

# Responsive Universal Design with Universal User Profiles and CSS User Queries

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**Keywords:** Responsive Design, Responsive Universal Design, Cascading Style Sheet, CSS User Queries, Universal User Profile.

**Abstract:** Accompanying the rapid progressing of information and communication technology, the number of web-based mobile applications grows significantly. The web page design does bring different user experiences on various mobile devices. The Responsive Web Design (RWD) was the first trial to deal with this issue. RWD aimed at designing adaptive web interface for different mobile devices. However, RWD consider only the difference of devices, but not the users, especially the needs of elders. This paper proposes the Responsive Universal Design (RUD), an enhancement of RWD, to consider both the devices and users. A unique Universal User Profile (UUP) is maintained for each user on device. Based on UUP, CSS User Queries functions are used to adjust the user interface dynamically with the best experience. RUD can increase the flexibility of web design, and improve user experience. A JavaScript library is implemented for build/load UUP, to parse user queries, and to apply CSS styles. This paper reports a critical step to create a universal and user-oriented web environment.

## 1 INTRODUCTION

Accompany with the fast growth of network and mobile technologies, no matter when or where, we can find people using mobile phone or tablet devices for Internet access. However, most of the web sites are designed for desktop. Mobile web sites are costly to design. In 2010, Ethan Marcotte coined the term Responsive Web Design (RWD) in his article. Through the adoption of CSS Media Queries, the RWD based web page can response different views for different devices. However, RWD could meet the needs for each individual user. In the meantime, the aging society is approaching rapidly, and the number of elders (senior citizens) in physical and mental degradation is fast increasing. Small text font and complicated workflow are difficult to learn and use for elders. Neither traditional web design nor RWD-design can solve the above problem. In other words, RWD based web sites are still not friendly for elder and children. The specialized web sites for elders do not provide personalized solution for user. In this paper, we extend the RWD to a meta-level as Responsive Universal Design, and designed two tools to solve the problems.

This research designed and implemented a Universal User Profiles (UUP) to save user's

experiences, behaviour, and preference. Accompany with the proposed CSS User Queries, which is an extension from the CSS3 Media Queries, web designer and/or developer can transform an ordinary desktop based web pages, to an adaptive page, we named the design process Responsive Universal Design (RUD). The design principals of RUD are: Universal design, Personalize optimization, and User Centered Design. The goal is to construct an Internet environment that allows the elder, the young, and the physical and spiritual disabled people to browse the web intuitively. The second section of this paper introduces the background of this research and current web environment. In the third section, we present the main idea of RUD's design. The fourth section illustrates the CSS User Queries and Universal User Profiles (UUP). The following section is the experiment and result of this research. The final section is conclusion and future works.

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## 2 BACKGROUNDS

This section introduces the two major background technologies of RUD: Responsive Web Design (RWD), and CSS3 Media Queries.

### 2.1 Responsive Web Design

The accessibility of a web page is depending on screen resolution and size of the device; it is different on a desktop, a notebook, a tablet, or a smartphone. In the past, there are two possible ways to deal with this situation. (1) Minimize the design layout for smallest size screen. (2) Develop various mobile version sites, and server detects mobile devices to redirect the sites to mobile version. From developer's view, the second solution is more popular. However, there are too many new device types available in recent years. To develop web site for each device is not only expensive but also difficult to synchronize and update for all versions.

Fortunately, Responsive Web Design (RWD), a flexible design paradigm, has been proposed for adapting multiple devices. RWD-based web sites can render a suitable layout based on different screen resolution or device type. RWD not only combined the front-end technologies, such as HTML, CSS, and JavaScript, but also integrated the concepts of information flow and graphic design. The web page could detect the screen size to respond the content and layout dynamically. Hence, RWD provides the best visual effects for contents. It also eliminated the need for additional development and maintenance costs for each device. For users, RWD provides consistency content style and user interface. RWD has become one of the leading web design trends.

### 2.2 CSS3 Media Queries

CSS3 Media Queries is a relatively new feature of CSS. It is now the core technology that makes RWD possible. Through the Media Queries, developer can set HTML elements' size and style dynamically. RWD provides the design idea of Fluid Grid, which makes web page linearized on the phone, and coordinate with flexible images and texts. Figure 1 shows a single page made with CSS3 Media Queries on desktop and iPhone.

With various CSS styles, we can not only produce different page layouts but also make some change of page content. For example, the CSS attribute 'display' can choose either to control the content display, or not to control.



Figure 1: Example of Responsive Web Design with CSS3 Media Queries.

## 3 RESPONSIVE UNIVERSAL DESIGN

The user experience issues are receiving increasing attention. RWD supports adaptive design and style for various devices, but the difference of users is not considered. Here we propose a RWD-based extension which aiming at the user difference and experience. The Responsive Universal Design (RUD) is based on the following three principals:

- Universal Design

Similar to the concept of general universal design, we do not use RUD for specific groups. This design pattern does not only meet the need for elderly people, children and disabled persons, but also for the average person.

- Personalize Optimization

The main focus of responsive design is changing for difference. A web page is not suitable for anyone to browse. We need to do specific modification for different user, and provide them a most friendly experience.

- User Centered Design

Relative to "rendering on what devices", this design attaches more importance for "display for what type of user". The focus is returning to the user, and the design is initialized from the user's view.

Moreover, RUD is based as RWD and keeps all the advantages, e.g. lower development and maintain cost, high compatibility, etc.

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## 4 UNIVERSAL USER PROFILES AND CSS USER QUERIES

To achieve the Responsive Universal Design (RUD), mechanisms to record user's experience and to query the preferred rendering are required. Here, we design the Universal User Profile (UUP) scheme and the CSS User Queries scheme.

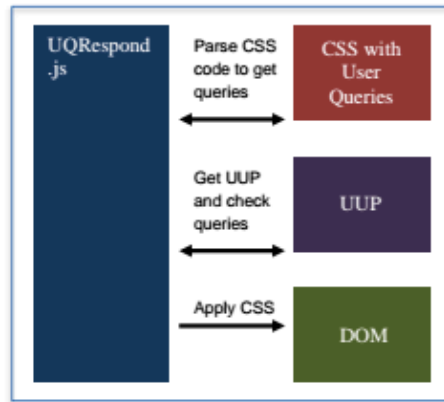


Figure 2: The relationship of JavaScript Library, User Queries, Universal User Profiles and Document Object Model (DOM).

### 4.1 Universal User Profile

RUD needs a mechanism to define the attributes and rules for the conditional query. All of user's attributes saved in a file dedicated to this task, called Universal User Profiles (UUP). Then, JavaScript can access and query for the user information to complete a RUD-based rendering. Figure 3 shows a setup screen layout of Universal User Profiles. Attributes in UUP include: Birthdate, Sex, Acceptable font size, Acceptable touch area, and preferred device.



Figure 3: Setup screen of Universal User Profiles.

- Birthdate

Birthdate is an important attribute in UUP and RUD mechanism. Due to the physical limitation, designers need pay more attention to elders and children when designing.

- Sex

This attribute is user's sex. We trust Internet is an open space and regardless of sex that anyone can browse, but the sex still will influence the user experience. We hope developer or designer can use this attribute for the style and composing, not for sexual content. It may also be useful for future data mining.

- Acceptable font size

UUP selected font size as a required attribute because most users are sensitive for the font size. This can ensure the experience of reading and make developers more convenient to set the font size.

- Acceptable size of touch area

More and more people connect Internet through the touch-based devices like tablet or smartphone. The size of button directly affected the experience of the web site. Each person has his/her own definition of "easy-to-touch", for example, elderly people or children may need a bigger button for correct touch selection. Hence, UUP added the Acceptable size of touch area as attributes. The value of this attribute is a width of button, developer or designer can use this attribute with the Fitts' Law (in Human Computer Interaction) to deploy a fit button.

- Preferred device

User's favoured devices and/or operating systems are also an important factor of user experience. UUP suggests give priority to the device that is using, to complete a consistency user experience. Also, if user/developers have any demands on special device, this attribute could be used to provide valuable information.

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Get UUP and check queries

Apply CSS

Parse CSS code to get queries

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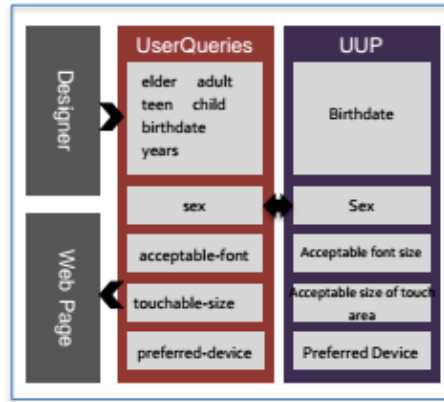


Figure 4: The model from the designer view.

#### 4.2 CSS User Queries

Similar to the CSS3 Media Queries used in RWD, RUD also needs a mechanism for querying user status and applying the selected CSS code. Extending the format of CSS3 Media Queries, we developed the CSS User Queries. The usage of User Queries is again similar to Media Queries. Developer just tags @user in the CSS code and performs the query. It is simple and straightforward. Figure 5 illustrates a CSS User Queries example for an elder whose minimum acceptable font size is 14 pixels, and the background of web page will be light yellow, and the font size start from 14 pixels.

```
@user elder and (min-acceptable-size:14px){
  body{
    background: #F8F1D9;
  }
  p,a{
    font-size: 14px;
  }
  .content{
    font-size: 16px;
    color: #333;
  }
}
```

Figure 5: An example code of CSS User Query for an elder.

CSS User Queries provides 3 ways to query about user's age.

##### 1. elder, adult, teen or child

Considering the distribution of users, users are divided to four age groups: elder, adult, teen and child. Developer can make a suitable adjustment for that age directly. The default area of each age are 0~14, 15~24, 25~64 and above 65 years old. Developers can adjust the border when they need.

##### 2. birthdate : yyyy (- yyyy)

If the developer likes to have a more precise query for age, 'birthdate' can be used as the parameter. Developer or designer can target a certain age to change the content or style of web sites. The parameter can be a range for some specify queries, e.g. '198x' or '1956 - 196x'.

##### 3. years : yy (- yy)

The third way is the current age representation. If developers want to query user's current age, they can user 'years\_old' to complete this. It has similar usage as 'birthdate'.

Developer and designer can perform the following queries for the other UUP attributes.

- Acceptable font size: ( acceptable-font : n px|em )
- Acceptable size of touch area: ( touchable-size : n px|em )
- Preferred device: ( preferred-device : device-type )
- Sex: Just add 'male' or 'female' in query.

#### 4.3 JavaScript Library: Respond for User Queries (UQRespond.js)

To accomplish a RUD-based page, we designed and implemented a JavaScript library to build or load UUP, to parse user queries, and to apply CSS styles. This library is called UQRespond.js. It forked from an open source project named Respond.js, a JavaScript library to enable responsive web designs in browsers that don't support CSS3 Media Queries. Based on Respond.js, we edited it for User Queries and added core functions for UUP.

When user connected to a user query website first time, website can actively initiate or passively request user to setup the UUP file. UQRespond.js provide a simple and fast setup for that, just call the function "createUUP()", and it will start the UUP setup in the

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touchable-size

preferred-device

acceptable-font

elder adult teen child birthdate years

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We are also building a web service that user can be authenticated through OpenID. In this case, user can switch between difference devices, and maintain the user experience at same time. The relationship between UUP and user/devices is shown in Fig. 6.

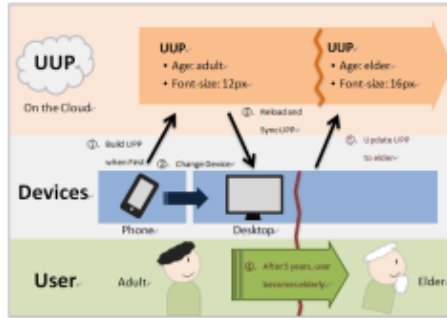


Figure 6: Schematic diagram of UUP, devices and user.

## 5 EXPERIMENT AND RESULT

This research proposed the Responsive User Design (RUD) mechanism for mobile web design. We designed and implement UUP Setup tool and library to verify the RUD. We also conduct real person experiment to investigate the user's behaviour with RUD. There are two objectives are expected from the experiment. First, User Queries can improve the user experience of reading and control a webpage. Among many User Experience parameters, we selected some quantifiable factors (e.g. reading time) to measure. Second, an UUP will bring a same fluent experience from web pages with different styles. We hope user can keep the improved user experience, which can be migrated from one RUD-based site to another.

There are two types of participants in this experiment, elders and teens. All participants have previous experience of using iPhone, iPad or Android devices. Before the experiment, subjects did not know the process of the experiment they will participate, and they will just receive an iPad with an opened web page. In the beginning, subject will enter their ages and set up a simplified UUP on the page. When the subject clicked the start button, the page shows an article and a next button. After read the article and clicked next, the web page will display a multiple-

choice question about the article. Each experiment has four rounds of article and question.

The article in the experiment is a short and simple story or news that everyone can read easily. This research prepared two different CSS layouts to make articles look like reading from different web sites as shown in Figure 7, and randomly selected the styles with enable or disable User Queries in those four rounds. Our experimental pages save the touch events, reading time and status of each subject for analysing.



Figure 7: Two different CSS layouts.

From the experiments, User Queries did improve participant's reading time. The User Queries enabled article reduced 12 percent reading time than disabled. It reduced 17 percent reading time for elder and 4 percent for teen. Totally 87.5 percent of participants improved reading efficiency with the UUP and User Queries.

Table 1: Experiment results.

		All	Elders	Teen
Selected font size (pixels)	26	26	27	26
	All	21.68	25.10	14.91
	User Queries enabled	20.27	22.73	14.60
Reading time (sec/article)	Default	23.10	27.48	15.24
	User Queries enabled	0.37	1.12	0.49
	Default	1.86	3.31	0.65
Difference reading time in different styled pages (sec/article)				
Number of touch events (times)		16	22	10

For the second objective, UUP will bring same experience from web pages with different style. The average reading time difference of two pages different with difference style is 1.86 seconds, and the average time difference become 0.37 seconds. It

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(sec/arti cle)

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Default 23.10 27.48 15.24 Difference reading time in different styled pages (sec/article)

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0.37 1.12 0.49

Default

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(times)

Number of touch events

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improved about 80 percent after enabled User Queries. As the result, UUP indeed improve the reading efficiency on the changing of the reading environment. This experiment is the first step of User Queries study, and we expect User Queries will become an essential tool for designer to improve the user experience.

## 6 CONCLUSIONS

The idea of Responsive Universal Design (RUD) with CSS User Queries, and Universal User Profiles (UUP) was inspired and implemented from the Orange Technology. RUD can increase the flexibility of web design, and improve user experience. The JavaScript library is still under development and experiments are conducted on testbed continuously. We will release it as open source libraries to mobile web developer/designer community. We are also evaluating and planning the business model of the UUP web service. This paper reports the first step to create a universal and user-oriented web environment, and we trust this will be a trend for the web design in the future.

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improved about 80 percent after enabled User Queries. As the result, UUP indeed improve the reading efficiency on the changing of the reading environment. This experiment is the first step of User Queries study, and we expect User Queries will become an essential tool for designer to improve the user experience.

## 6 CONCLUSIONS

The idea of Responsive Universal Design (RUD) with CSS User Queries, and Universal User Profiles (UUP) was inspired and implemented from the Orange Technology. RUD can increase the flexibility of web design, and improve user experience. The JavaScript library is still under development and experiments are conducted on testbed continuously. We will release it as open source libraries to mobile web developer/designer community. We are also evaluating and planning the business model of the UUP web service. This paper reports the first step to create a universal and user-oriented web environment, and we trust this will be a trend for the web design in the future.

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