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Product design with artificial intelligence

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Abstract

The study aims to overcome limitations by incorporating artificial intelligence concepts into design and development studies, to improve products, improve the ability to interpret design, minimize design development costs, and create more product designs quickly. The kind of algorithm the artificial intelligence sites have and the results obtained according to the entered data were previewed. Technical terms describing the product, washing, and futuristic definitions related to denim have been entered on sites that offer extensive resources for artificial intelligence design, and all the details about how the strongest of the design options offered on the site should be transformed into the product have been interpreted by our designers. These interpretations were converted into technical drawings and the sampling process was started. Denim trousers were chosen as the product, and in addition to the model design, the image given by artificial intelligence was tried to be captured during the washing phase. As a result of the study, positive results were obtained in terms of removing many boundaries and gaining a different perspective as a designer.

***Keywords*:** Artificial intelligence; design; technology; textile

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1. Introduction

Social development and change are among the most important factors that affect human beings and industry. To adapt to changing environmental conditions, many institutions and organizations have had to constantly renew and update themselves. The continuity of institutions and sectors is directly proportional to how they manage these changes. Because the factor of change has become a predictable but unpreventable situation. As it is constantly mentioned, “the only constant thing is to change itself”. It is guaranteed that organizations that cannot keep up with developments, whether global or local, will have problems and difficulties in competing and even maintaining their existence in the future. Technology and societies are now so intertwined that we have entered a period in which humanity, which used to be driven by technology to change, is now shaping technology itself according to needs and supply. This has led to a development model that grows stronger by feeding off each other. Change continued on its way, shortening the period with each passing period. To give an example from human history; While the transition from agricultural society to industrial society took approximately 5000 years, the 2nd Industrial Revolution took 200-300 years, the 3rd Industrial Revolution took 80-100 years, and the 4th Industrial Revolution was even shorter, down to only 30-40 years. Forecasts show that the world is rapidly moving towards the "information and digital society" and then to the "society of pioneering, innovation, and wisdom". With the clear situation shown by these processes, the 5th Revolution, which will affect and trigger the information society and industrial systems, will most likely emerge in a short time. Although it is not clear who the important characters who will provide great gains in the 5th Revolution will be, it is thought that those who are capable of understanding, foreseeing, and interpreting the main lines of the events caused by the progress will be able to gain power and gain (Öztemel, 2020).

As stated in the literature research conducted by Oz Temel and Gursev (2020), the basic elements of the fourth revolution are "cyber-physical systems", "internet of things", and "unmanned factories dominated by autonomous machines". The concept of "big data" has emerged with cloud computing technology. This has enabled every segment of society, not just industrial organizations, to see the importance of data. It is now easy to process a large amount of data, reveal meaningful information, and make decisions based on different dimensions (Oz Temel and Gursev 2020).

1.1. Literature review

1.1.1. Artificial Intelligence

If the concept of artificial intelligence is examined through the definition made by computer scientist John McCarthy, it is a branch of technology and science used to simulate and model human-like thinking, learning, and problem-solving abilities of computer systems (McCarthy, 2022). Artificial intelligence involves the development of systems that can analyze data, make predictions, make automated decisions, and perform complex tasks with creativity (Chatterjee, 2022). It aims to enable computers to perform functions similar to human intelligence (Coskun & Gulleroglu, 2021; Matin et al., 2023)

Experts, technology investors, and scientists who lead to developments in the field of technology ask the question "What is artificial intelligence and what are its benefits?" If the definition of artificial intelligence is developed based on some of the comments made in their titles; “Artificial intelligence is an effort to imitate a machine's ability to think like a human” by Alan Turing (British mathematician, computer scientist, and cryptologist) (Topal, 2017). The first of these is the formation of the universe, the second is the beginning of life, and the third is the emergence of artificial intelligence.” comments are available (Pirim, 2006).

If the concept of artificial intelligence is summarized in line with the above comments, it is emphasized that artificial intelligence is an effort to imitate the human-like intelligence and thinking abilities of computers. In addition, it is underlined that artificial intelligence is an invention that will provide great benefits for humanity and that there will be many changes and new expansions in the business world with this invention.

1.1.2. History of Artificial Intelligence

When much older periods in history are investigated, it is thought that there were artificial intelligence-like elements in the first Greek Mythology. The most important of these is a giant made of bronze called "Talos" (Mayor, 2023). This artificial giant can be thought of as an automatic surveillance system that does not have human intelligence. It is constructed of iron and copper, and this artificial giant represents the ideas about engineering and technology during the ancient Greek period. Different historical beginnings have been scientifically recorded regarding the entry into human life (Mccorduck, 2004).

The foundations of the history of artificial intelligence were laid by British mathematician Alan Turing's concept of the "Turing Machine" (Bowen, 2016). Turing showed that with this abstract theoretical model, any computational problem can be solved. In 1956, scientists such as John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon officially used the term "Artificial Intelligence" at a conference held at Dartmouth College. This conference introduced artificial intelligence as a branch of science. Basic concepts such as the first possibility of artificial intelligence (1 50 1970), expert systems, and symbolic logic are available. Artificial intelligence was used in early applications such as language processing, games, and simulations.

During the stagnant period of artificial intelligence (19 0-1980), artificial intelligence research entered a period of stagnation due to a lack of funding, insufficient computer power, and failure to meet high expectations. During this period, the "Artificial Intelligence Winter" occurred (Öztürk & Şahin, 2018). During the artificial intelligence resurgence (starting in 2000), more data, advanced algorithms, and more powerful computers have revitalized artificial intelligence research. New approaches and great successes such as machine learning and deep learning have been achieved. In today's artificial intelligence, artificial intelligence is used in a wide variety of applications. Meanwhile, automation is making a huge impact in industries such as healthcare, transportation, and finance. Artificial intelligence plays a major role in issues such as big data analysis and the Internet of Things, especially thanks to deep learning techniques (Arslan, 2020; Bian et al., 2022).

1.1.3. Artificial Intelligence, Design and Textile

In this regard, when development is so important and technology is so indispensable, and artificial intelligence algorithms are so integrated into daily lives, it is impossible for the design and textile industry not to be affected by this (Michelle et al., 2023). Sectors need to benefit from the main benefits it will bring to them and be close to this industrial development where technology is more active. Otherwise, as mentioned before, it will be impossible for them to survive in the competitive environment.

1.1.3.1. *The Journey of Artificial Intelligence and Textile from the Past to the Future*

The textile industry has been a historically important sector that meets one of the basic needs of humanity. Clothing, home textiles, industrial fabrics, and many other areas are related to the development and production of textile products. It has a wide range of production that is under the supply chain of the ready-made clothing industry (Esi, 2017). In recent years, the industry has experienced a major transformation with the introduction of artificial intelligence.

In the past, the textile industry traditionally involved the production of processed fabrics through manual labor and the use of machines. Product design and production were processes that required long periods of human labor. However, the textile industry grew with the Industrial Revolution, mechanical and weaving machines, and fabrication techniques (Shamsuzzaman et al., 2023; Manaia et al., 2023). This increased productivity but remained a process that relied on manual skills. The introduction of artificial intelligence into the textile industry has brought great potential to the sector. It helps to increase efficiency in the textile industry by making it smarter with machine learning and deep learning techniques (Ozberk et al., 2021). Some of the benefits of artificial intelligence development to designers, companies, brands, and the textile industry are as follows;

Contribution of Technology to Design Progress: Developing and developing technology provides significant support to designers in their personal and professional development. The use of technology can help designers increase their skills and make design and production processes more sustainable in general.

The Future Power of Brands Close to Technology and the Impact of Technology on Competition: It is seen that brands and companies that focus more on technology will progress more strongly shortly. This means that moving forward in harmony with technology can open new opportunities for companies that have experience with traditional methods. Technological change has an impact on competitiveness and on increasing product and service quality. With the use of new technologies and awareness of the principle of total quality management, product quality has increased and it has become possible to produce different shapes, sizes, and designs. In addition, new technologies contribute to the diversification of products and services, making it possible to respond to changing and evolving consumer needs. Being able to offer a wider range of products and services to consumers gives companies competitive power (Erdem & Köseoğlu, 2014).

Traditional and Technology-Focused Design Studies: Designers need to follow technological developments while working with traditional methods. This can be useful both for creating models and for improving subsequent stages of design, especially garment washing and care.

Needs of the Textile and Apparel Industry: The textile and apparel industry faces various needs to increase productivity and become more sustainable. This includes fiber identification, safer working conditions, forecasting demand, and similar factors.

Integration of Artificial Intelligence and Design: Artificial intelligence is desired to be integrated into design and development processes. Artificial intelligence can help designers overcome certain boundaries, think more creatively, and interpret design.

Goals and Benefits: Artificial intelligence can help designers improve their products. This can help minimize design development costs, create more product designs faster, and be more competitive in the fashion industry.

1.1.4. Working Logic of Artificial Intelligence Programs with Visual Design and Development Infrastructure

Visual design platforms generally use deep learning and artificial intelligence technologies to help users create, develop, and improve visual designs. To summarize the working logic of this type of platform, it is as follows.

1.1.4.1. *Data Collection and Training*

The first step is that such a platform involves collecting large amounts of data for deep learning algorithms. This data can include words, visual elements, colors, patterns, and design examples entered by designers or users. Algorithms are trained to learn this data and use it as a reference for future designs.

1.1.4.2. *Image Recognition*

Platforms recognize and analyze images uploaded or entered by users. This analysis includes the ability to recognize visual elements, objects, colors, and other features. Visual recognition algorithms come into play at this stage.

1.1.4.3. *Design Suggestions*

Based on the wishes and requirements of designers and users, platforms offer different design recommendations. Suggestions may include color palettes, typography, layout, and visual elements. These suggestions can speed up the design process of users, and provide guidance and inspiration.

1.1.4.4. Design Editing and Customization

Users can review the suggestions offered by the platform and use them to edit or customize their designs. For example, they can change colors, add text, or rearrange visual elements.

1.1.4.5. *Real-Time Analysis*

Platforms analyze changes made by users in real time and predict how they might affect the visual appeal or balance of the design. This offers users the opportunity to monitor and adjust the development of the design.

1.1.4.6. *Generating and Downloading Results*

Once users complete their designs, the platforms make them available for download in high-quality file formats (for example, JPEG or PNG). Users can thus use their designs for digital or print projects. Visual design platforms offer great value for both professional designers and those without design skills. These platforms use technology to make design processes more accessible, faster, and more creative. Deep learning and artificial intelligence contribute to making visual design richer and more impressive.

1.1.5. Projected Potentials for The Future

It is predicted that the combination of artificial intelligence and the textile industry will gain even more importance in the future. In particular, it can offer great opportunities for sustainability and personalization. Artificial intelligence can be used to make clothing production more environmentally friendly and more suitable for personal preferences. Technologies are also being developed to help better recycle clothing.

1.2. Purpose of study

Artificial intelligence and textiles can go hand in hand and help build a smarter, more efficient, and more sustainable future. This can offer great benefits to both consumers and the industry. It is estimated that the most important of these advantages may be cost reduction. It is predicted that artificial intelligence has the potential to reduce labor costs and provide energy efficiency by optimizing production processes.

2. Method

This study represents an initiative that aims to improve denim clothing design and washing processes through the use of artificial intelligence. The study begins with an examination of artificial intelligence algorithms and extensive resources, and a preview is made to understand the ability of these algorithms to design denim products. The working steps are stated below.

2.1. Procedure

2.1.1. Review of Artificial Intelligence Algorithms:

In the first stage, the algorithms of various artificial intelligence sites were examined. These sites were reviewed for their ability to recognize technical terms related to denim, such as clothing design, washing, and futuristic terms, and to provide design options. At this stage, the algorithm of the artificial intelligence site was thoroughly examined and a preview of the results obtained according to the entered data was made.

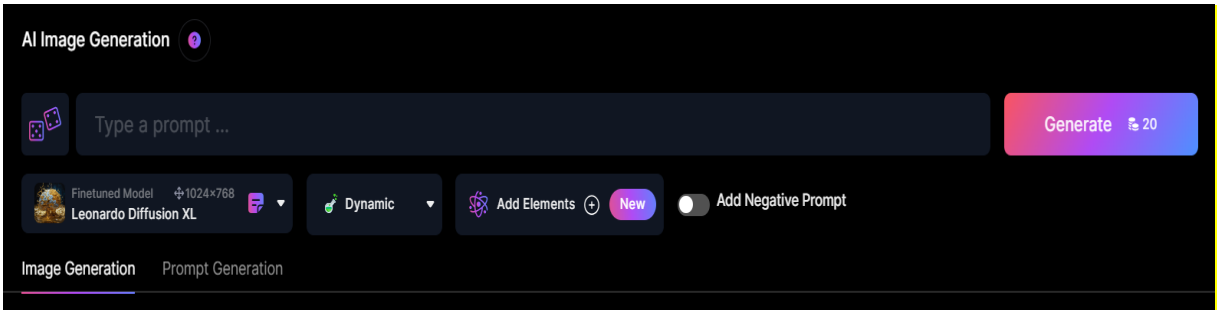
2.1.2. Entry of Artificial Intelligence-Related Data:

Technical terms related to denim clothing design, including product, wash, and futuristic terms, have been obtained from extensive sources. These terms have created basic data for the use of artificial intelligence algorithms. The data was searched by entering the artificial intelligence website.

General data was entered into the artificial intelligence by writing words and clear short sentences related to the subject to be developed in the "Type a prompt" section, which can be translated as "Artificial Intelligence Image Creation" in Figure 1. As terms, the terms "full body portrait of a beautiful cowboy woman", "cyberpunk", "denim", "vintage", and "jeanswear" were entered.

Figure 1

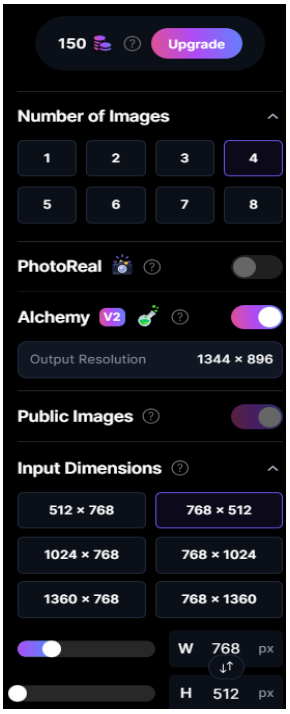
Artificial Intelligence Site Data Entry Screen



After data entry, adjustments were made with the TOOL section on the side and the "Generate" button was pressed. The program creates the artificial intelligence design in line with the choices and settings made.

Figure 2

Design Creation and Settings Screen



Artificial intelligence created designs according to the desired units and specified the images in the system as shown in Figures 3, 4, 5, and 6.

Figure 3

1st Study In Artificial Intelligence: First Image Acquisition Of The Program

Figure 4

2nd Study In Artificial Intelligence: The Study That Came After The Correction Request Made By The User

Figure 5

Final Images Obtained In Artificial Intelligence

Figure 6

Final Images Obtained in Artificial Intelligence

2.2. Design Comments and Detailing

After searching according to the terms specified on the artificial intelligence site, the options were increased until the desired design was reached, and a visually pleasing result was sought. When the artificial intelligence site was searched by technical terms, the design options presented were examined by the designers, and the strongest design was determined. The trouser design shown in Figures 5 and 6 was chosen as the product. After the design selection, the designers commented on how it should be technically transformed into a product. These comments were used to translate the design into technical drawings.

2.3. Samples

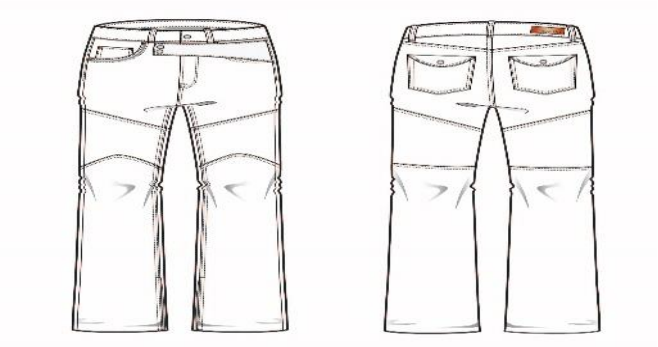
Sample production started based on design comments and technical drawings. As indicated in Figure 8, a technical drawing was made along with design comments to provide a visual closeness to the product we selected, presented by artificial intelligence. By examining the visual, interpreting it by the designers, and selecting the appropriate fabric with the engineering team, the artificial intelligence design was turned into a technical sheet to obtain a commercial product. After the technical drawing, the process including the washing process and printing and coating steps began.

Figure 7

The Method of Adapting the Design We Have Chosen, presented by Artificial Intelligence, to the Trousers We Produce

Figure 8

Technical Drawing with Design Comments to Provide Visual Closeness to The Product We Have Chosen, Presented by Artificial Intelligence



2.4. Integration of the Washing Process

After the leaflet studies, the pattern was prepared by the model shop team, and the cutting and sewing processes were started. The washing process of the raw denim fabric product has been started. During the washing phase, the design produced by artificial intelligence is aimed to closely match the washing processes applied in the real world. After the sewing process, the stages were determined and the formula was created. The steps are as follows;

a. Stone Washing
b. Hypo Bleaching
c. Polymer Coating
d. Water-Based Pigment Printing

Table 1

Chemicals And Usage Rates Specified in The First Formula

Chemicals Used	Usage Rates
Polyurethane	25%
Polyacrylate (Hard)	20%
Titanium Dioxide	20%
Macro Silicone	5%
Pigment Dye Substance	5%
Water	25%

Table 1 displays the chemicals and usage rates specified in the first formula. The desired flat black appearing parts on the product were subjected to the polymer coating process after the wet processes were completed, but the Titanium Dioxide used to provide covering during the coating process hurt the touch, resulting in a product that was too hard. Additionally, the color did not reach the desired black image.

Since the trial did not achieve the desired results according to the first prescription, a correction was made to the prescription. As stated in Table 2, the Titanium Dioxide rate was reduced by 10% and a soft (low vitrification point) Polyacrylate was preferred. In addition, the pigment dye ratio and macro silicone ratio have been increased to 10%.

Table 2

Chemicals And Usage Rates Specified in The Final Formula

Chemicals Used	Usage Rates
Polyurethane (Soft)	25%
Polyacrylate (Soft)	20%
Titanium Dioxide	10%
Macro Silicone	10%
Pigment Dye Substance	10%
Water	25%

The desired color, touch, and covering effect is achieved in the product made in this way.

2.5. Use of Printing and Coating Techniques

During the printing and coating stage, artificial intelligence and deep learning algorithms have been used to recognize and apply different style features such as printing and coating techniques, enabling the design of more innovative products compared to traditional design processes. The polymer coating process was first applied to the trousers washed according to the formula specified in Table 1. Since the desired appearance on the touch was not obtained after the polymer coating and the trousers were hard, no printing was applied afterward. Since the trousers obtained as a result of washing according to the formula specified in Table 2 met the requirements in terms of color, touch, and covering ability, a water-based pigment printing process was applied to the trousers washed with this formula after the polymer coating process.

Figure 9

Trousers Produced After Design Interpretations, Washing, Printing and Coating Techniques

As a result of this study carried out with artificial intelligence, a product with the desired appearance was obtained and some findings and predictions that will help vision development were obtained.

3. Results

The washing process of the trousers we designed was carried out according to 2 different formulas. In the washing process carried out according to the first formula, the desired flat black appearing parts on the product hurt the touch of Titanium Dioxide, which was used to provide coverage during the polymer coating after the completion of the wet processes, and a product that was too tough was obtained.

In the washing carried out according to the second formula, the Titanium Dioxide rate was reduced by 10%, a Polyacrylate with a low vitrification point was preferred, and the pigment dye rate and macro silicone rate were increased to 10%. When produced with this method, the desired color, touch, and covering ability of the product is achieved.

As a result of the study, various designs were achieved by using the artificial intelligence-supported visual design program, all the details were interpreted about how the design should be transformed

into a product in line with the selected design, and these interpretations were converted into technical drawings and the sample process was started, and artificial intelligence was used in the washing, coating, and printing stages as well as the model design. An attempt was made to capture the image.

As a result of the study, positive results were obtained in the trousers obtained in line with the design interpretations and technical drawings. After the cutting and sewing phase of the product according to the technical drawing, the Titanium Dioxide ratio used to provide coverage in the washing process carried out according to the first formula during the washing, polymer coating and water-based pigment printing stages hurt the touch, resulting in a product that was too hard. Additionally, the desired black image was not achieved. According to the second formula, when the Titanium Dioxide rate was reduced by 10%, the pigment dye rate and macro silicone rate were increased by 10%, and Polyacrylate with a low vitrification point was preferred, the desired color, touch, and covering ability was achieved in the resulting product. During the washing phase, excessive use of Titanium Dioxide hurts the product, and positive results have been obtained when Titanium Dioxide is used in the correct proportion. Positive results were obtained in creating the desired image on the product by using polyacrylate with a low vitrification point instead of macro silicone and hard polyacrylate included in the process. It has been observed that chemical ratios are important in terms of their effect on the product during washing.

4. Conclusion

Additionally, as a result of the study, positive results were obtained in terms of removing many boundaries and gaining a different perspective as a designer. The products obtained in the study enabled our technical team to develop different ways of working, many teams to come together and exchange ideas on how the image presented by artificial intelligence can be transformed into a product, to think outside certain boundaries, as a company, we are intertwined with technology and in a globally changing and developing market. It has contributed to strengthening ourselves and raised awareness about integrating artificial intelligence into the sector.

Artificial intelligence has made a significant contribution to this study process in accelerating design processes, providing suggestions, obtaining professional-level results, providing creative inspiration for designers, as well as providing rapid feedback to users thanks to its visual recognition and analysis capabilities, making it easier for designs to be original and impressive. Based on this, artificial intelligence is a source of innovation in the world of art and design, contributes to rapid design and prototype production, offers companies that want to gain a competitive advantage in the denim industry the opportunity to act more innovation-oriented and faster, and at the same time, designs are more sustainable. Considering that it supports more efficient production processes, sustainable material selection, waste reduction, and the provision of original and environmentally friendly products in the fashion world, it is planned to further integrate artificial intelligence into design processes in the future. It has been realized that artificial intelligence has a critical importance in terms of sustainability and change in the design and textile industry.

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