Research paper

Progressive Evolution of Designing Internet Maps on the example of Google Maps

Tymoteusz Horbiński

Adam Mickiewicz University in Poznań
Faculty of Geographic and Geological Sciences, Department of Cartography and Geomatics
10 Krygowskiego St., 61-680 Poznań, Poland
e-mail: tymoteusz.horbinski@amu.edu.pl; ORCID: http://orcid.org/0000-0002-9681-6762

Abstract: In this article the author follows progressive evolution in web design that has been observed in Google Maps over the last 13 years (2005–2018). The analysis includes the graphic presentation of buttons, their layout and the changes in the functionality of the website. The results of the analysis corroborate the argument that it is possible to adapt the existing concept of progressive evolution, to the needs of Internet cartography. In the process of the analysis several crucial changes were spotted, such as the fact that as a result of the technological advancement the need to scroll the map with up, down, left and down buttons disappeared, being supplanted by the dragging function. In article all the discussed changes in Google Maps as an application for desktop computers and laptops, as well as a mobile application, prove that the product has been constantly improved. In the author's opinion, the crucial aspect is to enrich the web map in the non-invasive way to make it as user-friendly and easy to use as possible. The synthetic juxtaposition allowed one to highlight the evolution, considered by the author an important feature of the non-invasive way of introducing changes. The author notes that progressive evolution on Google Maps and other internet maps will continue. It is important that the user's needs are noticed during these changes.

Keywords: Progressive Evolution of Designing Internet Maps, Internet Maps, Google Maps

1. Introduction

Google Maps was created in 2005 by Lars and Jens Eilstrup Rasmussen in Sydney for the Where 2 Technologies company. Initially, it was supposed to be a web application for downloading, written in the C++ language, however, after the company had been taken over by Google Inc. it was turned into a website. Launching Google Maps on the Internet altered the way of thinking, learning and working with geographical data (Dodsworth and Nicholson, 2012). Its revolutionary technology has been attracted public users, as well as professionals from numerous fields related to geographical space, for almost

15 years now (Medyńska-Gulij 2010). It comes as a surprise how it affects everyday life, helping one explore the location in practically any place and time on the entire planet. Google Maps is a web map (Nivala et al., 2008, Wang, 2014) or geo-search engine (Kowalczyk and Pokojski, 2018).

Not only did Google Maps have a significant impact on its users' private life but also opened a plethora of new opportunities in marketing, business analysis, urban planning, the development of infrastructural strategies, and traffic engineering. Among numerous positive examples of the use of Google Maps, sometimes one may encounter the negative ones as well, usually resulting from the fact that data exploration on the website takes place without logging in or any identification whatsoever imposed on users, which leads to the lack of control over Google Maps users, some of whom may use the application to select locations for undertaking unjustified and unexcused actions, e.g. terrorist attacks (Burney et al., 2018). Like every web mapping service, Google Maps follows general web innovations that need to be treated as purposeful improvements. Those apply not only to updates but also to any adaptations required by search engines, new versions of operating systems, constant technological development of the computer equipment and mobile devices, as well as continuously improved HTML/CSS standards, programming languages, such as JavaScript etc.

At present, thanks to responsive web design or creating different versions for websites and mobile applications, there is a clear distinction between web maps designed for personal computers, laptops, tablets and smartphones (Horbiński and Cybulski, 2018).

The development of web applications may be referred to as progressive evolution. The term evolution occurs in many aspects in the literature, and in all cases, it is understood as a gradual change in time. This change is defined as progressive if in a sense it causes improvement. Such improvement could include the emergence of new properties (Lehman and Ramil, 2003). Many authors strongly consider improving and, at the same time, maintaining the application, system, or with regard to this article, internet maps. Riggs (1969) stated that improvements are generally defined as actions that maintain the functioning of systems and meet the needs of users. Lientz el al. (1978) found that usually improvement is seen as more important than the creation of new applications. They also noticed that users' requirements for improvements and extensions are the most important area of problems related to application management. It is worth noting that radical or fundamental changes are generally not considered as an evolutionary changes (Lehman and Ramil, 2003).

In this article the progressive evolution shall be understood as a change in the web application (of the website and mobile application) that occurred from the creation of Google Maps until 2018. Such changes were related to the process of perfection and adaptation to technical and technological novelties that were gradually introduced at that time. The expression can be adopted to the needs of cartography in terms of web maps. The changes, demonstrated on the example of Google Maps, applied to the following elements of cartographic design: graphic presentation of buttons; size and shape of buttons; the place where buttons were laid out; the observed changes in the functionality of the map service.

The research process included the analysis of the look of the map service on the monitors of personal computers and smartphone display screens in the following order: the history of technological solutions introduced, their relation to changes in map functioning, crucial changes in the layout, number and graphic presentation of buttons (Medynska-Gulij 2011). The analysis for PC monitors was conducted for the period of 13 years, between 2005 and 2018 (Figures 1–5), and that for smartphones was carried out for different versions of Android (4.1–8.0), iOS (12.1) and of the website. A synthetic depiction of changes in particular elements, demonstrated in the form of Table 1 (for PC monitors), as well as the indication of tendencies observed in progressive evolution and the anticipation of the direction of further changes, constitute the result of the research.

The purpose of this article was to refer to the definition of progressive evolution presented with the use of web maps which exist in informatics in the context of systems or applications for the needs of internet cartography. The author also wanted to notice the changes that have been observed on Google Map (as an example of a globally recognized web map).

2. Analysis

2.1. Google Maps as a website for desktop computers

At the turn of the centuries it was predicted that paper maps would be supplanted by digital maps, and cartographers, apart from programming maps, would have to pay more attention to the design of interface tools (Howard and MacEachren, 1996). Google Maps constitutes a perfect example of a functional web map with advanced interface tools, hence, tracking changes in the interface layout and graphic presentation of buttons, as well as solutions employed may become the invaluable source of knowledge for all cartographers – programmers.

Already in its BETA version Google Maps had several crucial functions: search, zoom, move and change layers. Initially, web maps were scrolled by means of arrows up, down, right, left. The button is presented in the top left corner of the map in Figure 1. The Zoom function had a form of a scrollbar and the selection of layers was divided between three separate buttons. The Search function was not a direct map button but the element of the website linked with the map.

The map itself did not occupy the entire available space in the search engine window. Soon after launching the first version the satellite view function and directions function were added. At the same time Google Maps reached mobile phones in USA and desktop computers in UK (as the first country in Europe). Launching API was a crucial decision for increasing popularity of Google Maps (McConchie, 2008; Roth and Ross, 2009; Peterson, 2012). API is a set of code libraries made available by its creators to provide other users the access to the opportunities offered by the application (Boulos, 2005, Medynska-Gulij, 2012; Muehlenhaus, 2014). API allows one to add the Google map with its full functionality to the selected website.
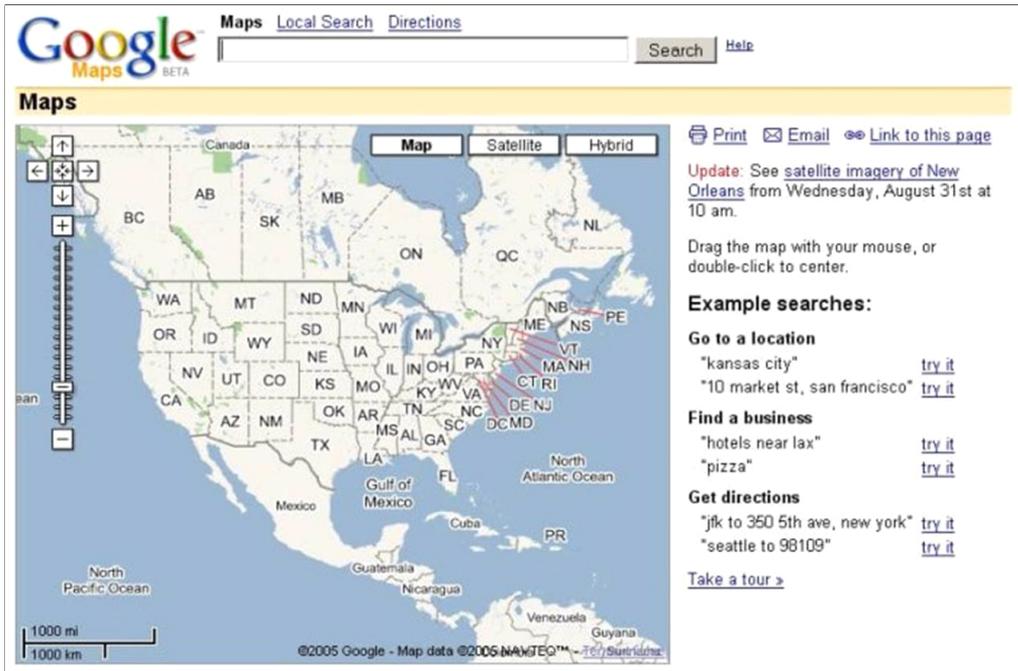
Fig. 1. Google Maps BETA in 2005 (website).
Source: https://www.eteknix.com/google-maps-10-years-old/.

The development of Google Maps could be observed already in 2006 when the button with the minimap function occurred in the bottom right corner. The function allows one to mark with a blue rectangle the area viewed at the moment on the map of the entire world (Figure 2 and Figure 3). Interestingly, the content of the map was initially located in the left part of the search engine window and was then moved to the right part.

Progressive evolution of Google Maps began in February 2007 when, along with the update, first facts about the intensity of traffic occurred (the Traffic button). Firstly, the information applied to over 30 cities in USA. A few months later, the Street View option was introduced for 5 cities in USA (New Jork, San Francisco, Las Vegas, Miami and Denver), initially functioning as a button in the same line as other layers. The map area was also enlarged and since then the map reached both the left and the right edge of the search engine window.

The year 2008 was, as the author maintains, the time of intensive promotion for Google Maps, as proven by the fact that the Street View function was then made available for the entire Tour de France route (the first Street View introduction in Europe). A month later, a few cities in Japan and Australia gained access to Street View. Moreover, the Google Map Maker option was introduced, allowing the users to directly update geographical databases and helping them to reflect the world by means of web map more accurately. Changes could be observed also in the design of buttons that scroll and zoom the map. Two now globally recognised b uttons-icons appeared, the first one being a but-
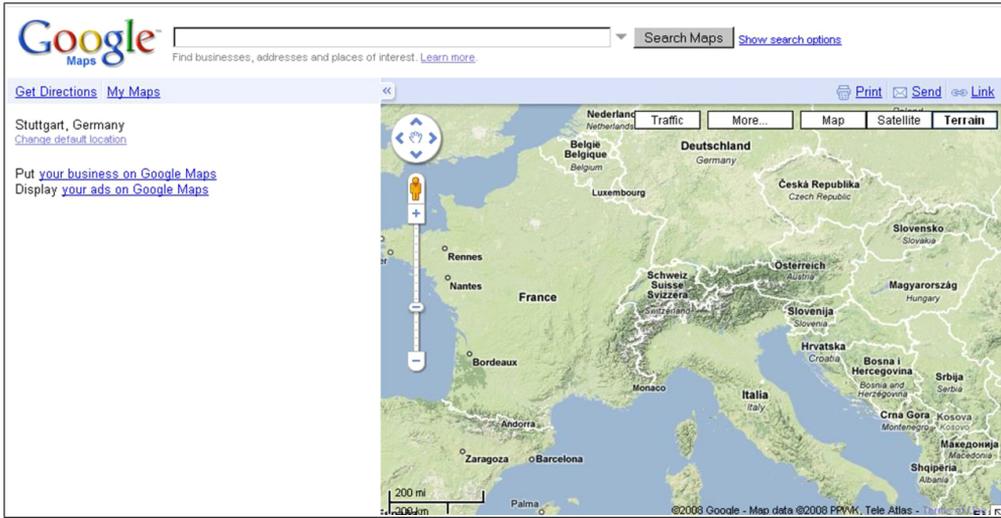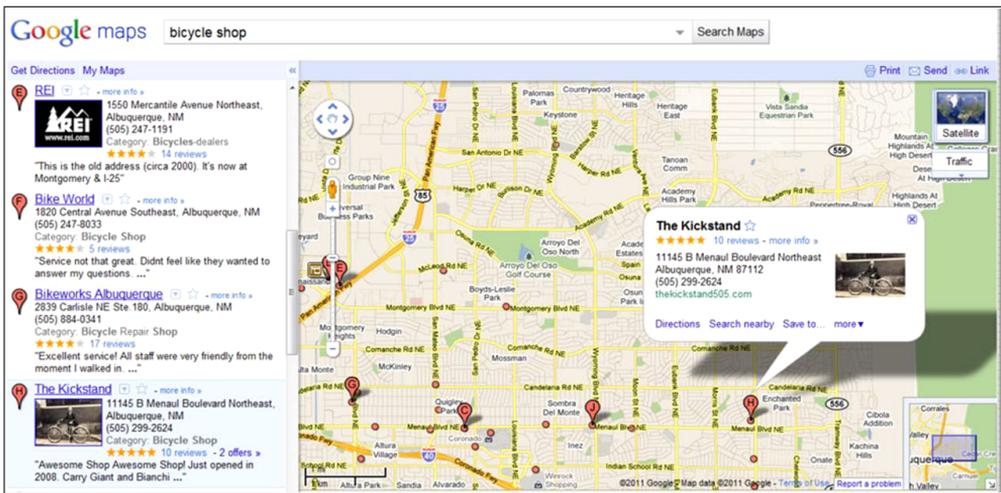
Fig. 2. Google Maps in 2008 (website).
Source: http://blogoscoped.com/archive/2008-11-25-n36.html.

Fig. 3. Google Maps in 2011 (website).
Source: https://www.treehugger.com/cars/google-maps-adds-feature-to-find-ev-charging-stations.html.

ton 🚶 that activates the Street View option, moved from the top right corner (button bar on which one can select a layer) to the top left corner, and the second one functioning as a characteristic button 🔄 that appeared in the centre of the button that scrolled the map (Fig. 2).

Adding that element allowed one to use the dragging option and scroll the map by means of left mouse button. A new layer, Terrain, replaced the former Hybrid layer, and the extra button, More, was added.

In 2010, the first piece of news about bike directions and bike trial appeared. Street View was available on all 7 continents. In 2011 changes in the presentation of buttons related to layers occurred, with 5 buttons being replaced by two. The first one, located in top right corner of the map, allows one to change base layer from base map to satellite view and the other way around. The other one, laid out directly under the first one, gave one the opportunity to use the additional layer, e.g. the information about the intensity of traffic (Traffic) without changing the base layer (Figure 3). In 2012, a characteristic button 🔍 replaced the Search Maps button in the box with the search option.

In 2013, another improvement of Google Maps was introduced. The Google logo has been reduced, the map area occupied the entire search engine window. Significant changes took place in button layout. Scrolling the map became the option handled by the mouse and programmers decide to remove the button previously used for that. The scrollbar that up to that time was used for zooming the map, was replaced by + and – buttons, located in the bottom right corner of the map, and the zoom function was taken over by the scroll wheel on the computer mouse. The base layer button, up to that moment located in the top right corner, was moved to the bottom left corner, and its former location was occupied by the Help & Feedback option. In the top left corner the search function was placed. Viewing 360° panoramic images from different parts of the globe was one of the extra functions added along with the aforementioned changes, represented by the button in the bottom right corner (Figure 4). The Street View option temporarily disappeared. That year, the Google Maps application was also rendered available to be downloaded for smartphones and tablets.
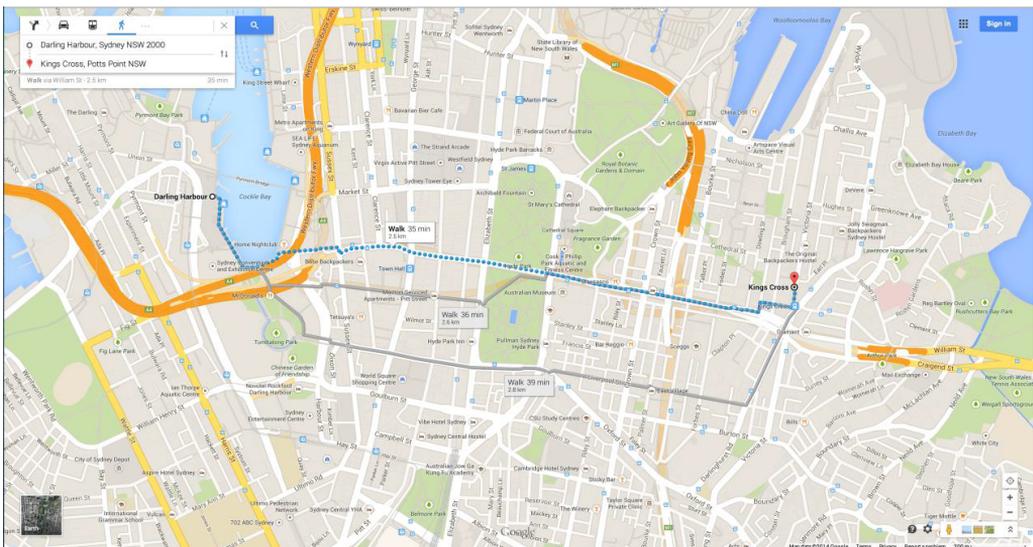

Fig. 4. Google Maps in 2014 (website). Source:
https://d33arxv7e4uhib.cloudfront.net/wp-content/uploads/2014/02/Screen-Shot-2014-02-20-at-12.58.16.png.

In 2014 the Street View option reappeared, being placed in the bottom right corner of the window. Geolocation, allowing one to find current location of a Google Maps user on the globe, was another new option, added over the zoom button (Fig. 4). Obviously, PCs do not have the GPS sensor built into them, hence, the measurement is approximate and narrowed down to the big city area or district. The Help & Feedback button was replaced by buttons allowing one to use other Google services and log in to the portal.

In 2016, the Directions button was introduced. That function had been available earlier as the interaction with the Search function. As the author maintains, the use of that function, when combined with geolocation, was likely to increase dramatically, thus, the programmers responsible for the Google Maps design decided to create a separate button. The Menu button appeared, including layers of the traffic intensity. Both buttons were located in the top left corner of the search engine, making the panel along with the Search function (Fig. 5).
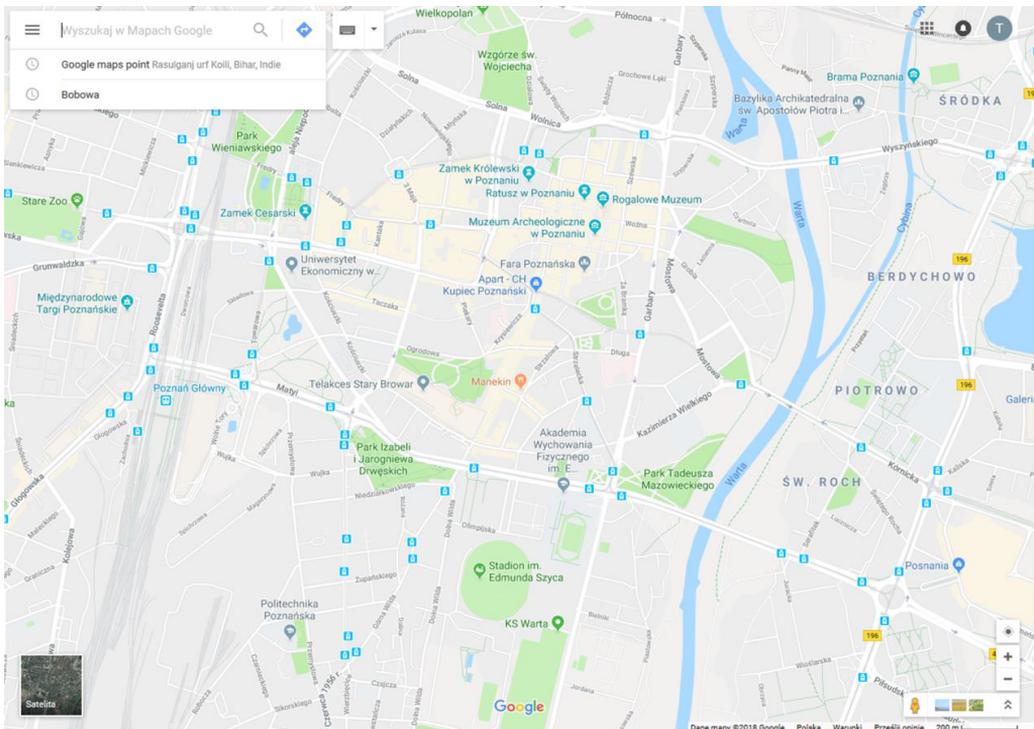

Fig. 5. Google Maps in 2018 (website)

In 2017 and 2018, the product was subject to constant improvement, with the opportunity to switch on the screen keyboard, the solution targeted at the holders of 2in1 laptops. While viewing satellite images, one can also use the compass function to rotate the view (the compass is north-oriented by default).

2.2. Google Maps on mobile phone

A few months after the debut of Google Maps for desktop computers the version for mobile phones was rendered available. From the archival pictures one may conclude that the application was simplified to the basic map version with the option of scrolling, zooming and place searching. The breakthrough took place in 2007, when the first Apple iPhone product with the touchscreen was launched. At that point, Google Maps had to face the pinch-zoom function, i.e. multi-touch gesture for enlarging and reducing the screen on the mobile phone. The first tailored application to be downloaded was released for iPhone 3G when it was launched. For many years the website was adapted to various mobile phones' operating systems: Android, Windows Mobile, BlackBerry or Symbian. Increasing efficiency of the equipment and widely available Internet on mobile devices resulted in Google Maps creating its own application. In mid-2013 Google Maps, as an application, was available to all smartphones and tablets with Android.

Progressive evolution of the Google Maps application can be observed for Android (Figure 6). Changes are visible for the button layout and their graphics. In the Android 4.1 version there was a characteristic top bar with Search, Directions and Log in options. In the bottom left corner there was the Menu function with the panel expanding on the left-hand side, and the Geolocation function located in the bottom right corner (Figure 6A).
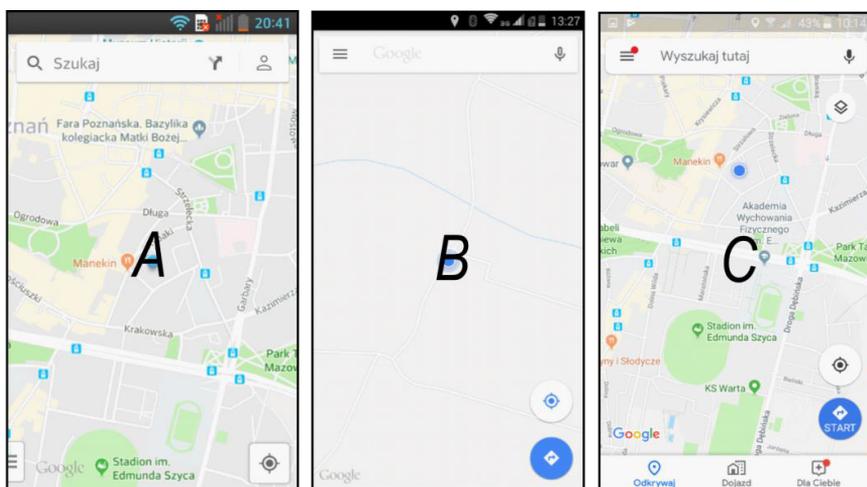

Fig. 6. Google Maps application on the system – A – Android 4.1 Jelly Bean (phone model – LG-E460); B – Android 4.4.2 KitKat (phone model – Goclever quqntum 2 500like); C – Android 5.1.1 Lollipop (phone model – Samsung Galaxy J3)

In the Android 4.2.2 version progressive evolution can be observed. The top bar gained the Menu function, previously located in the bottom left corner, and lost the Directions button, which became a separate button with a new symbol, located under Geolocation in the bottom right corner. The top bar received a function of voice search

represented by a microphone, and the button ^{Q} , as well as the Log in button disappeared. Logging in became the option required for using Google Maps. Individual buttons changed their shape from the square ones with rounded edges to circles (Figure 6B). The current view of the Google Maps application is available to Android 5.1. That version introduced a separate button for layer selection, the function that was previously available in the interaction with the Menu button. The bottom bar was also introduced on which one can save the everyday way to work or personalise their chosen area in terms of different events or locations.

At present, there are two versions of Google Maps, i.e. a mobile application and a website for desktop computers.T here are significant differences between those products, as well as between applications on different operating systems. The difference between iOS and Android consists in the different location of the Directions button, which in Android constitutes a separate button in the bottom right corner and in iOS it is a part of the top bar (Figures 7A and 7B). The website is not personalised (lack of the need to log in), thus, the bottom bar is different from the one in mobile applications. It has the option of layer selection (no separate button), or means of transport for selected route (the same fucntions are included in the menu located in the top bar). The voice search button was replaced by the symbol ^{Q} (Figure 7C). The Google logo, however, always located in the bottom left corner of the smartphone screen, constitutes the invariable element of different versions of Android, iOS or the website.
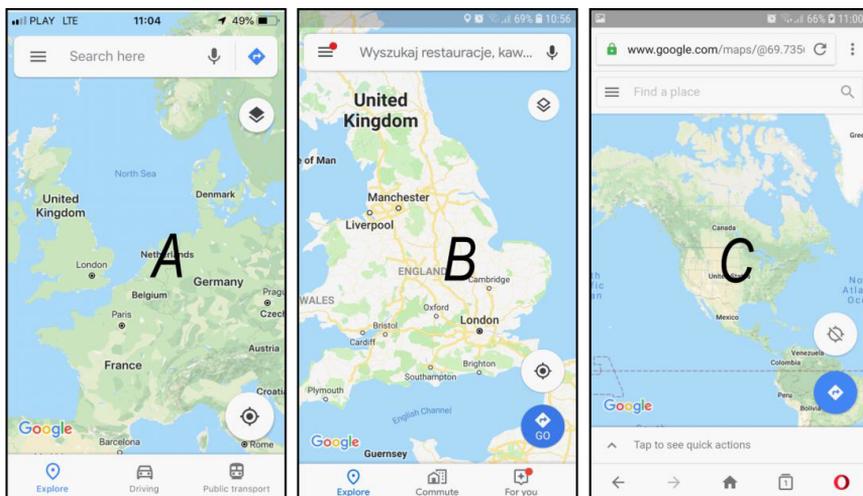

Fig. 7. Google Maps application on the system – A – iOS 12.1 (phone model – iPhone SE);
B – Android 8 Oreo; and C – website (phone model – Samsung Galaxy S7)

3. The synthesis of changes in Google Maps on desktop computers and smartphones

On the basis of the synthetic juxtaposition in Table 1 one can easily follow any changes in the number, layout and functions of buttons. A significant change in the functionality of Google Maps over 13 years becomes immediately evident. Aside from the changes im-

posed on by the technological advancement, new updates of operating systems on desktop computers and of search engines, or changes in HTML, CSS or programming languages (e.g. JavaScript) standards, Google Maps decided to implement its own changes, with locating Log in buttons in the main layout of the website as the most crucial one. It is definitely the user-oriented move, made to render the use of Google Maps as non-anonymous as possible.

Placing the login button in the main startup window draws higher attention of public user to this function. Just logging into the service is significant because it allows one to personalize Google Maps services towards a public user by minimizing anonymity. It is an important change that is being improved in subsequent years.

Moreover, one can witness the increase in the number of buttons available in the main website layout, which may result from the increase in basic resolution and the size of desktop computer monitors. The comparison of the 2005 and 2018 version of Google Maps proves that the change in the button design is also significant. Initially, buttons had names of their functions, currently names are visible only as tooltips and functions are represented as symbols. That innovation takes advantage of the intuitiveness of users.

Of course, in Table 1 only changes in the Google Maps start view are shown. The author realizes that some functions have disappeared from the service for good, such as

Table 1. The change in the number and layout of buttons in Google Maps 2005–2018
(LT – left top, RT – right top, LB – left bottom, RB – right bottom)

Computer														
Button with function	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Drag	LT	LT	LT	LT	LT	LT	LT	LT	–	–	–	–	–	–
Zoom	LT	LT	LT	LT	LT	LT	LT	LT	RB	RB	RB	RB	RB	RB
Scale	LB	LB	LB	LB	LB	LB	LB	LB	RB	RB	RB	RB	RB	RB
Minimap	–	RB	RB	RB	RB	RB	RB	RB	–	–	–	–	–	–
Geolocation	–	–	–	–	–	LT	LT	LT	–	RB	RB	RB	RB	RB
Search	–	–	–	–	–	–	–	–	LT	LT	LT	LT	LT	LT
Sign in	–	–	–	–	–	–	–	–	–	RT	RT	RT	RT	RT
Google Application	–	–	–	–	–	–	–	–	–	RT	RT	RT	RT	RT
Photos	–	–	–	–	–	–	–	–	RB	RB	RB	RB	RB	RB
Menu	–	–	–	–	–	–	–	–	–	–	–	LT	LT	LT
Share	–	–	–	–	–	–	–	–	–	–	–	RT	RT	RT
Keyboard	–	–	–	–	–	–	–	–	–	–	–	–	–	LT
Street View	–	–	RT	LT	LT	LT	LT	LT	–	RB	RB	RB	RB	RB
Change Layers — Map	RT	RT	RT	RT	RT	RT	RT	RT	LB	LB	LB	LB	LB	LB
Change Layers — Satellite	RT	RT	RT	RT	RT	RT								
Change Layers — Hybrid	RT	RT	RT	–	–	–	–	–	–	–	–	–	–	–
Change Layers — Traffic	–	–	RT	RT	RT	RT	RT	RT	–	–	–	–	–	–
Change Layers — Terrain	–	–	–	RT	RT	RT	–	–	–	–	–	–	–	–
Change Layers — More…	–	–	–	RT	RT	RT	–	–	–	–	–	–	–	–

Drag, and some have been included as the second level interaction with the option of selecting them in the Menu function, such as the Terrain layer. According to the author, the most important element of the web map is the startup interface, because it tells us which map functions are crucial. Therefore, the analysis focused only on these elements.

As far as smartphones are concerned, the cases analysed for Android, iOS and the website demonstrated the complexity of changes introduced. Interestingly, the Android system on smartphones does not update to the latest version when it is launched, e.g. the purchase of a smartphone with Android 4.1 allows for updates to 4.1.2 version maximum, without any interference with the software. It is convenient, as the new version of the system is launched along with the most recent version of the device, developing not only the software but also the application, regardless of the owners of older and poorer mobile phones. That fact is used also by Google Maps, which introduces progressive improvements for apps only for the most recent Android versions (Figures 6 and 7). On the other hand, the iOS system is updated for all iPhones with this system, which may be problematic when introducing more substantial changes in Google Maps, as older iPhone versions are technically weaker.

4. Conclusion

Thanks to the analysis, the author came to several conclusions due to changes that have occurred in Google Maps over 13 years. The first important change is to increase the intuitiveness of the site. The transition from buttons with subtitles to their pictorial representations is an example of these changes. Of course, there is a tooltip function, which still describes the functionality of buttons, but it only appears through desktop computer monitors or laptops. In the case of mobile maps Google Maps is presented as a website or an application, and relies solely on the intuitiveness of users. Another change is the transition to full-screen view, which in combination with the increase of the screen resolution, as well as the increase in the size of monitors and mobile phones displays increase the number of buttons in the home screen which should be noticed at first place by users (like button with login function). Of course, Google Maps also decided to remove arrows or pan button responsible for spatial navigation. This is related to global changes in functionality, such as the introduction of the first iPhone, and thus the dragging function. Google Maps is also a pioneer in implementing custom solutions not available on other websites, such as Street View. Google Map service is also aware of the worldwide recognition of their maps, so they decided to reduce their logo.

5. Summary

To sum up, all the discussed changes in Google Maps as an application for desktop computers and laptops, as well as a mobile application, prove that the product has been constantly improved. In the author's opinion, the crucial aspect is to enrich the web map in the non-invasive way to make it as user-friendly and easy to use as possible.

Currently, the development of cartography and the popularisation of web maps allowed one to extend the group of users and resulted in their lower experience (Reichenbacher, 2001; Fabrikant et al., 2008). Following that trend, when the disproportion in users' experience is large, one needs to focus more on usefulness and usability, and the changes introduced should be supported by the usability evaluation (Koua et al., 2006; Nivala et al., 2008; Haklay and Zafiri, 2008; Wang, 2014). Testing one product in a few solutions may help one highlight its advantages and disadvantages (Bojko, 2006), and, more importantly, work out certain schemes for further projects. At present, eye tracking, i.e. the analysis of eye movement, constitutes one the best, most reliable results measuring the effectiveness and usefulness of a cartographic product (e.g. a web map) (Byrne et al., 1999; Goldberg and Kotval, 1999; Cowen, 2001; Gitelman, 2002; Coltekin et al., 2009; Alacam and Dalci, 2009; Li et al., 2010; Popelka et al., 2012; Burian et al., 2018). The use of appropriate equipment allows one to achieve highly accurate results and gradually improve web maps, as well as set guidelines on design. According to Rohrer (2018), tracking eye movements is considered a behavioural (objective) method, as it demonstrated "what people do" instead of "what people think". As far as quality and quantity are concerned, tracking eye movement lies in between, which means that recorded data may be analysed both in terms of quality and quantity. Gradual changes in Google Maps and other web maps are going to continue. It is important to always take into consideration the needs of the user. On the basis of the analysis and synthesis carried out one could set trends in future changes. As the author maintains, in years to come applications are going to be even more personalised due to machine learning. The cooperation with other global and popular applications may be established. Moreover, a version of Google Maps for Windows Mobile systems may be created. The author realizes that the description of changes on the basis of photos, web pages and available literature does not exhaust the topic in the context of the description of the evolution of the functionality of Google Maps. The author notes, however, that this problem is a good example of the continuation of the research in the following years with a strong emphasis on the functionality of the website and its assessment by public users.

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