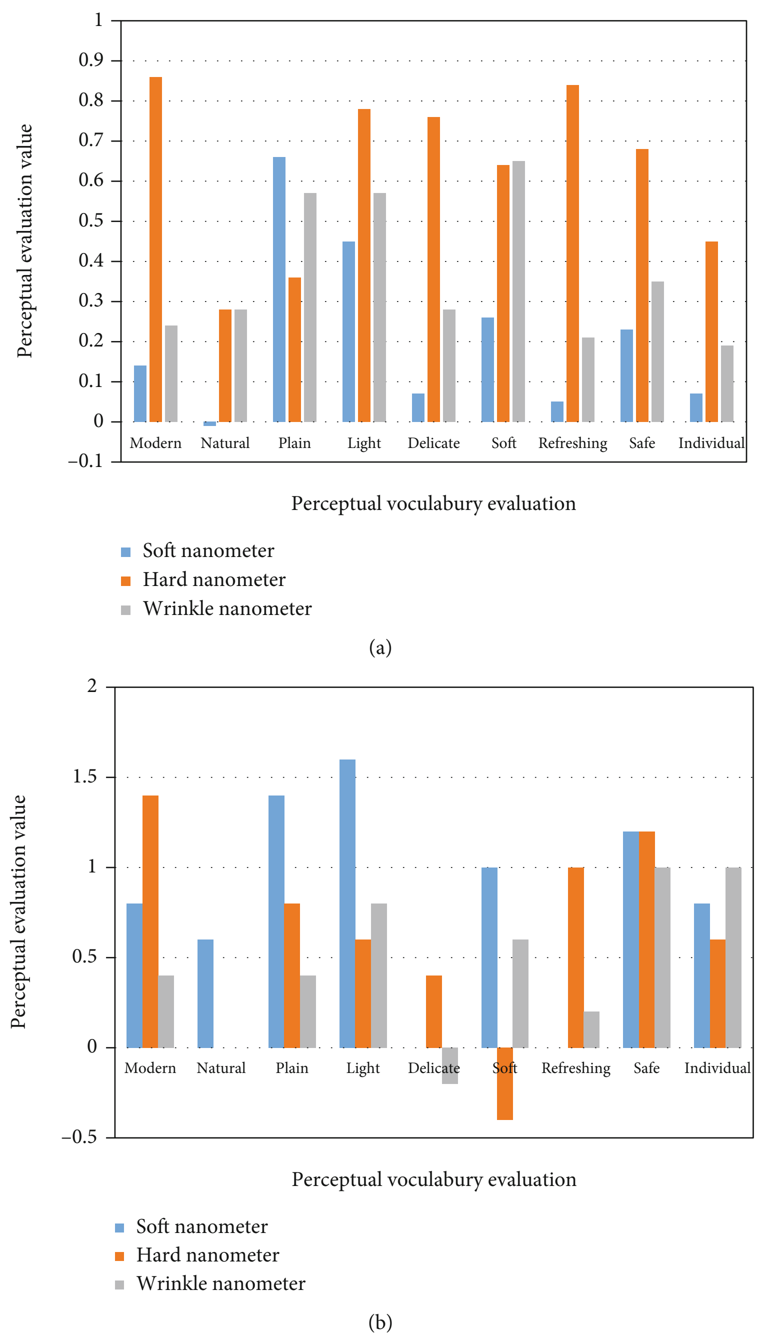
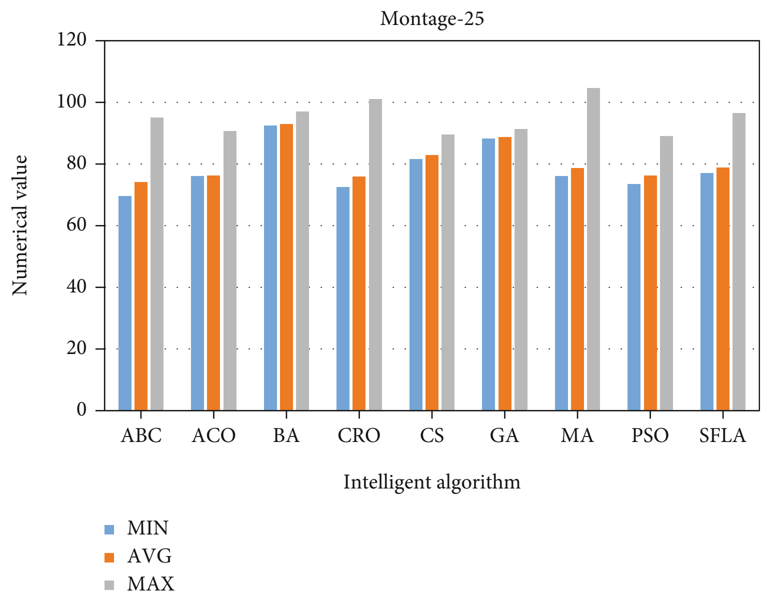


Figure 8: Online questionnaire and offline perceptual evaluation data statistics.



(a)

(b)

Figure 9: Continued.

(c)

Figure 9: Montage workflow completion time optimization results.

can draw relevant conclusions, that is, the innovative artistic design of nanomaterial products based on this algorithm has good stability and optimization effect.

3.2. Nanomaterial Products. Nanomaterials are ultrafine natural or man-made materials, mainly in the form of agglomerates or powders, and their grain size is nanometer. Its particle size is larger than atomic clusters but smaller than ordinary particles. The size is generally 100~102 nm, and the total number of elementary particles exceeds half. The surface activity of nanomaterials is relatively active, which makes nanomaterials have special electrical, mechanical, optical, magnetic, thermal, and other chemical properties. Nanomaterials mainly include nanoparticles, nanotubes, nanoblocks, nanofilms, and nanocomposites. Nanotechnology is a multidisciplinary science and technology that studies the properties and interactions of matter (including atoms and molecules) at the nanoscale (1~100 nm) and utilizes these properties. Nanotechnology is based on modern science and technology in many fields such as molecular biology, microelectronics, quantum mechanics, computer technology, and mesoscopic physics. It has been more than 20 years since the advent of nanomaterials and the technologies developed with them. The stage of material innovation and performance development has been roughly completed, and now it has entered the stage of technological improvement and comprehensive application [16].

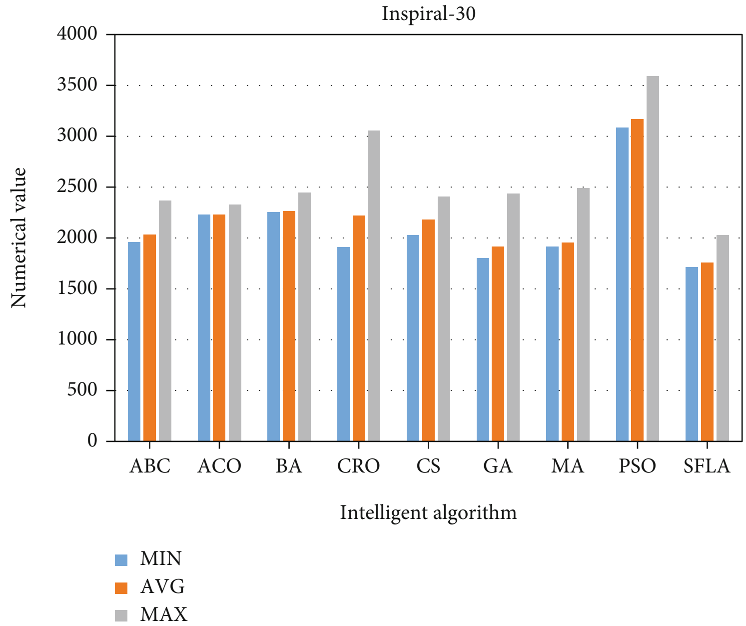
3.2.1. Application of Nanomaterials and Key Products. As a new type of material, nanomaterials have been widely used in product design and have received extensive attention from the government and scientific researchers since its inception. The rapid development of nanotechnology is bound to trigger a new design revolution. In the 1980s, nanocalcium carbonate was developed. It is a new type of ultrafine inorganic material with a particle size of usually 20~100 nm, but its technical content is relatively low. Due to its low price and high quality, it is widely used as an improved filling material. The data shows that nanocalcium carbonate materials have dominated the entire nanomarket and accounted for 29% of the overall size of the nano new material market. In addition to nanometer calcium carbonate, there are typical nanomaterials such as titanium dioxide and zinc oxide [17]. Figure 6 shows some common nanoproducts.

There are several nanomaterial technologies, devices, and products with excellent performance in the market, such as single electronic device, nanoblood glucose detector, immunochromatographic monitoring technology of nanocrystal bioprobe, nonpolluting nanowater-based paint, nanomodified high-power lithium ion battery, nanomodified solar cell, nano-self-cleaning cashmere sweater, nanomodified pigments, and nano-self-cleaning glass. Some typical application products of nanomaterials include nanoceramic knife, nanozinc oxide coated refrigerator, and nanotitanium dioxide car paint [18].

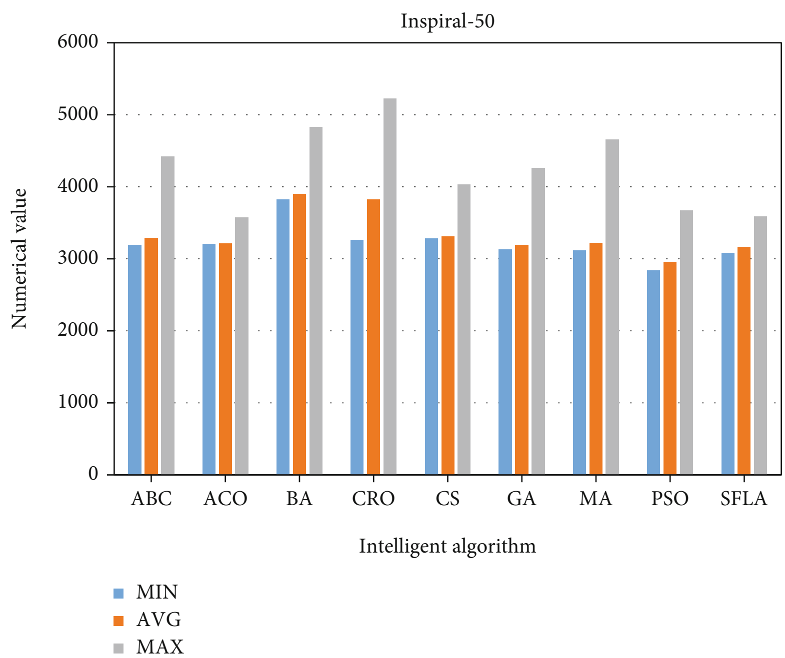
3.2.2. User Needs of Nanomaterial Products

(1) Users pay attention to the functional satisfaction of products and hope that nanoproducts have many functions and can get feedback more quickly

For example, nanotoothpaste should not only clean teeth like normal toothpaste, but also diagnose oral diseases and reduce inflammation and pain. More importantly, the free nanohydroxyapatite component contained in the nanotoothpaste has the effect of protecting and repairing the gums. The most basic function of ordinary refrigerators is the function of refrigeration and preservation, but this is

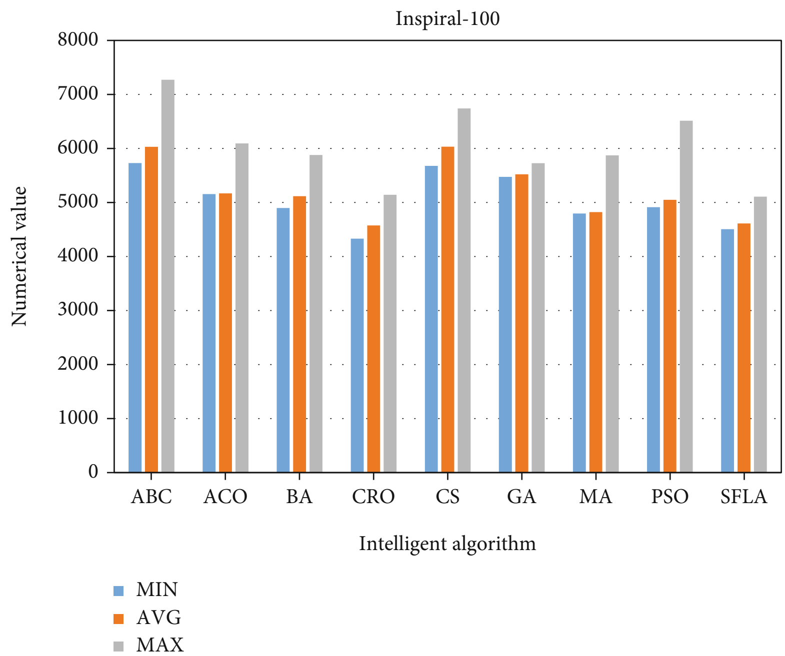


(a)



(b)

Figure 10: Continued.



(c)

Figure 10: Inspiral workflow completion time optimization results.

not enough. People require that refrigerators coated with nanozinc dioxide can effectively help people to sterilize and inhibit bacteria, thereby reducing or even avoiding the unpleasant smell of food stored in the refrigerator due to spoilage or peculiar smell from food. Compared with ordinary skin care products, the cosmetic effect of nanoskin care products is faster and more efficient. In addition, people also require that nanoskin care products can quickly form resistance to the dermis of the skin so as to play a repair function on damaged cells and then instantly achieve the surprising effect of antiaging. The role of nanosilver clothing is radiation protection and can effectively treat skin diseases. People's demand for its physical therapy and as a health care product far exceeds the demand for its beauty, cold resistance, and frost resistance [19]. The car paint added with nanotitanium dioxide can increase the hardness and strength of the car surface and increase the wear resistance and impact resistance of the paint. Moreover, nanotitanium dioxide can change the angle of its visible light with the change of sunlight, thereby reducing light pollution and meeting people's requirements for environmental protection. Nanoceramic knives have greater hardness than diamond and can always maintain people's functional requirements for "sharpness" without grinding. Nanozirconia ceramics have strong chemical stability, acid and alkali resistance, and antifouling characteristics, so they are more clean and hygienic.

(2) The user attaches great importance to the reliability of nanoproducts and requires nanoproducts to be durable, safe, and reliable

As small as nanotoothpaste, skin care products, underwear, sunscreen in daily life, and as large as nanodrug delivery vehicles, these products are in direct contact with the internal cells of the human body or the external epidermis of the body. While they were astounding, people also demanded that they not be toxic, damage, or have other undesirable side effects to the cells inside the body. Another example is the products that are in direct contact with food, such as nanoknives, plastic wrap, and refrigerators that are common in the kitchen. It is required that it should not have a certain chemical effect with food, which will lead to food spoilage or residual or harmful substances on the surface of food [20].

(3) Nanoproducts meet the interactive needs of users, which is mainly reflected in the portability of nano products

Because of their small size, light weight, and strong plasticity, nanoproducts are loved by the public because of their portability. The thickness of nanosolar cells is only 2 nm~6 nm, which is very thin and small, so it is easy to carry. The nanoelectronic display has good flexibility, bending resistance, and light weight, which can be easily carried by users. It opens the door to the design of wearable electronic products, which can make the distance between electronic products and people even smaller.

3.3. Innovative Art Design. The poor definition of the initial state has become one of the main characteristics of product innovation design, which is a very creative problem-solving process. More specifically, at the beginning of the design, the designer has only an incomplete and vague mental representation of the upcoming design. This requires designers to understand how to implement the next steps in the product innovation design process. Various loops in the process of innovative design have been studied and analyzed by a large number of scholars, such as iterative loops in problem space and pattern space, loops in problem definition, and loops in evaluation and generation stages [21]. IRTZ theory is a systematic, knowledge-based innovation method system, as shown in Table 3. It includes innovative thinking, analytical tools, and problem-solving tools, making it more operable and practical in application.

IRTZ is a problem-solving theory of invention, and the flow chart of IRTZ (shown in Figure 7) can be used as a description of IRTZ tools and methods.

The first step is to study and analyze the problems encountered. If contradictions and conflicts are found, the problems can be solved according to the principles. If the problem encountered is very clear but do not know how to solve it, then it needs to be used with some kind of effect to run a whole set of technological system evolution process that predicts innovation and then evaluate this process to achieve the final step. If a new problem is found during the implementation, the above process is repeated again until the problem is solved [22].

4. Nanomaterials and Models

4.1. Sensitivity of Nanomaterial Design Properties. In order to ensure the accuracy of the test, several nanomaterial simulation analysis methods are placed in the same test environment to test the accuracy ability. The settings of the test environment are mainly shown in Table 4.

In order to study the user's perceived intention needs, based on the online survey, the author distributed 100 questionnaires about the difference subscale of sensory vocabulary of nanomaterials. A total of 100 subjects' perception evaluations of nanomaterials were collected. According to the characteristics of materials, nine groups of perceptual adjectives, namely "clean and messy, natural and industrial, simple and gorgeous, light and heavy, safe and dangerous, modern and classical, individual and ordinary, delicate and rough, soft and hard," were selected. A 5-level lexical difference subscale was developed, as shown in Table 5. The nanomaterials involved in the questionnaire are all raw materials of the original color. According to the previous survey, the author also distributed 5 offline questionnaires with the same content as the online questionnaire. The results are shown in Figure 8. It can be seen from the survey that the respondents who filled out the offline questionnaire believed that the soft nano was the lightest and most comfortable to touch; the hard nano had the most modern features, and the wrinkled nano was softer than the hard nano. This clearly shows that there is a certain degree of deviation between the results of the online survey and the offline survey, with the maximum difference reaching 1.26. The reason why the perceptual evaluation of this material is so different is because there are also some differences in the visual and tactile effects [23].

According to Table 5, we can see that the softer nanomaterials give a more homely feel, while the harder nanomaterials give a modern freshness, and the wrinkled nanomaterials give a softer feeling. From the overall effect, good nanomaterials generally give people a simple and brisk feeling.

4.2. Montage Experimental Results. Under the Montage model, when the task volume is 25, 50, and 100, respectively, the maximum, average, and minimum values of the average completion time of each algorithm are shown in Figure 9. The formulas for calculating the mean and variance are

$$\bar{A}_i = \frac{\sum_{k=1}^{K} A_i^{\,k}}{K}, \tag{19}$$

$$\sigma = \left[\frac{\sum_{k=1}^{K} \left(\bar{A}_i - A_i^{\,k}\right)^2}{(K-1)}\right]. \tag{20}$$

σ and $\bar{A}_i$ represent the variance and mean of the ith evaluation value, where the range of i is $[1, 48]$.

According to Figure 9, the analysis is as follows: when the number of tasks is relatively small, the average completion time of algorithm ABC and algorithm ACO is lower than that of other algorithms, which are 74.13 and 76.17, respectively, while algorithm BA and algorithm GA are dwarfed. With the increase of the number of tasks, the average completion time of the algorithm ABO shows a significant upward trend, slowly surpassing all other algorithms, and also reduces its efficiency. In contrast, when the number of tasks is 25 and 50, the CRO completion time is relatively short. When the number of tasks is 100, the average completion time is the shortest among all algorithms. Compared to other algorithms, CRO is much more efficient in workflow completion time [24].

4.3. Inspiral Experiment Results. It can be analyzed from Figure 10 that when the amount of tasks is small, SFLA has the shortest average completion time, with a value of 2808.21, followed by ABC, and then GA. It is worth noting that the average completion time of algorithm MA is 0.7 times that of algorithm PSO. However, when the number of tasks is 100, among all algorithms, ABC has the longest average completion time, reaching 7287.47, followed by CS, reaching 6750.98. This comparative analysis reflects the extreme instability of the ABC algorithm in terms of average completion time. It can be concluded that as the number of tasks gradually increases, so does the time for each algorithm to run and complete. When the task volume is 100, the average completion time of CRO is the shortest, which is only three-quarters of the average completion time of CS.

5. Discussion

As a new type of material, nanomaterials have developed rapidly since entering the twenty-first century. They are receiving great attention and attention from the world, and researchers are also conducting in-depth research on them at a strategic height. The application of nanomaterials in product design is very exploratory, and this kind of exploration has special significance in the context of increasingly prominent environmental problems, so it has also attracted great attention from relevant personnel. Nanomaterials have irreplaceable advantages in product design. Taking material properties and usage patterns as innovative strategies, they have played a positive role in people's reunderstanding and positioning of nanomaterial product design. At the same time, it also enables nanomaterial product design to play an important role in a broader commercial platform. The innovative artistic design of products based on various nanomaterials is a follow-up to the concept of environmental protection, because nanomaterials are multifunctional. At the same time, it is also suitable for various processing technologies, which makes it widely used in different product fields, so as to further explore and effectively analyze the product innovation design of nanomaterials. Crowd search algorithm is more stable than genetic algorithm and particle swarm algorithm. According to the actual problems and cases, the effectiveness of the optimization algorithm is verified, and it can be found that the designed optimization algorithm can achieve a good optimization effect in application.

6. Conclusion

Through the above research and analysis, we can clearly see that the innovative design technology assisted by intelligent algorithms has been widely used in the product design process. Better optimization results can be obtained, and the innovation and efficiency of product design can be effectively improved to a greater extent. According to different design ideas and concepts, it proposes a method of product innovation design based on genetic algorithm. The results show that this method is very practical because of its realization of innovation. In the future, in the process of product art design, the use of intelligent algorithms to assist product innovation technology will certainly achieve diversified development and make the methods and methods to effectively solve the problems in this process multidimensional. Through the use of advanced modern technical resources, designers can further improve their ability to control product design and their ability to innovate and create. Most importantly, these achievements can be given back to the society and users in a more diversified way. Combining the characteristics of product design practice, this paper promotes the construction of nanomaterial experience library, provides effective methods and approaches for design practice innovation, and gradually forms a new design mode of material perception experience, which is one of the important development directions in the future. This research lays a theoretical foundation for establishing a practical intelligent algorithm-assisted product innovation system. In the future, we will comprehensively consider adding relevant constraint mechanisms to combine them with relevant evolutionary mechanisms to establish a product innovation design system that meets the needs of different subjects.

Data Availability

No data were used to support this study.

Conflicts of Interest

There is no potential conflict of interest in this study.

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