Responsive Type
Introducing Self-Adjusting Graphic Characters

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***Abstract*—In this publication we introduced a radical new concept of perceiving information in written form: Until today, after the layout process has finished, the shape of a single typographic character is treated as an unchangeable property. But due to current sensor and display technologies this does not have to be necessary anymore. We propose, to change the shape of each character according to various conditions of the user while maintaining its individual and discriminative identity. In contrast to fixed character shapes, *responsive* character shapes are not limited to be adjusted for a particular output media, but offers the possibilities to adjust to personal conditions such as age, position and defects of sight. This seemingly simple difference, however, questions information brokering fundamentally. It expands the possibilities, besides the engagement of the *media*, to perceive information within the *context* and the *conditions* of the individual. Through experiments and user studies, we demonstrated that our proposed approach, dubbed *responsive type*, is widely accepted and readability as well as legibility can be improved.**

I. Introduction

The beginning of cultural evolution started with individual communication first in oral and later also in written form. The invention of movable types around 1450 entered in a printing mass production, which allowed to spread knowledge through the world. The digital revolution has again tremendously changed the way we provide and perceive information. Text has become ubiquitous and present all the time on smart devices of all kinds, across devices and screen sizes: we read text messages, emails, PDF files and eBooks or browse websites while driving, having a conversation, by watching TV or sitting on the toilet. We interrupt whatever we do if a new message arrives. We skim-read, speed-read, cherry-pick headlines and paragraphs to grasp the provided information without single-minded concentration. In the age of digital media the speed in which we are able to recognize single characters and words became the limiting factor throttling back the pace at which we process information surrounding us.

We cannot cheat the basic limitations of our eyes (focus, speed of movement), attention and memory system, but we might be able to find new ways to present information in order to support the reading process. While industrialization necessitated standardization of type in its replication process [1], digitization offers a *liberation* of these stringent formats. Standardization follows a static environment and has optimized, over centuries, the requirements of an average human being. But optimizing for an average reader and an average surrounding might never be the optimal solution for a particular situation and individual—furthermore these circumstances and necessaries can even change in seconds.

To overcome these limitations we propose, to change the shape of each character according to various conditions while maintaining its individual and discriminative identity. The proposal offers a whole bunch of new possibilities in type design to respond to important factors such as reading distance, information density, screen sharpness, device orientation, age, eyesight, and so forth. But before we start with the introduction of *responsive type* we want to provide a brief overview of the development of type and its use as a stylistic device.

A. Movable Type and its Successors

The invention of using movable components (usually individual letters) to reproduce the elements of a document changed the way we reproduce text in written form. The world's first known movable type system was created in China around 1040 by Bi Sheng [2]. But not before the introduction of the movable-type printing system in Europe by Johannes Gutenberg around 1450 [1], movable types could demonstrate their superiority. In contrast to the thousands of characters needed in the Chinese writing system, European languages need a significant lower number which makes it much easier to handle. After their invention in the 1860^{th}, typewriters became a convenient tool for practically all written communication and quickly replaced handwriting except for personal correspondence [1]. While typewriters could offer only a very limited selection of type design, digitization offered nearly unlimited possibilities in layout and type design. This development started in the late 1960^{th} by the invention of the word processor [3] and is still an ongoing endeavor.

B. Typo as a Stylistic Device

Using typo and typography as a stylistic device has a very long tradition which comes in various forms. It can be:

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- *static* such as presented in printing books, posters and comics, where type represents content in an uniform and permanent way [4],
- *dynamic* as in *kinetic typography* which is an animation technique to express ideas using text-based video animation [5], [6], or
- *voice driven* as in *voice driven type design* where the shape of each single character is adjust according to particular acoustic features in the spoken reference [7].

Another approach, instead of manipulating the look of the text itself, is to use *emoticons* (ASCII-based character strings) and *smilies* (pictograms). Even though they have been demonstrated to be effective for remote emotional communication [8], additional characters have to be introduced and variation within text cannot be represented well. Furthermore, it has been investigated that emoticons and smilies have differential effects with regard to recipients mood, message evaluation, person perception, and cultural background [9]. Facial expressions are even interpreted completely differently and used for different purposes [10].

C. Introducing Responsive Type

If we follow the historic process, as briefly presented in Section I-A, we see that we have been undergoing a couple of changes due to the way of 'generating' text and layout by different input modalities. But how about the output modality? To the best of our knowledge the representation of characters has not changed significantly over the last centuries. But before we step deeper into the proposed *responsive type* we want to briefly review responsive design and its many variants.

II. Responsive Design

To address particular characteristics of the displaying media, the audience as well as the context in which the information is shown, it cannot be taken for granted that the presented information and its visual appearance should be equal for all cases. For centuries, therefore, the visualization has been adjusted to fulfill particular needs. With the introduction of computer technologies, instead of adjusting once and contributing this result again as unchangeable information and visual appearance, it became possible to respond to changing characteristics on the fly. But just recently this approach has been widely adopted, mainly due to the needs to represent web-pages on different screen sizes and resolutions to provide an optimal viewing experience—easy reading and navigation with a minimum of resizing, panning, and scrolling.

Because a broad number of terms exists to describe different ways of 'changing' design characteristics we want to give a brief summary here:

- In *fixed design* the level of detail and layout is kept constant.
- In *fluid design*, also referred to as *liquid design*, individual components adjust their size to the given space.
- In *adaptive design* different but specific device sizes are addressed by different fixed variants; e.g. for monitors, TV, tablet and smart phone.

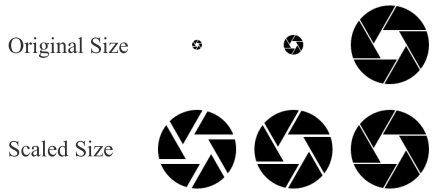

Fig. 1. Example of a *responsive* icon demonstrating different forms in original size and scaled versions to better see the differences [courtesy of Waybury, LLC].

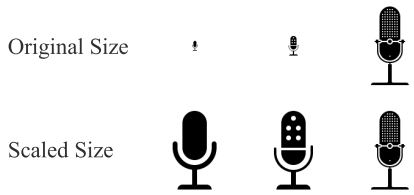

Fig. 2. Example of a *semantic* icon demonstrating different level of details in original size and scaled versions to better see the differences [courtesy of Waybury, LLC].

- In *responsive design* [11] layout, design and content changes on a continuous scale, see Figure 1.
- In *semantic design* not only the visualization of existing details is altered, but objects appearing or disappearing according to the context to present more or less information, see Figure 2 and 3.

The response in responsive design can be applied to various visual representations:

A. Responsive Layout

Responsive layout is an approach to provide an optimal viewing experience. In relation to responsive web design its goal is to provide different layouts across a wide range of devices with a minimum of resizing, panning, and scrolling [12].

B. Responsive Graphic

Just because vector graphics are infinitely scalable that does not mean that they are by default infinitely *legible*. The idea of *responsive graphics*—including responsive icons, responsive logos, and responsive illustrations—is to adapt the level of detail to their size and viewing distance.

C. Responsive Advertisement

Responsive advertisement, mainly in the form of web advertisement, adjusts the ads to fit into the given space. If the

Fig. 3. Example of a *semantic* logo demonstrating different level of details [courtesy of Warner Bros. Entertainment].

content of the ads is adjusted to the properties of the addressed audience this is not referred to as responsive advertisement, but as *targeted advertisement*, because a particular group of people is targeted [13].

D. Responsive Architecture

The idea of responsibility even found one's way into responsive architecture already in the late 1960^{th}. Sensors measure environmental condition, process data through a micro control system and enable buildings via actuators to reflect technological and cultural behaviors [14].

E. Predecessors of Responsive Type

Size-specific adjustments to type designs were practiced for 500 years of metal type printing: Characters in small sizes typically show an increased width and x-height, reduced stroke contrast and looser spacing in contrast to characters in large sizes, see Figure 4. Because punches had to be cut for each type size separately it came without an extra effort. But with the introduction of phototype, users gained the ability to simply scale a 'one-size-fits-all' font. As a consequence size-specific optimizations were largely given up and fonts made for headlines, therefore, became unreadable if reduced in size while small sized fonts looked clunky and inelegant when enlarged. Single-master designs also dominated the early years of digital type, but the coarse resolution of the pixel grid spurred a renaissance of type optimized for the right setting.

Fig. 4. Example of *optical sizes*: ATF Garamond, from left to right: 6, 8, 10, 12, 14, 16, 18, 24, 72 pt (From: [15]).

Besides optimizing the characters according to their size additional ideas to adapt or to present text have been proposed recently. Marko Dugonji introduce in the year 2013 a system, where a text sample on a monitor responds to the reading distance. More distance increases the font-size in real time and vice versa. Spritz developed a more progressive approach: they present text with the optimal word perception point located at exactly the place where you are already looking. By doing so text can be read without relocating the viewing point of your eyes and thus reading becomes faster and, in addition, textual representation needs less space [16].

In the following we refer to changing typographic characters as *responsive type* while *responsive design* includes all types of responsiveness as mentioned in this section. So to say, responsive type as well as all other forms are subsets of responsive design.

III. Fundamentals of Type

To get a better understanding of the proposed idea of responsive type it is advantageous for the reader to have a basic understanding of typography. Therefore, for those readers who are not yet familiar with the fundamentals of typography in visual communication we briefly review some basic properties.

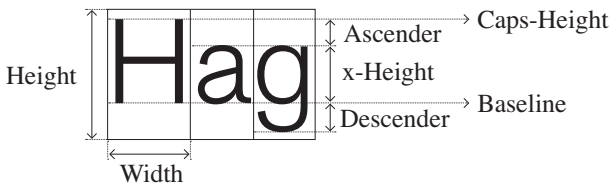

Fig. 5. Proportions of a character.

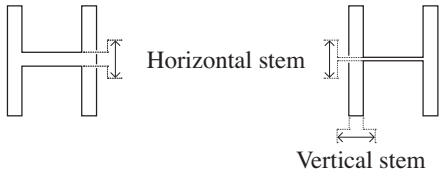

Fig. 6. Stroke contrast describes the difference between horizontal and vertical stroke widths.

A *character* in typographical scope means a visual sign which represents a letter, number or punctuation mark. Before digitization, a character was a piece of metal where the shape was represented by stand outs. Today, this shape, is represented as code snippet. When we refer to shape we mean the black mark of a character.

The proportions of character describe the ratio between the width and the height and also denoted the relationship between the ascender and descender of a character, see Figure 5. *Stroke contrast* is marked by varying vertical and horizontal stroke weights, see Figure 6. Varied stroke contrasts are rooted in specific writing instruments for such as the dip pen, printing techniques like copper engraving or a certain spirit of the age [17, p. 159] [18]. If a character could be well recognized, depends not only on the shape but also on the distribution of white space surrounding it [19], see Figure 7. Therefore, white space should not be considered as blank or unused space, but as an important element which enables the character in it to exist at all. A distinctive construction increases the pregnancy and therefore the legibility, too [20].

A fixed collection of characters in the same style hold one font. A whole type family consists of these fonts and provide usually additional nuances in font weights (bold, regular, light) and variations in horizontal width of characters (extended, regular, condensed). This full set of fonts usually are also available in contemporary type families in italic style, which slant slightly to the right [21].

Fig. 7. Different kinds of white space.

Fig. 8. A word image is defined by characters with descenders and ascenders.

A. Legibility

Legibility describes the process to recognize a specific structure of a word [22]. Familiar readers in contrary to children, can read longer text passages more efficient and faster, because they have less fixations and therefore wider saccades. A *saccade* describes the process of jumping from one fixation to the next part of a word. First indication for eye fixation could be capital letters. Every jump on average lies along eight characters whereby the area of fixation overlay each other. One fixation lasts between a fifth and a quarter of a second [23]. Experienced readers do not only analyze single characters, but also recognize word images which they compare with already learned word images [24]. A *word image* is the silhouette of a word. Figure 8 shows the *pregnancy* of a stylized word image which depends on well distinctive descender and ascender. Recognition of a characters—even more words—depends firstly on their stringency. The full character set of a typeface must follow the same proportions without emphasizing the characteristic of one character. The end of strokes (terminal), the direction of thickening (stress), the enclosed space within a character (counter) and the height of lower cases (x-height) are parameters which need to be considered [20].

IV. Responsive Type

Media for receiving written information becomes more coherent and versatile in these days. Current fonts are usually designed for specific media like paper or electronic displays. The special attributes of not only the media but also of the receiver postulate a more intelligent behavior of a character shape. In contrast to a fixed character shape, a *responsive* character shape is not limited to a particular media, but offers the possibilities to concentrate also on the act of perception. This seemingly simple difference, however, questions information brokering fundamentally. It expands the possibilities, besides the engagement of the *media*, to perceive information within the *context* and the *conditions* of the individual. Furthermore, this response has to be altered continuously in order to preserve a consistent legibility to produce ultimately a higher acceptance by the reader. This process of continuous change is characterized in Figure 9: Transmitting a typographical information begins with the formulation of sentences encoded as an array of characters. Before a character is received it undergoes a visual transformation by the responsive type rule set. The rule set is composed of an algorithm which corresponds to the particular media as well as context and conditions of the recipient (reader).

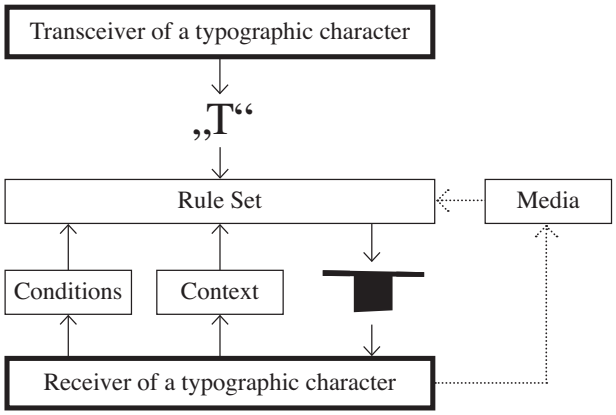

Fig. 9. The model of responsiveness shows, how the context, conditions and the media can affect the character shape. How the adjusted character shape is perceived by the reader could vice versa affect the rule set.

A. Character Shape

Designing a character shape is a long-winded task. Manually drawing character shapes for a broad range of purposes is inefficient. Current font editors enable to reduce the process of drawing character shapes [25]. They allow to interpolate between instances within an interpolation space, to generate and export a number of font styles. They normally consist of few nuances in font weight and variations in horizontal widths. Focusing on the needs of humans recalls the opposite between analogue and digital media. Corresponding to analogue environments—including the human being—requires a continuously handling without recognizable granularity. Approaches of 'digital' transformation of contours exist since the development of computer screens in late 1960^{th} to increase readability for the limited screen resolutions [26, p. 115]. Those fonts were optimized to fit into the digital raster and thus a limited number of instances would do.

B. Character Morphing

The process where one shape changes to another through a seamless transition by interpolation describes the process of *character morphing*. The two most influential parameters *context* and *condition* have different goals and thereby effect the character shape in a different manner. While the former aims to preserve the original shape as perceived by the reader after it underwent various transformations caused by the channel the latter optimizes the shape regarding the particular requirements of the reader.

Since, to the best of our knowledge, no type family or software exists which is able to fulfill our particular needs we drew our own type family and developed a font processing tool. This tool enables to change every parameter of each character in real time without loosing distinctive and aesthetic character shapes. Character shapes also communicate a certain impression. A typographic character shape does not only contain their substantial significant, but is also capable to embody a feeling. A typeface with serifs—a serif describes

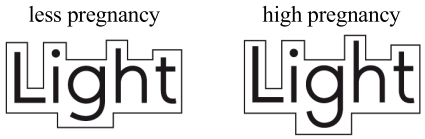

Fig. 10. Increasing pregnancy of a word image through extending its ascender and descender.

small lines attached to the end of a stem in a letter—create another impression as without. The here used typeface Times New Roman in the body text of this paper evoke other subjective feelings to the reader as a grotesque typeface as we see in Figure 10. Morphing a character shape could possibly adjust and effect the impressions of a typeface. Therefore in visual communication—with the aid of branding products with a clear identity—such adjustments are in the rarest cases desirable. It follows the conclusion, before we perform a character morphing, we must consider, if the process of morphing—depending on the given purpose—is located within the perception or outside of the perception of the reader.

C. Constrains according to a single character

Talking about legibility of a single character, we mean the distinctiveness of a character to other characters. How a character appears for the reader depends on his familiarization. It depends on individual capacity, cultural and social background and is formed by accordance within a society. In addition a well distinguishable character is also influenced by a clear construction and a consistent distribution of white space. The available white space is fixed in the vertical direction in contrary to the horizontal direction. A fixed height preserves the line height, which describes the distance from the baseline of the first text-line to the following, see Figure 5. Using white space in horizontal direction is more flexible, but effects the length of a text-line. The process of a continuously adjustment of a character shape does not follow the assumption to apply the same intensity of an adjustment on each character. For example increasing the stroke weight of the character 'S' is limited in its vertical direction in comparison to the character 'T' where more white space and less complexity exist.

D. Constrains according to an array of characters

Adjustments of character shapes could improved its legibility under particular situations. But, of course, not any adjustment makes sense in any situation. Besides the kind of media, context and personal conditions of the reader, the kind of textual visualization itself influence which adjustments are acceptable. Adjustment of the width of one character in a longer reading text is undesirable, because increasing the length of each line could break the layout and interrupt the reading process. Contrary to a long reading text, using characters on digital posters as a key visual doesn't require a high stringency as in longer text passages. The main purpose is here to generate attention and to widely spread information in public space.

Due to redundancy not every piece of information is required to decode the words successfully. In a chain of characters some characters or even specific forms of character shapes are more sufficient to receive a typographical information. The sequence of characters requires a particular white space, which is limited by the height and width of a format. Responsiveness of a character shape could benefit from a more or less transformation against other characters to preserve the whole information after the adjustment.

V. Responding Possibilities

While *responsive design* mainly considers the characteristics of the *displaying media*—size, resolution, aspect ratio, shape and orientation—in *responsive type* we focus on characteristics of the *reader*—reading experience (corresponding well to age), position, a-priori knowledge, cognitive capabilities, physical conditions and cultural background. In the following subsections we demonstrate how the shape of the characters can change according to a selection of these properties.

A. Refering to Shannon's Information Theory

Shannon's theory [27] is concerned with finding methods, dubbed codes, to increase the efficiency and to reduce the error rate of communication over a distorted channel. These codes can be roughly subdivided into *source coding* (data compression) and *channel coding* (error-correction) techniques. In contrast to Shannon's information theory, which has been developed for technical systems, its application to *responsive type* has to consider the abilities and expectations of the reader (a human being).

Assuming that readers are not willing to change their hardly learned codes (the characters), the goals of responsive type can be formulated

- to optimize the provided information to better fit to the abilities of the receiver and
- to compensate for 'channel' errors without altering the expectations of the receiver.

While in vision channel compensation for the human receiver, to the best of our knowledge, has not been used it is applied in audio already for decades [28] using inverse digital filters (finding a 'good' inverse impulse response, however, is a non-trivial task [29]). This requires to change the shape of the characters

- to support the abilities of the receiver and
- to be perceived by the receiver as close as possible to their undistorted counterpart.

B. Source Coding

Every human being has its own needs according to physical and psychic conditions. Those conditions are not of a constant nature, but even anatomy, culture, cognitive possibilities are changing over lifetime [30]. The human ability to focus an image decreases for elderly people. Nevertheless the perceptual sense always depends on the constitution of human (daytime, allocation of attention, etc.). Objective studies eclipse the fact that the condition of a human being is always relative and never absolute.

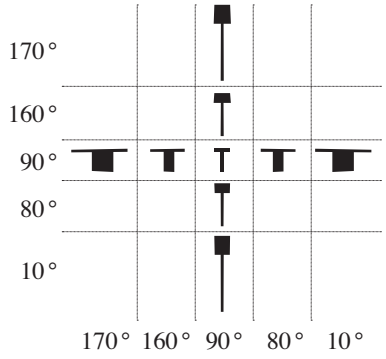

Fig. 11. Changed character shape to compensate for particular viewing angles.

Responding to Reading Experience (Age): Legible character shapes are based on specific habitual parameters, which depend on reading culture [31, p. 37]. Individuals who learn reading need a more pregnancy word image than readers with significant reading experience, because they have already internalized it [Section III-A]. To assist on that circumstance the word image could respond to the age of the reader, which usually corresponds well with the skill of reading, by a more or less profound word image. Raising the descender and ascender for younger people supports them in reading. Reducing descender and ascender for older people offers the benefit to place more text (of the same size) on the same space, because the line-height could be reduced too. Referring once again to Figure 10 we can see the different perception between a lower and higher pregnancy of a word image.

C. Channel Coding

Reading is affected by different transformations caused by the channel including the

- *perspective* such as position, orientation, reading distance,
- *displaying media*—whether digital or analogue—such as bended material and screen properties, and
- *eyesight* such as being shortsighted.

Responding to Perspective: Even though conceptualized as 'flat' two dimensional images typographic characters undergo a three dimensional transformation stemming from the perspective and, in some cases, the displaying media. These transformations decrease the distinctiveness of the given characters. To preserve legibility the shape of the characters can be adjusted to compensate for the *keystone effect* [32] using anamorphic mapping [33]. How the character shape has to be changed according to a particular viewing angle is demonstrated in Figure 11.

Responding to Eyesight: Visual perception enables human being the elementary ability to read typographic signs. As other physical abilities the visual organ is subjected by an aging process. All fields of visual communication are originate on an average 'normal' human, although we know about their uniqueness and individual habits. Following transformation is devoted to *emmetropia*—an error in focusing of light by the eye and reason for decrease visual acuity.

Through the transformation of a character shape we could improve their legibility without using optical equipment or by increasing the font size which might be less practical, because the available size of output media is commonly fixed. To apply legibility through a transformation in shape it has to be assumed that the respective output device knows about the seeing disorder (such as the dioptre) of the reader. The left 'Y' in Figure 12 shows a common shape for a normal visual acuity and its visual impression under blurriness (of course a blur filter is only a rough approximation of a seeing disorder). The character shape of the right example was designed for a person with emmetropia, which—under blurriness—persists a more distinctive character shape. Figure 13 demonstrates the effect of different blur factors for normal and optimized (for blur factor 50) character shapes for the word hotkey.

To avoid distracting the reader by unusual characters, like the character 'Y' on the right side of Figure 12, the shapes have to be morphed responding to the readers current state: Is the reader wearing optical equipment like glasses? Are these perfectly corrected? The perceived sharpness does not only depend on the dioptre but also on the actual distance between the text and the reader.

VI. Experiments

The simple possibility to be able to do something, of course, does not justify that it has to be done. In this section we support how this new possibilities of responsive type can be used to good effect by objective and subjective measures.

The participants of our user study were randomly selected volunteers. In total 24 participants (11 female, 17 male; age from 21 to 57; mean 30) were exposed to responsive type and asked to fill out a questionnaire. The score, followed the rules of a forced choice Likert scale, ranged from (1) *strongly agree*, (2) *agree*, (3) *neutral*, (4) *disagree* to (5) *strongly disagree*.

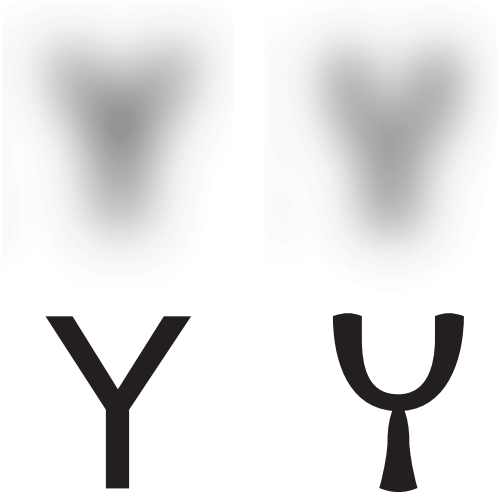

Fig. 12. On the left side a 'Y' designed for a normal visual acuity. The right side shows the same character but designed for low acuteness without using optical equipments.

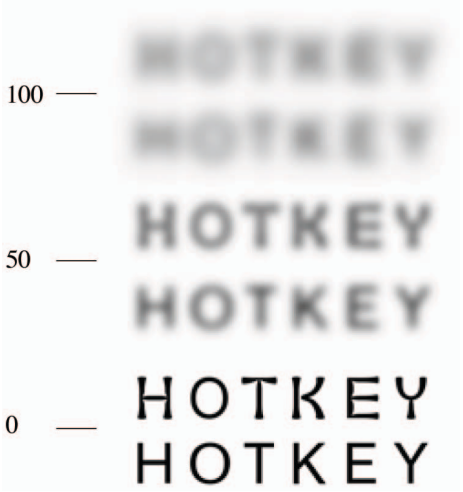

Fig. 13. Effects of different blur factors for normal and optimized (for blur factor 50) character shapes for the word hotkey.

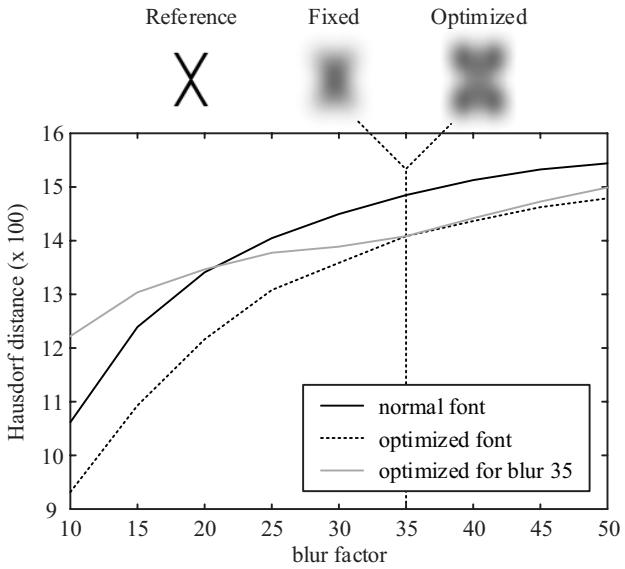

Fig. 14. Hausdorff distance for original and optimized characters.

A. Acceptance

The question if responsive type is useful for several applications has been answered by most participants positively with an average score of 1.38 (variance 0.55)—only one person disagreed and two were neutral.

B. Readability and Legibility

Readability and legibility are defined by a couple of factors. To measure the similarity between distorted and original characters we have used objective and subjective methods.

Similarity Between Distorted and Original Character: To determine the degree of resemblance between two objects that are superimposed on one another we have used the *Hausdorff distance* [34]. We compared *blurred* images of the original character and the responsive character (adjusted to the respective blur level) to the images of the original character. Figure 14 presents the results of these experiments. We see that the responsive character can provide a much lower Hausdorff distance than the original character. This states that responsive type can better maintain the shape of a character. It is also interesting to note that a wrong optimization can lead to results which can be worse than the original character. This effect is for instance present for low blur factors if a character has been optimized for a high blur factor. Figure 14 demonstrates this effect where the visual representation is optimized for a blur value of 35 and applied over all blur factors. We observe that the character optimized to a blur value of 35 is doing better for blur values of 20 and above but cannot match the results of the unchanged font for values below 20.

Classification Accuracy: To measure classification accuracy we let the participants read randomly chosen characters under different blur factors. No errors have been made for blur factors 20 and 30. This changed for a blur factor of 40, here we observed an error rate of 1.5% for fixed and 0.7% for optimized character shapes. A blur factor of 50 resulted in error rates of 28.1% for fixed and 20.0% for optimized character shapes. Optimizing the shape, therefore, can help to improve the readability of characters.

Legibility and Reading Habit: To measure legibility we compared three different type sets and let the participants decide which one would be preferred for particular blur values. Comparing the results in Figure 15 we observe that for high blur values people prefer responsive types (manually and automatically optimized) while for lower values people preferred fixed types. What form is closer to the reading habit is not answered as uniformly as for legibility, see Figure 16. But the same trend can be observed: for high blur values people prefer responsive types while for lower values people prefer fixed types.

Comparing the preference for legibility as well as reading habit between the two different responsive type optimization approaches we observe that the automatically optimized shape, according to the Hausdorff distance, is preferred in all cases except for blur value 30. This result can be explained by the fact that the process of optimizing the Hausdorff distance by a random walk cannot guarantee to find a global optimum and might get stock in a local optimum. We expect to get better results by using more sufficient optimization approaches.

VII. Review and Outlook

We introduced a new concept to perceive information in written form: Instead of treating the single character as an unchangeable property we let the single character change its shape according to various conditions while maintaining its individual and discriminative identity. We gave three examples where responsive type can be used to good effect. It was demonstrated by objective and subjective measures that readability and legibility can be improved. In addition we

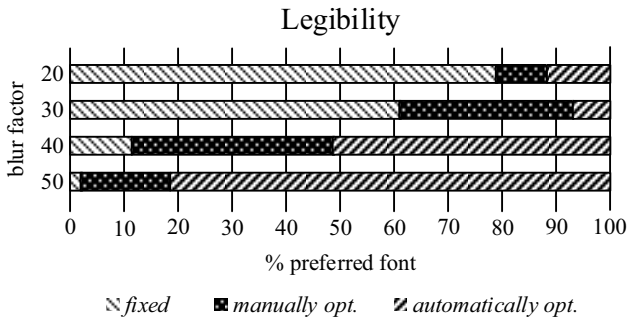

Fig. 15. Legibility for fixed type and two versions of responsive type (manually and automatically optimized).

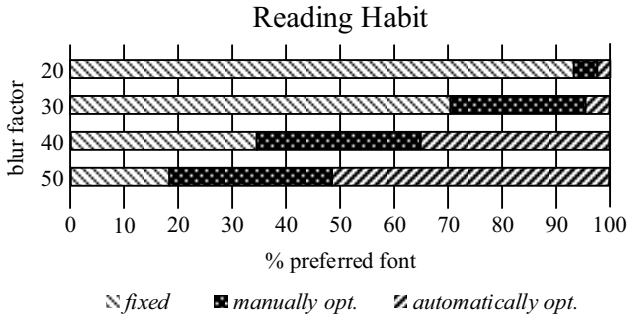

Fig. 16. Reading habit for fixed type and two versions of responsive type (manually and automatically optimized).

demonstrated that responsive type even better fits the reading habit under certain conditions.

Future work can point into different directions. Additional distortions can be compensated which we have not addressed in this publication including for instance bended materials or different velocities between the reader and information (e.g. traffic signs). Using the Hausdorff distance as an objective function to optimize the shape of the characters was able to improve the similarity between the original character and the character under distortion. This optimization—by visual inspection—is leading to character shapes which seems to have additional optimization potentials.

A demonstration system will be shown at the 'Infosphere' exhibition at the Center for Art and Media (ZKM) Karlsruhe at the end of 2015. There the approach of responsive type will be made accessible to a broad audience. By observing the reactions of the audience we hope to get additional insights.

REFERENCES

[1] R. Kinross, *Modern Typography*. London: Hyphen Press, 2010, vol. 2.

[2] J. Needham and T. Tsuen-Hsuin, *Chemistry and Chemical Technology, Paper and Printing*, ser. Science and Civilisation in China. Cambridge University Press, 1985, vol. 5, no. 1.

[3] E. C. Berkeley, "Secretaries Get a Computer of their Own to Automate Typing, Computers and Automation," in *Computers and Automation*, vol. 18, no. 1, January, 1969, Retrieved 10 September 2013, p. 59.

[4] P. Shaw, "Codex: The Journal of Letterforms," in *The Menhart Issue*. John Boardley, 2012.

[5] J. Lee, S. Jun, J. Forlizzi, and S. E. Hudson, "Using Kinetic Typography to Convey Emotion in Text-Based Interpersonal Communication," in *The 6th conference on Designing Interactive systems*. ACM, 2006.

[6] R. Rashid, Q. Vy, R. Hunt, and D. I. Fels, "Dancing with Words: Using Animated Text for Captioning," *Intl. Journal of Human–Computer Interaction*, vol. 24, no. 5, pp. 505–519, 2008.

[7] M. Wölfel, A. Stitz, and T. Schlippe, "A Voice Driven Type Design Demo," in *Proceedings of Mensch und Computer*. Gesellschaft für Informatik e.V., 2015.

[8] L. L. Rezabek and J. J. Cochenour, "Visual Cues in Computer-Mediated Communication: Supplementing Text with Emoticons," *Journal of Visual Literacy*, vol. 18, no. 2, 1998.

[9] T. Ganster, S. C. Eimler, and N. C. Krämer, "Same same but different!? the differential influence of smilies and emoticons on person perception," *Cyberpsychology, Behavior, and Social Networking*, vol. 15, no. 4, pp. 226–230, 2012.

[10] T. Koda, "Interpretation of emotionally expressive characters in an intercultural communication," in *Knowledge-Based Intelligent Information and Engineering Systems*. Springer, 2004, pp. 862–868.

[11] E. Marcottes. (2010) Responsive Webdesign In A List Apart. [Online]. Available: http://alistapart.com/article/responsive-web-design

[12] E. Marcotte, *Responsive Webdesign*. A Book Apart, 2011.

[13] M. Wölfel, "Interacting With Ads in Hybrid Urban Space," in *Cyberworlds 2014*, 2014.

[14] N. Negroponte, *The Architecture Machine: Toward a More Human Environment*. The MIT Press, Jnauary 1975.

[15] T. Ahrens and S. Mugikura, *Size-specific Adjustments to Type Designs*. Just Another Foundry, 2014.

[16] Spritz Technology, Inc. (2014). [Online]. Available: http://www.spritzinc.com/the-science/

[17] D. B. Updike, *Printing types, their history, forms and use, a study in survivals*. Geoffrey Cumberlege, Oxford University Press, London, 1922, vol. 2.

[18] P. Bickham, *The universal penman, engraved by George Bickham*. Snowball Publishing, 2012.

[19] R. Klanten, M. Mischler, S. Bilz, and N. Thoenen, *Type One*. Berlin: Die Gestalten Verlag, 2004.

[20] J. Tschichold, *Meisterbuch der Schrift*. Hamburg: Nikol Verlagsgesellschaft, 2011, vol. 3.

[21] F. Smijers, *Counterpunch, Making Type In The Sixteenth Century, Designing Typeface Now*. London: Hyphen Press, 2011, vol. 2.

[22] G. Unger, *Wie man's liest*. Sulgen: Niggli, 2006.

[23] A. W. Inhoff and K. Rayner, *Das Blickverhalten beim Lesen*. Berlin/New York: Günther, Harmut/Ludwig, Otto, 1996.

[24] J. Hochuli, *Das Detail in der Typografie*. Niggli, 2011.

[25] FontLabStudio, *Next Generation professional Font Editor — Postscript, Truetype, Unicode, Opentype, User's Manual for Macintosh*. Fontlab, Ltd, 2006.

[26] P. Karow, *Schrifttechnologie, Methoden und Werkzeuge*. Springer Verlag, 1992.

[27] C. E. Shannon, "Communication theory of secrecy systems," *Bell system technical journal*, vol. 28, no. 4, pp. 656–715, 1949.

[28] R. Genereux, "Signal processing considerations for acoustic environment correction," in *Audio Engineering Society Conference: UK 7th Conference: Digital Signal Processing (DSP)*, Sep 1992. [Online]. Available: http://www.aes.org/e-lib/browse.cfm?elib=6164

[29] M. Wölfel and J. McDonough, *Distant Speech Recognition*. John Wiley & Sons, 2009.

[30] S. V. Saxon, M. J. Etten, and E. A. Perkins, *Physical Change and Aging: A Guide for the Helping Professions*. Springer Publishing Company, LLC, 2010.

[31] J. Bergerhausen and S. Poarangan, *decodeunicode – Die Schriftzeichen der Welt*. Verlag Hermann Schmidt Mainz, 2011.

[32] R. Raskar, "Oblique projector rendering on planar surfaces for a tracked user," in *Proc. of SIGGRAPH*, vol. 99, 1999, p. 260.

[33] R. Kingslake, *Optics in Photography*. Published by SPIE—The International Society for Optical Engineering, 1992.

[34] D. P. Huttenlocher, G. A. Klanderman, and W. J. Rucklidge, "Comparing images using the Hausdorff distance," *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, vol. 15, no. 9, pp. 850–863, 1993.