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BEST PRACTICES FOR DEVELOPING SECURE FRONT-END WEB APPLICATIONS

Sidorov D. Best Practices for Developing Secure Front-End Web Applications. In the course of the work, a review of trends and best practices in creating user interfaces was conducted. To achieve this goal, attention was focused on the use of advanced technologies and design methods by interface developers, which have been permanently evolving in recent years. The methodology used to create intuitive and convenient interfaces is revealed. The main trends and innovations in the design of user interfaces were mentioned. The impact of user experience (UX) on the development process is indicated. Practical examples and cases of implementation of the latest approaches in real projects are given. It is also proposed to apply the selected best practices for creating a user interface in accordance with the characteristics of each of them, which will make the development of user interfaces easier and more efficient, based on which practical recommendations were provided for optimizing the development process. These guidelines can be used both at the departmental level of large corporations and by individual developers and freelancers, making them universal in terms of accessibility and comprehensibility. The received recommendations are the basis for the newest paradigm of development and optimization of interactive user interfaces, which can change the approach to the development of user interfaces in general. The very question of changing the paradigm of creating interactive user interfaces based on information about the interaction of applications with the user, not only in the framework of web development, but also in desktop development, is determined to be relevant for further research, which will be considered in future scientific works.

Keywords: web development, frontend, user interaction, web design, browser, mobile optimization, applications, cross-browser compatibility.

Сідоров Д. В. Кращі практики розробки безпечних інтерфейсних веб-додатків. В ході роботи було проведено огляд трендів та найкращих практик у створенні користувацьких інтерфейсів. Для досягнення цієї мети було акцентовано увагу на використанні розробниками інтерфейсів передових технологій і методів дизайну, що постійно еволюціонують в останні роки. Виявлено методологію, що використовується для створення інтуїтивно зрозумілих та зручних інтерфейсів. Було згадано основні тенденції та інновації у дизайні користувацьких інтерфейсів. Зазначено вплив користувацького досвіду (UX) на процес розробки. Наведено практичні приклади та кейси впровадження новітніх підходів у реальних проектах. Також запропоновано застосування обраних найкращих практик створення користувацького інтерфейсу в відповідності до особливостей кожної з них, що зробить розробку користувацьких інтерфейсів простішою та ефективнішою, на основі чого були надані практичні рекомендації для оптимізації процесу розробки. Ці рекомендації можуть бути задіяні як на рівні відділів великих корпорацій, так і індивідуальними розробниками та фрілансерами, що робить їх універсальними в контексті доступу та зрозумілості. Отримані рекомендації є основою для новітньої парадигми розробки та оптимізації інтерактивних користувацьких інтерфейсів, що здатне змінити підхід до розробки користувацьких інтерфейсів в цілому. Саме питання зміни парадигми створення інтерактивних користувацьких інтерфейсів на основі інформації про взаємодію додатків з користувачем, не тільки в рамках веб-розробки, але і десктопної розробки, визначено актуальним для наступних досліджень, що будуть розглянуті в майбутніх наукових працях.

Ключові слова: веб-розробка, фронтенд, взаємодія з користувачем, веб-дизайн, браузер, мобільна оптимізація, застосунки, кросбраузерна сумісність.

The problem statement. Modern programs contain not only a visual representation of elements on the screen. Thanks to the interactive design, the programs also take into account the interaction of the user with the graphic elements of the program. Interaction design is a specialized field of design that focuses on how users interact with certain products and services. Digital products have greatly benefited from the implementation of this area of design by integrating the user interface into the overall user interaction [1]. It is this approach that allows interactive interface developers to combine software and hardware into digital solutions that users love. Interactive interface designers can encourage users to engage in certain types of interactions by using various elements in the interface. In this way, they help them avoid unwanted interaction, reducing the risk of a negative user experience.

As of 2022, 67% of people worldwide used mobile phones. 80% of them had smartphones, and 96% of Internet users [2]. This shows the importance these gadgets play in society, from making calls and playing games to getting credit information from the bank or the weather forecast, and the direct correlation between having a mobile phone and using web applications. An increasing number of different mobile applications are being created to help their users perform a wide range of tasks, and most of these applications have an interactive interface.

To ensure the success of using the application, developers strive to maximize the quality of the user experience, and therefore, user satisfaction [3]. In 2018, the total number of mobile applications

downloaded was 194 billion, with each smartphone user having many applications installed on their phone [4].

Interactive design has become one of the most important elements in the process of web development and mobile application development. Typically, users interact with interface elements to perform certain actions they need. If they can't interact with the user interface the way they want, the results are usually suboptimal. Disappointment appears, which negatively affects interaction with the user and calls into question the reputation of the developer in front of the customer of the application or site.

During user interface (UI) development, developers create the visual elements of a web application, such as colors, typography, icons, and graphics. The design of the interface should correspond to the style of the brand and reflect the needs of the target audience. The interface design should also be adaptive, i.e. adapt to different screen sizes and resolutions, meet the requirements of mobile optimization [5].

The main problem in web development and web design has now become the issue of insufficient competence of front-end developers and designers. Among all the reasons that lead sites to failure, it is necessary to highlight errors in its design, lack of cross-browser compatibility (does not work in all browsers) and lack of adaptive layout [6]. One way to solve this triple challenge is to create interactive user interfaces, based on existing best practices in accordance with the characteristics of each one, which will make web development easier and more efficient. Websites and applications developed based on these practices will be optimized for use on mobile devices and in a variety of browsers, making them more accessible to potential users. All this requires a paradigm shift in the creation of user interfaces and their unification, which is possible only when the main trends and innovations in the design of user interfaces are identified.

Formulation of the purpose and objectives of the research. The purpose of the article is to research and reveal modern innovative approaches in the creation of user interfaces, with an emphasis on the use of advanced technologies and design methods. To achieve the goal, the following tasks of the current research were solved:

1. The peculiarities of creating user interfaces and interactive interfaces as areas of web design are explained.
2. The methodology used to create intuitive and convenient interfaces is revealed.
3. The main trends and innovations in the design of user interfaces are considered.
4. The impact of user experience (UX) on the development process is determined.
5. Practical examples and cases of implementation of the latest development approaches in real projects are mentioned.
6. Based on the previous steps, practical recommendations were developed to optimize the web development process.

Among the general scientific methods that were used to solve research tasks and achieve its goal, the following should be noted:

- monitoring method: used to collect, systematize and analyze information about user interfaces and their development features;
- comparison method: came in handy when researching different methodologies for creating interfaces and comparing them;
- the method of abstraction: was used during the research in order to highlight the main concepts and categories;
- methods of analysis and synthesis: used in the process of identifying the stages and factors of development, as well as the most influential elements of the researched object.

To solve the general tasks of the current research, the following groups of special methods were used: information collection methods; information processing methods; methods of analytical work; justification method.

The relevance of the researched topic is argued by the importance of quality control of websites and applications that allow users to make their lives easier and more convenient, and developers to attract funds and, based on previous experience, to create increasingly high-quality and modern websites and applications that will have intuitive and convenient user interfaces.

Analysis of recent research and publications. Today, the topic of web development and optimization of mobile and web applications for various platforms and browsers in the context of the user interface, as well as its derivatives, is of interest to many domestic and foreign researchers and practitioners

in the field of information technology, and especially front-end development specialists. Among the Ukrainian scientists who researched this topic, it is necessary to mention H. Chemerys, O. Barkalov, R. Babakov, O. Blahodelskyy, O. Pushkar, Y. Hrabovskyy, I. Bardus, and O. Pryvezentsev.

H. Chemerys in her scientific publication considered the principle of the «golden» ratio in the process of designing the user interface of websites. She proved that the application of classical principles of composition in the process of prototyping the user interface of websites has a positive effect on the harmonious perception of design as a whole [7].

In the joint article of O. Barkalov and R. Babakov, the issue of development and use of cross-platform software was considered, which was based on a study of the speed of various libraries designed for building a graphical user interface of applications written in the Python language [8].

In his scientific work, O. Blahodelskyy conducted a literature review and analysis of the features of the use of modern computer technologies to create the external interface of web applications based on the application of machine and deep learning models [9].

O. Pushkar and Y. Hrabovskyy, in their article, analyzed the characteristic features and principles of building a user interface and substantiated their own author's approach to the development of an intellectual user interface of educational publications in the e-learning system [10].

I. Bardus and O. Pryvezentsev reviewed the job duties of specialists who develop user interfaces (UI designer, UX designer, front-end developer, graphic designer and user experience researcher) and described the full process of their development, from concept to cross-platform support [11].

From among foreign researchers, it is worth noting M. Lazuardy, D. Anggraini, E. Planas, G. Daniel, M. Brambilla, J. Cabot, A. Narayanan, A. Mathur, M. Chetty, M. Kshirsagar, W. Nasution, P. Nusa.

The article by M. Lazuardy and D. Anggraini presents a comprehensive overview of the development of SIASN web applications. In addition, the advantages and disadvantages of React.js and Next.js as the main technologies in building the user interface of the SIASN program are considered [12].

E. Planas, G. Daniel, M. Brambilla, and J. Cabot investigated the application of model-driven techniques to the development of software applications with embedded multi-functional user interfaces. They also proposed a new domain-specific language (DSL) to define several types of dialog interface (CUI) [13].

A. Narayanan, A. Mathur, M. Chetty, and M. Kshirsagar conducted research on the evolution of «dark patterns» (user interfaces that encourage users to make decisions they would not otherwise make). During the research, it was determined that a number of world-famous online services are trying to mislead users through the use of «dark templates» [14].

In the joint scientific work of W. Nasution and P. Nusa, a design prototype (user interface)UI/(user experience)UX of an Indonesian educational web program called "IdeIn" was considered, which was developed using the method of design thinking. All stages of design development and its features are also described [15].

Having analyzed the most up-to-date materials that are currently publicly available, such as scientific works, monographs, articles on specialized sites, we can conclude that the topic of web development and optimization of mobile and web applications for various platforms and browsers in the context of the user interface is relevant and interesting for many researchers around the world.

Also, mentioning and evaluating the significant contribution of the researchers listed above to the review of the current topic, it is necessary to note the lack of a single universal approach to the study of issues and features of web development through the prism of user interfaces and interactive user interfaces as elements of web design.

Presentation of the main material and substantiation of the obtained research results.

First of all, it is necessary to explain the meaning of the phrase «user interface». A user interface (UI) is generally anything that facilitates interaction between a user and a machine. In the world of computers, it can be anything from a keyboard, a joystick, a screen or a program. In the case of computer software, this can be a command line, a web page, a user input form, or any program interface [16].

The design of the interface, created according to all the canons of UI design, helps the user to quickly understand what function, which icons, buttons perform, what follows. Whether the user continues to use the application or closes it after a couple of minutes depends on the UI design. Today, user interface is not only about interactivity and animation. This is what allows a brand to stand out, convey its mission and emotions, and create additional value for its customers. The stages of the development and approval processes of the user interface can be seen in the table. 1.

Table. 1. Step-by-step development and approval of the user interface design

№	The name of the development stage	The essence of the step
1	Transfer of materials and briefing on the project	After completing the work on UX design, all the obtained data is transferred to the UI team: research, conclusions, insights, artifacts and prototypes with an explanation of all user paths and business features. This helps the UI team quickly dive into project materials, specifications, niche trends, and other relevant information to understand the needs of the target audience, project goals, and client requirements
2	Interviews and insights	Developers ask questions that can help choose the optimal style of the future product. They ask about the mood, emotions, brand book, logo, current site (if any) and the tasks they need to solve at this stage. If there is a site, ask the owners what they like and don't like about the current design. In addition, developers are asked to describe how they see the future site using metaphors. In this way, the owners can convey the desired mood of the product – it should be restrained and professional, or light and relaxed. All of this helps to understand the overall vision and design goals. It can be a simple desire to have a fresh, stylish interface, or something more specific. For example, stand out among competitors with the help of non-standard design solutions
3	Moodboards	After receiving all the necessary information, developers start creating moodboards to finally define the style of the future product. That is, customers get several options to choose from and can choose what they like. They also add some sketches of market trends and proven solutions to Figma as references. It is there that developers decide which elements to include in the design. After approving the details of the interface, they proceed to direct work on the design, taking into account all the requirements and preferences of customers
4	Concept development and page design	The creation of the interface itself begins with the main page and some key pages. In the case of e-commerce, this can be the main page, product card, cart and checkout. Developers create their design and style, including the smallest details such as layout, fonts, color palette, icons, etc. After that, they show the design of key pages to the customer, justifying the chosen design solutions and their importance for achieving the project's goals. If the client is satisfied with everything, the developers move on to developing the design of the rest of the site's pages. When key pages are finalized, work begins on designing other pages/screens in all possible states and with all details in mind. Secondary pages include: blog, service pages, personal account, content and service pages, etc
5	Animation	Depending on the project and the chosen solutions, developers can lay down and develop CSS animations to make the site more interactive and interesting. Animated prototypes can be created to visually demonstrate specific user interactions with the interface that are difficult to explain in words. This includes smooth transitions between pages, attractive animation during page scrolling, pop-up elements, drop-down menu
6	UI guide	At this stage, a detailed UI guide is created, covering all the main aspects of the design: from colors, fonts and line spacing, indents to interacting with information based on user behavior scenarios, interactive/pop-up elements, button clicks, transitions, and more. This step-by-step guide ensures a smooth transition from design to development, leaving no room for guesswork around design features and user interaction
7	Author's supervision of execution	After all stages of design creation and approval are completed, the project is handed over to the development team. Since the entire development team is responsible for the final design of the project, it is important for them that all UI solutions and ideas are correctly implemented. That is why they carry out the author's supervision of the work at all stages of development.

Next, it is necessary to determine the specifics of creating user interfaces and interactive interfaces as areas of web design. These features are determined by the following development goals of these interfaces:

- convenience and practicality: the product is easy to use, which means that more people will be inclined to use it;
- beauty and uniqueness: the product is more pleasant to use and looks aesthetic, which attracts more and more users.

It is now important for any developer to understand the characteristics of a good user interface and why it is so important to the success of their product. Features of creating a user interface are shown in fig. 1.

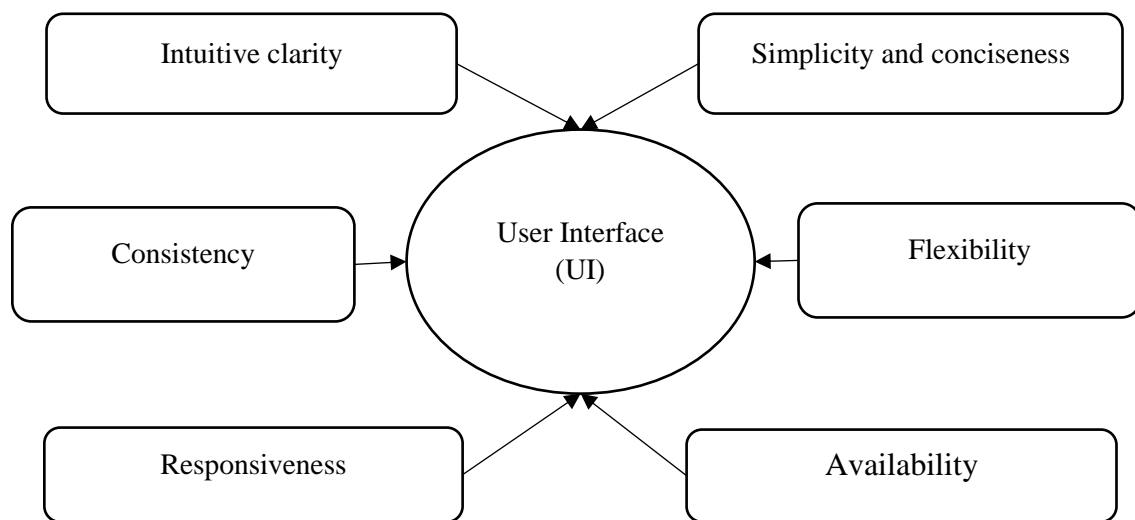


Fig. 1. Features of a qualitatively created user interface

The essence of the features of qualitatively developed user interfaces is explained in more detail below:

1. Intuitiveness: users should be able to understand how to use the product without reading long instructions. The best way to achieve this is to use familiar conventions and make functions self-evident (use easily recognizable symbols).

2. Simplicity and conciseness: a good user interface is always simple and clear. It should include only the elements that are absolutely necessary and nothing else, which will make it easier for users to find what they are looking for and allow them to use the product without getting tired.

3. Consistency: all elements of the user interface should be consistent with each other. This includes schemas, typography, iconography, and the overall design language; all of these elements create a better experience that is pleasing to the eye and easy to use.

4. Responsiveness: a good user interface should be attractive and work well on all devices and platforms, being cross-browser and cross-platform (optimized for mobile applications as well). This is important because, as previously identified, more and more people are using mobile devices to access the Internet.

5. Flexibility: a good user interface should be flexible and be able to adapt to different screen sizes, resolutions, and orientations (landscape or portrait), as developers do not know what device users will use to access the site or application.

6. Accessibility: a good user interface should be suitable for use by people with disabilities or special needs. This means making text alternatives available for images and allowing users to adjust the font size of these text alternatives. [18].

Summarizing the peculiarities of user interface development, it should be noted that it is conceptually defined as a combination of understanding the needs of the target audience and the skills of the frontend designer and developer (UI team).

The next step in the research is to review the user interface elements. UI components are an integral part of the design of a website or application. They are the building blocks for all products. Any web

designer or front-end developer needs to have a deep understanding of user interface elements and how users interact with them. Designers typically don't draw UI elements themselves when they create web pages or mobile apps. They usually start with a ready-made repository of user interface elements. As a rule, there are three main categories of user interface elements, all these groups are shown in fig. 2.

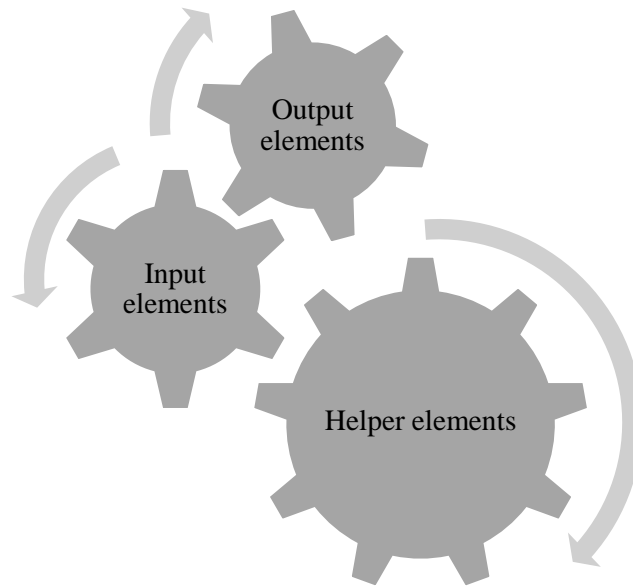


Fig. 2. Groups of user interface elements

The functions of the user interface elements can be briefly explained as follows:

1. Users use them to add the information they need and move on to the next step.
2. Elements show the result of a previous user action.
3. They help to move around the site or application, get information and draw the user's attention to a certain element [19].

Next, the main trends and innovations in the development and design of user interfaces will be described and listed:

- in 2024, design integrated with artificial intelligence has become more common, allowing designers to solve complex problems and expand the boundaries of their creativity;
- in 2024, animated icons have become a staple of user interface design, breathing new life into interfaces. Tools like Midjourney have helped designers create stunning 3D visuals that captivate users;
- typography plays a vital role in user interface design, and in 2024, big and bold fonts will become the dominant trend;
- dark mode has gained immense popularity in the last decade. Its development continued in 2024. This user interface trend offers a sleek and modern aesthetic, reducing eye strain in low-light conditions;
- the trend towards minimalism in design continued in 2024. Conciseness of interfaces helps to ensure the desired level of interaction with the user, allowing him to focus on working with the main elements [20].

In conclusion, it should be noted that the design of user interfaces is constantly evolving, and in 2024 there will be significant achievements and trends. For the designers of the future, the main task has become to combine their creativity and technical expertise to create interfaces that bring pleasure to the users of websites and applications.

Also, it should be noted that the user experience (UX) plays a decisive role in the success of creating user interfaces. Prioritizing UX can lead to increased user engagement, better retention and loyalty, better brand reputation, and lower development costs in the long run.

UX methods can be used to define design, such as:

- user research;
- persona creation;
- prototyping and testing.

User-centered design is a common process today, in which developers and designers take the needs of users as the starting point for all design and further development of a product.

Practical examples and cases of implementation of the latest development approaches to user interfaces will be shown based on the overview of the website and the application.

Popular social media management service Hootsuite uses a fixed menu for its landing page and offers three eye-catching social sign-up buttons. But if the user wants to register using e-mail, then after clicking «create a new account», he will not go to a new page, because the system will display a window with illustrated fields. The Hootsuite app encourages users to fill out their details and start using the service right away, showing how much time they can save. After registering and adding social networks, the user will see an interactive guide to start working with the application.

The My Energy website, created to track the consumption and costs of energy, gas and water, clearly explains to users why certain data is needed and shows that registration is performed simultaneously in three steps: classifying the house, entering the address, verifying the location. Site users can use the tips section to mark tips they are already following, add them to to-do lists, and quickly view tips using filters and Saving Impact and Effort Required indicators presented in the form of gradient circles.

To speed up and simplify the process of developing user interfaces, it was decided to provide a number of recommendations, among which are the following:

- it is necessary to achieve maximum interaction between all members of the UI team, which allows to reduce time spent and the number of possible errors during development;
- it is necessary to conduct research on the market of technical innovations, looking for more powerful means of development, which will allow to win the competition from other developers;
- it is necessary to develop the creativity of designers by analyzing the works of other creators or artists during exhibitions;
- for frontend developers, as well as designers, their soft skills are important, which allow them to effectively interact with a manager or client, listening to his user experience.

Most of the recommendations given do not apply to hard skills, because due to the constant development of the website and application market, all developers must constantly improve their professional skills, regardless of frontend or backend.

Conclusions and prospects for further research.

In today's conditions of intensive development of information technologies, it is impossible to imagine a person's life without websites or mobile applications. During the work, an overview of the features and stages of user interface development, from the idea to direct implementation by the designer and front-end developer, was conducted. The main trends and innovations in the design of user interfaces in recent years and decades were mentioned. The impact of user experience (UX) on the development process is indicated as the main factor of successful development. Practical recommendations for speeding up and simplifying the development of user interfaces were also provided. These recommendations can be used both at the level of corporate departments and by individual developers or freelancers, which makes them universal. The received recommendations should become the basis for changing the paradigm of front-end development, which can change the paradigm of creating websites and applications as a whole. The very question of changing the paradigm of creating interactive user interfaces based on information about the interaction of applications with the user, not only in the framework of web development, but also in desktop development, is determined to be relevant for further research, and will be considered within the framework of these studies.

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