



Innovative Applications of Materials in Product Design: A Multidimensional Exploration of Economic Benefits and Health Value

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Abstract

With the rapid development of new material technologies, the application of materials in modern product design is gradually shifting from a focus on single functionality to multidimensional value creation. Material performance innovations not only drive improvements in product functionality and aesthetics but also demonstrate significant potential in economic benefits and health protection. This study, themed "Innovative Applications of Materials in Product Design," combines economic and medical perspectives to analyze the multifaceted applications and value of new materials in product design. The research adopts a combined approach of case studies and theoretical analysis, examining the innovative applications of intelligent materials, biomaterials, and antibacterial materials in fields such as electronic devices, medical instruments, and daily necessities. It reveals how materials play a critical role in enhancing product competitiveness and meeting health demands. From an economic perspective, the study analyzes the cost-effectiveness and market premium potential of material innovations. From a medical perspective, it explores the contributions of materials to health protection and personalized medicine. The findings indicate that new materials hold significant importance in enhancing product value, optimizing user health experiences, and promoting sustainable economic development. However, challenges such as high research and development costs, technical barriers, and societal acceptance remain major obstacles to their widespread adoption. In the future, with technological advancements and the widespread adoption of green design concepts, the deep integration of materials and product design will bring more synergistic benefits to health, economics, and the environment. This research provides theoretical support and practical references for designers, enterprises, and policymakers.

Keywords

Material innovation; Product design; Economic benefits; Medical applications; Sustainable development

1. Introduction

1.1 Research background

With the rapid development of science and technology and the ever-changing consumer needs, the cross-integration of material science and product design is becoming an important force driving innovation. From traditional materials to smart materials and biomaterials, the functional and sustainable innovation of materials provides designers with

new creative tools, while also showing broad application prospects in the economic and medical fields. In recent years, society has paid increasing attention to green design, personalized products and health protection, and the application of new materials plays a vital role in meeting these needs.

1.2 Research objectives

This study aims to explore the potential of materials in improving economic value and meeting health needs by analyzing the innovative application of materials in product design. The paper evaluates the cost-benefit of material innovation from an economic perspective and explores the design value of new materials in health-related products from a medical perspective, thereby providing theoretical basis and practical reference for enterprises, designers, and policymakers.

1.3 Research significance

The innovative application of materials is not only a reflection of technological progress, but also has far-reaching significance in improving product market competitiveness, promoting social sustainable development, and optimizing human health experience. This study integrates economics and medicine perspectives into the discussion of material design, reveals the important role of material innovation in the future market and health industry, opens up ideas for designers, and provides direction for corporate innovation.

2. The Relevance of Materials Science to Innovative Design

2.1 Basic concepts and development of materials science

Materials science is a comprehensive discipline that studies the properties, structure, and application of materials. Since the Industrial Revolution, the development of materials has evolved from traditional metals and ceramics to modern polymers and composite materials. In recent years, the rise of smart materials (such as memory metals, conductive polymers), nanomaterials and biomaterials has provided more possibilities for modern design. For example, graphene is widely used in the design of electronic devices due to its high conductivity and high strength, while degradable biomaterials show great potential in medical products.

2.2 The essence of innovative design

Innovative design is a process of meeting user needs, solving practical problems and creating social value. As a core element of design, materials not only directly affect the functionality, durability, and appearance of products, but also play a key role in green environmental protection and cost control. For example, the application of lightweight materials significantly optimizes the performance of automotive and aviation products while reducing energy consumption.

2.3 Inspiration of materials on design thinking

The characteristics of new materials often inspire designers. For example, the shape memory characteristics of memory metals have inspired the adaptive design of medical equipment, while the application of antibacterial materials has led the trend of healthy home and public facility design in the post-epidemic era. This design thinking based on material innovation breaks through traditional functional limitations and brings more added value to products.

3. Specific Application of Material Innovation in Product Design

3.1 Application in electronic products

3.1.1 Breakthroughs in smart materials

The application of smart materials in electronic products has greatly improved the product's versatility and user experience. For example, the combination of flexible screens and conductive polymers makes wearable devices more fit to the human body, enhancing wearing comfort and interactivity.

3.1.2 Protective functions of nanomaterials

Nano-coating technology is widely used in the anti-scratch and anti-fouling design of smartphone screens, while also improving the screen's touch sensitivity and display effects.

3.2 Application in medical products

3.2.1 Medical value of biomaterials

The innovative application of biomaterials in medical device design has attracted much attention. For example, polylactic acid (PLA), as a biodegradable material, has been widely used in surgical sutures, orthopedic implants, and drug delivery systems, significantly reducing surgical trauma and patient recovery time.

3.2.2 Health protection of antimicrobial materials

The application of silver ion and copper-based antibacterial materials in medical equipment and hospital facilities effectively reduces the risk of hospital-acquired infections and provides a safer environment for patients and medical staff.

3.2.3 Dynamic adaptability of smart materials

Smart polymers are being used to create adjustable medical implants such as cardiovascular stents and artificial joints because of their ability to respond to temperature, humidity, or pH.

3.3 Application in daily consumer products

3.3.1 Popularization of environmentally friendly materials

The application of biodegradable plastics in food packaging and disposable products effectively reduces environmental pollution. For example, the combination of pulp molding technology and plant fiber materials provides new options for environmentally friendly tableware design.

3.3.2 Functional expansion of health materials

The application of antibacterial coatings and bamboo fiber materials in daily necessities such as bedding and household products not only enhances the comfort of the products, but also effectively improves the health experience of users.

4. Economic and Medical Analysis of Innovative Material Applications

The widespread application of material innovation has brought far-reaching impacts to many fields, especially in economics and medicine. Its innovation has not only changed the production methods of traditional industries, but also improved the quality and efficiency of health products, providing new impetus for social and economic development. The following is a detailed analysis and expansion of the economic and medical value of materials from the perspectives of cost-benefit analysis, market competitiveness, consumer preferences, and innovation driven by medical needs.

4.1 Cost and benefit analysis: Balancing long-term value

From an economic perspective, the application of new materials may face high R&D and production costs in the early stages, but the long-term benefits they bring cannot be ignored. Material innovation creates a greater market premium for companies while reducing life cycle costs by improving product performance and optimizing resource utilization. For example, lightweight materials such as carbon fiber composites, although their manufacturing costs are higher than traditional materials, their application in the aviation and automotive industries significantly reduces fuel consumption and maintenance costs, ultimately achieving a win-win situation for the economy and the environment.

In addition, the application of antimicrobial materials has brought significant cost savings to the medical system. Although the use of antimicrobial coatings in hospital equipment increases manufacturing costs, it effectively reduces the rate of hospital-acquired infections and significantly reduces secondary treatment and hospitalization costs caused by infections. This hidden economic benefit saves a lot of money for the public health system while improving patients' treatment experience and satisfaction.

For enterprises, the economic value of material innovation is also reflected in the market premium ability of products. Take Apple as an example. It uses innovative materials such as high-performance ceramics and sapphire glass in its smart watches, making its product pricing significantly higher than that of its competitors. This case shows that consumers are willing to pay an extra premium for products with high-quality material attributes, reflecting the commercial potential of material innovation.

4.2 Market competition and consumer preferences: Driving forces for material innovation

Changes in consumer demand are an important driving force for material innovation. In the post-epidemic era, people's attention to health and safety has increased significantly, and the demand for material products with antibacterial and protective functions has increased rapidly. For example, household antibacterial coating products have quickly become popular among consumers and have become an important means of daily health protection. This trend has created a larger market space, allowing companies to quickly capture market share through material innovation.

Consumers' perception of materials also directly affects the market performance of products. According to the marginal utility theory of economics, consumers' willingness to pay for material products is proportional to their perceived value. For example, the combination of flexible displays and conductive materials in wearable devices not only enhances the technological sense of the product, but also increases consumers' recognition of the product's functionality and fashion. This increase in perceived value directly drives the sales growth of innovative material products and creates more profits for companies.

4.3 Material innovation driven by medical needs: From functionality to precision health

Medical needs provide a wide range of application scenarios for material innovation. From surgical instruments to drug delivery systems, the application of new materials has greatly improved the performance and safety of medical products. In particular, the design and application of biomaterials and smart materials provide revolutionary solutions for personalized medicine and health management.

4.3.1 Medical value of biomaterials

The degradable properties of biomaterials have led to their widespread use in the medical field. For example, degradable materials such as polylactic acid (PLA) and polyhydroxybutyrate (PHB) have been used to make surgical sutures and drug carriers, reducing the biological rejection caused by traditional materials and significantly improving the patient's recovery rate. In addition, the design of degradable implants also provides longer-lasting treatment options for orthopedic, cardiovascular, and other surgeries.

4.3.2 Health protection function of antibacterial materials

The research and development and application of antimicrobial materials are important innovations in the medical field in the post-epidemic era. For example, copper-based and silver-based antimicrobial coatings have been widely used in medical equipment, hospital facilities and public places, significantly reducing the risk of infectious disease transmission. Due to their long-lasting antimicrobial properties, these materials are not only used in hospitals, but are also gradually entering the home product market, providing more comprehensive protection for consumers' daily health.

4.3.3 Personalized medical breakthroughs using smart materials

Smart materials are ideal for personalized medicine because of their ability to respond to environmental stimuli, such as temperature, humidity, and pH. For example, smart polymers can release drugs based on human body temperature for precision drug delivery systems, while the elastic recovery properties of shape memory alloys provide better solutions for the design of artificial joints and cardiovascular stents. These materials have shown great potential in improving treatment efficiency and reducing the risk of complications.

4.3.4 Economic and medical synergy of materials innovation

Material innovation has shown significant synergistic benefits in the combination of economics and medicine. Take bionic materials as an example. Their application in the medical field has significantly improved the performance of medical products and created high-value markets for enterprises. For example, bionic skin materials not only provide

a more realistic alternative for burn patients, but also become the core competitiveness of enterprises in the high-end market due to their high technical threshold and production difficulty.

At the same time, material innovation has driven the healthcare industry towards sustainable development. For example, recyclable bio-based medical devices reduce waste generation and reduce resource consumption in the medical system. This integration of economic and medical value not only helps companies build competitive advantages, but also contributes to global sustainable development goals.

5. Challenges and Future Trends of Material Innovation

5.1 Technical and commercialization barriers

Although material innovation brings many design possibilities, its commercialization still faces many obstacles. For example, the production process of smart materials and nanomaterials is complex and costly, which limits their popularity in the mass market. In addition, consumers' concerns about the safety and long-term reliability of new materials also need to be eliminated through publicity and education.

5.2 Sustainable development and future directions

In the future, green design and sustainable materials will become mainstream. For example, the circular economy model requires that products consider the recycling and reuse of materials during the design phase, while the development of bio-based materials will further reduce dependence on non-renewable resources. At the same time, the combination of artificial intelligence and material science will accelerate the research and development of new materials, optimize material performance through big data simulation, and achieve personalized customization of design.

6. Conclusion and Outlook

Material innovation is an important driving force for the advancement of product design, and its impact on technological progress, economic value enhancement, and health protection is becoming increasingly significant. This study explores the innovative application of materials in modern product design from a multi-dimensional perspective, revealing its key role in optimizing user experience, promoting economic development, and meeting health needs.

Material innovation has significantly expanded the possibilities of product design, making design not only limited to the combination of function and aesthetics, but also involving new dimensions such as green environmental protection and health protection. Take smart materials as an example. Their memory, responsiveness and adaptability have brought a new design logic to medical equipment, electronic products, and health management equipment; nanomaterials have injected new impetus into the design of consumer electronics, transportation, and energy products by improving durability, lightness, and versatility.

Material innovation provides huge market value from an economic perspective. Despite the high initial R&D costs, innovative materials ultimately maximize economic benefits by reducing the use costs during the product life cycle (such as energy consumption and maintenance costs) and improving product premium capabilities. Take the application of lightweight composite materials in the aviation and automotive fields as an example. The reduced fuel consumption not only reduces carbon emissions, but also significantly saves operating costs. In addition, material innovation also enables companies to respond more effectively to changes in consumer preferences, especially in terms of health protection and sustainability, thereby gaining an advantage in market competition.

From a medical perspective, the innovative application of materials has become an important means of solving health problems. The development of biomaterials, antibacterial materials and bionic materials has made medical equipment and health management equipment more personalized, intelligent, and safe. For example, the use of degradable biomaterials in surgery reduces the risk of postoperative complications for patients; and antibacterial coating technology is particularly important in the post-epidemic era. Its application scenarios have expanded from hospital equipment to household products and public facilities, providing higher protection for social health.

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