

USAGE OF AUGMENTED REALITY TECHNOLOGIES IN THE LIGHT INDUSTRY

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Abstract: The article considers the use of augmented reality technologies. The analysis of directions of development of AR technologies in light industry is carried out. The dynamics of the development of augmented reality technologies in the garment industry and the fashion industry over the last decade is considered using the tools of Google Trends and SE Ranking. A study was conducted among women and men on awareness of the use of QR codes in light industry. The constructive-technological solution of a cuff of a sleeve of a women's jacket with use of AR technologies is offered. Men's pants are made using a QR-code on the label, which contains a link to the site TKSHV – Market.

Keywords: Augmented reality, QR-code, apparel, fashion industry, technology.

1 INTRODUCTION

Today, more and more people use online services to make purchases and choose a potential product. In the process of technology development, the question of attracting and making the audience interested on the Internet is becoming more and more important. There are many different digital marketing tools that help companies understand the consumer better, collect statistics and understand the specifics of decision making. However, the means of influencing the consumer until recent times remained at the traditional level: banner advertising, video advertising, integrated messages in video and text materials, classic outdoor advertising and more. Now there is software that blocks advertising, such as AdBlock, which does not allow advertising materials to appear on web pages, which significantly reduces the effectiveness of this tool. A large number of people, using social networks and messengers, find the product directly on the pages of web stores, and pay attention to discounts and ads from them, use newsletters. Based on the current development of technology, companies are beginning to use augmented reality (AR), which helps to distinguish the product in both the real and virtual world. New integrations help to attract the consumer's attention, improve the use of technology, help to understand information, provide an idea of the product even if the consumer has not seen it. To a better extent, such issues are being studied in the United States and Western Europe. However, today there are no specific works on the use of augmented reality in retail.

AR is a new trend in marketing and sales strategy that allows brands to provide their customers with

a unique experience with the convenience of connecting to their mobile devices [1]. In addition, it is possible to increase the level of interaction with the product anywhere, which gives the consumer a deeper knowledge of the product, and increases its rational and emotional motives for buying. One of the key elements to the success of applications and AR in general is to create an intuitive and simple interface that will not require much time to learn and get used to.

If in the industrial market, we strive for the most pragmatic and simple visual representation, for ease of operation and understanding by customers, then in the consumer market it is necessary to choose the functionality for a particular product. Therefore, it can be concluded that the design and interface of applications should be clear and simple to achieve the highest level of conversion and engagement.

2 DISCUSSION IDEAS

QR codes (Quick Response) are machine codes in the form and templates that can be scanned to view hidden information. They can be recognized using special scanners or smartphones. The reader decrypts the encoding and publishes information, which can be in the form of photos, text, links to the site, etc. [2].

A QR code can hold a large amount of information in a small image, the complexity of which depends on the amount of information. The maximum amount of information can be more than two printed pages. Modern devices for scanning QR-codes and the corresponding software allow to read the encoded data automatically [3, 4].

There are static and dynamic QR-codes. The static QR code contains the information specified when it was generated. Dynamic QR-code is multifunctional: it can be connected to additional functions that can be changed [5]. Dynamic QR codes are not tied to a specific data format. QR code viewers recognize encoded information and display to the user: text, graphics, information on web-pages, email, SMS, phone numbers, geographical coordinates, the ability to view 360° videos from the virtual store and other data. The type of information is specified when generating a QR-code [6]. To get the information directly to the screen of a mobile phone, just run the program to scan the code and point the camera lens at the code. The decoder program recognizes the type of information and performs the necessary actions, such as opening a web-page (in this case, you need to connect to the Internet) [5].

The use of AR technologies by industry giants, and their success, has prompted less known companies to implement similar technologies for consumers not only in the form of mobile applications, but also for websites and other platforms in the B2C and B2B areas. Thus, this tool becomes not only a new and powerful element in marketing, but also a trend for markets as a whole. The use of augmented reality greatly simplifies the spatial understanding and presentation of visual information for both employees and customers who want without special skills and in-depth knowledge to understand the process and principle of operation of certain devices or equipment [7]. It can also significantly reduce production costs by reducing the need for physical interfaces.

Thus, we can say that augmented reality with some time and increasing availability of technology will be able to conquer the market and significantly increase the effectiveness of digital marketing.

To get the most out of augmented reality economic activity, you need to develop the right and optimal software product that will be new to the market and supported by many platforms. With the current growth of global competition, this issue is becoming crucial to be able to compete in markets and have the opportunity to attract and interest most of the audience and attract new ones.

The pioneer in the use of AR in retail is the American brand of clothing and accessories American Apparel, which was able to reduce the burden on staff. Together with the technology giant Qualcomm, the retailer has developed a mobile application Vuforia, which provides information about any product in the range [7].

All you have to do is point the smartphone camera at the product label, and all the necessary information will appear on the screen: price, material, characteristics available in the store, colors and sizes, etc. You do not need to wait for the consultant to check for the required size or color, the client can find out for himself.

The app also shows product reviews from other users and their ratings. The buyer can immediately share his opinion, put the number of "stars" of the product and post a review on social networks.

"Smart mirrors" is the most famous application of augmented reality in fashion retail. This technology is used by many retailers and brands. For example, the Neiman Marcus luxury department store chain has installed 58 full-size MemoMi Labs "smart mirrors" in 34 stores. The devices use AR technology, artificial intelligence and gesture recognition software. A mirror such as a virtual locker room allows you to change the color of clothes in a matter of seconds and consider different combinations of outfits and accessories. The HD camera mounted on the mirror records eight-second videos - during this time the buyer has time to return in front of the mirror in all directions to get a full view of the 360°. The mirror interacts with the mobile application Neiman Marcus - the customer can send recorded videos to phone or share on social networks.

Platforms such as Google, Unity, Facebook or Snapchat also include AR web applications for ready-to-use fashion manufacturers and distributors. However, the problem of their use arises due to the different requirements for the format of 3D files, which has each of the respective platforms. To create and view augmented reality, existing digitally produced production files usually need to be first optimized and converted to meet the required conditions.

In general, it can be argued that from a technological point of view, the creation of 3D objects, as well as the visualization of AR embedded, static 3D clothing in physical spaces work quite well and can be used by brands and e-shops today. Dynamic fittings also work quite well in the segments of accessories and footwear, but are not yet perfect enough for clothing.

Industry experts emphasize the need to start experimenting with AR now that the technology is maturing and is expected to be fully operational within the next five years [8].

Three-dimensional visualizations have already reached a sufficient level that allows companies to digitally create garments that can hardly be distinguished from a photo of a real product. However, their large-scale production is still considered expensive and especially difficult to implement by small clothing companies. This is expected to change over the next few years, thanks to newly developed software tools and the inevitable digitization of design processes, paving the way for the wider spread of augmented reality technologies in the field of clothing distribution. Tools for visualizing models and virtual fittings will also be refined, achieving a high level of accuracy.

3 PRELIMINARY RESEARCHES

3.1 Research on the development of AR technologies

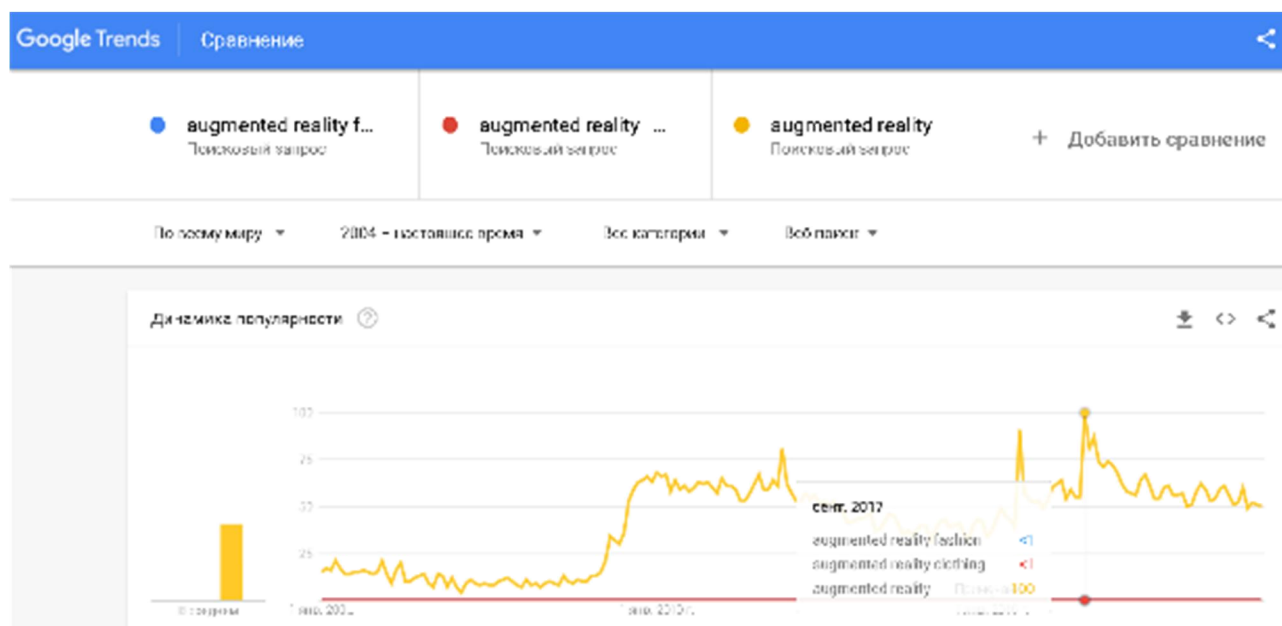
Studies of the development and popularity of augmented reality technologies using the tools of Google Trends and SE Ranking (Figure 1) found that the vast majority of potential consumers of such technologies do not associate them with clothing [9].

At the same time, even among the existing consumers and manufacturers who use augmented reality in clothing or related areas, there are no representatives of many countries. Among all the existing areas of augmented reality, its use in clothing is only 12% (Figures 2 and 3, Table 1).

Table 1 shows a fragment of the analysis of the directions of development of AR technologies in light industry [1, 10-18].



a)



b)

Figure 1 Analysis of the frequency of queries relevant to the phrase "augmented reality in clothing" using Google Trends

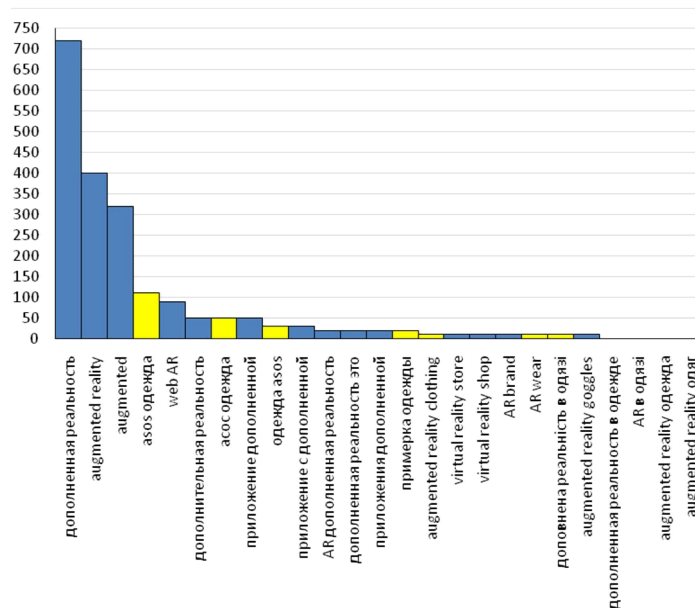


Figure 2 Analysis of the frequency of queries relevant to the phrase "augmented reality in clothing" using SE Ranking tools

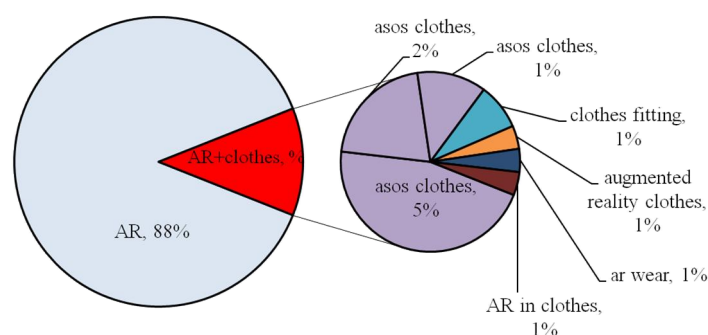


Figure 3 The ratio of the frequency of augmented reality queries in clothing to the total number of queries

Table 1 Analysis of directions of AR technologies development in light industry (fragment)

Brand (name of the application), year of issue	Brief description	Feature	Range
1	3	4	5
deKryptic (the Boosted Art Augmented Reality App), 2020	deKryptic's collection consists of various garments - from hoodies and tees to denim jackets and jeans. The subject matter for the brand's graphics is quite diverse and suitable for all ages. The AR clothing spotlights various beloved cartoons through playful collaborations, including one with Dexter's Laboratory and even Popeye. The garments come to life with the Boosted Art Augmented Reality App, boasting "beautiful 3D animations and rich sound effects to accompany that graphic." Wearers can share it across their social media channels, as well.	Animation of prints on clothes	T-shirts
GOAT, 2019	GOAT, which is recognized as a global destination for authentic sneakers, is now launching an AR sneaker Try-On feature to help its users virtually see rare and exclusive sneaker styles on their own feet. Prior to launching this feature, GOAT introduced an augmented reality feature to give sneakerheads a better way to get to know the materials and textures of sneakers. Already familiar with this technology, fans will appreciate being able to see some of the most coveted sneakers appear thanks to the magic of augmented reality before their eyes. Some of the styles that can be previewed virtually with GOAT's Try-On include designs from Nike and Air Jordan, as well as unreleased samples like the Air Jordan 4 Undeafated and Air Yeezy 1 Glow in the Dark Tour.	Virtual fitting	Sneakers

Carlings, 2019	Changing the image and text that appears on a shirt usually calls for purchasing a new style or making some kind of DIY modification but The Last Statement T-shirt by Carlings sets itself apart with a design that can be digitally updated. The t-shirt makes the most of a new feature on Instagram called Targeting Tracking, so that the plain white shirt can be enhanced with Instagram's augmented reality filters. Previously, AR effects and filters on Instagram have been limited to faces but the body and pieces of clothing can now be enhanced with augmented reality graphics as well. Pointing the Instagram camera at the logo on the t-shirt calls up a design that seems incredibly realistic and makes it easy for social media users to use a single shirt for photographing different looks.	Animation of prints on clothes	T-shirts
IKAR, CGTrader, 2019	At CommerceNext 2019, CGTrader - the world's largest source for licensable stock and custom 3D models - is introducing augmented reality innovations to shape the future of fashion, retail and customer experiences. CGTrader is working with IKAR to transform traditional 2D images and paper catalogs into 3D, AR experiences for the design and manufacturing company's lines of apparel and active wear. With these AR innovations, IKAR will be able to effortlessly show its seamless apparel styles on 3D fashion models without the cost or time investment of traditional photoshoots. Additionally, the technology will allow for a range of designs, colors and styles to be visualized without needing physical garments to be produced for meeting with customers in the fashion industry.	Virtual catalog	-
(The Apparel App), 2016	The Apparel app is a digital platform that allows consumers to customize their garments using augmented reality. Consumers can add geometric and modular patterns and shapes to their clothing using the app that move around and add dimension to the clothing. The app works in conjunction with a simple black shirt that when viewed through a camera on a smartphone with the Apparel app pulled up, can be altered with moving geometric shapes that shift and change on and around the shirt. The designs are visual translations of data from a Twitter feed, so the shapes change depending on the incoming interactions from the social media account. The connection between design, social media and fashion moves in real time against the black shirt for consumers to see	Clothing animation	T-shirts
FXMirror by FXGear Helps Users Virtually Try on Garments, 2018	Seoul-based augmented reality brand FXGear recently unveiled its FXMirror concept which acts as a virtual fitting room platform that aims to take retail technology and experiences to new and exciting heights. Already trialed inside Korea's Lotte Department Store, the AR mirror works by calculating a person's exact height and measurements to showcase the most precise image of what clothing looks like when worn. When describing FXGear's latest ventures, the company's CEO Choi Kwang-jin states that AR is one of its primary areas of focus. "In China, customers who purchase their garments online account more than 50% of all purchases. When purchasing clothes online, people want to know if it fits. I believe FXMirror's mobile version can help customers find this out," he said	A smart mirror	-
Ralph Lauren (Snapchat), 2020	With the help of Snap, Ralph Lauren is bringing its polo pony logo to life with augmented reality - meaning that the logo can be scanned from virtually any surface to start an AR experience. Scanning the Ralph Lauren logo starts an experience - at this time of year it's a festive one - that has the potential to lead app users to purchase	Logo animation	-
LKM Lab, 2020	LKM Lab is a brand that's behind virtual runway shows, designing incredibly unique backdrops for designers to choose from for their shows. The brand utilizes 3D animation alongside virtual reality technology to create a virtual environment that immerses and wows the viewer. What's more, is that these designs can change at any moment, creating a versatility and excitement that's exclusive to virtual shows	Virtual show	-
Neiman Marcus (Neiman Marcus), 2019	"Smart mirrors" - the most famous solidification of augmented reality in fashion retail	Virtual fitting	-

Also, AR technologies are used by other brands and firms that are not presented in Table 1: Gucci (2019), Puma's LQD Cell Origin (2019), Wannaby's 'Wanna Kicks' (2019), Adidas Ultraboost (2018), Gymboree (2018), aiaa 'Teemoji' (2017), Virtuali-Tee (2016) and others [18].

According to Table 1, a diagram was constructed (Figure 4) which demonstrates the dynamics

of the development of augmented reality technologies in the garment industry and the fashion industry over the past decade.

Analysis of the development of augmented reality technologies in the garment industry and fashion industry shows their rapid development over the past decade. The most common technologies that are now available to the general public are

the application of printed images on T-shirts and other knitwear, which serve as augmented reality markers and are animated using special mobile applications (Table 2, Figures 5 and 6).

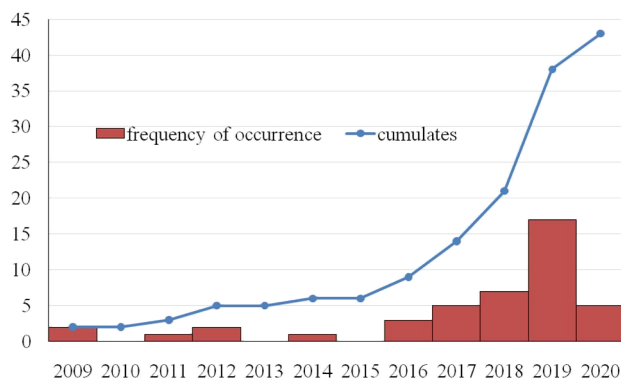


Figure 4 Dynamics of development of augmented reality technologies in the garment industry and fashion industry

Table 2 Frequency of usage of augmented reality applications in clothing and the garment industry in general

Direction of usage	Type of usage of AR	Frequency of occurrence [units]
Animation	Animation of prints on clothes	9
	Clothing animation	3
	Animation prints	1
	Logo animation	1
	Photo animation	1
Database	Database	1
Fitting	Virtual fitting	16
	Virtual show	4
	Smart mirror	1
Prototyping	Virtual prototyping, catalog	1
	Virtual prototyping	1
Catalog of virtual 3D models	Virtual catalog	5

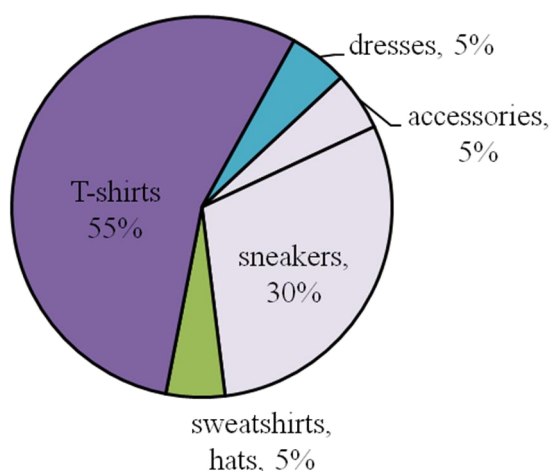


Figure 5 The range of clothing using AR-technologies

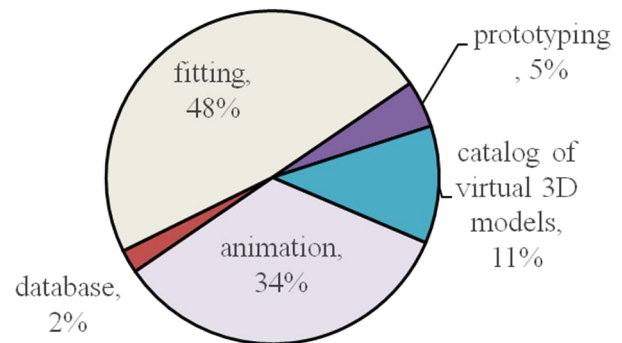


Figure 6 The ratio of AR usage in clothing

3.2 Research of consumer use of QR-codes in light industry products

To determine the awareness of QR-codes among consumers (separately for women and men), a study of the use of QR-codes in products was conducted. It was conducted by surveying people of different ages and genders of 10 respondents of each type, a total of 100 people.

Then, with the help of expert evaluation, the main ways of using the QR code were identified. Determining the most commonly used basic ways of using a QR code is possible only using the research methodology. To solve the tasks, the method of expert survey and expert assessments, mathematical statistics, experimental methods to determine the actual values of indicators were used.

The method of determining the most important ways to use the QR-code was performed in the following stages:

- conducting a survey among consumers of clothing;
- analysis of expert assessment;
- identification of the most significant ways to use the QR-code;
- chart construction.

For calculations and registration of work, the program Microsoft Office Excel and the program EXPERT are used. These programs are used during research at the Department of Garment Technologies and Design of Khmelnytskyi National University.

The use of QR codes in various fields is modern and progressive. If you apply them in the production process, you can improve several production issues. For example, tissue storage is a very large process in the production process of any enterprise. Tissue passports are confused, lost, you should always look for the necessary information in stacks of paper. But researchers at Istanbul University have found a way to use QR codes. They have developed a special program in which data about a particular fabric are entered: geometric data, balances, sellers. All you need to do is mark the rolls of fabric with QR codes and provide scanners or smartphones to your

workers to read the information. This reduces the process of finding information in the warehouse [19].

Equipment manufacturers also do not lag behind progressive trends. In the Netherlands, a special machine was created to embroider QR codes on an industrial scale. LogoBorduurstudio (Barneveldi, the Netherlands) has allowed the use of a computer-controlled embroidery machine to make fabric consisting of QR codes. This allows you to embroider barcodes on clothing or other products [20, 21].

Siruba was one of the first manufacturers of sewing equipment to use QR codes on sewing equipment [22]. They apply a laser to the metal table serial number, model name and QR code. The operator brings the smartphone to the code, reads it and, when connected to the Internet, receives complete information about the model, series, operating instructions and more [23].

Unfortunately, today the least common is the use of QR-codes in production automation. Reading the codes would speed up the production process and reduce time.

Code generators are widely available online and do not require special knowledge to implement them. In addition, the introduction of such technology in enterprises does not require the purchase of any additional equipment, as it involves the use of employees' own mobile devices, which are provided to almost 100% of the population.

As an experimental technology, tools have been developed that can replace instruction cards in employees' workplaces. For example, these could be Instructional Technology Maps (TICs) for quality controllers. Such maps can present controlled indicators for each operation, written rules and methods for assessing the quality of basic operations on the main control indicators. The presence of the card "TIC quality control operation" reduces the risk of subjective assessment of the object of inspection by the controller, as it contains instructions that determine the sequence and method of checking the quality of the assessed area of the product. Therefore, similar tools using augmented reality can be developed for quality controllers in individual operations of the technological process. The generated codes allow: to obtain the sequence of processing the node (or the content of the organizational operation) in the form of plain text (Figure 7); get the sequence of processing the node (or the content of the organizational operation) in the form of a pdf-file, which additionally shows the assembly diagram of the section of the node; view a virtual 3D model of the site; watch a video showing the sequence and techniques of performing direct technological operations.

The Figure 8 shows dynamic codes that provide interaction with pdf-files and video-files Figure 9.



Figure 7 The work of a static QR-code to obtain the technological sequence of processing the node in the form of simple text: a) QR-code; b) application of the code using Google Lens



Figure 8 Dynamic QR-codes

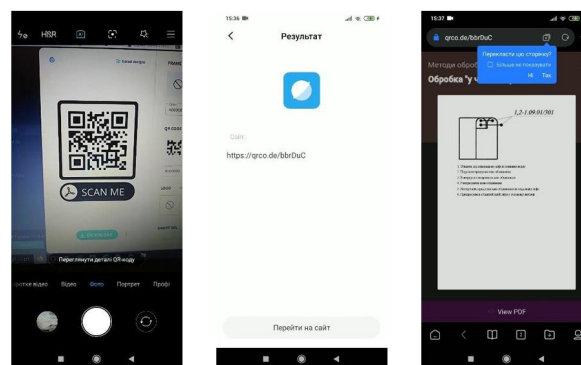


Figure 9 The process of obtaining information in the form of a pdf-file

Today, the development of virtual three-dimensional forms of garments in mass production has traditionally focused directly on products. Usually the algorithm for building a virtual model is based on the use as a basis of scanned with a body scanner typical representatives of each type of clothing. In this case, the default is the same type of technological processing of the virtual basis of the product and designed in a specific design situation. As a result, the virtual model is created only in the form of an external shell, without displaying complex functional units and without taking into account the allowances for technological processing.

To implement technologies of virtual representation of product forms directly into the manufacturing process in the form of an instruction card or additional manual for training beginners and high quality manufacturing, there is a need to present in three-dimensional space not the whole product, but only parts. Each node should reflect the operation / operations that are performed at a specific workplace in the sewing flow. For example, the selected node (finishing the top of the part "in the clean edge") is built using a universal graphics editor AutoCAD. The mentioned editor allows to execute both plane drawings, and to construct three-dimensional objects and to carry out their visualization.

The cross section of the node was constructed by Operation "Polyline". Conversion to a three-dimensional model is performed using the "Extrude" command. For clarity of the received model all details are painted in contrasting (Figure 10).

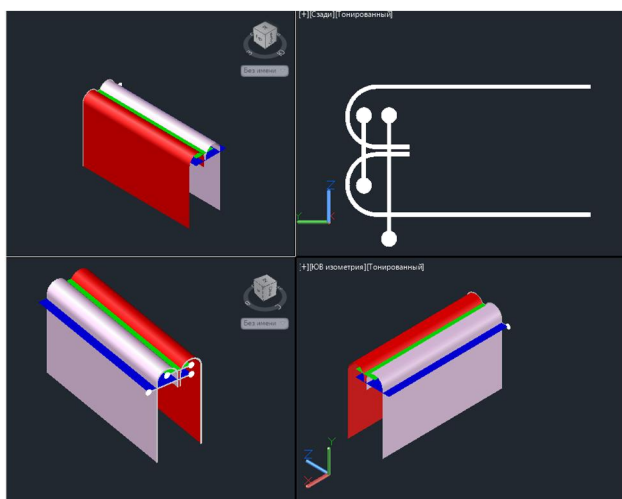


Figure 10 3D-model of node processing

3.3 Application of AR technologies in the manufacture of cuffs for women's jacket sleeves

For the practical application of augmented reality technologies, it was decided to make a women's costume, which is decorated with the effect of augmented reality "snow falls" and sounds "Shchedryk-Shchedryk" based on the works of artist Olena Golembowska.

The print is made on the overlay cuff of the sleeve of the women's jacket from the suit. The choice of such an augmented reality marker location is argued by the fact that in this case, the augmented reality effect can be viewed directly by the clothing owner (when the woman is wearing a suit) and does not require outside help.

To apply prints on the fabric of women's costume as markers of augmented reality technology, the technology of sublimation printing was chosen.

Sublimation printing is printing with ink, in which it passes from sublimation paper to textile material under the influence of high temperatures. The image is printed with sublimation inks using a printer on the appropriate sublimation paper, which is covered with a thin layer of special varnish [24].

The fabric is placed in a special thermos press machine, which is a two Teflon plates. One of the plates of the thermos press machine has a heating element. Paper with the finished image is placed on the fabric and clamped with a thermopress for a minute, giving a high temperature and pressure of several hundred kilograms. Under the action of temperature, the paint turns into a gaseous state, while separating from the carrier (paper) and immediately penetrating into the structure directly of the fabric (in this case, the cuff fabric). Among textile materials, it is better to prefer synthetic fabrics (a higher percentage of synthetics provides higher image quality and durability). It is not possible to print on already colored, colored or dark fabrics or products (the background, that is the base color should be light or white) [25], so a white gabardine was chosen to make a cuff with a print on it (Figure 11).

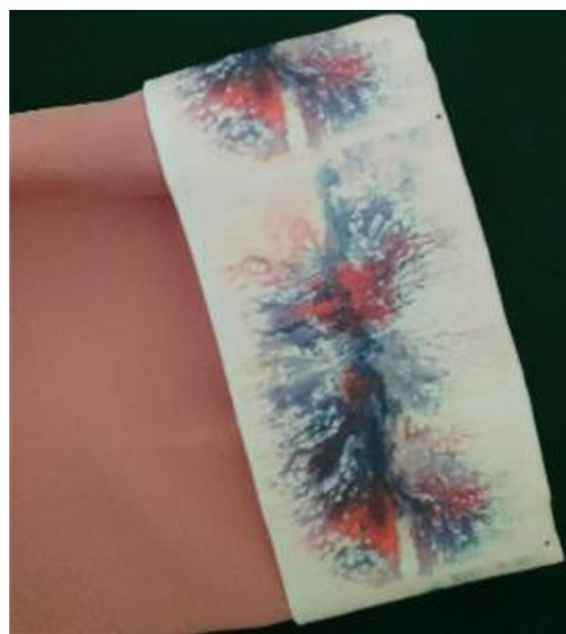


Figure 11 Technological solution of a cuff of a woman suit with use of print and AR technologies

4 EXPERIMENTAL

A separate study was conducted among women (W) and men (M) on the use of QR codes in garments. The analysis of the answers is given in the summary table of the survey of clothing consumers (Table 3). To improve the perception of the obtained results, on the basis of the processed data of Table 3 diagrams were constructed (Figures 12-14). This allowed us to evaluate them.

Table 3 Responses from clothing consumer surveys

Questions	Age	to 20		20-30		30-40		40-50		over 50	
	sex	W	M	W	M	W	M	W	M	W	M
Do you know what a QR code is?	yes	6	9	10	10	10	10	10	10	8	6
	no	-	1	-	-	-	-	-	-	2	4
Do you often come across a QR code in your life?	yes	8	4	9	4	8	6	6	4	4	3
	no	2	6	1	6	2	4	4	6	6	7
Do you use a QR code?	yes	9	4	9	4	8	6	7	3	2	3
	no	1	6	1	6	2	4	3	7	8	7
Did you come across the picture as a QR code on your clothes?	yes	8	5	7	4	5	5	4	2	2	-
	no	2	5	3	6	5	5	6	8	8	10
Have you come across an embroidered QR code?	yes	2	1	3	1	1	2	-	-	-	-
	no	8	9	7	9	9	8	10	10	10	10
Have you seen the applique in the form of a QR-code?	yes	-	-	2	-	1	-	-	-	-	-
	no	10	10	8	10	9	10	10	10	10	10
Did you see the QR code on the garment label?	yes	8	5	9	7	7	5	5	3	2	-
	no	2	5	1	3	3	5	5	7	8	10

From the Figure 12, we can conclude that 96% of women know what a QR code is, and 70% have met it in their lives and used it. However, only 52% of women encountered pictures with a QR code on their clothes. Even fewer women saw the embroidered and applied QR code of 12% and 6% respectively. However, 62% of women saw the labels depicting him. The average percentage of awareness and use of the QR code among women of all ages reached 52.6%.

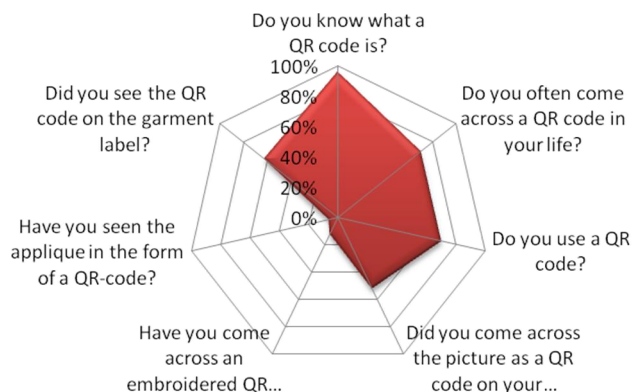


Figure 12 Diagram of a survey of **women** regarding the introduction of QR codes in the garment industry

From the survey chart of men in Figure 13 we can conclude that 90% of men know what a QR code is, but only 42% have met it in their lives, and used only 40%. Only 32% of men met pictures with a QR-code on their clothes. Even fewer of them saw the embroidered QR-code 8%, and made the application did not see. Only 40% of men saw labels with a QR code image on them. The average percentage of awareness and use of QR-code among men of all ages reached only 36.0%. This figure is much lower than for women by almost 17%.

From the women and men survey chart in Figure 14 can be seen that 93% of women and men know what a QR code is, 56% have encountered it in their lives, and 55% have used it. Only 42% saw images with

a QR code on their clothes. Only 8% saw the embroidered QR-code, and only 3% made the application. Only 51% of respondents saw labels with the image of the QR-code. The average percentage of awareness and use of QR-code among respondents of all ages reached 44.3%, which shows a lack of awareness and use of QR-code by respondents.

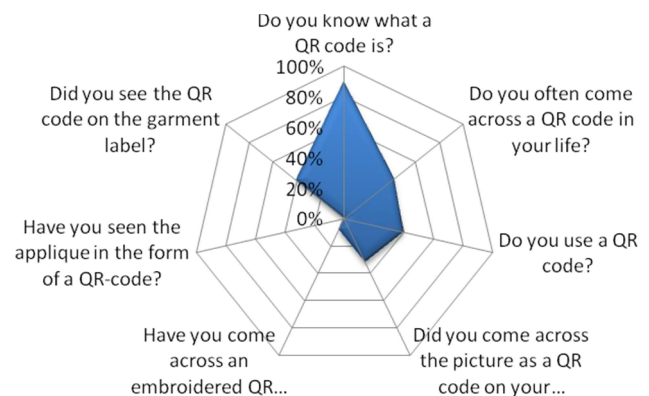


Figure 13 Diagram of a survey of **men** regarding the introduction of QR codes in the garment industry

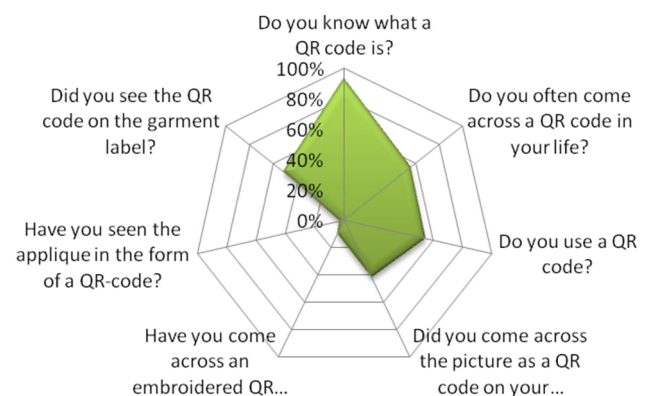


Figure 14 Diagram of a survey of **women and men** regarding the introduction of QR codes in the garment industry

Awareness and use of QR-code by respondents depending on age were studied separately.

From the diagram (Figure 15), the survey of women it is clear that the most knowledgeable and most often use the QR code of women under 40 years. Women over the age of 50 know and use them the least.

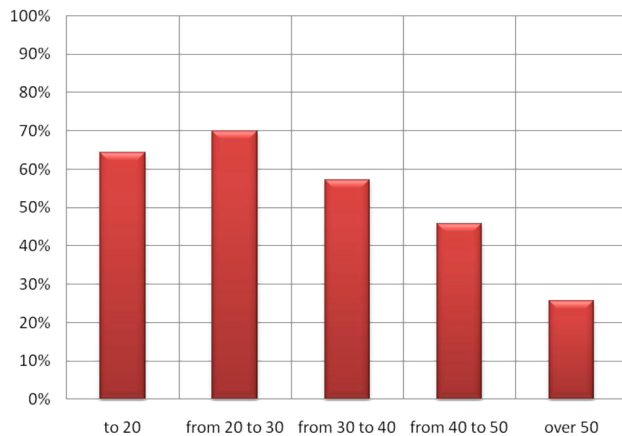


Figure 15 Diagram of a survey of **women** regarding the introduction of QR codes in the garment industry

From the diagram (Figure 16) a survey of men shows that the most knowledgeable and most often use of QR code by men, as well as women happens if they are under 40 years old. However, the peak of the chart is with men between the ages of 30 and 40, and with women between the ages of 20 and 30. This shows that men's interest in QR codes comes later. The least aware about QR-codes and least used they are by men over 50 years.

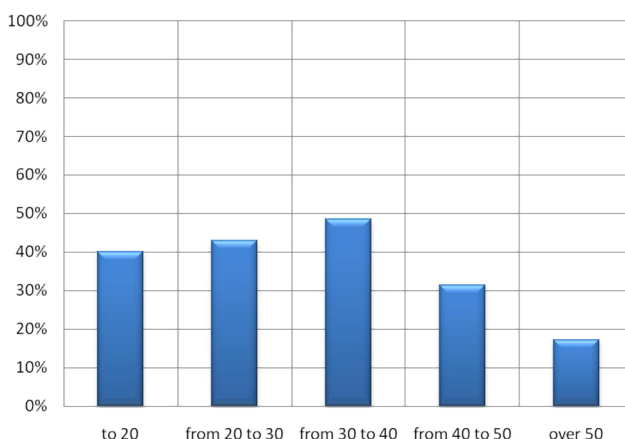


Figure 16 Diagram of a survey of **men** regarding the introduction of QR codes in the garment industry

From the diagram (Figure 17) a survey of women and men shows that the most aware and most often use the QR code consumers aged up to 40 years. However, the peak of the chart is between 20 and 30 years. Consumers over the age of 50 know and use them the least.

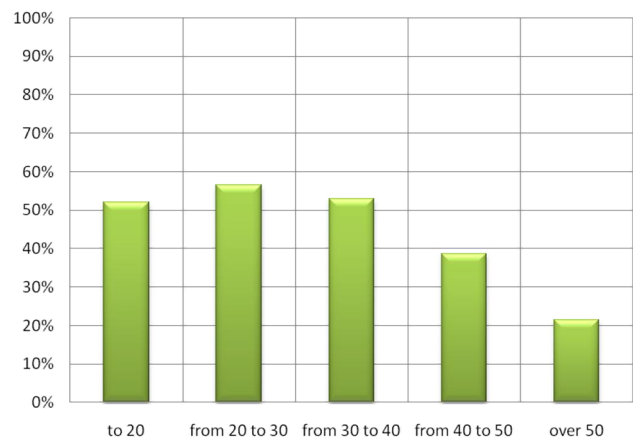


Figure 17 Diagram of a survey of **women and men** regarding the introduction of QR-codes in light industry

There are many paid services that provide tools for generating color or non-format codes. As part of the research, to perform a QR-code on the label of men's pants, it is proposed to use the free service QR Code Generator [26]. As a result, the service for generating a QR-code provides a link for placement on the site, ready code for embedding. The process of creating the code does not take much time - you only need to specify the source data for encryption and click "Generate".

5 RESULTS

The functioning of the generated dynamic QR-codes is presented in Figures 18 and 19.

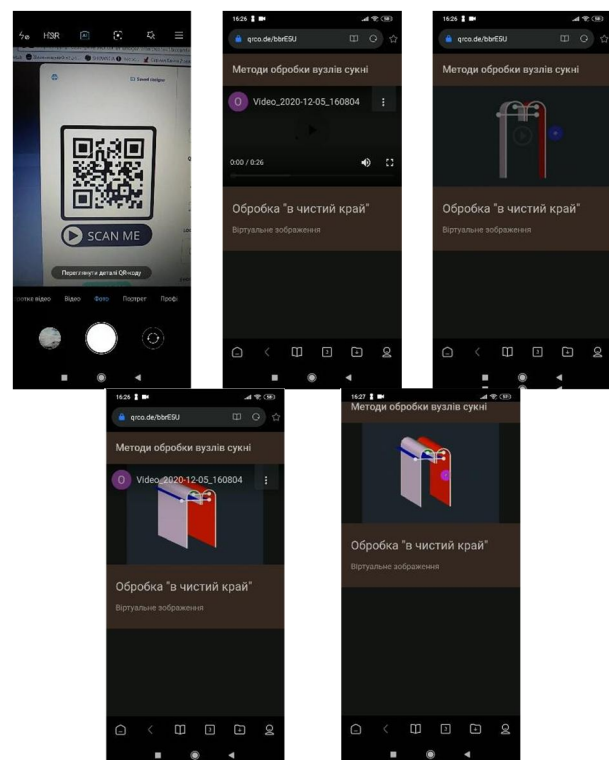


Figure 18 Use a QR code to view a 3D node processing model

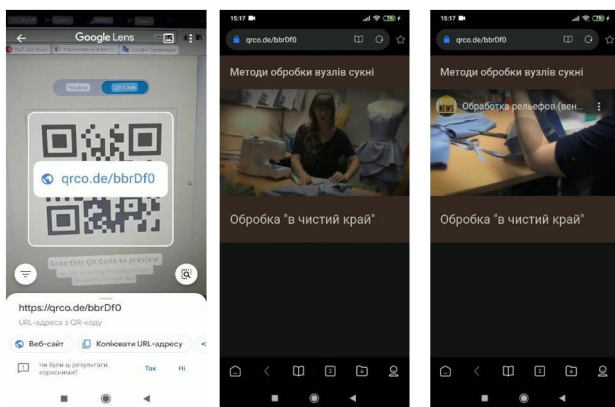


Figure 19 Use a QR code to view a video demonstration of node processing

The database of augmented reality images of the mobile application Artivive includes works by artist Olena Golembowska, who has been working in this direction for quite some time. The artist presents her works through her Instagram page, holds exhibitions and presentations. From the page of the artist (with the prior oral consent of the author) were selected several paintings that in their color content correspond to the color scheme of women's costume, which was designed at the Department of Garment Technologies and Design of Khmelnytsky National University (Figure 20).



Figure 20 Screenshot of the Artivive mobile application and the effect of augmented reality (snow falls and sounds "Shchedrik-Shchedrik")

Taking into account the results of the study, men's pants were also made using a QR-code on the label, which contains information about the product (size, material composition and link to the site TKSHV – Market). On the site there are only men's pants and information about them (size, material composition, operating conditions and other information). From the site you can go to the Telegram-channel, where it is convenient to ask additional questions about the product, see the process of creating a QR-code, etc. It is also planned to create other channels on social networks, such as Instagram, Facebook, Viber, etc. This will allow the consumer to use a more convenient social network.

The embroidery of the QR code on the label made using JANOME 350 E embroidery machine (Figure 21) [27].



Figure 21 Making a QR-code on the label of men's pants

The women's suit and men's trousers, which were made according to the research results, are shown in Figures 22 and 23.



Figure 22 Women's suit with usage of AR technology



Figure 23 Men's pants with usage of the QR code on the label

6 CONCLUSIONS

The results of the generated dynamic QR-codes will increase the awareness of garment specialists in the field of application of augmented reality technologies in the technological process and for training new workers, which in turn will increase the efficiency of production capabilities and ensure product competitiveness.

As a result of research on the development and popularity of augmented reality technologies using Google Trends tools and SE Ranking it was found that the vast majority of potential consumers of such technologies do not associate them with clothing. Among all the existing areas of augmented reality, its use in clothing is only 12%.

Analysis of the development of augmented reality technologies in the garment industry and fashion industry shows their rapid development over the past decade. The most common technologies that are now available to the general public are the application of printed images on T-shirts and other knitwear, which serve as markers of augmented reality and are animated using special mobile applications.

As a result of the research, a constructive-technological solution of the patch cuff of a women's jacket was proposed, on which a print-painting of the artist Olena Golembovska was applied, which was included in the image database with augmented reality of the Artivive mobile application.

It can also be concluded that the QR code is popular and developing and spreading in the world. Areas of application are increasing every day, so it is possible that the garment industry will use it more and more.

Studies have shown that the most aware and most commonly users of QR-codes are consumers under 40 years. However, the peak of the chart is between 20 and 30 years. The least aware about QR-codes are consumers over the age 50, regardless of gender. This shows that men's interest in QR-codes comes later, namely from 30 to 40 years.

It is also worth noting certain advantages of using QR-codes:

- a large amount of information. Information is recorded in two directions: vertical and horizontal. This approach can significantly increase the amount of stored information;
- easy scanning with digital devices. This makes it possible to easily and quickly transfer data to electronic form without manual typing;
- the presence of an error correction algorithm. It allows you to recognize damaged codes;
- the ability to read in motion. It is possible to read data from the window of a moving car;
- the opportunity to develop a QR-code for Facebook, Instagram, etc. There are special free applications for this.

Taking into account the results of the survey, men's pants were made using a QR-code on the label, which contains a link to the site TKSHV - Market. The site contains men's pants and information about them (size, material composition, operating conditions and other information). From the site it is possible to go to the Telegram-channel, which also contains all the necessary information about the product. In addition, it is possible to get feedback from the manufacturer, ask additional questions about the product and see the process of creating a QR-code and more.

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