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İÇİNDEKİLER

CHAPTER 1

PRECAUTIONS TO BE TAKEN AGAINST LEGAL AND REGULATORY THREATS IN BRANDING IN THE PRINTING INDUSTRY[1]

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Abstract

Brand is the most important element that distinguishes a business's products or services from its competitors. The brand represents the business' reputation, values and customer experience. A strong brand creates long-term revenue and competitive advantage by increasing customer loyalty. The printing industry plays a critical role in establishing and protecting the brand. Printed materials such as product packaging, brochures, catalogs and billboards convey the brand visibility and message to the expected viewership. Quality printing helps the brand create a professional and trustworthy image. Brands can lose their advantage if they are not protected against legal and regulatory threats. Counterfeit products damage brand reputation and undermine the trust of consumers. Legal disputes and trademark rights violations can cause financial and reputational damage to businesses. Brands operating in international markets must comply with the legal regulations of different countries; Otherwise, they may face legal sanctions.

This article will discuss brand protection strategies and precautions to be taken against legal threats. At the same time, the role and contributions of the printing industry in this process will also be evaluated. These evaluations will shed light on how brands can be made stronger and more protected both through printed materials and in the digital environment.

Keywords: Branding, Printing industry, Threats, Legal disputes, Trademark rights

Introduction

Branding is an essential element for businesses today. However, the brand concept went through a long evolution process until it reached its current form (Fig. 1). Branding strategies have varied throughout different periods historically (Holt, 2004) and have been shaped by changing consumer preferences and technological advances (Kotler et al., 2021).

Figure 1: *Coca-Cola Brand Evolution (URL1)*

The idea of a brand first appeared in the Greek and Roman eras (Starcevic, 2015) (Fig. 2). During this period, it was common for products to be marked and identified by their manufacturers. However, the modern use of brands started with the Industrial Revolution. With the Industrial Revolution, mass production made products more widely available to consumers and increased the recognition of brands (Papp-Váry, 2016).

Figure 2: *A sample of branding from Rome history (URL 2)*

Strategies for branding started to change even more with the turn of the century. Large companies have begun to use techniques such as advertising, packaging design and marketing campaigns to encourage customers to purchase their goods and services (Klimchuk & Krasovec, 2013). As of right now, media communication channels including radio, television, and newspapers have been crucial in raising public awareness of brands (Alhaddad, 2015).

Today, rapid developments in digital technologies, widespread use of the internet, increase in conscious consumers, etc. It has brought about new searches in branding strategies, depending on many factors. Especially the increase in the use of social media and rapid developments in digital marketing have enabled brands to find new tools to reach and communicate with their customers. Thanks to digital technologies, they have the opportunity to make their brands known faster (Tsimonis and Dimitriadis, 2014). Another important issue affecting branding strategies is that it fulfills the social responsibilities that consumers expect from the brand and has a transparent structure that ensures their sustainability (Lin et al., 2017).

Constantly developing and changing branding strategies from ancient times to the present day, the main objectives of brands are to differentiate their own products from the products of their competitors in the market and to gain the trust of their customers and create their loyalty (Webster Jr, 2000). As in other sectors, new targets are being shaped in branding strategies with the combination of technological developments (Smilansky, 2017). While the value of the brand increases, it is possible for the brand to face legal and regulatory threats. In the branding process, these threats include making copies of the brand's products, using the brand name, unauthorized use of the brand logo, copyright violations, etc. Situations may arise that violate the intellectual property rights of the brand, including (Chaudhry and Zimmerman, 2009). These situations may affect the brand's reputation and cause customer losses, as well as have serious negative effects on its legal rights (Figure 3). In order to avoid such problems, brands should pay attention to taking appropriate precautions against legal and regulatory threats during the branding process and even benefit from legal consultancy on this issue (Evans et al., 2019).

Figure 3: *The brand's reputation and legal rights (URL 3)*

Brands should take the appropriate actions to safeguard their rights to intellectual property. Legal processes such as trademark registration,

patent application, and copyright registration help brands officially protect their intellectual property rights (Tryce, 2020). Additionally, brands must actively establish a monitoring and infringement detection process to monitor and protect their products, logos, and other copyrighted materials (Kiser, 2016) (Fig. 4)

Figure 4: *Logo from copyrighted materials (URL 4)*

Precautions to protect brands against legal and regulatory threats are vital. These measures start with brands protecting their intellectual property rights, establishing a strong legal foundation, and complying with regulatory requirements. In this way, brands can both protect their legal rights and strengthen their reputation.

Brand and Brand Building Process

A brand is a name, symbol, sign, or artwork that sets one good, service, or company apart from the competition. (Ward et al., 2020). A brand informs consumers about the quality, reliability and uniqueness of a product. While brands generally reflect a company's reputation and value, they play an important role in consumers' preferences (Erdem, & Swait, 2001). It should not be forgotten that a good brand can create loyalty among customers and this can provide a competitive advantage with other brands (Hoeffler & Keller, 2003).

Figure 5: *Brand building process (URL 5)*

Market Research and Analysis: The brand building process begins with market research and analysis. Since the target audience's demands, preferences, and market trends determine whether the brand succeeds (Park et al., 1986). For this reason, the business should conduct detailed research to determine its target audience and consumer preferences. Understanding the factors that influence consumer decisions helps shape a brand's marketing strategies. These factors should be obtained by communicating directly with the target audience through customer feedback and surveys (Kennedy & Guzmán, 2016). Understanding their expectations and satisfaction levels is important for the development of the brand. In the meantime, the market's competitors' strengths and weaknesses should be identified in order to evaluate the market's size and potential for growth (Ghafoor et al., 2012) (Fig 5).

Determination of Brand Values: The fundamental principles and character of the brand are established during the brand creation process. A brand's goal, vision, and basic values are what define its identity (Urde, 2003). While the mission states the brand's reason for existence and its purpose of contributing to society, the vision expresses the future goals and ideals of the brand. The uniqueness of brand values is determined by competitive analysis and differentiation strategies (Gupta et al., 2020). By examining the brand values and positioning of competitors, the brand's

unique value proposition can be revealed (Michell et al., 2001). However, when determining brand values, not only commercial but also social and environmental responsibilities should be taken into account (Porter & Kramer, 2006). Determining the brand's values will help the brand create a strong identity and ensure the brand's long-term success by establishing a deep bond with consumers

Defining the Target Audience: In the branding process, it is determined who the target audience is and what their needs and desires are. Consumer feedback and market research also play a critical role in understanding the thoughts and expectations of the target audience (Tsai & Men, 2013). This information allows the brand to interact with its target audience and meet their expectations. Correctly defining the target audience allows the brand's marketing strategies to be effectively created and ensures that the brand offers products and services that meet the needs of the target audience (Park et al., 1986). In this process, the demographic and psychographic characteristics, shopping habits and needs of the target audience should be determined. Demographic data forms the basis of the brand's marketing strategies. Psychographic features reflect consumer behaviors and motivations, so the brand can establish an emotional bond with consumers (Martinez & Montaner, 2008). Examining shopping habits and determining needs shapes the brand's product and service offering and helps the brand differentiate from its competitors in a competitive environment (Slade-Brooking, 2016).

Brand Name and Logo Design: During the brand creation process, the name and logo of the brand are determined (URL 6). The choice of brand name and logo design plays a critical role in promoting the brand and creating its identity (Wheeler, 2017). When determining the brand name, attention should be paid to the values represented by the brand and the determined goals. The name to be determined should be unique and have a positive connotation in the minds of the target audience (Aaker, 2009). Additionally, it should not conflict with other trademarks that are registered or in use and should fit into the long-term brand strategy (Alashban et al., 2002).

Figure 6: *Nike logo design and its development over time (URL 6)*

When designing a logo that reflects the identity of the brand, it should be a simple and recognizable logo as well as reflecting the values that the brand represents (Gernsheimer, 2010). When designing a logo, importance should be given to the usability of the design in different sizes and environments, as well as the suitability of the chosen colors to the values of the brand (Suriadi et al., 2022).

Determining the name of the brand and planning the brand's logo correctly during the design process will have a positive impact on both the effective creation of the brand's identity and its rapid recognition (Adams et al., 2006). In this way, it will be faster for the brand to establish a healthy bond with its targeted consumer base and thus gain an advantage in the market.

Determining Visual and Verbal Communication Strategies: The communication strategies that the brand will use and its success in managing them will strengthen the brand image. Thus, brand awareness will increase and the loyalty of target consumers can be gained (Nandan, 2005). For this reason, during the branding process, an innovative brand communication strategy should be developed that will strengthen the brand image, thus enabling it to establish a strong bond with its target audience, and make it compatible with continuous innovative trends (Wijaya, 2013).

While realizing the brand's communication strategies, it should analyze the audience it will appeal to among the existing consumers in the demographic structure of the market and take their preferences into consideration. However, while doing this, the identity and values of the brand should be taken into consideration and the necessary form of communication should be determined according to the table we encounter. Advertising, content marketing, social media etc. By using multiple communication channels together, wider audiences can be reached (Palmatier et al., 2019). Because using more than one channel at the same time will increase the visibility of the brand and thus increase brand recognition (Vukasovic, 2013). Measuring and analyzing the effectiveness of communication strategies will enable strategic decisions to be made and processes to be continuously improved.

Promotion and Marketing of Products: During the branding process, the brand's products are introduced and then marketed. While the brand's products are introduced and marketed, the values and benefits of the brand are emphasized and consumers are conveyed why the brand should be preferred (Park et al., 1986). This process is carried out in line with a strategic communication and marketing plan for the brand's target audience.

In this process, first of all, the core values of the brand such as customer focus, quality, innovation and environmental friendliness should be brought to the fore in the marketing of services. The benefits offered by the brand should be clearly stated in the promotion and marketing processes. Details such as the benefits that products or services provide to consumers and how they respond to consumers' needs and expectations should be included. In addition, it should explain to consumers why the brand should be preferred by emphasizing the unique features of the brand and its difference from its competitors. Consumers' interest and trust in the brand should be increased by highlighting the values provided by the brand, the experience it offers to customers and the factors that increase brand loyalty (Delgado-Ballester & Munuera-Alemán, 2001).

In this process, the brand's communication strategies include social media, advertising, events, influencer collaborations, etc. It should be delivered to the target audience through various channels. Choosing the right communication channels and presenting content that suits the preferences of the target audience will ensure the effective promotion of the brand. (Czinkota yet al., 2021).

Improving Customer Experience: In the branding process, improving customer experience is important. To increase customer satisfaction and strengthen customer relationships, the brand must provide customers with a unique and satisfying experience (Peppers, & Rogers, 2016). This process aims to increase brand loyalty by making customers' interactions with the brand more positive, meaningful and satisfying.

The most important factor in this process is that the feedback from consumers should be taken into consideration and feedback should be given to the consumer and the process should be followed closely. Evaluation of the data obtained can turn negative aspects into positive ones, increasing consumer satisfaction and therefore the reputation of the brand (Mascarenhas et al., 2006).

Adoption of a consumer-oriented management strategy by the brand in a competitive environment will increase the brand's awareness as it will enable healthier communication with consumers (Wali et al., 2015).

Managing Brand Reputation: The perception, value and reliability of the brand determine the reputation of the brand. For this reason, it is important to manage the reputation of the brand in the branding process (M'zungu et al., 2010). The brand's preference by its customers will be ensured by the good reputation it has created during the branding process.

The brand's reputation will be achieved by clearly expressing its core values, that is, the brand's mission, vision and values, and consistent-

ly advancing these values (Harris and De Chernatony, 2001). Carefully monitoring, measuring and evaluating consumer feedback is important in managing brand reputation. For this, consumer complaints should be given importance and necessary measures should be taken to raise their satisfaction to higher levels. Efforts should be made to encourage positive feedback from consumer complaints to continue, and to ensure consumer satisfaction by giving constructive responses to negative feedback (Nasr et al., 2018).

Media relations also play an important role in managing the brand's reputation. Media relations strategies ensure that the brand is represented accurately and with positive news. Press releases, press conferences, and networking media relations help the brand create a positive image in the media.

Managing the brand's reputation during the branding process is critical to the long-term success of the brand. Factors such as the right communication strategies, careful monitoring of customer feedback, and media relations help the brand build and maintain a positive reputation. In this way, the brand gains the trust of customers and gains a competitive advantage (Lau & Lee, 1999).

Threats a Brand May Face

A brand may face various threats arising from various internal and external factors. Each of these threats can impact the success of brands. They equires brands to be strategically prepared to deal with these threats (Shocker et al., 1994). Assessing the importance and impact of each threat can help brands develop strategies that address these threats (Fig. 7).

Figure 7: *Threats faced by brands (URL 7)*

The threats that a brand may face can be listed under the following headings:

Competition: The increase of competing brands offering similar products or services may result in increased competition and fragmentation of the customer base (Libai et al., 2009). Increasing competition may require brands to make more efforts to maintain or increase their market share. To gain competitive advantage in a competitive environment, it is important for brands to be innovative, adopt customer-focused strategies and constantly monitor the market. A brand may face new competitors entering the market (Bose, 2012). New initiatives or existing competitors moving into different market segments may increase competition and reduce the market share of brands (Liu & Yang, 2009). Competing brands offering innovative products or services may reduce a brand's competitiveness. Consumers' brand preferences may change in response to higher quality features and lower prices that other brands in the market can offer (Ghodeswar, 2008).

Technological Changes: Rapid developments in technology can lead to major changes in marketing. The competitiveness of brands may be affected by the emergence of new technologies or the development of existing technologies. This process may also threaten traditional business models as it creates new business areas (McGrath, 2010) (Fig. 8).

Figure 8: *Threats related to technological changes (URL 8)*

Change in Consumer Preferences: Another factor that affects the success of the brand is the change in consumer preferences. For example, as the importance of healthy living trends increases in the market, consumers prefer healthier and natural products in this direction. For this reason, the brand may experience consumer losses. It is important for brands to

review their products and services according to these trends and take precautions to avoid consumer losses (Chung et al., 2020).

In parallel with the development and increase in the digital experiences of consumers who prefer brands, the presence of the brand on online platforms should be increased. Strengthening the digital presence of brands will increase their recognition by consumers in increasing digital experiences. Digital customer experience can determine the competitive advantage of brands and influence consumers' brand preferences (Peppers & Rogers, 2016). Consumers may demand more personalized and customized services. Brands strengthening customer relationship management and establishing personal connections with consumers can increase customer satisfaction and support brand loyalty (Tsai, 2011).

Crisis Situations: Crisis situations can seriously affect a brand's reputation. For example, product scandals, management errors, or operational problems can damage a brand's credibility and reputation and cause customer loss.

Crisis situations can seriously affect a brand's reputation. In particular, crises such as product scandals, management errors or operational problems can damage the brand's reputation and shake the trust of consumers (Griffin, 2014). Crisis situations can negatively affect brands' relationships with their customers. Customers' trust in the brand may decrease and brand loyalty may decrease (Hsieh & Li, 2008). Failure in crisis communication and crisis management, in particular, can further reduce customer confidence. Crisis situations may cause brands to lose customers. Especially if crises are directly associated with the product or service quality of the brand, it may be inevitable for customers to move away from the brand (Kang et al., 2023).

Uncertainty and communication deficiencies in management in crisis situations reduce the motivation of brand employees and, as a result, their work efficiency decreases.

Legal and Regulatory Issues Regarding Trademark:

Brands may face legal and regulatory issues due to issues such as copyright infringements, failure to comply with consumer protection laws, or neglect of product labeling requirements. Since these will limit the brand's activities in the market, it may have negative consequences on brand reputation. For this reason, legal and regulatory compliance should be taken into consideration during the branding process. This process can be secured by complying with the legislation, protecting the rights of consumers and obtaining legal consultancy while doing these. In crisis situations du-

ring branding, the methods and steps to be followed by brands in dealing with legal problems should be determined through crisis communication and crisis management strategies. These steps are important in going through this process in a healthy way.

Legal Basis of the Trademark Concept in Turkey

The legal basis of the concept of trademark in Turkey was laid in the Ottoman Empire. The first regulation on this subject was the "Trademark Regulation" issued in 1888. This regulation was abolished by the Republic of Turkey in 1965 after the Trademarks Law No. 551 was put into effect. However, over time, the Trademarks Law No. 551 began to fail to meet Turkey's needs in this regard.

In addition, with the influence of the European Community, of which Turkey is a member, and the Ankara Agreement signed in 1963, as well as the full membership process of the Customs Union, new regulations were needed regarding intellectual and industrial rights. (Yazici Inan, 2001; Karaca, 2015) Decree Law No. 556 on the Protection of Trademarks was published by the Council of Ministers in 1995. In the same year, a regulation was issued on the subject showing the implementation of the Decree Law No. 556 on the Protection of Trademarks. However, since this regulation was not sufficient, a new regulation was put into effect on 26.6.2004 (Official Gazette, 1995) The Ministry of Industry and Trade carried out the transactions regarding industrial rights in Turkey for a long time (until 1994). However, since these processes required specialization, a new decision was taken in 1994 and it was decided to establish the Turkish Patent Institute (TPI) with the Decree Law No. 544.

Brand as a Legal Concept

the Decree Law on the Protection of Trademarks, which is in force regarding trademarks, trademarks can be defined as words, figures, letters, numbers, including personal names, the form or packaging of goods, provided that they enable the goods or services of one enterprise to be distinguished from the goods or services of another enterprise. It is defined as all kinds of signs that can be displayed by drawing or expressed in a similar way, published and reproduced by printing.

As can be understood from these definitions, the sign to be used as a trademark should distinguish the goods or services of a business from others and should include all kinds of personal names, words, shapes, pictures, logos, letters, numbers, shape of goods or packaging, three-dimen-

sional shapes in a way to ensure this distinction. , colors and scents can be used as brands (Yasaman, 2004).

Brand Shape Size

While the Trademarks Law No. 551 states that letters and numbers alone cannot be registered as trademarks (Art. 4/1.c), this limitation has been abolished with the Decree Law No. 556. For example, brands such as IBM, BMW, KFC have the opportunity to register their names in this way. In addition, the expression "form" in Article 5 of the Decree Law means "drawings, pictures, symbols, emblems"; It also refers to "concrete expressions with lines or colors, arrangements and compositions of words, pictures, graphics and color mixtures or combinations" as well as "designs, patterns, geometric shapes, graphics and photographs".

Therefore, the scope of signs that can be trademarked seems to have expanded with the Decree Law. Graphics, designs, personal names, words, letters, numbers, logos, shapes of goods and packaging, slogans consisting of several words, word-shape combinations, three-dimensional forms, short melodies and colors are also included in the concept of sign. (Karan, 2002; Karan & Kılıç, 2004).

Another preferred issue regarding trademarks is that personal names can be registered as trademarks together with their first and last names or only with their first name if they have a distinctive character. For example, Dr. Oetker, Koç, Sabancı, Adil Işık etc. Trademarks are among the examples registered in this way. In addition to the business name and trade name, pseudonyms can also be registered this way. For example, the nickname "Little Sparrow" etc. It can be registered as a trademark (Şenocak, 2003; Karaca, 2015).

As can be clearly understood from Article 5 of the Decree Law, distinctiveness is presented as a basic condition regarding the trademark. Another important issue, in addition to being distinctive about the trademark, is that the relevant sign can be displayed with a drawing or expressed in a similar way. However, the distinctive feature must be acquired before the trademark is registered. On the other hand, there are those who think that distinctiveness can be achieved with registration and therefore it is not a requirement for registration (Karaca, 2015; Arkan, 2019; Oytac, 2002; Tekinalp, 2004; Noyan, 2009).

Trademark and Trademark Rights in Legal Perspective

Trademark right is an absolute right that prevents the use of the trademark without the permission of the owner and has similar effects. Absolute

rights; It is one of the rights that can be violated by anyone, and therefore the owner of the right can claim against anyone who violates it and demand that his rights be respected.

Absolute rights can be in question in three different matters. The first of these is persons, the others are material and intangible goods. In particular, the trademark right is one of the absolute rights that can be claimed on intangible goods and is left to the exclusive control of the person who registers it in the registry by choosing a sign that is available to everyone, and thus creates an absolute right that can be claimed against anyone and requires compliance by everyone (Tekinalp, 2004; Ertas, 2002; Karan & Kılıç, 2004; Karaca, 2015).

According to Turkish law, the right to be claimed on the trademark; It is an absolute right that can be measured in money, can be acquired through inheritance, can be transferred and therefore pledged and seized, and can be invoked against anyone (Karayalcin, 1968).

Trademark rights naturally provide the owner or institution with exclusive rights and powers to use, benefit from and dispose of the trademark.

Technical Legal Problems That May Occur Regarding Trademark

a) Copyright Violations:

A brand may face copyright infringements. Claims of copyright infringement, especially of elements such as product design, brand logo or advertising materials, can negatively affect the brand's reputation and legal status.

b) Legal Disputes:

Brands may face legal disputes. Legal lawsuits filed against the brand by consumers or competitors in the market may cause both a decrease in the brand's reputation in the market and an increase in brand costs.

c) Failure to Comply with Consumer Protection Laws:

Brands may face consumer protection laws due to misleading advertising or unfair trade practices. These can negatively affect both consumer loss and brand reputation.

d) Data Security Violations:

Brands may face both legal and financial responsibilities due to data security breaches that cause customer information to be leaked. This will seriously affect both the reputation and reliability of the brand.

e) Failure to Comply with Advertising Standards:

Failure to comply with the brand's advertising standards, advertising practices that are misleading or create unfair competition will cause brands to experience legal problems and therefore loss of reputation.

g) Regulation Changes:

Brands should closely follow legislative changes. Otherwise, the brand may face legal uncertainties. In particular, it should closely follow the changes in consumer protection laws and sectoral regulations and rearrange its brand activities accordingly.

h) Violation of Intellectual Property Rights:

The brand may face legal problems where rival brands in the market face intellectual property rights violations such as claims of infringement of patent, trademark or design rights.

The Role of the Printing Industry in Brand Creation

Thanks to professional printing services, brands can have the opportunity to prepare visuals in a more impressive way. Thanks to the products obtained in this way, the brand's reach to its target audience will be positively affected. For this reason, the printing industry and the opportunities it provides play an effective role in branding. Some of the topics in which the printing industry is effective in branding are listed below.

a) Visual Identity and Logo Design: Logo design has an important role in increasing the recognizability of a brand. Logo is an important element that reflects the brand image and increases its recognizability. The printing industry has an important role in creating the visual identity of a brand (Park et al., 2013). It is important that the brand is represented effectively. For this, brand products and the brand's logo and visual elements used in their promotion must be printed in high quality (Wrona, 2015). Concluding the logo design process in a careful and planned manner will ensure that the brand identity increases in the market (Walsh et al., 2010).

b) Advertising and Marketing Materials: he high quality of printed materials (brochures, flyers, posters, catalogs, etc.) used by brands to promote their brand products more effectively will support both the advertising and marketing strategies of the brand and increase its recognition (Jedlicka, 2010). The printing industry uses advanced technological facilities to obtain high quality of such materials. High quality printed products increase the visual identity of the brand and enable it to reach the target audience quickly (Slade-Brooking, 2016).

c) Packaging Design and Printing: Boxes used to package a product carry both the brand's logo and the brand's messages on their surfaces. These boxes contribute to increasing the recognition of the brand. (Agariya et al., 2012; Abdalkrim and AL-Hrezat, 2013). Professionally designed and quality printed packaging is important to reflect the quality and value of the brand (Rettie & Brewer, 2000). In this process, the printing industry provides services to brands in the design and printing of product packaging to increase the visual appeal of brands (Garber et al., 2000).

d) Corporate Identity Materials: Materials that reflect the corporate identities of brands include business cards, envelopes, letter papers, and other office supplies. Professional printing services help brands consistently represent their corporate identities by ensuring high-quality, uniform production of these materials (Lupton, 2006). This reinforces brand recognition, presents a polished and cohesive image to clients, partners, and stakeholders, and enhances the overall professional appearance of the company. Consistency in printed materials also helps to build trust and credibility, making a strong impression in every business interaction (Napoli et al., 2014).

e) Materials for Events and Activities: Various printed materials are needed to be used in events sponsored or attended by brands. These materials include invitations, posters, banners, participant badges, etc. is available. The printing industry can help brands strengthen their presence at events. Additionally, the brand's information can be printed on various promotional products such as pens, keychains, coasters, etc. personalized with the brand's logo or slogan (Keller, 1987; Shimp, 2000).

CONCLUSION

Branding is important in distinguishing the business's products or services from its competitors, and at the same time increasing the reputation, values and customer experience of the business. A strong brand will be achieved by producing products or services associated with a quality and reliable brand in a healthy way. At this stage, the printing industry plays a critical role in the brand building and protection process. Printed materials increase a brand's visibility and will enable the brand to reach the intended viewers. In addition, the printing industry will ensure the protection of the brand with the products obtained by using original and difficult to imitate printed materials in the fight against counterfeiting and imitation products.

In today's competitive business environment, it is not enough for brands to just have a strong appearance; They also need to be protected against legal and regulatory risks. For this reason, brands need to constantly monitor environmental changes and new threats by conducting market

and competitor analysis. Additionally, brands must comply with legal regulations and make necessary updates. This will minimize potential criminal and reputational risks by ensuring brands comply with current legal standards. Increasing the reliability of businesses will contribute to growth and success in the long term.

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URL 4: https://brandingstrategyinsider.com/10520/

URL 5: https://www.searchenginejournal.com/local-branding-strategy/293907/

URL 6: https://looka.com/blog/nike-logo/

URL 7: https://blog.bfore.ai/brand-impersonation-cyber-threats-101

URL 8: https://www.linkedin.com/pulse/s%C4%B1n%C4%B1rl%C4%B1-zaman-sonsuz-teknoloji-bir-%C3%B6mre-s%C4%B1%C4%9Fan-cihan-g%C3%BCl-akal%C4%B1n-x91he/

CHAPTER 2

PRECAUTIONS TO BE TAKEN AGAINST LEGAL AND REGULATORY THREATS IN BRANDING IN THE PRINTING INDUSTRY

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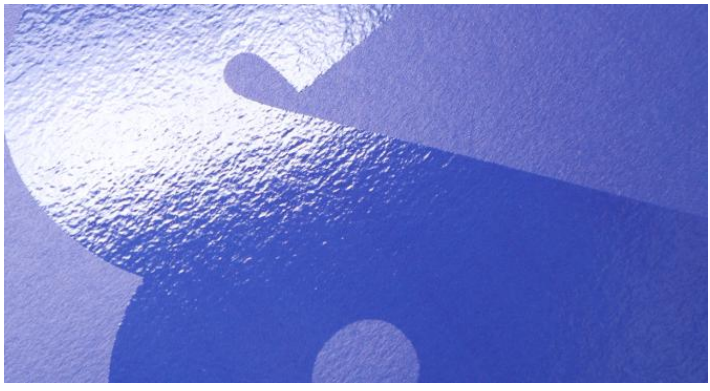
Introduction

The printing industry faces challenges in maintaining product quality while meeting environmental requirements. Surface coatings are a key element in improving printed materials and have a multifaceted role. They protect printed products from external influences such as moisture, UV radiation and physical wear, but also enable the achievement of specific aesthetic effects such as high gloss, matte or textured finishes. The development of coating technology has enabled the emergence of new solutions that combine functionality, aesthetics and sustainability. Physical methods such as varnishing and lamination are still widely used, but there is increasing interest in advanced techniques such as UV curing, nanotechnology coatings and smart coatings that can respond to changes in the environment. In addition to technical and aesthetic aspects, the emphasis is on the development of environmentally friendly materials and processes that reduce emissions of harmful substances and waste, which is crucial for the future of the industry. The aim of this paper is to analyze in detail different types of surface coatings, their advantages and disadvantages, and to explore the potential for further development in the context of sustainability and innovation.

What is surface coating?

Surface coating is the application of a thin layer of material to the surface of the substrate in order to improve its properties. Surface coating can be applied to paper, cardboard and other different materials in order to obtain the desired characteristics such as gloss, smoothness, resistance and durability. (Application and testing of graphic materials, 2022)



Picture 1: [Varnish on paper] source: https://shorturl.at/SbsmD

The role of surface coating in printing technologies

The role of surface coating in printing technologies is to improve the aesthetics, performance and functionality of the product. Surface

coating achieves different aesthetic effects such as high gloss, matte finish or special, metallic or pearlescent, reflections and tactile effects. Furthermore, it protects the print from external influences such as, for example, UV radiation, wear and moisture. (Holmberg & Matthews, 2009; Kettle, Lamminmäki, & Gane, 2010; Chen et al., 2024)

The impact of surface coating on print quality and durability

Surface coating also impacts, improves, print quality and durability. In terms of print quality, the surface coating affects smoothness, increases contrast and adds special effects such as UV gloss or soft touch finishes. In terms of durability, coatings protect printed materials from external influences. They can be used as a membrane that protects the print from water, oil and the like, and this enables a longer life of the print itself. UV-resistant coatings prevent color fading, while laminated surfaces provide extra strength and impact resistance. (Macinić, 2013; Lentz & Assembly, 2013; Montemor, 2014; Makhlouf & Abu-Thabit, 2019)

Types of Surface Coating

Surface coatings are used to protect graphic products but also serve to decorate the graphic product. Coating varnishes are based on organic binders that can be liquids or powders, whose drying mechanism is physical or chemical. Surface coating application methods can be by brushing, spraying, dipping and other surface treatment processes and result in a protective and decorative coating with special properties. Varnishes generally consist of a binder (the binder creates a dried film), solvents and additives. The main ingredient of the varnish is the binder or a combination of binders. Its role is to ensure good adhesion to the printing substrate, which means that it holds all the components together and to create a thin, uniform film on the surface. The dried coating should have a certain gloss and should have satisfactory mechanical properties. (Holmberg & Matthews, 2009; Makhlouf & Abu-Thabit, 2019)

a)Physical coating methods - varnishing and lamination

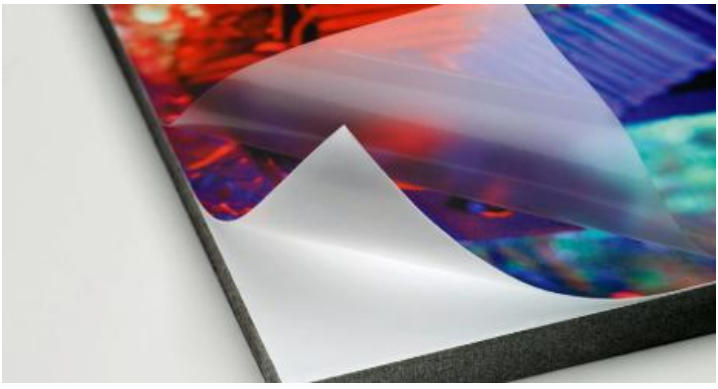
In physical coating methods, drying occurs by evaporation of water or solvent from the varnish. Evaporation of liquids from solutions or dispersions with macromolecular compounds, i.e. drying in air at room temperature, baking at elevated temperature. Also, cooling of molten macromolecular compounds, i.e. melting on a cold substrate or melting on a hot substrate. In this method, the varnish dries quickly and does not require any additional chemical reaction.

Varnishing and lamination improve the aesthetic impression but also improve the life span of the graphic product. Varnishing creates a glossy, matte or silk effect (aesthetic effect) but is also used to protect the product

from scratches, external influences, moisture... Varnish can be applied to the entire surface, but can also be used as a spot varnish where the varnish is applied only to certain parts of the print (aesthetic appearance, highlights the main parts of the design). In this process, the varnish is applied to the surface of the product and then dried by evaporation of the solvent or physical processes. (Golub, 2019) Varnishing does not involve changing the chemical structure of the coating during drying. (Hanzer, Šprem, & Perica, 2019)

Lamination involves applying a thin film to a graphic product, only physically joining the materials, for additional protection and aesthetic appearance. The lamination process is carried out by hot or cold gluing, depending on the type of material. Lamination, like varnish, provides resistance to moisture, external influences, etc. It can also give a glossy, matte or silk effect. (Hersa, 2023)

Lamination and varnish are often used on book covers, promotional materials, packaging and business documents, thus ensuring a professional look, durability and functionality of the graphic product. Varnish and laminate should be used if the graphic product requires a high degree of resistance or if the product will be exposed to humid conditions after printing. (Chen et al., 2024)



Picture 2: [Lamination] source: https://shorturl.at/JaV1Q

b) Chemical coating methods - UV curing and water-based coatings

With chemical coating methods, drying is based on chemical reactions or hardening processes in order to create a permanent layer. Film formation through chemical reactions such as polymer synthesis or polymerization of molecular compounds. (Makhlouf & Abu-Thabit, 2019; Montemor, 2014)

UV curing uses ultraviolet light (UV) to initiate a chemical reaction that will lead to rapid curing of the coating. The coating contains photoinitiators that start the polymerization of monomers and oligomers under UV light, which results in the formation of a solid protective layer. UV coatings are strong and resistant, and the process itself enables a reduction in production time and high product quality. UV coatings are resistant to wear and chemicals and create a glossy or matte effect. Thanks to its speed and efficiency, UV curing is widely used for high-quality printed materials, packaging and promotional products. (Chen et al., 2024; Lentz & Assembly, 2013)

With water-based coatings, drying takes place by evaporation of water and the reaction of binding components. After the water evaporates, the polymer particles crosslink, which creates a permanent protective layer. Water-based coatings are popular due to the reduced emission of harmful substances and the very sustainability in production. Their application includes coating books, magazines, packaging and other graphic products. These coatings provide good protection, resistance to moisture and the possibility of creating different final effects.

Both processes, UV curing and aqueous coatings, contribute to a higher quality and more durable final layer of graphic products. (Chen et al., 2024; Faccini et al., 2021; Montemor, 2014).

c) Pigment and polymer-based coatings

Like other coatings, pigment and polymer based coatings are used to improve the aesthetic and functional properties of printed materials, packaging, promotional materials and the like (graphic products). These coatings combine pigment substances for coloring and polymers to create a protective layer. (Agi, 2004; Holmberg & Matthews, 2009)

Pigment coatings are based on pigments, organic and inorganic particles that do not chemically react with the material but remain stable in the coating. Pigment coatings are often used to achieve a stronger color effect and protection against UV radiation and other external influences. They can also achieve special effects such as metallic, matte or mirror finish. (Chen et al., 2024; Hanzer, Šprem, & Perica, 2019)

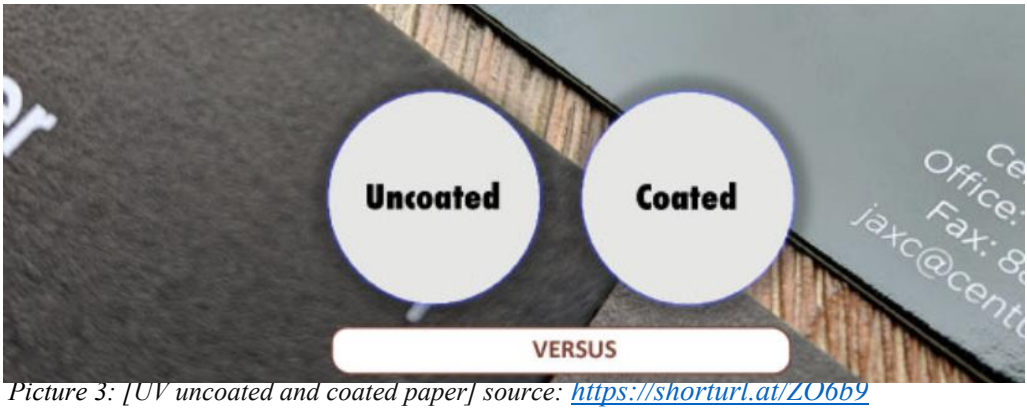
Polymer coatings are high-molecular substances that are used as binders in coatings. They can be thermoplastic or thermoset, depending on the type of polymer used and the way it is dried. These coatings provide resistance to moisture, abrasion, chemicals and UV radiation, creating tough, flexible and long-lasting layers. Polymer coatings are often used in combination with pigments to obtain the desired color and protection.

Pigment and polymer coatings combine aesthetic and functional advantages, making them indispensable in the graphic industry for the production of high-quality, long-lasting and visually attractive products. (Holmberg & Matthews, 2009; Makhlouf & Abu-Thabit, 2019)

Advanced Coating Techniques and Applications

a) UV Curing Coatings

With UV curing coatings, UV light is used to dry the coating and the result is a coating with high durability and resistance. When the coating comes into contact with UV light, an instant hardening reaction of the coating is obtained. UV curing coatings also reduce the emission of organic compounds (VOC) gases, which makes them more environmentally friendly. This technology is often used in the production of optical lenses, the wood industry and the automotive industry. (Chen et al., 2024)



Picture 3: [UV uncoated and coated paper] source: https://shorturl.at/ZO6b9

b) Plasma Coating Technology

Plasma Coating Technology uses high-energy plasma to deposit a thin film on the surface of the material. This technology provides excellent adhesion and uniformity of the coating and enables surface modification without the use of high temperatures or chemicals. Applications include medical equipment, electronics, and aerospace, where high purity and coating precision are required. Plasma coating can improve corrosion resistance, wear resistance and biocompatibility of materials. (Makhlouf & Abu-Thabit, 2019)

c) Inkjet Coating (Digital Coating)

In Inkjet or Digital Coating, inkjet printing technology is used to apply the coating to different surfaces (Yılmaz, U. et al, 2021). This technique is ideal for applications in electronics and printed materials, as it allows for customized designs and rapid changes in the production process. In industries where great adaptability and quality control are required, inkjet coating is ideal because it also reduces waste and has great flexibility in production. (Kettle, Lamminmäki, & Gane, 2010; Li et al., 2022)

d) Nanotechnological Coatings

Nanotechnological Coatings use nanomaterials to achieve unique properties such as superhydrophobicity, increased mechanical strength and scratch resistance. These coatings have the ability to provide corrosion protection, self-cleaning surfaces, antibacterial coatings and improved optical properties. Nanotechnological coatings can significantly improve the functionality and durability of products, making them useful in various industries such as medical, automotive and electronics. (Montemor, 2014)

e) Electrospinning Technology

Electrospinning Technology uses electrostatics to produce high aspect ratio nanofibrous coatings that have their own unique functionalities. This technology is often used in biomedical applications and in the creation of advanced composite materials. Nanofibrous coatings created by electrospinning have a diameter of several nanometers, resulting in extremely high specific surfaces and improved absorption and response properties. (Agi, 2004)

f) 3D Coating Techniques

3D Coating Techniques are used for coating in 3 dimensions (width, height and depth). With complex geometry, it improves surface coverage and improves performance such as protection, durability and aesthetic experience of the product. This technology is particularly useful in industries such as automotive, aerospace and medical, where precise and uniform surface protection is required. (Makhlouf & Abu-Thabit, 2019)

g) Sustainable Coating Technologies

Sustainable Coating Technologies focuses on environmentally friendly materials and processes to reduce the negative impact on the environment. Sustainable coating technologies use water-based coatings, biocompatible coatings and processes that reduce the use of chemicals and unnecessary consumption of energy resources. Sustainable coatings reduce emissions of volatile organic compounds (VOC) and waste. They support

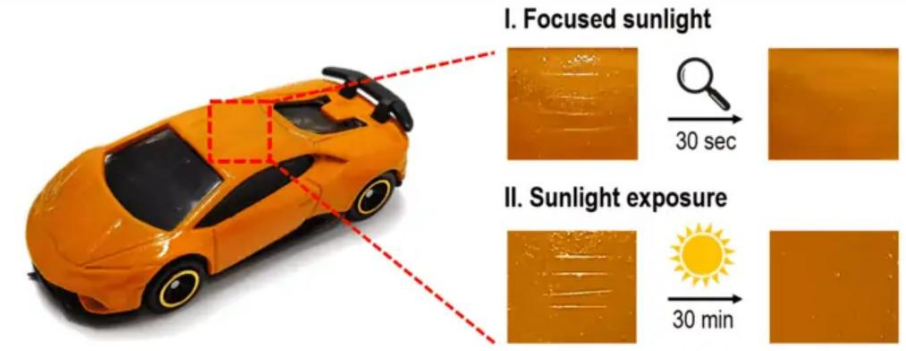
environmental sustainability and safety for the environment and workers who work with these coatings. (Faccini et al., 2021)

h) Smart Coatings (Functional Coatings)

Smart or functional coatings adapt to changes in the environment such as temperature, humidity, mechanical damage, etc. these coatings react to environmental stimuli and are used as a thermal barrier, also they are fire-retardant, they can also be hydrophilic or hydrophobic, self-cleaning, anti-fouling or anti-microbial. Applications include coatings to protect electronics and medical devices. Smart coatings improve the safety, efficiency and longevity of the product. (Montemor, 2014; Chen et al., 2024)

i) Self-Healing Coatings

Self-Healing Coatings use microcapsules or polymers that react to damage and restore the surface by themselves. Self-healing coatings automatically repair damage, extending the life of the coated material. Since long-term damage resistance is an important factor, these coatings are often used as automotive coatings and coatings for aircraft components. (Hanzer, Šprem, & Perica, 2019)



Picture 4: [Self-Healing coating] source: https://shorturl.at/1HarW

j) Hybrid Coating Systems

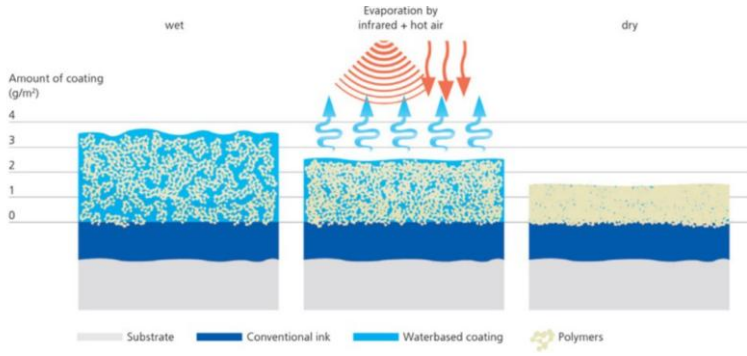
Hybrid coating systems combine multiple coating techniques to take advantage of the advantages of each technique and achieve a superior performance result. By combining different coating techniques, high resistance, durability and desired aesthetic qualities can be achieved. These systems enable the adaptability and multifunctionality of coatings, which is essential for advanced industrial applications. (Makhlouf & Abu-Thabit, 2019; Montemor, 2014)

Coating Materials

a) Water based coatings

Water-based coatings use water as the main solvent. They consist of a finely dispersed mixture of modified acrylic resins, water-soluble resins, wax and additives dispersed in water. The dry matter content in these coatings is 35% to 45%. Water as the main solvent results in lower production costs. Water-based coatings do not have an intense odor, contain a lower amount of volatile organic compounds (VOC) and make them safer to use, i.e. they have a lower negative impact on the health of workers who handle them. Also, washing the printing unit is easy, with just water. These coatings are often used in applications on paper, cardboard, packaging and similar graphic products, they give a high gloss of the varnished print, have good mechanical protection and the print does not yellow after a certain time. These coatings may have slightly lower durability compared to solvent-based coatings, especially in conditions of high humidity or on outdoor surfaces where deformation occurs due to humidity. (Makhlouf & Abu-Thabit, 2019)

Each ingredient has its own role in a water-based coating. Styrene acrylic resin gives shine to the coating, wax provides scratch resistance, silicone reduces foaming, acrylate dispersion accelerates drying and reduces abrasion, wetting agent serves for wetting, ammonia has the role of releasing the resin, matting pigments (for matte coatings) give a matte effect, and water serves as the main solvent and helps adjust the viscosity of the coating. (Holmberg & Matthews, 2009) Water based coating is dried by a combination of penetration and evaporation of water. The varnished surface should not be touched for the first 10 seconds after the print is formed, while the entire varnish layer will dry longer. A print that is resistant to scratches will be obtained only after the dye has completely dried. Here, an important factor is the composition of the printing substrate itself. (Montemor, 2014)



Picture 5: [Drying process of Water-based coatings] source: https://shorturl.at/TZTIO

b) Solvent based coatings

Solvent-based coatings contain organic solvents that evaporate during drying, leaving a solid coating layer on the surface. Solvents are the main component of these coatings and allow the dissolution of other chemicals in the mixture. Solvent-based coatings often use alcohols, ketones, aromatic hydrocarbons or esters as the main solvents. These solvents have high VOC emissions, which makes them less environmentally friendly, increases the cost of waste disposal, and makes them potentially harmful to the health of workers who handle them. These coatings are often used when printing on plastics, metals and other materials that require additional resistance due to their ability to resist moisture, UV radiation and abrasion. (Hanzer, Šprem, & Perica, 2019)

As mentioned, solvents are the main part of solvent-based coatings and each of the listed has its own role and use. Alcohols are used as solvents because they have the ability to evaporate quickly, ketones, although they are effective in diluting polymers and have a very fast drying time, also have an intense odor. Aromatic hydrocarbons provide excellent adhesion and fast drying but are often very toxic. Esters can be highly diluted and evaporate quickly enough. In addition to solvents, the composition also includes polymers that ensure adhesion to the substrate, pigments and fillers that provide color and aesthetics, and additives that improve certain properties. (Makhlouf & Abu-Thabit, 2019)

In solvent-based coatings, after the coating is applied, the solvents begin to evaporate, which causes a decrease in the viscosity of the coating. As the solvents evaporate, the polymers thicken and form a film on the surface. This process is very fast with most solvents, which allows the coating to become solid in a relatively short time. This process can also be accelerated by using UV light or elevated temperature. (Faccini et al., 2021)

c) Biodegradable and environmentally friendly coating materials

Biodegradable coatings break down naturally over time, which makes them an environmentally friendly solution for products that are used once or as packaging (not used long-term). These coatings use natural raw materials such as polysaccharides (starch, cellulose) that have the ability to form a protective layer that improves antimicrobial properties, proteins (casein, soy) contribute to the stability and adhesion of the coating to the paper, lipids (beeswax, fatty acids) provide excellent protection from moisture but their stiffness can reduce the flexibility of the substrate, polyester coatings (PHA) are compatible with paper substrates and have good biodegradability. (Chen et al., 2024)

The main advantage of these biodegradable coating materials is the reduction of negative impact on the environment, and they are in line with ecological trends in the packaging industry. These coatings are often used for products that are consumed quickly and for which it is important to reduce waste. Although they reduce the negative impact on the environment, their mechanical properties have drawbacks (the hydrophilic nature of biopolymers results in lower resistance to moisture), and therefore have a shorter lifespan compared to other coatings. (Makhlouf & Abu-Thabit, 2019)

Environmentally friendly coating materials are aimed at reducing the negative impact on the environment throughout the product's life cycle. These coatings may include recycled materials or bio-based components that do not have a negative impact on the environment, and are used in the production of printed materials (eco-paper, eco-cardboard or eco-packaging). Environmentally friendly coating formulas aim to reduce the amount of VOC, use renewable resources and do not use toxic chemicals.

Given global environmental concerns, more and more printers and packaging manufacturers are adopting environmentally friendly coatings to reduce CO2 emissions and the negative impact on the ecosystem. (Faccini et al., 2021)

Picture 6: [Wax as environmentally friendly coating material] source: https://pubs.rsc.org/en/content/articlelanding/2018/gc/c8gc02439a

d) Materials providing UV protection and lightfastness

Materials that provide UV protection and lightfastness are very important for long-term stability and color preservation in the printing industry. The ability for the coating and the print to remain stable and not change under the influence of sunlight is extremely important. UV coatings

are often used in outdoor advertising printing, such as posters or billboards. UV coatings contain UV stabilizers that prevent (absorb UV rays) the penetration of UV rays into the substrate, which prevents fading and damage to the print itself. In addition, UV coatings also improve the strength of the material, increasing its resistance to weather conditions. (Chen et al., 2024)

The lightfastness factor is also crucial for materials such as artwork, promotional materials, etc. Coatings with a high lightfastness factor use stabilizers that almost completely eliminate color changes over time, thereby extending the life of printed materials and maintaining the visual quality of the product.

These materials allow printing and production processes to a greater degree of adaptation to market needs, as well as sustainability and long-term preservation of printed materials. (Faccini et al., 2021)

Impact of Coating on Printing

Coatings such as UV varnishes and water-based coatings significantly affect, improving, the color saturation and gloss of the print. Glossy coatings reflect more light, which leads to higher contrast and makes colors more vivid, which means that images can appear more dynamic and attractive, especially when it comes to advertising or packaging. Matte coatings give a more sophisticated and subtle look to the product with less reflection. Textured varnishes (e.g. spot UV varnishes) create a tactile experience and are often used to emphasize design elements, creating a three-dimensional effect. (Chen et al., 2024; Makhlouf & Abu-Thabit, 2019)

Coatings offer protection to printed materials, by protecting them from damage caused by handling, external conditions or wear. UV varnishes protect the print from wear and fading caused by UV rays, which extends the life of the printed material (graphic product). Lamination, for example, adds a protective layer that also provides protection from external influences. These coatings are essential for printed materials that are exposed to frequent handling or harsh conditions. (Montemor, 2014; Makhlouf & Abu-Thabit, 2019)

Coatings have the role of protecting the surface and preserving the quality of the print, especially when the materials are exposed to external influences. In terms of abrasion resistance, certain coatings increase resistance to scratches and physical damage. This ensures a long-lasting and high-quality appearance of the print, which is important for materials such as promotional materials or packaging. Coatings such as water-based coatings create a protective barrier that prevents moisture from entering the material of the product, thereby increasing the durability of the print, which

is extremely important for outdoor advertising, brochures, etc. Temperature resistance is also extremely important so that there is no deformation or change in the impression of the graphic product. (Holmberg & Matthews, 2009; Montemor, 2014)

Next-Generation and Innovative Approaches

a) Properties and applications of nano coatings

Nano coatings represent a revolutionary approach in printing technologies, offering properties such as increased wear resistance, water resistance, protection against UV radiation and improved paint adhesion. The application of nano coating enables the development of high-quality and long-lasting products, thus opening up new opportunities for innovation in the industry. In addition, nano-coatings are increasingly used for adaptation to specific functions such as antibacterial surfaces, self-cleaning effect, and protection from dirt, thus contributing to sustainability and expanding the spectrum of potential uses. (Chen et al., 2024; Montemor, 2014)

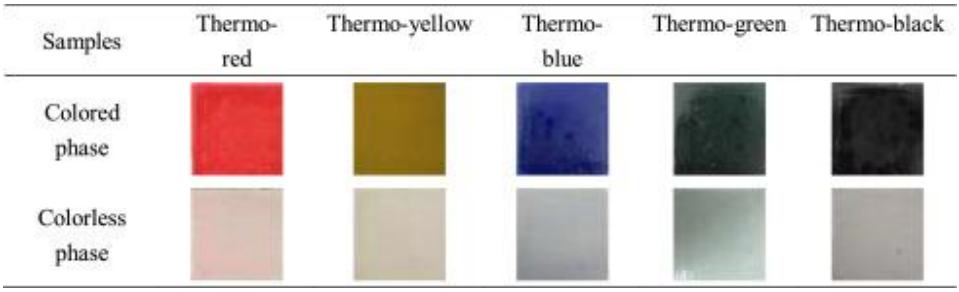
When nano coatings are used, the need for cleaning the printing machine is reduced, bridging is reduced and the overall yield and efficiency of the production itself is increased. Among the most commonly used nano coatings in printing technologies, hydrophobic and oleophobic coatings, UV protective coatings, antibacterial coatings, as well as scratch-resistant nano coatings and conductive coatings stand out. These coatings make it possible to adjust the properties according to the specific needs of the industry, which gives the printed products additional value and functionality. (Chen et al., 2024; Makhlouf & Abu-Thabit, 2019)

b) Smart coatings

Smart coatings represent a new generation of coating technology that allows printed products to adapt to certain environmental conditions. These types of coatings enable aesthetic, interactive, but also great functionality of the product itself.

For example, thermochromic coatings change color under the influence of temperature, which makes them very useful for food and beverage packaging. They can serve as indicators of freshness or temperature changes. Photochromic coatings react to UV radiation and change color. They are often used in promotional materials and security applications. Electrochromatic coatings change color under electric voltage and are used in smart devices such as electronic packaging. Self-healing coatings have the ability to regenerate damaged surfaces, which increases the durability and resistance of the product. sensor coatings contain nanoparticles that react to chemical or biological changes and are very useful in

pharmaceutical production and food packaging (eg monitoring the state of food - spoiled or fresh). (Montemor, 2014; Makhlouf & Abu-Thabit, 2019)



Picture 7: [Thermocromatic coating] source: https://shorturl.at/WtPDs

c) Eco-friendly and biodegradable coating technologies

Increasing awareness of the need to protect the environment encourages the development of coatings that have a minimal impact on nature. Ecologically acceptable coatings are made from natural or renewable materials, such as starch, cellulose or vegetable oils. They enable high functionality with reduced use of harmful chemicals. (Chen et al., 2024; Faccini et al., 2021)

For example, water-based coatings are an alternative to traditional solvent-based coatings, which automatically reduce the emission of volatile organic compounds (VOC). Compostable coatings provide protection to printed materials, but are completely biodegradable under natural conditions, which makes them ideal for packaging. Coatings based on vegetable oil are a natural alternative to synthetic materials, and ensure durability and sustainability. These coatings not only support sustainable development, but also help align printing technologies with increasingly stringent environmental regulations. The development of environmentally friendly technologies represent significant steps towards a sustainable future of the printing industry, i.e. brings a new level of quality and responsibility to the industry. (Makhlouf & Abu-Thabit, 2019; Montemor, 2014)

Applications of Surface Coating Methods

Coatings are of great importance in various industries because they play a key role in the protection, functionality and aesthetic impression of the product. In the packaging industry, surface coatings are used to provide protection from external influences such as moisture, and to preserve the quality of the product itself. Lacquers as well as lamination are often used to achieve high gloss, scratch resistance or a unique tactile effect. Barrier

coatings such as polyethylene or biodegradable coatings are often used for packaging in the food industry because they ensure hygienic safety. Packaging for food and drinks, pharmaceutical blister packs, luxury packaging and packaging for cosmetics and electronics are often coated with UV coatings because they enable quick drying and additional protection from damage. (Holmberg & Matthews, 2009; Makhlouf & Abu-Thabit, 2019)

In the advertising industry, coatings ensure the protection of printed materials and thereby ensure a longer life span of the graphic product. Application of coatings for outdoor applications such as billboards, posters or banners that are exposed to UV radiation, moisture and mechanical wear, UV resistant coatings are used that provide protection from these influences. Matte or glossy coatings are adjusted depending on the lighting conditions, which can improve the visibility and readability of advertisements. These coating methods are also used in the production of sales displays, wall graphics and vehicle stickers. (Chen et al., 2024)

For artistic printing and high-quality photo printing, coatings ensure durability, color stability and protection from damage. Using matte, satin or glossy coatings will preserve the integrity of the artwork and photos over a long period of time. these coatings enable the adjustment of the visual presentation according to the desired aesthetic effects. Spray coatings are also often used to uniformly cover sensitive surfaces such as canvas and photographic paper. These methods are often used for artwork reproductions, professional photographic prints, photo books and gallery displays. (Montemor, 2014)

Comparisons and Challenges

In graphic technology, the coating of printed materials plays a key role in improving the quality, protection and visual appeal of the product. There are different coating methods that are applied depending on the needs and requirements of production, each of which brings advantages, disadvantages and technical and environmental challenges.

When we talk about the advantages and disadvantages of different coating methods, coating during printing (inline coating) enables rapid integration of the coating during printing, thus shortening production time and reducing additional steps in the product production process. this method enables precise application of the coating, but the choice of coating is limited and requires a greater investment in the maintenance of the equipment. (Makhlouf & Abu-Thabit, 2019)

Offline coating enables a larger selection of coatings and better control over product quality, but costs increase due to additional space and necessary equipment. Since the coating is applied outside the printing

process, steps are added and more time is needed. (Holmberg & Matthews, 2009)

Varnishing is a popular choice due to its low cost and easy implementation. However, its limited resistance to external influences makes it less suitable for more demanding applications. (Faccini et al., 2021)

Lamination is ideal for luxury packaging and protection of graphic products, however, high costs and the use of plastic materials that have a negative impact on the environment represent significant challenges. (Chen et al., 2024)

Economic and environmental impacts are also one of the challenges that can be solved in certain ways. When talking about the economy of production, it depends on the chosen coating method. Classic coating methods reduce production costs, while special coatings increase costs. The process is much more efficient when using digital methods (such as the inkjet method) which enable precise and personalized coating and also reduce waste. (Montemor, 2014)

Environmental challenges of coating include emissions of harmful solvents and the use of non-biodegradable materials. There is an increasing focus on sustainability that encourages the use of water-based coatings to reduce emissions, but the development of biodegradable coatings and laminations contributes to reducing negative environmental impacts. (Makhlouf & Abu-Thabit, 2019)

Technical challenges are often encountered in the coating process. Uneven coating can be solved by better roller calibration and the use of precision coating systems. Adhesion problems can be solved by surface treatment of the material, such as corona treatment before coating. Air bubbles in lamination are often caused by incorrect temperature and speed of the lamination process, and dust removal from the material before the process also contributes to the quality of the final product. Solvent pollution can be reduced by using water-based coatings and waste gas capture systems. (Holmberg & Matthews, 2009; Montemor, 2014)

Applying the right technological and sustainable solution and continuous improvement of the coating process are key factors for facing economic, technical and environmental challenges.

Conclusion and Future Perspectives

Advanced surface coating methods are the foundation for the future of the printing industry, combining technical excellence, environmental responsibility and innovation. Developments in technologies such as nano coatings, smart coatings and hybrid systems are enabling the creation of

products with unprecedented functionality and aesthetic characteristics. Nano coatings, thanks to their precision and resilience, enable improvements in the durability and quality of printed materials, while smart coatings offer interactive solutions such as color change or self-healing of damage. Further advances are expected towards the digitalization of processes, which will enable a higher level of personalization and reduce waste. Environmentally friendly materials and processes will be in the spotlight, as global requirements for reducing emissions and waste become increasingly stringent. Water-based coatings and biodegradable materials already play an important role, but future innovations should further reduce environmental impact. Circular economy initiatives as well as the use of renewable resources will be key to long-term sustainability. Current research is focused on incorporating nanotechnology, biocompatible materials and digital systems into printing processes. Future trends include the increased use of artificial intelligence and machine learning to improve coating processes and the application of new methods such as electrospinning to create highly functional coatings. The development of multifunctional coatings that combine protective, aesthetic and interactive characteristics opens up new opportunities for the industry. In conclusion, the future of the printing industry lies in innovations that combine sustainability and technological progress. The development of advanced surface coating methods not only improves product quality, but also contributes to global environmental challenges and meets increasingly complex market demands. (Chen et al., 2024; Makhlouf & Abu-Thabit, 2019; Montemor, 2014)

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