

# Creativity Support for Mock-up Design

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## ABSTRACT

*This paper presents an evaluation of creativity support cues in a mock-up generator for designing a module-based mobile application to help spark ideas during the design process. After an initial test with four types of creativity cues (Sparks) potential for assistance was discovered in all four types (hand-holding, informative, bad example, challenging) between participants with various amount of design competences and experience. The mock-up generator, developed with Vue.js, consists of a version with and without creativity support was evaluated. The prototype was based on Visiolink's (digital publishing company) approach to module-based releases, and was expanded with the aforementioned Creativity Sparks for the comparative evaluation. The feedback from the participants showed the version created with Sparks was preferred both in terms of usability of the system and the final design, with a significant difference found in the Hedonic qualities. Most of the participants reported the Sparks having an impact on their design decisions and big-picture planning of the mock-up creation.*

## KEYWORDS

Creative Sparks, Creativity Support, Design for Media houses, Mock-up Creation, Support during the design process, Comparison test, Thematic Evaluation.

## 1 INTRODUCTION

During development, prototypes are essential for multiple reasons - they can provide customers with visual feedback along with tangible interaction and can also be used as a discussion point should there be misunderstandings regarding the design or functionality. They also provide a visual common ground between the customer, project management and developer. Making changes to the prototype instead of the final solution increases the efficiency of the project, since less iterations will be needed when implementing the final design. By prototyping, the process of design becomes more time-efficient and less resources are spent for reaching a desired result.

In a study by Elveruma and Weloa [8] it was discovered that prototypes play an important role in various stages of development. The benefits of prototypes allows a team to explore concepts, reduce technical uncertainties and provide characteristics about the product requirements. In Human-Computer Interaction (HCI), prototyping is often used in the early phases of a project to explore possibilities, determine requirements and, through iterations, progress the development. Since the prototyping phase has a big influence and the potential to improve the whole pipe-line of a project, it is worth identifying how the process could be further improved.

A digital publishing company called Visiolink [20] became a point of interest for the project, since they develop customer solutions in form of apps with customisation tailored to each individual customers. These kind of processes can become more efficient by introducing prototypes to showcase design choices and functionality. Visiolink develop "News Modules" solutions [19], which allows the media house customers to customise their application with certain modules that display their content (e.g. narrated articles or podcast modules). Since the development of Visiolink solutions might take several months, a tool to reflect the customers' design choices before starting development would optimise the workflow.

In order to optimise the prototype phase in a project, assistance and guidance tools can be used. An example of such tool could be seen in *Clippit - the Office Assistant* introduced in Microsoft Office (1996) [22], whose goal was to assist the user of Office products by guiding their work and prompting suggestions or hyperlinks on the screen. Clippit was met with a mixed set of responses - some deeming it annoying and counter-productive, while others finding it helpful at guiding their work. It is not unusual to get stuck while carrying out a task, which can result in frustration and decrease in quality of the end product - this issue can be addressed by the assistance tools.

The aim of our research would be to distinguish the different approaches to assistance in prototyping, evaluate their quality and effectiveness and suggest the most optimal solution for designers of any level of expertise. Since we are pursuing a design-oriented research (due to our interest in Visiolink's solutions), the assistance cues would be investigated in the area of prototyping for a User Interface (UI) design workflow. The following hypothesis was formulated in order to help us determine the approach to the project:

*"Assistance cues will have a beneficial influence on the design phase and the quality of the end result of a mock-up creation tool for a UI product."*

With the hypothesis formulated, the next steps were to research related work and state of the art solutions in the area of prototypes and assistance/guidance tools, in order to gain a better understanding on the principles and applications in the field of design.

## 2 BACKGROUND

To gain a better understanding of the intent, design and implementation of assistance cues, and to understand the prototyping process, the following background research was done.

### 2.1 Related Work

In a paper by Lockerbie and Maiden [12], they developed a "Bright Sparks" implementation, which is based on supporting design thinking and creative problem solving. Their solution implements *Sparks*, which are questions to evoke creative thinking - it puts the reader

in a different context of thinking and planning by the use of abstract scenarios and fictional or real-life personas. This way the Sparks aim to shift the thinking process into a perspective that makes use of strong qualities and traits of said persona (e.g. James Bond - ability to solve problems under stress) and apply it to the context of the task at hand. This approach expects creative thinking from the user in order to apply the abstract thought into tangible solutions to problems - to Spark creativity, thus the name "Sparks". Results from the study show that their implementation provided evidence of effectiveness in regards to creative thinking.

Giving users creative support in both a health-care and news journalist context has been explored by Maiden et. al. [14] [13]. In their works they discovered that creativity support is used to resolve risks at a manufacturing plant in a risk management process, and that it can be used to help journalist find new angles on news stories. Both studies include creative support for different target groups and the results revealed the implementation to be more effective when compared to the original techniques used without the creativity support.

In a study by Frich et. al. [10] they compared different creativity support tools (CST) used in HCI. CST can be defined as tools used to help users to make creative discoveries [11]. They grouped trends and tendencies into categories such as *creative processes* and *target group* among others. Within the investigation it was discovered that idea generation was the most popular creative process, designers being the most popular target group for CST, and experts being the most popular level of expertise. A summary of findings from said paper was formulated as: *"A Creativity Support Tool (...) is employed to positively influence users of varying expertise in one or more distinct phases of the creative process"* [10]. This definition points towards a more contextualised approach instead of one-size-fits all approach where the types of users should be addressed.

Inie and Dalsgaard [11] present a qualitative study on how 20 professional interaction designers utilise idea management, which is the process of *"capturing, developing, organizing, retrieving, and sharing ideas"* [11]. It was further discovered that in order to develop the best creativity support the focus should be on the target user and not the product being created and furthermore understand both *what* the user is doing and *why*.

Ideas and creativity are associated with each other and both are often an essential part of the design process, but one is not guaranteed to be able to ideate efficiently through the entirety of the process, as described by Dorst and Cross; *"...there can be no guarantee that a creative 'event' will occur during a design process..."* [7]. The study addresses the creativity in the design phase as a problem solving task, where it was discovered that introducing information related to the context could lead to simplifying the design problem, which would occur to the designers as a creative event or idea. This further reinforces the intent of implementing Creativity Sparks as even a kick-starter for design ideas - while they might not give an exact idea and provoke creative thinking towards a specific goal, Sparks can be used on a low level "seeding" of a thought that could potentially expand into a final solution.

The concept of design thinking is based on fast learning, idea generation and fast prototyping, where the Bright Sparks could prove effective for designers, since new ideas are essential for creative designing and help to progress the design process. The creative

clues can be separated into different types. One type of Spark is the one used in [14], where the workers are presented with Sparks in form of statements to support their work. In [13] both of the aforementioned types of Sparks appear, as some are questions for encouraging the journalists to find new angles on existing stories, while others are statements to aim at improving the workflow.

## 2.2 Visiolink Design

Visiolink's News Modules solution consists of a series of modules inside a mobile application that displays content offered by each individual media house. They are able to choose from a selection of predefined modules, which Visiolink offers as a standard. The modules are as following:

- Top / Newest issue module
- Article teaser module
- Live news module
- Advertisement module
- Podcast module
- Supplements module
- Narrated articles module
- Archive module

The customisation possibilities include colours, fonts and more, but these possibilities vary for every module. Other than the modules the app consists of a top- and bottom bar to allow for navigation between different sections of the application.

## 2.3 Types of interfaces

Another important aspect of prototyping within the area of design is types of interfaces presented to the users. Findlater et. al. [9] defined 3 different types of interfaces based on their purpose and behaviour:

- Static - no change to the interface occurs. There is no control over the design and functionality of the interface,
- Adaptive - the system dictates how the interface changes. User control is minimal or none, but the interface often changes based on the user's actions,
- Adaptable - the user gains control over the interface and its design. The interface becomes customisable and can be freely adjusted to the user's needs.

Another type of interface they proposed is Mixed-initiative kind, where the amount of control over the interface design is split between the user and the system itself - these interfaces contain elements from both Adaptive and Adaptable designs. Findlater et. al. conducted a comparison experiment between the above types of interfaces to measure their usability, error rate, speed of operation, etc. The results showed, that the adaptive menu (interface) proved to be the slowest in use, but it was preferred over the adaptable and static designs. These results illustrate that the significant amount of system control in some interfaces, such as drop-down menus, can be preferred over customisable and static counterparts. This is important to ensure that the prototypes serve their purpose as intended. While creating a creativity supported mock-up generator the intent to keep in mind is to provide the user with a responsive and simple tool, so that the design process can be as efficient as possible for the sake of time and workload. The Adaptable type of

interface suits this idea, as it puts all control in the hands of the users and is not the slowest in use. An advantage of this approach is that everything about the system (within technical limitations) becomes tweak-able - the user can modify and change the interface in any way they desire, as long as it is possible on the back-end side of the system. An alternative to this approach would be the Adaptive interface, which while being slower to use, was proven to be a preferable choice for users, as the change happens mostly on the system side. With this, the user can concentrate more on the ideas and help themselves with the interface changing to their liking without much effort. The advantage of such an approach would be the ease of use of the system, with little-to-no necessity to interact with the system per se, but rather putting one's ideas to practice.

One approach to designing a mock-up generator would be to utilise computational layout generation, like the wire-framing tool developed by Dayama et. al. [5], which support designers by providing layout suggestions. Even though the solution proved to be both easy and efficient for interactive use, a better approach would be to provide hints or information, rather than providing layout suggestions. This should be implemented with the focus on each individual user's preferences being a high priority.

Based on the research, it was addressed that creativity support provides a positive influence when compared to techniques without said creativity support, which emphasises the advantages of CST implementations. When developing CST, a beneficial approach would be to focus on the individual user and fit their needs in order to provide the best support. With ideas and creativity being essential to the design phase and idea management being used by professional designers, providing guidance and support in said phase should provide a better experience and have an influence on the outcome.

### 3 CREATIVITY SPARKS

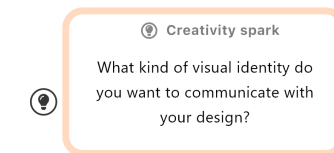
Based on the findings from Related Work research, we decided to call our approach to support tools "*Creativity Sparks*", since they would combine the "Sparkling of ideas" and the "creative output" generated. By doing this, we hope that it can be used as a tool to connect design thinking and creative problem solving. Having researched the different types of Sparks it was decided to use the two types of Sparks ("Abstract/Question" and "Hint/Information"), but also to extend the number of options to fit a wider range of potential users. As the target group was defined as designers of any level of expertise, a decision was made to create four types of Sparks in order to provide sufficient levels of support and creative inspiration for said target group. As mentioned, each Spark is tailored for a different level of design expertise, providing targeted and valuable input for the user. To not distract the user unintentionally, the Sparks can be revealed by pressing a button with a light bulb icon, which is an action taken by the user. Only certain customisation options have a Spark attached to it where it was deemed possible. To close the Spark the user presses the light bulb button again.

The Sparks will act as a source of inspiration and should be easily accessible. Since the purpose of the Sparks is to assist the user, they should only be placed close to the areas where the creativity

support applies to. For each customisation where creativity support is deemed feasible, an array of each Spark type will be attached.

#### 3.1 Challenging Sparks

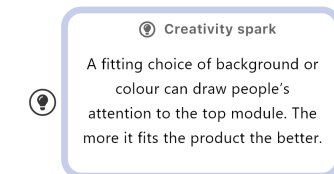
Our design and implementation of the Sparks resembles the approaches described in Chapter 2, but expands on them with a different intent - instead of the persona generation, the Sparks aim to propel the designer into a different, potentially unexplored path of thinking about the design. The Spark asks "outside the box" questions, puts the user in a theoretical situation, tries to invoke a client-side of view perspective. This Spark is aimed at high level of expertise designers, as the level of creativity expected is high and the knowledge of basic design skills is required. By asking questions regarding the customisation possibilities, the Spark might provoke reflective thoughts, which could lead to design ideas that the user did not initially consider. An example can be seen in figure 1.



**Figure 1: An example of a challenging Spark. This shows the Spark for the background behind the front cover in the top module.**

#### 3.2 Informative Sparks

Our approach to these Sparks also resembles the approach described in Chapter 2, being based on the principle of providing the users with information on the topic - no direct step-by-step instructions or hypothetical questions, but hints based on facts or outsource information. This type of Spark is aimed for designers of lower levels of expertise, but not complete beginners, since it does not support creativity to such an extent as the Challenging Spark, but it also assumes that user possesses basic design skills. The user can get inspired by the Spark, but the aim is not to "think outside the box", rather to find concrete solutions to the design based on common principles. An example can be seen in figure 2.

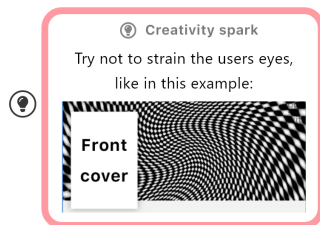


**Figure 2: An example of an informative Spark. This shows the Spark for the background behind the front cover in the top module.**

### 3.3 Unorthodox Example Sparks

This Spark was inspired by the idea to use one's experience in context of an unusual situation in order to generate a new approach to the design. One of the inspirations behind this Spark is the website arngren.net [2], which houses a rather unusual design for a online shop-type website - the products and their prices are clustered without any order, creating a very chaotic design. However, an argument can be made, that because of this design decision, the website stands out from it's competitors, attracting more attention to itself and the products displayed.

This type of Spark can be considered controversial, as it provides the user with a visual example including unorthodox/questionable designs. The use of such an example in the context of design choices is supposed to provoke the user to make choices that would contradict the ones taken in said unusual example - this can help users gain knowledge on what to avoid in design and how to work around making "bad" choices. The controversial aspect of this Spark is that oftentimes unorthodox designs can actually provide better results (in clicks, views, engagements) than the "good" designs, due to the nature of the shock factor, vibrant colours, unorthodox design choices, etc. This Spark expects medium level of expertise from its users, since the amount of creativity involved is high and the knowledge of basic design skills is required. An example can be seen in figure 3.

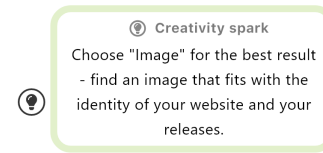


**Figure 3: An example of an unorthodox example Spark. This shows the Spark for the background behind the front cover in the top module.**

### 3.4 Hand-Holding Sparks

The final Spark was created for the inexperienced designer who would be in need for direct instructions and best practices to follow. Even though this type of Spark has little creative content it could prove useful for certain people. The Hand-Holding Spark is based on a step-by-step tutorial principle, where if picked, the choices presented to the user would result in a effective design workflow and a satisfactory end result.

The goal of these Sparks was to give the user instructions for more optimal design choices, urge the user to consider the advice that the Spark gives, and take the design process through a rather streamlined flow (by intent, the user was meant to follow each Spark). This approach, when followed thoroughly, would result in a specific final design, which would be identical between each user, due to the nature of the Sparks. The amount of Creativity is low, as the Spark attempts to take control over the design. An example can be seen in figure 4.



**Figure 4: An example of a hand-holding Spark. This shows the Spark for the background behind the front cover in the top module.**

## 4 LOW-FIDELITY DESIGN

In order to design a prototype for this project, it was decided to collaborate with Visiolink and use their module-based structure as a base for the design. Visiolink also promised, as part of the collaboration, to test the prototype for us - which helps us define a target group consisting of designer of various levels of expertise. In order to begin the ideation process for what a creativity Spark consists of and how it can be implemented to aid more efficient and coherent designs, a low fidelity (lo-fi) prototype was created. The aim of the lo-fi prototype was to discover the difference between different types of creativity Sparks - their impact on the design, their usefulness, the level of influence on the entire design process. The aim of the initial experiment's results would be to illustrate and encapsulate the different kinds of Sparks to be used in the final experiment.

### 4.1 Prototype

The lo-fi prototype was created in Adobe XD to allow the addition of interaction to the interface. To design the prototype an iterative design approach was taken. The final design ended up being a Graphical User Interface (GUI) with two columns - one column for the customisation possibilities and one for previewing the choices made and the progressing design. Each of the Visiolink-like modules are presented to the user one-by-one. All the design possibilities are spread out across multiple screens, depending on how many customisation options the current module has, meaning the user will have to go through the screens to get all of the customisation done. When the user has exhausted all design possibilities for a module, it will be added to the progressing design in the preview screen. The low fidelity prototype can be seen in figure 5.

### 4.2 Evaluation

The initial test was performed with 11 Visiolink employees, in order to gain an insight into the applications and effects of different kinds of Sparks, provided by designers of different levels of expertise. The participants were asked to state their job position and to rate their design competences from one to five - one being no design experience and five being professional design experience. This experiment was conducted by facing the testers with identical tasks, but each permutation of the task held one of the four Creativity Sparks, providing different creativity/assistance cues to the testers. We chose to perform the initial lo-fi test with Visiolink's employees, due to the fact that the design knowledge factor is present and as such the test puts more emphasis on the impact of the Sparks



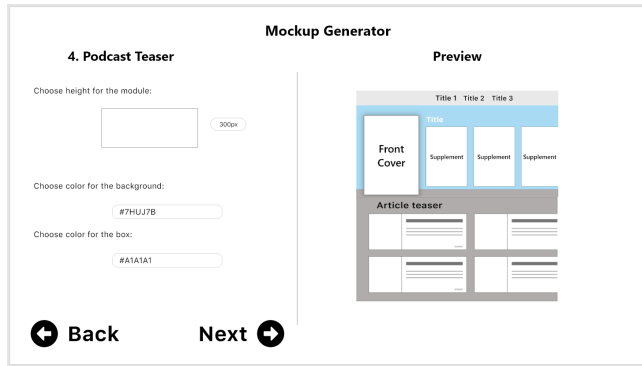


Figure 5: The low fidelity prototype of the mock-up generator.

themselves, rather than testing the Spark in a setting of the trial-and-error nature of design choices usually taken by non-experts. The participants would navigate through an Adobe XD prototype and answer a follow-up questionnaire afterwards. The prototype showcased the four types of creativity Sparks inside the intended context of use, being the mock-up generator. However, the generator was a static solution, meaning that it limited the interaction to only clicking on the Spark in order to activate it, and progressing to the next module - there was no other possibility for user input during the test. The four Creativity Sparks types each had three examples, meaning a total of 12 Creativity Sparks were examined and rated by the participants. The end survey consisted of questions about the Sparks' intent of use, ideas generated by the Sparks, potential for creativity support, and a pick for the type of Spark that made the best impression on the user.

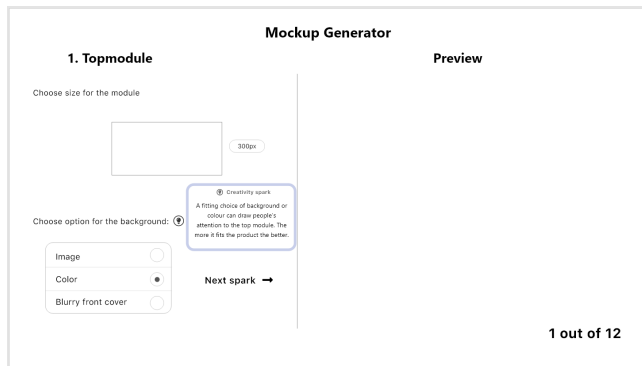


Figure 6: The prototype showcasing the Sparks inside the mock-up generator.

### 4.3 Results

The ratings of each spark type can be seen in table 1. and distribution seen in figure 7.

When looking at the Spark that made the best impression and best served its purpose the Unorthodox Spark has 36,5% of the votes, with the Informative, Challenging and Hand-Holding Spark each

Type of Spark	Combined rating
Red (Unorthodox Example)	59
Blue (Informative)	54
Yellow (Challenging)	49
Green (Hand-holding)	47

Table 1: The combined score of each Spark.

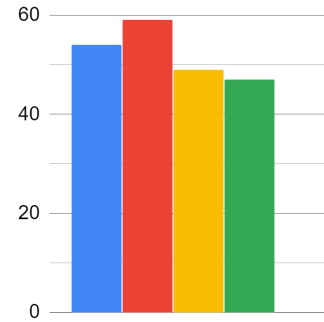


Figure 7: The distribution of Spark types.

getting 18,2% of the votes and "none specifically" getting 9,1%. The distribution can be seen in figure 8.

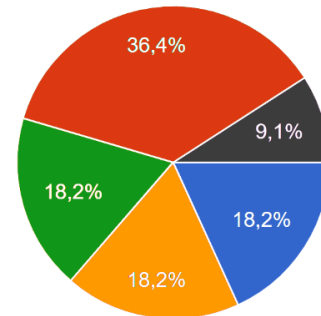


Figure 8: The rating distribution of the preferred Spark type.

When grouping the participants by their design competences the Challenging Spark was favoured by the participants with a "design score" of 3, where the Spark received an average score of 6,2, and the Unorthodox Spark was favoured by the participants with a design score of 2, where the Spark received an average score of 6,4. The higher score for the Challenging Spark rated by the more experienced designers suggest that questions for creativity support are more valued if more design experience is present.

Even though the Unorthodox Spark was favoured, there was only 12 points separating the best from the worst rated Spark. Since the average rating for each Spark changed noticeably when looking at the participants design rating it shows that each Spark could prove useful for a specific user, depending on their design experience. It was therefore decided to keep all four Spark types and introduce an initial questionnaire to determine which type of Spark would provide the best creativity support for each participant.

## 5 FINAL DESIGN

With the Lo-Fi prototype test results in mind, the next step was to create a new iteration of an interactive prototype involving the Creativity Sparks and conduct an experiment in order to determine the amount of creative influence and workflow support for the users coming from the Sparks. This time, the main goal of the prototype was to create a user interface that allows users of any level of expertise to reach a point, where the created mock-up reflects the users' design ideas. For the final test, due to the interact-able nature of the prototype, the users should be able to get close to their envisioned designs with just a handful of basic interactions. The app consist of a two column design where all user interaction takes place in the left column, and the preview of the design choices are shown on the right. This can be seen in figure 9.

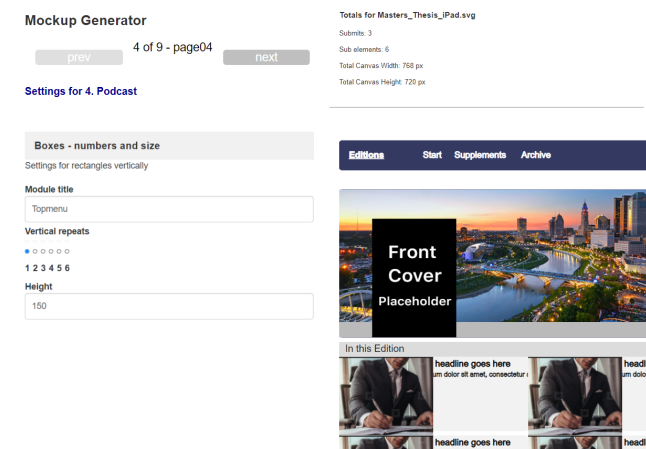


Figure 9: The mockup generator interface.

The application consists of seven of the Visiolink standard modules that the user can reorder and customise. Furthermore a top- and bottom bar are also able to be customised, but the position is fixed. Each module has its own design choices and limitations and contain various amount of pages depending on the amount of customisation possibilities of the said module. Each page contains a set of related fields, that are shown to the user in order to be populated. To navigate the screens in the mock-up generator the user presses the "Next" or "Back" buttons. When the user has completed the design for the current module, it can be submitted, which appends it to the previous module in the preview column. It is not possible to go back and change the design of a module after it has been submitted, due to technical limitations.

The desired type of Spark, along with determining a file name and a device type is set on the first screen of the mock-up generator, also known as the "Overall setup" screen, which was only handled by the researcher. For this test the "iPad" device was the only one able to be selected, since it is Visiolink's most used device among the users of the media houses. Each Spark type was renamed to "Version" followed by a number between 1 and 4 depending on the Spark type, to avoid participants being influenced at the beginning of the test.

Three third party tasks in form of dragging, dropping and re-arranging images in Adobe Photoshop [15] were added to further emphasise and evaluate Sparks' role in supporting the design. The tasks include designing a background for the so-called top module, an advertisement and a bottom-, or navigation bar. The decision to include outsource tasks with Sparks support in this test was taken due to the limited interactions that the prototype allowed - since designs tasks often involve more steps than choosing font sizes, colours and background colours, we wanted to put more agency in the users' hands with these outsource tasks. While given more opportunities for design choices, we hoped the end result from each user would provide an observable difference, not only between each other, but also between their No-Sparks and Sparks end products. Each time the participants were done with the third party task the image was imported into the mock-up generator and shown in the preview and as part of the final .SVG mock-up.

When a participant has completed the design, the output of the application is able to be saved to the hard drive as an .SVG file. By saving the .SVG file in the same folder as the assets used in the design it is possible to have the assets shown as part of the mock-up. Therefore each participant was given two folders, one for the "without Sparks" version and one for the "with Sparks" version.

The aim of the final design of the prototype and the experiment that would follow was to find a difference between the two versions - with and without Creativity Sparks support. We hoped that due to the input from the Sparks, the user would change their design decisions, creating a different result to the one taken with the No-Sparks test. This does not mean that the goal was to observe a "better" result - the hypothesis was formulated as *"Assistance cues will have a beneficial influence on the design phase and the quality of the end result of a mock-up creation tool for a UI product"*, meaning that a desired outcome was any difference in the quality of the end result, followed by verbal answers supporting the idea of a beneficial change of vision for the participants. The measures taken to approach evaluating the upcoming results with this goal in mind will be seen in Chapter 7.

## 6 IMPLEMENTATION

The Mock-up Generator App is a Single Page App developed in Vue.js [21], which is one of the most used and popular JavaScript front-end libraries, used as a framework for building user interfaces. The software choice is backed by three basic characteristics of the library:

- It is able to run rather sophisticated apps without builds (i.e. running on a server like Node.js).
- It is able to run just by double-clicking a single code-file.
- It is able to run without any internet connection, as dependency files (Vue.js itself, css-libraries etc.) can be downloaded and referred locally.

The app is able to generate SVG-files, which can be imported into some of the popular mock-up software on the market like Adobe XD[1] and Sketch [17]. Each SVG-file contains all the design elements needed for the app. Since the system deals with .SVG files the customisations made, such as colours and sizes are stored directly in the design code. After save, the SVG-file can be imported directly and without any loss into the software used for finishing

the mock-up. The images imported into the mock-up project are stored as paths, which makes them able to be shown in the .SVG file when stored in the same folder.

The Creativity Sparks are stored in an array with the *inputhelpversion* determining which type of Spark to be shown through out the app. The *helpshow* function consists of if-statements determining if the Spark should be shown at all. Each customisation field has a set of Sparks linked, but the light bulb is only shown if the Spark contains text.

"vueM.html" is the only executable file, that runs every function of the mock-up generator. It consists of the following - strictly isolated - sections, which takes advantage of classic html-like division of code:

- `<style>` contains all css-styling used to format and give the app an appealing look.
- `<body>` (until script) is home for the html-template, which is made of html code and curly-braces ('{' and '}'). The inside of the curly-braces references different parts of the app-state, which is a tree of data being built up by the app behind the scenes. The merge of html and data creates the resulting html file rendered on the screen.
- The `<script>` tag stores among others the data mentioned above.

The *initial data()*-object offers static data like default values and the collection of Sparks. The *computed* object is for ongoing re-calculation of computed data tree-values triggered by any input/change, as it occurs. *Methods* is the place for code-heavy-lifting of any kind. Any method in this department gets triggered by a pre-defined user-action and runs subsequently - i.e. imposes changes (mutations) to the data tree (state), which again changes the user interface.

Each page of the mock-up generator contains its own set of options and customisations, with various amount of pages being hidden depending on the possibilities for the current module or page. The functionality of each page can be described as following:

- PAGE01-PAGE03 contains general settings and is only handled once for each resulting SVG-file. One important page is the page offering the user to change the sequence of the nine available modules throughout the entire application.
- PAGE04-PAGE08 are cycled through once for each module, that the app/SVG-file consists of - in the user-defined order. The pages present various settings, that the user may or may not alter. Each instance of a page vary from module to module. Some modules offers colour- and box-settings - or rather: they do not hide the same settings from the page. Other modules are more focused on text settings, which is also reflected in the pages and settings shown to the user. Some modules offer some degree of vertical repeat-ability.
- PAGE09 shows up, each time a module-design has been completed. In this case the purpose of the page is to let the user return to PAGE04 and start setting up the next module on PAGE04 to PAGE08.
- When all 9 modules have been designed, PAGE09 turns up one last time with the Save-button, that offers the user to save all settings - which is previewed to the right - in a

single file. The .SVG file format allows it to be imported into a prototyping software to add interaction.

The `exportSVG()` method almost leaves the Vue.js scope. This has been forced by the fact, that javascript is not able to save anything on a file - at least directly. Hence the actual saving of each SVG-file is being carried out using DOM-manipulation techniques, that reside in `exportSVG()`.

## 7 EVALUATION

The final evaluation was performed with 10 Visiolink employees of different job positions (Product Specialists, Project Managers, Product Manager, Marketing, Key Account Managers and Business Intelligence) between the age of 25 and 40, including both male and female participants, with six of them having participated in the initial evaluation. The test was setup at the Visiolink office in a enclosed room. Two laptop were used - one for the participants, with the mock-up generator, questionnaires and sound recording, and one for the researcher taking notes. The test setup can be seen figure 10.



Figure 10: The setup for the evaluation.

The evaluation involved designing a Visiolink-like application mock-up using the prototype twice - one without Creativity Sparks and one with. At the start of each test the participants were given a theme to initially steer their creative thinking. The theme alternated between a farmers and a business magazine. After the participant completed designing a mock-up they would answer a short *Attrakdiff* [18] and a *System Usability Scale* (SUS) [4] forms, and afterwards answer in-depth questions in a semi-structured interview.

The participants were encouraged to think out-loud when interacting with the prototype, while the researcher took notes on the phrases, questions and "unusual interactions" brought up by the testers. A think out-loud approach was taken, as it allows thoughts and considerations from the participants to be noted, while also explaining the thinking process occurring during the test that cannot be seen (or can be missed) in the final data. Before using the mock-up generator the second time the participant answered a short initial interview to figure out which type of Spark should be

used to aid in the designing process. It is worth noting that the participants who also participated in the preliminary test would be assigned a Spark type independent from the outcome that test. This decision was taken due to two reasons - first being the curiosity whether those participants would stay true to their original choice, second being to keep the test consistent for every participant. The initial interview consisted of three questions; two statements where they would pick the most fitting statement out of four and rate their creativity problem solving skill from 1-5. Once the participant completed the second design, they would once again answer the same Attrakdiff questionnaire, SUS and a new set of in-depth questions asked in a semi-structured interview.

To get User Experience (UX) feedback on a detailed level the Attrakdiff questionnaire was used. The questionnaire also has the benefit of assessing the users' feelings in regards to the product. The Attrakdiff questionnaire used in the experiment features 11 questions from the original Attrakdiff questionnaire, which consists of 28 questions. The questions are spread across three categories, which determine the Attractiveness (ATT), Hedonic Quality (HQ) and Pragmatic Quality (PQ) of a system. The distribution of questions consist of four question in the ATT category, three in the HQ category and four in the PQ category. While ATT focuses on the looks, HQ and PQ focus on user experience and usability respectively. The shorter version of the questionnaire provides detailed information about each category without taking too much time away from the evaluation session.

The usability of the prototype was evaluated using the SUS, which is used to estimate the system's effectiveness, efficiency and satisfaction coming from using the system. The SUS is a quick and easy method to determine a system's usability by listing 10 statements to be ranked on a Likert scale. During the test session a 7-point Likert scale was used, but was converted and mapped to a 5-point scale in order to calculate the SUS scores. The decision to include both SUS and Attrakdiff questionnaires, as well as the semi-structured interview was made based on the differentiation between quantitative and qualitative results expected from the experiment. The reasoning was that, in a hypothetical scenario, should the results from the semi-structured interview indicate that, for example, the Sparks worked flawlessly and were a perfect support tool during the design process, but at the same time the prototype's functionality and the final product's appearance were severely underwhelming, the argumentation for such results could be problematic. For this reason, the SUS and Attrakdiff questionnaires were aimed at supporting the validity of the results from the semi-structured interview, by putting them in context of an evaluated and scored prototype. By having a solid foundation in a prototype and final result rating, the analysis of the semi-structured interview can be performed more reliably.

## 8 RESULTS

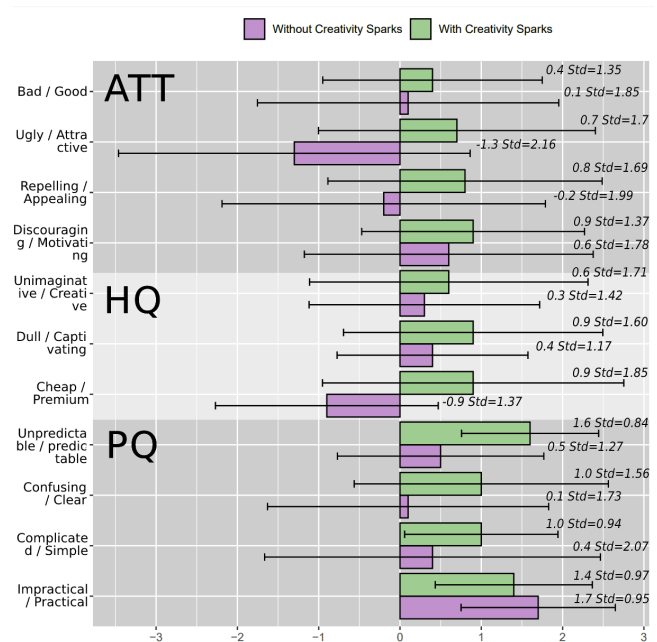
With the evaluation of the Creativity Sparks prototype performed, the answers from the semi-structured interviews and the scores from the SUS and Attrakdiff questionnaires were analysed.

Out of the 10 participants the Unorthodox Sparks were chosen six times, Challenging Sparks four times and Hand-Holding Sparks

Without Sparks	
Category	Mean
ATT	3.8
HQ	3.933
PQ	4.675

**Table 2: The means for each Attrakdiff category in the "without Sparks" solution.**

one time. The Informative Sparks were not chosen by any of the participants and thus results for this Spark cannot be presented and analysed. From the Attrakdiff questionnaire, it can be observed that the "with Sparks" version of the prototype is the overall preferred version by being better rated in 10 out of 11 categories, with the "Impractical / Practical" category being the only favoured category for the "without Sparks" version.



**Figure 11: The Attrakdiff score for the prototype with and without Creativity Sparks including the standard deviation.**

An example of two mock-ups designed by the same participant can be seen in figure 12. The left-hand side shows a mock-up designed using the "no Sparks" version where a farmers magazine was the given theme. The right-hand side shows a mock-up created using the "with Sparks" version where a business magazine was the given theme.

The overall mean for each of the Attrakdiff categories can be seen in table 2 for the "without Sparks" version and table 3 for the "with Sparks" version.

Since the evaluation is repeated measures and comparing two groups where the data cannot be assumed to be normally distributed, the Wilcoxon signed-rank test was used. The two mock-up versions were compared across the three categories and with the





Figure 12: Two examples of mock-ups created by the participants. A farmers magazine in the no-Sparks version on the left and a business magazine with Sparks on the right.

With Sparks	
Category	Mean
ATT	4.7
HQ	4.8
PQ	5.25

Table 3: The means for each Attrakdiff category in the "with Sparks" solution.

Wilcoxon signed-rank test	
Category	p-value
ATT	0.202
HQ	0.02798
PQ	0.1501

Table 4: Wilcoxon signed-rank test performed on the three Attrakdiff categories (ATT, HQ, PQ) between the "without Sparks" and "with Sparks" versions.

Wilcoxon signed-rank test, a p-value for each category was calculated. The results can be seen in table 4.

It can be seen in table 4 that a p-value of 0.02 was found in the Hedonic Quality category. Since the p-value is below the 0.05 threshold it confirms a statistical significant difference.

When examining the average SUS score of the "with Sparks" and "without Sparks" versions the "with Sparks" version was favoured, scoring a higher average SUS score of 76.91 against the "without Sparks" version with an average SUS score of 71.66, which showed no statistical significance. Both scores are above average [16], which confirms the interface being usable and users are able to achieve their objectives without too much effort and have an overall satisfactory experience.

## 8.1 Thematic Evaluation

After each session of designing the mock-up using the prototype, a semi-structured interview followed. Its purpose was to gather information about how the participant felt, what they thought, how their perspectives might have changed, and what their opinions on specific elements of the experiment were. However, since data gathered from a semi-structured interview, as well as the researchers observations and notes on the thinking aloud process during the evaluation, are of the qualitative nature, as opposed to the SUS and Attrakdiff scales' quantitative nature, a different approach to analysing the data had to be taken. All of these were an important aspect of the evaluation, since it provided us with in-depth information about the participant's thinking, feelings, influence of the Sparks, etc., giving us an insight into aspects of the experiment that could not be measured quantitatively. In order to evaluate the collected responses *Thematic Evaluation* was used - a method of analysing qualitative data based on coding the responses, finding themes within them and analysing the discovered themes [3]. For this evaluation, a *Inductive approach* was chosen, as it assumes that the data will determine the themes, as opposed to the *Deductive approach*, which approaches the data with pre-determined themes, based on background observations and knowledge. In this experiment's case, there were no concrete assumptions on the responses, as the Sparks were meant to provoke any degree of change in thinking, inspiration or big picture planning, rather than a specific, mostly positive, change.

During the prototype phase, the following themes were discovered:

- Limitations of the prototype, difficulty in navigation
- Inability to correct choices and/or mistakes
- Effectiveness in getting something done quickly
- Learnability of the prototype with time
- Helpful in visualising ideas and reaching a good result based on it

These themes display that the participants reported two leading observations about the prototype - first being the limitations of the software, displayed by the inability to correct one's choices, missing a "go back" functionality after submitting a module, as well as overall difficulty in navigating the prototype. The second observation was that the prototype allowed them to visualise their idea in a quick manner, reaching a satisfactory mock-up result while also being able to efficiently learn the software. The take-aways from this session are that while the prototype was lacking



crucial functionality, it was deemed as a efficient tool for fast idea visualisation.

During the Sparks test, the following themes were discovered:

- Lack of creative input from the Sparks, inability to find use of the Sparks
- Confusion about the purpose of the Sparks
- Appreciation of the non-intrusive nature of the Sparks
- Sparks helping with big picture planning
- Sparks providing inspiration and changing decisions
- Sparks helpful during the design process, providing insight into the client perspective
- Helpful in making the right decision when in doubt
- Sparks provoking new thoughts about design
- Sparks provide a feeling of safety in the design process

The evaluation of the Sparks test answers brings forth a number of observations - most importantly, the diversity of answers and resulting impressions on the participants. Examples of the polarity of answers can be observed when comparing the themes of *Lack of creative input from the Sparks, inability to find use of the Sparks* and *Sparks providing inspiration and changing decisions, Sparks provoking new thoughts about design*. This means that the diversity in the effects of the Sparks can be observed, producing different results for different participants with the same Spark. Another noteworthy result is the theme of Confusion regarding the purpose of the Spark - while some participants were able to make use of the contents of the Sparks, others found them confusing and progressed with their original intent of the design. However, the majority of the themes illustrate that the Sparks proved to be a tool that inspires new thoughts, helps with big-picture planning and aims the design towards a more optimised outcome, while provoking the feeling of safety and "making the right decision".

**8.1.1 Reflection on the discovered themes.** This section aims to confirm that the themes discovered in the evaluation represent the data collected in the semi-structured interview. The themes were created by coding the data, which is a process of finding key phrases in the transcribed interviews, that display a thought or a feeling reflected by the participant. When the codes repeat throughout the interview answers, a theme can be created. Since the test was conducted twice - once without and once with the Sparks, two different sets of themes were expected to emerge. As mentioned before, we took the Inductive approach to analysing the data, which resulted in the data providing the themes. With this in mind, we also took a *Semantic approach*, meaning that we analysed only the explicit content of the data, rather than assuming underlying contents. Due to the aforementioned assumptions, the themes reflect the data reliably. Should the dataset be larger, a Qualitative Data Analysis (QDA) tool could have been used, possibly resulting in a different set of findings and themes, since there would be no subjective factor involved. However, since the dataset consisted of only 10 participants' answers, the data was evaluated without the use of QDA tools and is thus prone to slight skewing of the results interpretation due to subjective approach to the answers. With that said, the themes fit the codes found in the answers given by the participants, since all of the main key-points and key-phrases are reflected in the final evaluation.

## 9 DISCUSSION

### 9.1 Satisfactory Spark choices

An important aspect of the Creativity Sparks was to provide the best creativity support for each individual, in relation to their level of design experience. To correctly identify the best fitting Spark for the participants, an initial interview was setup, which provided information about the participants' preferences in terms of creative thinking and creativity regarding problem solving. With the participants identifying the two most fitting statements and giving themselves a creativity score, in case the two statements did not match, the most fitting Spark was selected in the "with Sparks" version. When examining the feedback from the participants, the majority saw the Sparks as helpful and proved to be useful in the design process. When giving the initial interview to determine the choice of Spark it was never mentioned that the answers given by the participants would be linked to the choice of Spark. Having the effect of the answer being unknown to the participants could contribute to a better choice of Spark. It was noted that one of the participants seemed confused about the information given by the Unorthodox Example Spark. Whether the wrong Spark type was given or the Spark type was misunderstood remains unclear. Judging by the feedback from the participant the intent of Spark was correctly identified, stating that the examples were unusual, but decided to go in her own direction, which by design was the intention behind the Spark.

In total, six out of the ten participants participated in the Low-Fidelity Creative Sparks survey, where only two participant received the same Spark as chosen as their favourite in said survey. These two participants both gave positive feedback on the Sparks, meaning that the consistency of choice reflected the ability to find use of the Sparks, corresponding to the level of design experience. Overall five out of the six participants who also participated in the Low-Fidelity Creative Sparks survey gave positive feedback, which could suggest that having done the initial survey makes one better prepared for how to use the Sparks more efficiently in their intended purpose.

### 9.2 Majority of Unorthodox Example Spark users

Since the process of assigning Sparks was carried out by a human, rather than a system, the potential for erroneous choice of Sparks per participant could occur. This could have led into the Unorthodox Example Spark being chosen 6 out of 10 times. However, it can be argued that the choice of target group had an impact on this result - since the participants were all employees of a digital publishing company, it was expected that the level of design expertise would be higher than that of an average person. As a result, the Unorthodox Example Spark was chosen most often, as it both provided a visual example and challenged the designer - which were two of the most welcome features of the Sparks.

When consulting the results from the initial Sparks survey the Unorthodox Example Spark was also the preferred type among the participants in terms of score, best impression and fulfilling its purpose best. While examining the feedback from the semi-structured interview, it confirms that the Unorthodox Example Spark was

providing positive results four out of six times in terms of creative input, which could indicate the right types of Spark were chosen. The two participants who had less success with the Unorthodox Example Spark seemed to have other expectations of the Spark's purpose and were confused about the unusual designs shown. For those two participants Unorthodox Example Spark might not have been the most optimal choice. Again, this occurrence could have been a result of human error in the Spark assigning process - it is possible that a different Spark would fit the participants' needs and expectations better. While analysing the interview answers, it could be argued that Participants 6 and 8 should have received the Informative Spark instead of the Unorthodox Example Spark, since their answers reflected a more informative and relatable approach to what they expected from the Sparks. However, they were able to find positive aspects of the Unorthodox Example Spark as well, meaning that the choice was not a complete failure - it could be argued that there might be a need for a Spark that combines both the Unorthodox Example Spark and the Informative Spark for such designers. The nature of the Unorthodox Example Spark encourages creative thinking with the unusual colour, arrangement, or image choices, depending on the customisation at hand. When presented with the statements in the initial interview the Unorthodox Example Spark was the only one to mention concrete visual examples, which might have made the statements for the Unorthodox Example Spark more appealing.

### 9.3 Lack of Informative Spark users

During the initial interview no participants gave answers that would suggest the Informative Spark being the most fitting for them. That could either be due to the lack of interest in the nature of Spark, being facts and information, or simply the other Sparks being more appealing. Since the nature of the Creativity Sparks is tailored to provide creative support suited for each individual it was decided to leave the Informative Spark untested instead of "forcing" the Spark onto a test subject who might not get any useful guidance from it.

The initial assumption about this Spark was that it would be considered a "default" choice - meaning that it would be aimed at the average user, with low design experience and low expectations of creative input. By prompting users with general information, industry-standard suggestions, examples of best practices, the aim was to create a Spark that would guide the user towards a specific goal, but leave enough room for subjective interpretation of the contents in order to arrive at an original result. It can be argued that there was no need for such an approach between our target group, since their design expertise was above the average user. However, due to no tests performed on this Spark, we cannot make any more assumptions regarding its purpose and application in the context of the study.

With this said, one of the participants was given the Hand-Holding Spark, based on his initial questionnaire answers. The Spark proved to be quite helpful for that individual, providing him with good support in the design process. This could mean, that while the Informative Spark being unable to find a niche, the Hand-Holding Spark, which would be considered "a level lower",

was in fact able to be tested with one participant, and rated positively. Thus, an assumption can be made that creating a support tool for designers would best suit either beginner/inexperienced individuals, or highly experienced designers, without a need for a middle-ground/default choice.

### 9.4 Inspiration and Guidance

While using a creativity support tool such as the Sparks, one could argue that the most efficient and helpful approach would be to provide the user with visual aids. By looking at a template, pre-made banner, or an exemplary module, the participant can draw direct inspiration for their design and apply elements of the examples directly, should they feel like it would fit their product. This creates a dissonance between "inspiration" and "guidance" coming from the Sparks - the example is most noticeable with the Unorthodox Example Spark, since the purpose of the Spark is the direct opposite of inspiration. In this case, the Unorthodox Example Spark provides the user with an example of a controversial and questionable design suggestion for their product and since the purpose is to shift the thinking process into one that tries to discourage the users from making similar decisions, the Spark could be considered as "guiding" rather than "inspiring". However, this cannot be observed uniformly, as some participants stated that they felt more "inspired" by the questionable/unorthodox example, rather than "guided" towards avoiding such decisions. This means that the Unorthodox Example Spark cannot be clearly identified as supporting either approach, but rather it's aim is to help the user by the means of their own interpretation of the content, which resulted in confusion of the Spark's purpose in a few cases.

The distinction between "guidance" and "inspiration" can be observed when comparing the Hand-Holding Spark and the Challenging Spark. These Sparks are based on two very different principles - the Hand-Holding Spark aims to guide the user on a step-by-step basis, encouraging them to choose the most optimal, industry-standard design for their product, leaving very little possibility for creative thought. On the other hand, the Challenging Spark provokes the users' creative thinking by inspiring them with open questions, "food for thought" sentences and encourages the users to reflect upon their choices and design decisions in order to reach a new, possibly more optimised and fitting result. In this case, the Hand-Holding Spark would be considered "guiding", while the Challenging Spark would be considered "inspiring".

### 9.5 Significant difference in the Hedonic Category

The Hedonic category describes qualities more related to the emotional aspect with reactions like *outstanding*, *impressive*, *exciting* and *interesting* [6]. Since the Hedonic quality is a subjective aspect of a user interface, the preferences vary from person to person. The nature of the Sparks is to provide creative feedback and allow the participants to think more about the design choices, which could result in a positive emotional reaction among the participants when previewing the mock-ups created with the "Sparks version". Since the participants are both designing and judging the mock-ups there is also the factor of bias to consider. In general the "Sparks version" was preferred by the majority of participants, getting both a higher

SUS score and a higher mean in 10 out of the 11 Attrakdiff categories. It is however also worth noting that the learning curve could have had an impact on the results. This could prove true both in terms of getting used to the layout of the system and getting more familiar with how to customise the mock-up to each individual's liking. But since this would be more reflected in the SUS, rather than the Attrakdiff questionnaire, which produced means of results remarkably higher in the "Sparks version", it would suggest that the "Sparks version" was the overall a better system to interact with.

## 9.6 Learning Curve of the System

Since the experiment consisted of two, subsequent tests, where the set of tasks were the same, granted that the second test included the Sparks support tool, it could be argued that the participants were able to learn the system of the prototype during their first test, which allowed them to be more efficient and generate a better result during the second test. One of the measures taken to avoid this issue was the choice of two distinct themes for the end product of the prototypes - a Farmer Magazine and a Business Magazine. These two choices were based on two different markets and target audiences, meaning that the same sets of colours, fonts and other design choices should not be applied directly to both products. With this, we hoped to decrease the possibility of learning the design process in the first test and applying it directly to the next. Another approach taken to address this issue was the Sparks themselves - while the usability and affordances of the prototype remained the same, the overall task of creating a design for a product of a Business or Farmer magazine was altered by the appearance of Sparks. The input provided by the Sparks aimed at altering the experience, design choices and the end product of the second test, which in most cases, it did. The process of designing both magazines was different from one another, since the expected results of the end products were disjointed - the participants had different ideas in mind (on top of the new ideas that the Sparks gave them) and made different decisions regarding the final designs. This can be seen in figure 12.

## 9.7 Design of the Sparks

Probably the most controversial point was also the most basic one - the Sparks being designed by non-experts in the field of UI design. With that said, most of the Sparks were created based on background and market research performed, colour theory analysed, and knowledge gained during analysis of Visiolink's solution. However, since the target group chosen consisted of participants with high levels of design experience, it could be argued that the system was design by low-level designers for high-level designers. This can be seen as an issue regarding the validity of the experiment, given that the decisions made for the design of the Sparks stemmed from an ongoing research, rather than a solidified and time-tried experience. However, the results from the experiment are rather satisfactory granted the aforementioned concerns. Most of the participants enjoyed the Spark they were given and found it useful and helpful in their design workflow, being provided a feeling of safety, inspiration for designs, big-picture planning support and a feeling of making "the right choice". This would mean that granted the difference in levels of expertise between us and the target group, the

end result was satisfactory to both groups and could be expanded further.

## 10 FUTURE WORK

A drawback that was mentioned by multiple participants was the inability to either preview your customisation choices as they are being applied, or to go back and edit the module after being submitted. The absence of said feature might influence the users' overview of the customisation made for the module at hand. This fact could also contribute to the SUS increase from the "without sparks version" to the "with sparks version", since the participants might be more used to absent of a preview and better adapt. Even though the SUS test revealed an above average score in both mock-up generator versions, the implementation of previous mentioned feature would greatly improve the user experience.

Since the many of the responses from the evaluation mentioned the possibility of applying the Sparks to other media, an example of a platform similar to the module generator would be website creation tools such as Wordpress. It could be argued that designing a website is governed by similar principles as designing a module-based magazine - colours, fonts, placement of UI elements, box spacing, etc. Due to this observation, the Sparks could find a direct application in said medium. The design process of a Wordpress website could be made easier for designers of any level of expertise given the Sparks tailored specifically for website creation. While the biggest benefit might be found in lower-level Sparks, such as Hand-Holding and Informative Sparks, the more abstract Sparks could also help the more experienced users create a more interesting and polished product.

Sparks helpful nature does not need to end in UI oriented tasks either. Another application of Sparks could be found in creative writing, or music composition. We believe that both of these areas require a creative input from the writer, which can, and often is a problem, especially if creative burnout or artistic block occurs. Sparks would aim to remedy this issue - starting with low-level building blocks, such as directly suggesting chord sequences, major or minor modes, melody examples for music composition, through questionable and unorthodox examples for writing ideas, principles and plot progression structures, ending in food-for-thought Sparks that would aim to propel one's creativity towards an original piece with hypothetical questions and challenging ideas. This example also illustrates that the Sparks are not limited to technical, software and UI-related jobs, and can be taken to different real-life contexts. Sparks might also find a use in every day tasks, such as cooking - supporting the inexperienced cooks with ingredients lists and instructions, through more experienced chefs with more exotic ideas and unusual dishes suggestions, ending with veteran chefs who lack a new idea for extending their repertoire of dishes in the menu.

## 11 CONCLUSION

This paper reports the design and first evaluation of the implementation of creativity support inside a mock-up generator. The implementation provided the designers of any level of expertise creative with ideas regarding customisation choices in the design phase.

The project provided a valuable insight into the importance and effectiveness of creativity assistance tools. The results showed that, while sometimes confusing, the Sparks were able to steer one's creative thinking and big-picture planning resulting in alternate design choices, sometimes deemed as "better". The implementation of the prototype could have been improved, as it was reported that the lack of functionality proved to be quite troublesome at times, however the mock-up generator was able to fulfil its purpose of enabling the users to visualise their ideas efficiently. While the Informative Spark was not evaluated by any of the participants, the Unorthodox Example Spark was chosen most often, providing mostly positive feedback. Participants reported a feeling of inspiration, safety, direction, creative support and "going the right direction" when using the Sparks. The participants' statement was emphasised by the Attrakdiff feedback with a p-value of 0.02798 found in the Hedonic Qualities, which rejects the null hypothesis. This, along with the Thematic Evaluation performed on the answers from the semi-structured interviews, means that we are able to support our hypothesis of assistance cues having a beneficial influence on the design phase and the quality of the end result of a mock-up creation tool for a UI product.

In reflection, the process of assigning each participant with a Spark could have been improved, creating an automated system for said selection. This way, the factor of human-error and subjective bias could be avoided, resulting in a more reliable process of Spark selection. This could result in the Informative Spark being evaluated and scored by some participants, however, as discussed, it is possible that there was no niche for this type of Spark among the target group, as the level of experience and expertise exceeded the purpose and intent of this Spark. Overall, the experiment brought good results that could be taken into a wider context - with a better implementation on the system end of the project, Sparks could become a valuable tool for designers and other creativity-dependant workers alike.

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