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RESPONSIVE WEB DESIGN – CURRENT STATE & NEEDS ANALYSIS

The paper presents a case study of designing and testing a responsive web page. Responsive web design is a novel technique becoming more and more popular among web developers. Economic factors of web market show that today applications and pages need to be adapted to different resolutions and devices. Responsive web design is an answer to this problem. The paper also offers techniques adapted to interface testing procedure. The procedure is based on the expert method and the cognitive walkthrough. The combination of those two techniques proved to be able to adjust web pages created to different devices.

Keywords: *responsive web design; GUI; expert analysis, cognitive walkthrough.*

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АДАПТИВНИЙ ВЕБ-ДИЗАЙН: АНАЛІЗ СУЧАСНОГО СТАНУ ТА ПОТРЕБ У ПОДАЛЬШОМУ РОЗВИТКУ ЕКОНОМІКИ

У статті представлено приклад дизайну та тестування адаптивної веб-сторінки. Адаптивний вед-дизайн – це відносно нова технологія, яка стає все більш популярною серед розробників. Економічний аналіз веб-ринку демонструє, що сучасне програмне забезпечення та Інтернет-сторінки мають бути адаптовані під різні розміри екрану та для різних пристроїв. Адаптивний веб-дизайн саме і вирішує цю проблему. Описано техніку адаптації веб-дизайну до інтерфейсу. Дана процедура спирається на експертний метод та метод покрокового керівництва. Комбінація цих двох методів дозволяє адаптувати веб-сторінки до різних пристроїв, що і продемонстровано на реальному прикладі.

Ключові слова: *адаптивний веб-дизайн; графічний інтерфейс користувача; експертний аналіз; когнітивне покрокове керівництво.*

Табл. 2. Рис. 3. Літ. 30.

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АДАПТИВНЫЙ ВЕБ-ДИЗАЙН: АНАЛИЗ СОВРЕМЕННОГО СОСТОЯНИЯ И ПОТРЕБНОСТЕЙ ДАЛЬНЕЙШЕГО РАЗВИТИЯ ЭКОНОМИКИ

В статье представлен пример дизайна и тестирования адаптивной веб-страницы. Адаптивный веб-дизайн – относительно новая технология, которая становится всё более популярной среди разработчиков. Экономический анализ веб-рынка показывает, что современные приложения и Интернет-страницы должны быть адаптированы к различным разрешениям экрана и для различных устройств. Адаптивный веб-дизайн решает данную проблему. Описана техника адаптации веб-дизайна к интерфейсу. Данная процедура опирается на экспертный метод и метод когнитивного пошагового руководства. Сочетание этих двух методов позволяет адаптировать веб-страницы к различным устройствам, что и описано на реальном примере.

Ключевые слова: *адаптивный веб-дизайн; графический интерфейс пользователя; экспертный анализ; когнитивное пошаговое руководство.*

Introduction. Recent research (Mitchell et al., 2012) shows that more than three-quarters of the US adults (77%) own laptop or desktop computers. Computer market, however, achieved stabilisation for the last several years. On the other hand, mobile market is growing rapidly. Nearly 44% of the US adults own smartphones, and

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18% of them own tablets. Those numbers convince web developers about the existence of certain global trends.

More and more people use smartphones (mobile phones, tablets) to access emails and browse web pages. According to different studies (comScore, 2012), mobile phones and tablets almost doubled their share of web traffic in just one year (from 7% in 2011 to more than 13% in 2012). Users change devices more and more often. Patterns of their behaviour can be hardly predicted. These results in very fast blurring of the boundaries of the way people use the Web. Additionally, Internet worldwide users have increased from nearly 2 bln in June 2010 to 2.3 bln in December 2011 (Smashing Magazine, 2013).

Such diversification of devices currently used for web browsing forces developers design more and more cross-channel websites (Resmini and Rosati, 2011), prepared to be accessed from different devices with various screen resolutions, operating systems, internet browsers etc. Great diversification of currently available devices and more sophisticated project of new solutions makes totally impossible to offer the same experience between different devices. What is more, devices offer different features and make users adapt different users' scenarios. Even the cost of time losses of users might have economic effects.

"Responsive web design" (RWD) technique is one of the currently popular solutions to this problem. This is a new method, getting more and more popular during the last 3 years. This technique is used to adapt a website to different users' scenarios.

The term "responsive web design" was introduced by E. Marcotte (2010) in his article. E. Marcotte (2011) wrote the book "Responsive Web Design", in which he explored new techniques and proposed some design patterns. "Responsive design" was awarded the second development trend of the year 2012 and year 2013 was declared to be the year of responsive web design (Cashmore, 2012).

The goal of RWD is to deliver high quality experience to users no matter what kind of device they use and irrespective of the screen resolution of this device. Elements of the page are displayed, but they may de displaed in different ways to adapt to the device. The idea of RWD is to provide easy reading and navigation with a minimum of resizing, panning, and scrolling across a wide range of different devices.

RWD techniques adapt design patterns, common solutions to different design problems. For example, there are layout patterns, navigation patterns, menu patterns, form patterns etc. Responsive web design is based on 3 different techniques:

- Fluid grids (or fluid layouts) – allow the content to resize with a browser window, in contrast to rigid fixed-width grids.
- Flexible images consist in defining their size in relative units (e.g., percentage) instead of fixed sizes (centimeters or pixels).
- Media queries – a CSS3 module (Rivoal, 2012) that allows a web designer define different CSS style rules based on the characteristics of a device the website is being displayed on.

Recent literature review. There is extensive literature on users experience and usability testing. However, there is still a niche regarding responsive web design in research. This new technique, however, is getting more and more popular and the number of papers concerning this issue is rising.

As it was noted by (Insfran and Fernandez, 2008), web applications have become the backbone of business and information interactions (Rinder, 2012). Usability and user experience is of great importance. The need for usability evaluation methods has become critical because users will choose the web application more user friendly, giving better user experience. Development of the Internet and changes in use of the web force developers put more attention to usability. So it is no longer a luxury, but rather a necessity (Abran et al., 2003). Usability is commonly associated with software engineering and in particular website engineering (Seffah and Metzker, 2004).

Methods for usability evaluation (like cognitive walkthrough, expert analysis, think-aloud testing) are widely used (Gulliksen et al., 2004) to test and improve software usability (Norgaard, 2006). This is the only way to check the quality of an interface and its adjustments to users, their needs and limitations (Bastien, 2009).

One can find numerous studies related to usability evaluation and testing methods in general (Cockton et al., 2003; Dumas, 2003; Hornbek and Frokjor, 2005; John and Mashyna, 1997; Karat et al., 1992). However, it is important to notice (Norgaard, 2006) that many studies do not take place in a practical, real software development environment, but in a laboratory with non-expert users. Moreover, it is also important to plan and describe the process of evaluation in detail (John, 2004; Wixon, 2003).

Usability evaluation is one of the most important steps in the user centred design process of any interactive system (Bastien, 2009). Usability testing is performed to (Bastien, 2009) assess the degree to which a system is effective and efficient.

There are 3 typical approaches for evaluating user interfaces. They are: inspection-based evaluations, user-based evaluations and model-based evaluations. Both, inspection- and user-based evaluations are well documented and widely used by usability practitioners (Bastien, 2009; Jeffries et al., 1991). The third one, model-based evaluation, is considered to be limited in use and expensive to apply (Cockton et al., 2003).

Applied evaluation method. Among different methods of user experience assessment two are suited for RWD page testing. They are: expert analysis and cognitive walkthrough. They can be adapted to rate GUI and the user experience on different kind of devices.

GUI of the responsive design web page needs to be checked and tested by users working on different type of devices. This is the only way to test responsiveness of a page – to check users' viewing experience GUI quality evaluating methods.

Expert analysis in combination with a cognitive walkthrough seems to be the most reliable method for assessment of responsive web page design of GUI quality. As it is shown in (Krug, 2000) in most cases group of several experts using the adequate methodology is able to detect and correct over 85% of errors in software – this applies also to errors in GUI quality. Testing can never completely identify all the defects within software (Pan, 1999).

Expert analysis is one of the most widely used methods for application testing. Experts, while using the application, check predefined areas. Those areas are defined to help examine application compliance with interface design guidelines, such as Nielsen-Molich heuristics (Nielsen, 2000; Nielsen and Molich, 1990) and to detect potential problems.

Each of those predefined areas can be divided into several more detailed subareas. What is more, they usually have detailed issues assigned to help experts cover more important aspects of GUI quality (Laskowski, 2012).

A simplified cognitive walkthrough emphasizes the ease of interface learning as well as viewing experience during the initial contact with the system. This method might be successfully used in combination with the expert analysis method. This method is based on few tasks, which a user will perform during work with an application, e.g., making a purchase (Jacobsen and John, 2000).

The difficulty of each step is usually evaluated using the Likert scale of 1 to 5, with 1 meaning "very easy", 5 – "very difficult". The cognitive walkthrough is composed of several phases (Jacobsen and John, 2000):

- Reading process and assessing the impact of reading the content.
- Defining the user and choosing task scenarios including defining the user profile, choosing task scenarios and assessing the impact of selection.
- Transforming a task scenario to an action sequence including defining the way of transforming is done.
- Walking through the action sequences and assessing its impact on problem detection.

The expert analysis criteria consist of the detailed list of areas and subareas with questions assigned to each point. The list is a modified version of the list called "LUT list" which we proposed in 2013. Modification consists in adjusting sections concerning different devices and resolutions. The group of main areas contains: *Application interface, Navigation, Data structure and Data input.* Detailed list of questions is presented in Table 2 in the paper's results sections. Table 1 presents the grading scale used to assess each evaluated assessed area.

Table 1. **The grading scale applied to the LUT list,** *authors' development*

Grade	Description
1	Critical usability errors were observed, preventing normal usage or discouraging user from using the application.
2	Serious usability issues were encountered, which may prevent most users from task realization.
3	Minor usability issues were observed, which if accumulated may have a negative impact on user's performance.
4	Single minor usability issues were observed, which may have negative impact on user's work quality (e.g. poor readability).
5	No usability issues influencing either user's performance or work quality were identified.

The most important issues concerning the interface quality are organized in the following areas: application interface, navigation, data structure and data input. The set of questions, defined by the authors and called the LUT list, is shown in Table 2.

Cognitive walkthrough involves 3 scenarios containing tasks to perform. The results of the analysis performed using those two methods presents the users' experience and GUI quality of prepared responsive web page design. This approach enables checking the ability to accomplish tasks at different resolutions and using different navigation methods. Those differences, however, influence the results in that way, that it spreads the number of performed moves.

The project of RWD page. Here is the example of the web page created using the Foundation framework of a responsive web design. The web page should be readable

with a minimum of resizing, panning, and scrolling. It was created to present users' interface navigation mechanism and to get to know users' viewing experience.

Table 2. **The expert analysis results (LUT list),** *authors' development*

Application interface		**4.44**
Layout	Is the layout readable?	4.8
	Is it adjusted to different resolutions?	4.3
	Is it adjusted to mobile devices?	4.6
	Is it consistent?	4.3
	Does it support task implementation?	4.2
Navigation		**4.38**
Ease of use	Is the access to all elements of menu easy and intuitive?	4.9
	Is the use of menu easy?	4.7
	Is the localization of menu intuitive?	3.9
Menu hierarchy	Isn't the menu hierarchy too complicated?	3.7
Navigation structure	Is the navigation structure intuitive and understandable for users?	4.4
	Is the navigation well adjusted to the screen resolution?	4.7
	Is it well planned?	4.1
Screen elements	Do they support the navigation?	4.6
Data structure		**4.49**
Ease of use	Is the access to all sections of an application easy and intuitive?	4.8
	Is the access to all functions of an application easy and intuitive?	4.4
Information hierarchy	Isn't the information hierarchy too complicated?	3.9
Information structure	Is the information structure understandable?	4.7
	Is it consistent?	4.7
	Is it well planned?	4.4
Data input		**3,99**
Data	Is the data validated by the form elements?	3.3
	Do the forms have elements acting as hints for the input data (e.g, on format or data range)?	3.1
	Can an average user fill in the form easily?	4.5
Forms	Are they designed in a readable way?	4.5
	Are they adjusted to mobile devices?	4.1
	Do they allow user to input all necessary data?	4.4

The web page is simple, it does not have any extensive functionality. It contains several main sections:

- Articles – extended thematic articles including photos.
- Gallery – several galleries each containing a collection of photos
- Form – typical web form composed of several questions.

The home page contains news shortcuts and links to the remaining contents of the page.

The menu section is placed on the left side of the page. Mobile and smart phone users, however, can see the menu at the top of the screen to make it more readable.

Figure 1 presents the example screen of this web page. The screen contains the section of articles. Figure 1a presents a screenshot taken on a computer, and Figure 1b – on a mobile phone. The same page is displayed slightly different at those devices. The location and the look of menu is different as well as the size of figures.

Differences between web pages adjusted to computers and to mobile phones can be also seen in Figures 2 and 3. These figures present mockups of the two chosen web pages. Figures 2a and 3a present mockup dedicated to computers and tablets with the resolution of minimal width 768 px, whereas Figures 2b and 3b show mockups dedicated to smartphones with small screens (maximal width: 767 px).

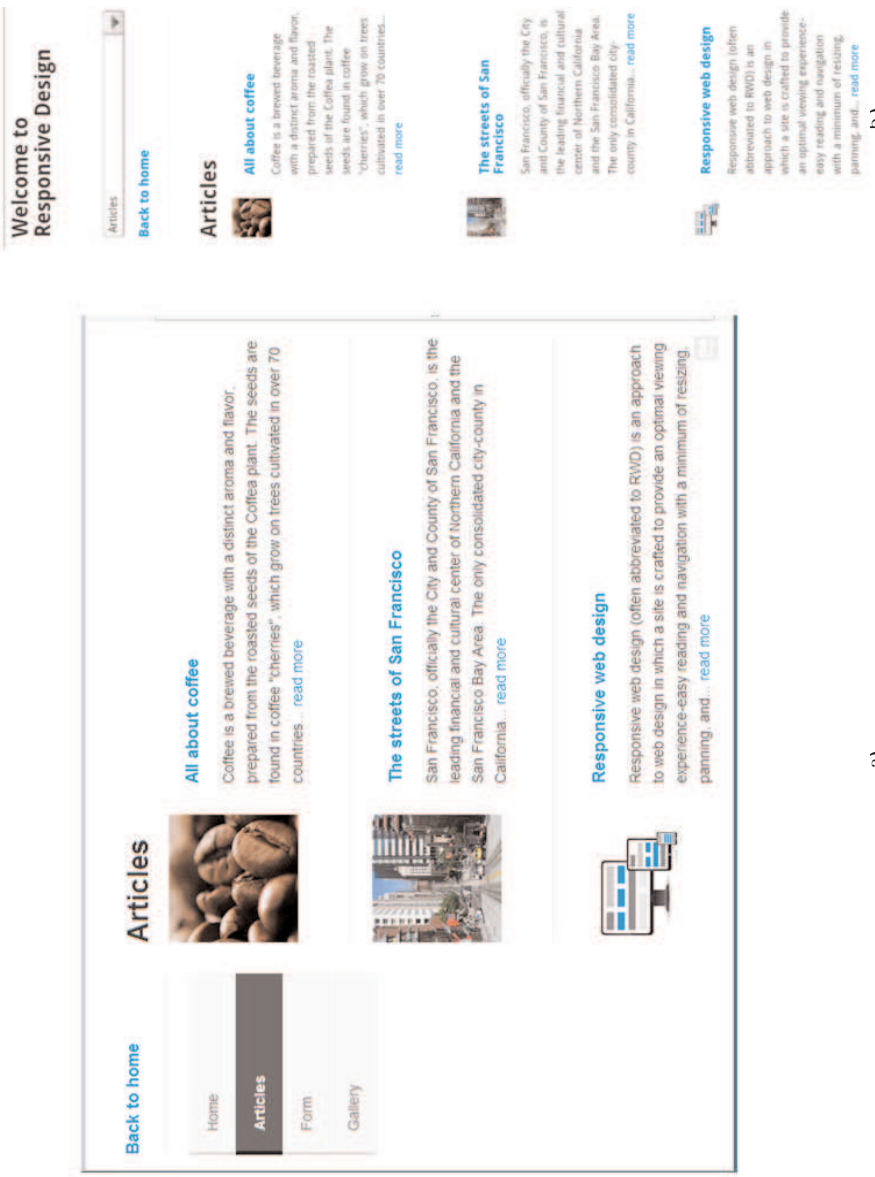

Figure 1. **Sample screenshot of the web page,** *designed by the authors*

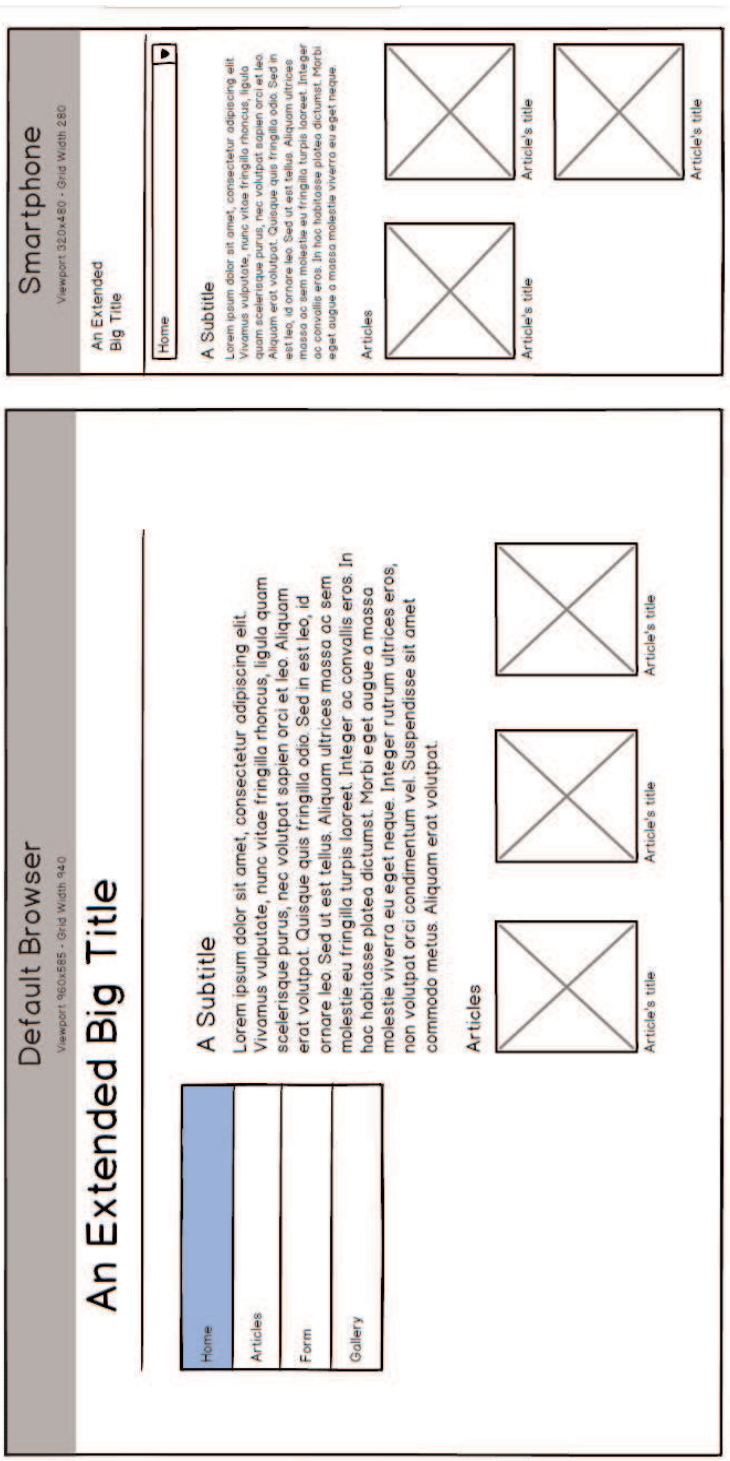

Figure 2. **Sample mockup of the home page,** *designed by the authors*

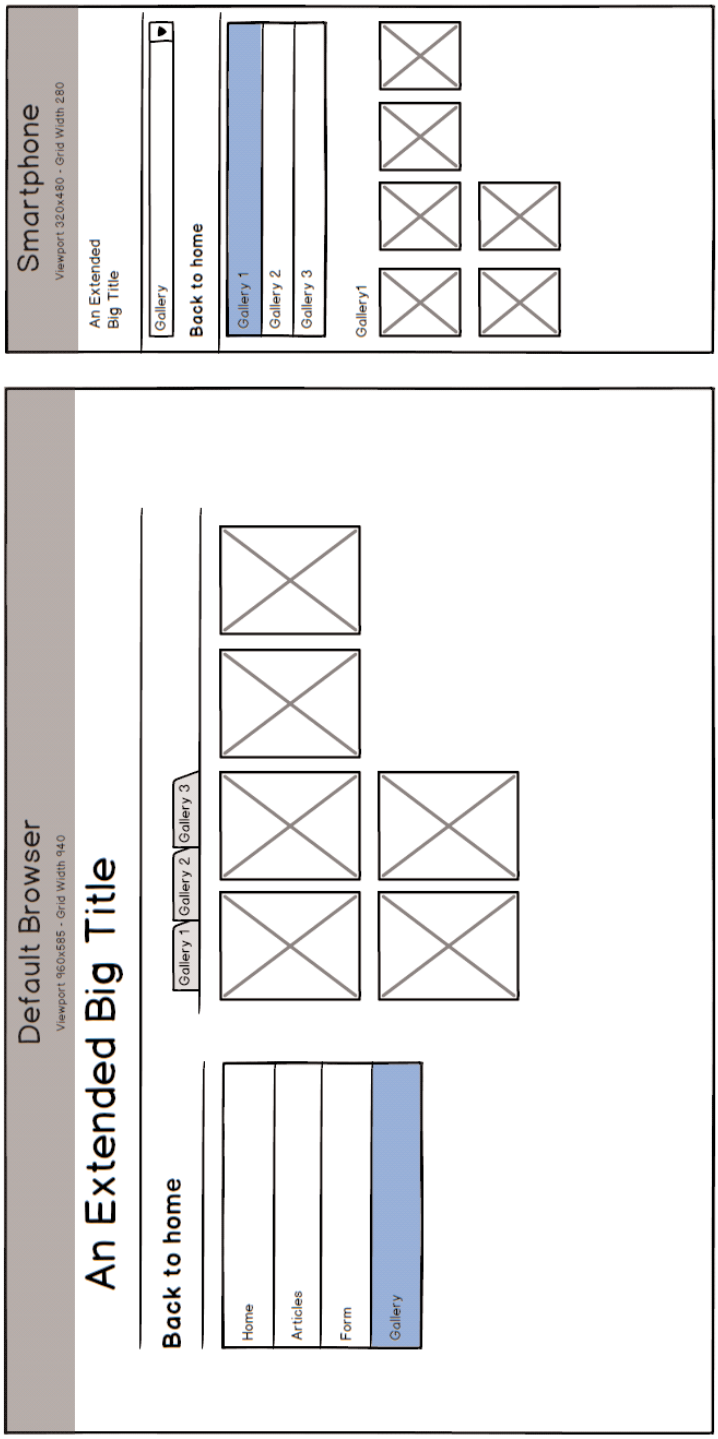

Figure 3. **Sample mockup of the gallery page,** *designed by the authors*

The page is always adjusted to screen resolution, so horizontal scroll is never displayed. The menu related to mobile phones also differs – it has the form of a drop-down list and it is located at the top of a web page. Menu referring to higher screen resolution devices has the form of a list and it is located at the left side of the web page. Also the size and location of figures are different.

The goal of the useful, high quality GUI is to adjust the web page view to the screen. Differences between web pages for computers and mobile devices are designed to improve the users' experience on different devices.

Summary. The main goal of the presented case study was to assess the capabilities of responsive web design (RWD) and to determine the users' experience of the web pages RWD. The case study was based on the two methods (expert analysis and cognitive walkthrough) applied on web experienced users using different devices like computers, smart phones, tablets.

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