

Pros and Cons of Tangible and Digital Wireframes

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***Abstract*—This innovative practice is a work in progress that analyzes how a tangible wireframe can be more effective for team communication than a digital wireframe at specific development stages through design activities and processes. It has been found that tangible wireframes are easy to work with and can provide a clearer view of a product's design. To validate this finding, the research focused on the effectiveness of communication through three main aspects of the wireframe: Design, Features, and Layout. These aspects indicate functionality and aesthetic of the website design. The additional outcome implies pros and cons of both tangible and digital wireframes. Research information has been analyzed from data collection of classes activity recorded at an IT faculty. The results showed team communication through wireframe creation depends upon the user experience of team members, understanding of goals, and ability to select tools for digital or tangible wireframe suitable for the design stage. Therefore, this research can guide an instructor of web development by choosing the right tools and techniques appropriate for learners—those without and with experience. It is counted as contributions to the computing educational field.**

***Keywords*—Wireframe, Tangible wireframe, Digital wireframe, website design**

I. INTRODUCTION

This research focuses on how effective communication in creating a tangible wireframe contrasts with a digital wireframe and the benefits of wireframes. Given that a digital wireframe is dependent on a computer application or software to develop a wireframe, a tangible one is composed of easy to use material objects [11]. A tangible wireframe can be effective in the computing educational field by bringing out the soft skills (interpersonal skills) of students and how students utilize these skills in an advanced design class with a digital wireframe [1]. Students in a technological course developing applications and websites can range from beginners to experienced users [4]. Thus, the importance of this research on wireframes creation cannot only impact education but also impact on related staff in industry [2]. Since tangible

wireframes were introduced and found to be useful for designing websites, this research uses a variety of design aspects and observations to determine their effectiveness to gain full understanding of how a tangible wireframe performs in contrast to a digital wireframe [6].

In computer education, both technical and soft skills of students are important in any learning environment [3]. The way to increase critical thinking, creativity, and new ideas are from feedback and discussion within a group. Since 2017, teaching students of different backgrounds in web design can start with a simple wireframe as a basic platform before continuing with advanced design with digital tools or software. To research the right wireframe for the right group, this research, therefore, consists of 5 sections including 1) this introduction, 2) literature review, 3) research design, 4) research experiment and results 5) conclusions and future research.

II. LITERATURE REVIEW

A. The Importance of Website Design with Wireframes

All apps and websites need to be arranged to best accomplish a particular, predetermined task and purpose. Layouts of the websites designed and their effectiveness were analyzed with supported reasons [14]. All aspects (design, features, layout) can indicate level of effectiveness to achieve tasks by evaluating its functionality along with components [15]. Website design relies on tools that could be tangible or digital tools. The design process is challenging. At the early wireframing design stage, however, simple prototyping techniques to express an idea can save time and expense [3]. There are choices for website wireframes both digital and tangible. Most website designers use free software to come up with a draft before developing a final mock up. Basic wireframing such as a tangible wireframe, allows for expressing the design concept and its efficiency without a significant time investment during the process for brainstorming, analyzing, developing, and evaluating the final product [5]. In addition, it can combine high-level structural work, such as flow charts and screen design, to connect the underlying conceptual structure (the information architecture) at the back-end to the design front-end (the user interface) [7]. Lastly, layouts of the websites designed, how and why

things are arranged and their effectiveness was analyzed with supported reasons [14]. These three components can prove how effective the website had been designed to achieve its task by proving its functionality, features and components [15].

B. Background of Tangible Wireframe

A tangible wireframe represents a page schematic or blueprint. It turns abstract ideas into something tangible without extreme carefulness and precision [1]. Tangible objects on a wireframe are deemed to be useful in group work and communications. The advantages are faster than doing it digitally; team can manage and spread out their workflow rapidly; team can test the effectiveness of their methods; and it forces group discussion [8].

Tangible wireframes utilize an unplugged situation, which means no digital media is needed for the situation, and all members of the team can fully focus on the objects in front of them. This allows group communications to be effective: the exchange of ideas with one common goal to achieve [9]. Beginners without skills such as those who have had no experience with designing websites can also share ideas in the project whereas people with experience can let their leadership shine in managing a team to accomplish the task as well as making sure to get the key points across [4]. The main limitation is not being able to expand and push the limits outside the box of a pre-given set of component objects [5].

C. Description of Digital Wireframe

Currently, the popular wireframe that is widely used is a digital wireframe. It allows mock-ups done digitally via a device as a computer, tablet, or mobile. The Interaction Design Foundation suggested a number of free (open-source) wireframe tools such as Frame Box, Jumpchart, Wirefy, Axure, and MockFlow [21]. There are also cost-based free tools for students in educational institutions as Adobe XD and Mockplus (30-day free trial version). Digital wireframes allow for high fidelity providing an interactivity of design to test features. Hartson and Pyla [22] stated that interaction wireframes are best generated with a software tool (such as Sketch). Furthermore, digital wireframes are not limited to the pre-given functions as users can expand and customize what they would like to display [8]. Digital wireframes provide multiple items and a variety of designs but will come with pre-requisites such as needing prior experience when working with wireframes or designs to build a prototype. Its advantages are providing an interactive environment; can be tested on a real device; user can create functions outside the box [16]; adaptive to technology [19]; and builds technology aids such as Machine Learning [20].

III. RESEARCH DESIGN

A. Data Collection

Data collection was gathered from two different class activities in two undergrad classes at the IT faculty. The common ground of both classes is that they are a required

class, with a style of hybrid 2 hours lecture and 1-2 hours lab or class activity, and the activity's goal is to design a website for a restaurant. The main part of the class activity is for learning to use web design tools. The difference is a tool for designing a website is either a tangible or digital wireframe. Freshmen use a tangible wireframe or a Wireframe Toolkit (a provided teaching and learning material available at IT faculty internally). Wireframe Toolkit is a set of hands-on tangible wireframe objects (40 – 50 pieces) made by using a black and clear acrylic sheets to cut out a limited number of geometric forms as rectangles, squares, circles and triangles in different sizes to be arranged on the sized acrylic background sheet. Juniors use a digital wireframe or a design website prototype software such as Mockplus or Adobe XD that is available free for students at this educational institution.

B. Two User Groups

First group, the “Beginner” group, are freshmen students just starting their first semester. They are 13 high school graduates in science or arts. The majority of 8 students have no prior knowledge meaning they never had experience dealing with wireframes and web designing. The remaining 5 students had slight experience but limited knowledge of basic design components from using the template of a web-authoring tool.

Second group, the “Experienced User” are junior students at the third year undergrad level. There were about 160 students who learned at least 15 courses related to IT. The courses were software engineering, software development programs, system architecture, programming languages, database, and web design tools, which were offered during their previous 2 years. They have skill sets in technology, web and multimedia, and web technology. They are starting to apply IT knowledge to a case study.

C. Two Courses Background

The freshmen's class uses basic tools for teaching IT since the students are new to the field and the study program. They are at the beginning stage to build their IT fundamental knowledge along with team collaboration and soft skills. The appropriate teaching tool is important to support these students to learn and increase their ability in website design. The course description on the school's website states “...basic concepts for programming; database technology; data communication; computer network systems and the Internet; ethical and social issues in information technology” [23]. Students are to build basic knowledge and explore a variety of hardware, software, and media. They are expected to understand the big picture of IT as a whole including website design concepts. This class is a 4 hours class meeting weekly with 2 sessions. The lecture session is 2 hours in the classroom and the other 2 hours is in the computer lab or project-based lab for workshops and group activity. This class emphasizes hands-on with actual machines or devices such as reassembly hardware, installing OS, and designing a website from idea to concept for basic understanding. Students need engagement and are provided clear step-by-

step guidance from their instructor. The average class size is small between 7 – 15 students as it is an IT curriculum for an international program taught in English. An average of 3-5 students participate in each group activity.

The junior class is a higher level course that uses advanced tools for teaching and learning. In regard to course description, this selected class addresses “...user interface design process; design tools; design principles and guidelines...” [24]. The class meets weekly divided into 2 parts: 2 hours lecture and 1 – 1.5 hours class activity. The instructor introduces available software and demonstrates examples. Later, students can work on class activity and homework by trying other extra tools in which they are interested. The application tool enables them to get work done or accomplish goals with the help of a teaching assistant. Number of students is about 100 – 180 students as it is the ordinary Thai language IT program. Some small group activities average 3-5 students per group.

IV. RESEARCH PRELIMINARY EXPERIMENT AND RESULTS

In this study, the research experiment involved two class activities and results: 1) Tangible Wireframe Activity of freshman class, 2) Digital Wireframe Activity of junior class and 3) Experiments Results. Both the research preliminary experiment and result of selected class and user groups aims toward the same design goal of using a wireframe that brings ideas to concept before building the website. The assigned activity is to design a wireframe that is able to show functionality and aesthetics for a restaurant website by using the assigned wireframe tool.

A. Tangible Wireframe in Class Activity

This activity is in the freshmen class. The design of the activity was to separate this beginners group into two groups that will include 5-7 members: Group 1 has no experience with wireframes. Group 2 has slightly more experience. Both are considered Beginner users. Each group will receive a set of a Wireframe Toolkit shown in Figure 1. Then, the captured video footage pre-recorded as a classroom activity was studied to analyze both groups.



Fig. 1: A Wireframe Toolkit

The plan for this class activity involves designing a restaurant website. The students have 2 hours of lab after a lecture of 2 hours on the basic structure, components and design process of a website. During the first hour of the lab session the instructor showed examples of website design, introduced the Wireframe Toolkit and explained website requirements (banner, search function, images, content, social media). The following hour students started using a

tangible wireframe for half an hour and at the end of the class 30 minutes reserved for their group presentation and critique of their ideas. During designing the website with objects, an actual 15-minutes was spent with designing the website to match the goal and requirements. They started discussing, planning, and brainstorming together with available objects in each set. The study of two groups on a tangible wireframe is shown in Figure 2 including the before and after design process during the planning phase and the finished product.



(a) Planning Process

(b) Completed Design

Fig. 2: (a) Using tangible wireframes during the planning process by group 2; (b) the completed design with tangible wireframe by group 1.

As shown to the left in Figure 2 (a), the process of tangible wireframes creation provides a participatory experience to the group members. This planning process allows a flow of ideas and the trial and error the group goes through to achieve finishing the task in 12 minutes.

As shown to the right in Figure 2 (b), this is the completed look of the wireframe after their finish of discussion and exchange of ideas. The tangible wireframe illustrates the completed product of the final design to be implemented on the web. The two parts of Figure 2 illustrate that tangible wireframes can spark a group discussion and create an effective design meeting the required goal.

B. Digital Wireframe in Class Activity

For a Digital Wireframe, the experiment conducted with junior students counted as an experienced users group. They are assigned to work on a design website with either Adobe XD or Mockplus wireframe tools. At this study level, a group of students often work on high fidelity wireframes where they can build prototypes that interact with users to test functionality and concept. An instructor gives a lecture of UI elements and prototype tools, and walks through the Mockplus application with some design examples. Students follow the exercise to create a simple wireframe with basic components. This is followed by an hour or 90 minutes to work on the wireframe for the restaurant website. Students are in a team of 5 members working in the computer lab for creating a wireframe with functionality on mobile devices that have requirements given by the instructor. Since they have design skills and are familiar with design tools, they split the work into 2 main tasks: technical task and research information task. The technical members started using a digital wireframe from Mockplus on basic components of a website as shown in Figure 3 (a). While others worked searching for

related items: picture, icon, button, image, info for the website, the group worked well independently yet there was not much conversation among them. They only spoke together when they needed a confirmation or clarification on the wireframe by their group.

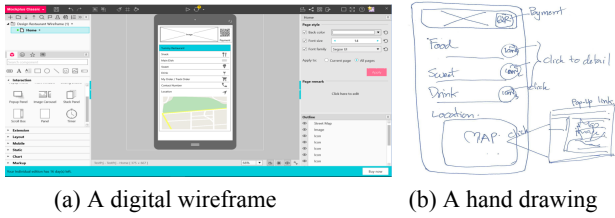


Fig. 3: (a) A digital wireframe example by using Mockplus; (b) A hand drawing of a digital wireframe.

The digital wireframe they created required components able to be tested by a user. It offered interaction as if an actual working application of the restaurant website. It has an image, button, icon, and links for menu, location, and food order in the prototype. Students took about 40 minutes to plan function and appearance through trial and error while working in parallel with other team members researching the information a general restaurant website requires.

C. Experiment Results

The tangible wireframe experiment illustrates beginner users without prior knowledge and experience tend to interact well with the tangible wireframe in showing a flow of ideas through the process resulting in an effective end product of a finished design within 11 minutes. The other beginner group with slight experience showed a need for adjustment to engage in communication. However, after adjustment the group did complete a simple yet effective design. The process took a little longer: 13 minutes for completion. A Figure 2 (b) shows the design of the restaurant wireframe with basic components of functionality (button, icon, text area, search bar, contact), and the layout and components are clear and the aesthetics understandable. The presentation of the wireframe took about 10 minutes, and it captured the audience's understanding. They utilized team collaboration by helping each other from brainstorming ideas to visual concepts of each object. While limited to objects in a Wireframe Toolkit, the activity stimulated them to engage in discussion and make decisions together to decide what to do with the limited resources. This involves how usable a website functions and how relevant it is to the task [2].

The digital wireframe group result spent 40 minutes while using Mockplus on the computer. This group of 5 junior year students are experienced users. They took 15 minutes discussing ideas. They started their layout ideas basically on a sheet of paper shown in Figure 3 (b) drawing components with words indicating functions for interaction by a user. They gave each component a name and action (if applicable). Another observation is that the team discussed their hand drawing together before starting with Mockplus. They represented ideas and made decisions on this drawing

talking with team members. After everyone agreed, they split the work into 2 subgroups.

The last observation is that while each member worked on their own, some might refer to Figure 3 (b) to double check the design when using Mockplus. This happened back and forth between designers in referring to the hand drawing. In effect the conversation and creative thinking of ideas that resulted came to illustrate the draft drawing as a guide for collaborative teamwork.

V. CONCLUSIONS AND FUTURE RESEARCH

A. Conclusions

Tangible wireframes have demonstrated a tendency to be effectively used by a freshmen student group with no prior experience. They did easily bring team collaboration to work together as a group and to create a product that achieved the goal. Tangible wireframe supported the flow of ideas and communication throughout the project. There was an exchange of ideas, engagement, and immediate feedback among all group members throughout the process to achieve tasks in the most efficient way. In contrast the junior year team split into two groups to work with a digital wireframe. However, tangible wireframes are limited by their out of the box features. On the other hand, the cons of digital wireframes with regard to soft skills and group work makes a less engaging group experience as well as requiring prior wireframing knowledge and application usage [10].

TABLE I. A COMPARISON PROS AND CONS BETWEEN TANGIBLE AND DIGITAL WIREFRAMES

Wireframe	Pros	Cons
Tangible	<ul style="list-style-type: none"> -Suitable for beginner design user -Increasing soft skills -Spend less time -Low learning curve, no need prior skill 	<ul style="list-style-type: none"> -Limited items for design components -Suitable for Basic design website -Not flexible for experienced user
Digital	<ul style="list-style-type: none"> - Suitable for Advanced design user or experienced user -Availability of flexible design items -Suitable for complex functionality and detail 	<ul style="list-style-type: none"> -High learning curve -Need prior knowledge/skill for tools -Spent more time -High cost compared to Tangible wireframe

B. Future Research

In the future this research is aimed to collect more data and test different types of tangible and digital wireframes. Subjects will be changed and mixed with both experienced and inexperienced to test how well group communication occurs and how well the end product performs. There will also be testing of important factors founded from research on different users with experience or no experience in the dimensions and size of the group/team. Another extension will be comparison of tangible and digital with criteria factors on the time spent, components and designs that meet the quality standards of website development.

REFERENCES

- [1] A. Karr, "Wireframes Defined," (2014), [ACM, Online]. Available: <https://interactions.acm.org/blog/view/wireframes-defined>
- [2] Y. Huang, C. Wang, J. Hsu, "Leveraging The crowd for creating wireframe-based exploration of mobile design pattern gallery," (2012), [ACM,Online]. Available: <https://dl.acm.org/doi/abs/10.1145/2451176.2451182?download=tru>
- [3] M. Hamm, "Wireframing Essentials," (2014), [Online]. Available:<http://www.nicolasespinoza.cl/wp-content/uploads/2018/04/Matthew-J.-Hamm-Wireframing-Essentials.-An-introduction-to-user-experience-design-2014.pdf>
- [4] L. Lamar, "Introduction to a user interface design/information architecture process for web sites," (2001), [IEEE, Online]. Available: <https://ieeexplore.ieee.org/document/971564>
- [5] S. Oliphant, "App Design Wireframe Workbook: grids and guides for designing your phone or tablet app," (2016), [ACM, Online]. Available: <https://dl.acm.org/doi/book/10.5555/3074043>
- [6] Y. Lai, Y. Liu, Y. Zang, S. Hu, "Fairing wireframes in industrial surface design," (2008), [IEEE, Online]. Available: <https://ieeexplore.ieee.org/document/4547943>
- [7] J. Li, J. Yang, J. Zhang, "LayoutGan: Synthesizing Graphic Layouts with Vector-Wireframe Adversarial Networks." (2019), [IEEE, Online]. Available: <https://ieeexplore.ieee.org/document/8948239>
- [8] E. Malone, "The Pros and Cons of Wireframing in a Website Redesign," (2017), [Online]. Available: <https://www.growthdrivendesign.com/blog/the-pros-and-cons-of-wireframing-in-a-website-redesign>
- [9] Graphicintuitions, "Wireframing - Pros & Cons + Why?," (2019), [Online]. Available: <https://www.graphicintuitions.com/blog/discover-the-hidden-gems-within-mockups/>
- [10] H. Armstrong, "The Pros and Cons of wireframing on Paper," (2019), [Online]. Available: <https://teamtreehouse.com/library/the-pros-and-cons-of-wireframing-on-paper>
- [11] J. Hannah, "What's The Difference Between A Wireframe, A Prototype, And A Mockup?," (2019), [Online]. Available: <https://careerfoundry.com/en/blog/ux-design/difference-between-wireframes-prototypes-mockups/>
- [12] T. Lazarova, "Low Fidelity Wireframes vs High Fidelity Wireframes," (2018), [Online]. Available: <https://mentormate.com/blog/low-fidelity-wireframes-vs-high-fidelity-wireframes/>
- [13] J. Dougherty, *Claims Disputes and Litigation Involving BIM*, (2015), UK: Routledge [Print]. Available: UTS ePress
- [14] C. Leuva, "Pros & Cons of High-Fidelity Wireframes," (2016), [Online]. Available: <https://www.websitemagazine.com/blog/pros-amp-cons-of-high-fidelity-wireframes>
- [15] Justinmind, 5 pros & cons of the UI mockup in web design, (2016), [Online]. Available: <https://blog.prototypr.io/5-pros-cons-of-the-ui-mockup-in-web-design-da953db7271e>
- [16] Axure, Axure RP 9, (2020), [Online]. Available: <https://www.axure.com/>
- [17] Adobe, Adobe XD, (2020), [Online]. Available: <https://www.adobe.com/sea/creativecloud/ui-ux.html>
- [18] Canva, Canva (2020), [Online]. Available: <https://www.canva.com/>
- [19] O. Ramon, J. Molina, J. Cuadrado, J. Vanderdonckt, "GUI Generation from Wireframes," (2013), [Article]. Available: https://www.researchgate.net/publication/270159107_GUI_Generation_from_Wireframes
- [20] Q. Yang, J. Zimmerman, A. Steinfeld, A. Tomasic "Planning Adaptive Mobile Experiences When Wireframing." (2016), [Article]. Available: https://www.researchgate.net/publication/302352981_Planning_Adaptive_Mobile_Experiences_When_Wireframing
- [21] Interaction Design Foundation "9 Free to Use Wireframing Tools" Available: <https://www.interaction-design.org/literature/article/10-free-to-use-wireframing-tools>
- [22] R. Hartson and P. Pyla, *The UX Book Agile UX design for a quality user experience*, 2nd ed. Reading, MK: Morgan Kaufmann 2018 [E-book] Available: ScienceDirect e-book.
- [23] "Faculty of Information Technology," Accessed on: May. 29, 2020. [Online]. Available: <https://www.it.kmitl.ac.th/subjects/6036001/>
- [24] "Faculty of Information Technology,"Accessed on: May. 29, 2020. [Online]. Available <https://www.it.kmitl.ac.th/subjects/6016310-human-interface-design>