Stranger Screens: Exploring the Application Themes for Interactive Freeform Devices

Marcos Serrano
IRIT- University of Toulouse
France

Andrés Lucero
Aalto University
Finland

Pourang Irani
University of Manitoba
Canada

Anne Roudaut
University of Bristol
United Kingdom

ABSTRACT

Advanced technologies are increasingly enabling the creation of freeform devices: interactive devices with non-rectangular form-factors. We explore the applications they inspire and how users may interact with such freeform devices. In a week-long design workshop, we invited non-specialist designers to invent freeform devices and reflect on their myriad form factors and the applications they engender. We clustered their concepts into Introspection, Community and Magic Exploration applications, allowing to understand the perspective of non-specialists on freeform devices in real life.

CCS CONCEPTS

• **Human-centered computing** → **Displays and imagers**; **Empirical studies in HCI**.

KEYWORDS

Freeform interfaces, design futuring

ACM Reference Format:
Marcos Serrano, Andrés Lucero, Pourang Irani, and Anne Roudaut. 2022. Stranger Screens: Exploring the Application Themes for Interactive Freeform Devices . In *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI '22 Extended Abstracts), April 29-May 5, 2022, New Orleans, LA, USA.* ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3491101.3519707

1 INTRODUCTION

The pervasive rectangular screen, which has dominated the display industry for decades is slowly giving room to a future in which devices and their displays may take any arbitrary shape. For example, it is now possible to manufacture displays having any 2D shape [9, 33], and circular displays are already available on many smartwatches. Devices with such non-traditional displays are commonly referred to as Freeform devices [30–32], as they can assume any non-planar and non-rectilinear shape. With this fundamental shift in display form factors, the looming question that arises for interaction designers includes how to integrate and take advantage of the non-rectilinearity of such interactive devices that may soon become common. Furthermore, opening the space of possible topologies for displays creates a tremendous need for understanding the interplay between shapes, interactions, applications and contexts.

Freeform devices take their roots in Shape-Changing (SCI) [1] and Organic User (OUI) Interfaces [15] but constitute a specific subcategory defined by their non-rectilinear nature. To date, characteristics of freeform devices and their supersets, including SCIs or OUIs, have been primarily defined by taxonomies driven by technological innovations [29, 36]. Previous explorations of the design space of such devices heavily focus on shape transformation, for example how a change in shape may relate to a user's emotions [35], input gestures [20] or interaction metaphors [28]. In contrast, little is known on how the non-rectilinearity of the display itself drives thematic applications on such devices.

In this paper, we address this gap by specifically examining freeform devices, or 'Stranger Screens', in the context of applications they benefit. This work takes a complementary approach to recent developments in freeform device research [31, 32, 34], that has involved limited perspectives beyond those of the research community. In contrast to past literature on SCIs, our work moves away from looking at the transformation of the devices and rather investigates the state of the device at a given time. In particular, we know little about how such displays may integrate into everyday lives through meaningful applications.

We adopt the established speculative design techniques used in HCI [5] to explore, in an unconstrained manner, how freeform devices could become part of our daily living. We carried this through an exploratory one-week long workshop where participants produced, in an unrestricted manner (to either technology or scenario), novel freeform devices. The goal was to imagine possible futures. The analysis of their creations unveiled three design axes behind the concept of freeform devices: Introspection, Community and Magic exploration. We believe that these concepts go beyond what current applications have proposed for typical usage of freeform devices and pave way for new usage directions.

'Stranger Screens' is an exploration of the potential impact that freeform devices can have on our everyday digital interactions. In this vein, our contribution consists of an understanding of inspirational application themes related to freeform devices.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.
CHI '22 Extended Abstracts, April 29-May 5, 2022, New Orleans, LA, USA
© 2022 Association for Computing Machinery.
ACM ISBN 978-1-4503-9156-6/22/04…$15.00
https://doi.org/10.1145/3491101.3519707

2 RELATED WORK

2.1 Freeform Interfaces

The term 'Freeform device" was used by Serrano et al. [31, 32] to refer to devices having a non-rectangular display. By extension, in this paper we consider a freeform device any device not having a rectangular shape, in contrast to current laptops or smartphones for instance. Research on Freeform devices has mostly focused on the design of non-rectangular content according to static shape features [31, 32, 34], or on how to dynamically organize its content according to the available display surface [25].

Freeform devices take their roots in Organic User (OUIs) and Shape-Changing (SCI) Interfaces. Researchers have produced a number of explorations on the design space of shape-changing interfaces or organic user interfaces. The common element among these explorations is their focus on the shape transformation [27]. Researchers have also investigated the best design approaches for ideating shape-changing devices. Rasmussen et al. [19, 28] investigated the use of sketches, Fuchs et al. [11] employed origami paper prototypes, Everitt et al. [8] conducted a deployment of a prototype in a public environment, while Sturdee et al. [38] first employed brainstorm sessions within a public engagement study, and later proposed an approach combining low-fidelity prototypes, high fidelity video footage, with end-user diagrams and scenario sketching [37].

However, previous work did not answer the question "how such shapes are influenced by specific applications", which is the goal of this work.

2.2 Design Futuring Approaches

In this paper we adopt a research method inspired by recent design futuring approaches [18], such as design fiction [4] and speculative design [5]. The common goal of these approaches is to use design methods to imagine alternative futures. These approaches are well suited to explore emerging technological concepts and their future adoption [21]: as such, design futuring has been applied to brain computer interaction [39], interaction with robots [2] or animal-computer interaction [14] among others. To our knowledge, such an approach has not been applied to the topic of freeform interfaces. The closest exploration we could find was the work by Rasmussen et al. [26] who present three speculative scenarios imagining the future of living with SCIs, again from a shape transformation perspective.

3 WORKSHOP: EXPLORING APPLICATIONS AND FORM FACTORS

To explore the topic of interactive freeform interfaces we faced the challenges involved with the nascent and emerging nature of such technologies. We adopted a Research through Design[1] (RtD) approach [10, 17, 40], where the act of designing is in itself a confrontation of various forms of knowledge, both formalized and experiential, which brings about new knowledge. This knowledge can for instance be generated by designing an artifact, by the artifact itself, and by evaluations of use, and later be generalized as design recommendations, theories or frameworks. We organized a one-week exploratory workshop to identify application ideas inspired by freeform devices.

Figure 1: Workshop participants used a variety of ideation tools, such as sketching, computer-aided design, crafting and video projection.

3.1 Method

The workshop involved 12 students (10F/2M, 21 years old on average) from a Master course on design at the University of Toulouse (France). Students had no previous knowledge of HCI. Students were supervised by two senior external designers (i.e. not teaching in their course). We decided to carry out a long duration workshop as this gives the participants time to really expand on their ideas. The workshop spanned over five full days, from Monday to Friday.

3.1.1 Monday: Introduction. The first day consisted of a set of seminars given by different individuals related to the perspectives on Stranger Screens: three researchers in HCI working on non-rectangular interfaces [32], spatial immersive analytics [6] and authoring tools for designers [24]; a collector of old screens and displays; as well as the two designers that supervised the rest of the workshop. Each of the presenters showed slides and video examples related to their topic.

3.1.2 Tuesday-Thursday: Design Rounds. From Tuesday to Friday, the students worked in groups on their projects. The 12 students could organize into groups as they wanted: 8 of them formed 4 groups of 2 students, while the other 4 students worked individually. The schedule was similar each day: each group met the supervisors once in the morning, and had to present their daily advances to everyone else by the end of the day. All the ideas came from the participants, and were refined through iterations with the two supervising senior designers (graphic and UX designers). During these three days, all participants shared the same space, a large prototyping room (i.e. with a few scattered chairs and tables), that they could rearrange if needed. The room included a fabrication workbench with multiple craft tools. They could also use videoprojectors as well as their personal laptops (all of them had a version of Adobe Creative Suite).

3.1.3 Friday: Idea Sharing. The last day of the workshop consisted in a group presentation of the resulting design artifacts. For each project, the participants presented the final prototype, as well as contextual illustrations, mind maps with the main themes, and the intermediate prototypes and drawings (which were hung up on the wall behind the final prototype).

3.2 Data Collection and Analysis

For each project, we collected a written essay by the participants describing their project in their own words; a set of pictures of the final prototype; as well as pictures of the design process (see Figure

[1] https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/research-through-design

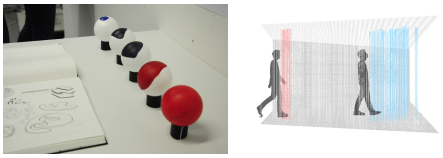

Figure 2: Some projects shared elements of intimacy (Introspection theme), as in Flux and Game Shower.

1). In total, we collected and analyzed 212 photos. Two researchers carried a thematic analysis of the projects using both pictures and text, refined by using affinity diagrams [22], to find the main themes that emerged from the design process. This followed a process of developing from lower level codes to higher level themes. A first coder proceeded to create initial codes that were refined with the other coder, before coding all the projects and proceeding to the grouping by themes.

3.3 Results

Our analysis revealed three main themes, that we describe hereafter and illustrate with the different projects.

3.3.1 Theme 1: Introspection (Intimacy). We tagged the first theme, Introspection, on three of the presented projects: Flux, Game Shower and Monocle. These projects share elements of intimacy in terms of being directly related with or coming in close contact with one's body.

Flux is a spherical object that displays the evolution of the menstrual cycle through a colorful wave (Figure 2 - left). Flux creators said the following regarding their idea: *"Menstruation is invisible in our society and the project FLUX, through an offbeat object, intends to make them visible and normal."* Softly caressing the sphere with a hand allows to reveal precise information, thus increasing a woman's awareness of their menstrual cycle. This design contrasts with menstrual tracking phone apps, that tend to use stereotypical feminine attributes, such as using the color pink or flowers, and that unveil concerns about accidentally disclosing the cycle [7].

Game Shower is an interactive device for showers in public swimming pools (Figure 2 - right). A game is projected onto the water of the shower where users pass through, thus effectively turning an ordinary shower into a shower display that covers one's body. This idea is related to the interactive water surface of the AquaTop display [16], that uses the water surface of the bathroom to project information.

Monocle is a portable video-guide intended for museums that one straps onto their forehead. Its creators describe Monocle as such: *"The curved form of the device, like a hand mirror, will appear to the visitor like a second face that initiates a discussion, like a speech bubble."* This project extends other see-through displays [13] by focusing on the overall shape of the display and the handle.

Overall, these projects employ the freeform shape to get the device in close contact with one's body: the spherical shape of Flux can be caressed, the water in Game Shower covers one's skin, and the curved form of Monocle can be grasped like a hand mirror.

3.3.2 Theme 2: Community. We tagged the second theme, Community, on four of the presented projects: Pass the Sound, Internal Tissue, Focus, and Nautical Mile. The common thread among these ideas is a multi-user and caring-for-others aspect, be it another person, an animal, or the environment.

Pass the Sound is a project that deals with group music listening practices (Figure 3 - left). It consists of a set of screens that can be separated, or collated to collect something [12]. Its creators describe their idea like this: *"[Pass the Sound] is a neutral support that allows people to have common access to a music library. It's a way to listen to music together, in a more equitable way."*

Focus is a device that allows an animal to be brought back to the owner in case the animal is lost and found by a stranger. This is how its creators describe the idea: *"A QR code contains the coordinates of the owner in order to be able to contact if the animal is found."*

Finally, Nautical Mile is a professional exploration instrument for students (Figure 3 - right). *"At the end of the game, students use sonar to keep memories of the discussion when meeting with the person."*

3.3.3 Theme 3: Magic Exploration. We identified the third and final theme, Magic Exploration, based on these three projects: the aforementioned Flux, Imaginarium and Monocle. These three ideas share the notion of augmenting a person's senses and abilities, allowing them to see and access information that would otherwise not be available to them.

First, the aforementioned Flux project uses the metaphor of a crystal ball [3] to tell the future of the menstrual cycle, or in this case, revealing information that is normally hidden. Its creators describe Flux thusly, *"by bringing the crystal ball closer to the digital screen, it is a question of associating the technology with a form of magic."*

Imaginarium is a parabolic screen for kids in hospitals (Figure 4 - left). As per the authors, *"the shape has been chosen to offer an immersive journey through different universes, like a window or an escape from the hospital."*

Finally, the aforementioned Monocle (Figure 4 - right) is a device that gives its user some sort of superpowers. Their authors say, *"it enriches and enhances the reality."*

3.4 Summary

This exploratory workshop revealed some inspirational themes that emerge from the concept of Stranger Screens. In addition, it suggests a number of possible domains, applications, shapes, ways to interact, and multi-user scenarios, among other things.

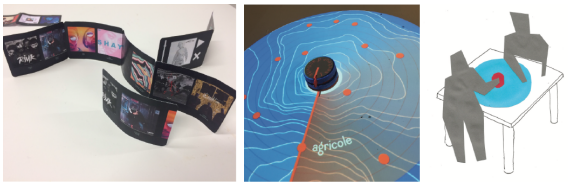

Figure 3: A common thread among some ideas is a multi-user and caring-for-others aspect (Community theme), as in Pass the Sound (left) and Nautical Mile (center and right).

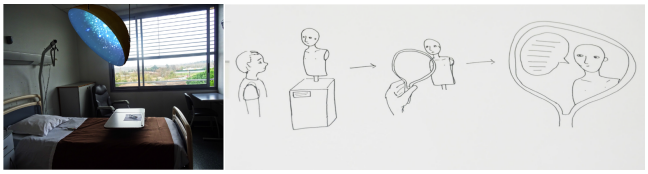

Figure 4: Some ideas share the notion of augmenting a person's senses and abilities (Magic Exploration theme), as in Imaginarium (left) and Monocle (right).

4 DISCUSSION AND FUTURE WORK

In this section we discuss our results in light of our goal which was to explore application themes inspired by freeform displays. We particularly discuss the differences we found with previous work that were more technologically driven and highlight directions for future work.

Our study unveiled three inspirational themes imagined by non-specialist designers for freeform devices: introspection, community and magic exploration. It is interesting to note that these themes differ considerably from those mentioned by prior work on freeform devices [31, 32]. The main application scenarios of these previous work were in-vehicle displays, pocket devices, non-rectangular furniture such as cooktops and road signs. In contrast, non-specialist designers placed more emphasis on the *Why* (i.e. what is the design/usage implication of freeform shapes), rather than on the *Where* (i.e. where can a freeform shape fit in our environment).

In the future, we plan to explore the freeform devices imagined by non-specialist designers. However, since these devices have a variety of form factors, we will need to adopt approaches that could better fit the scale and characteristics of these ideas, such as bodystorming or play acting [23]. We plan to develop design probes corresponding to the proposed ideas of handheld devices. We will carry both controlled studies on the dexterity and discoverability of such devices, as well as longitudinal studies similar to [8] so that we can investigate the practicality of freeform devices.

ACKNOWLEDGMENTS

This work was supported by the ANR JCJC PERFIN grant (ANR-18-CE33-0009). We thank Anthony Masure and all the students of the Masters program on *Transdisciplinary design, cultures and territories from the University of Toulouse.*

REFERENCES

[1] Jason Alexander, Anne Roudaut, Jürgen Steimle, Kasper Hornbæk, Miguel Bruns Alonso, Sean Follmer, and Timothy Merritt. 2018. Grand Challenges in Shape-Changing Interface Research. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (Montreal QC, Canada) *(CHI '18)*. ACM, New York, NY, USA, Article 299, 14 pages. https://doi.org/10.1145/3173574.3173873

[2] James Auger. 2014. Living with Robots: A Speculative Design Approach. *J. Hum.-Robot Interact.* 3, 1 (Feb. 2014), 20–42. https://doi.org/10.5898/JHRI.3.1.Auger

[3] Hrvoje Benko, Andrew D. Wilson, and Ravin Balakrishnan. 2008. Sphere: Multi-touch Interactions on a Spherical Display. In *Proceedings of the 21st Annual ACM Symposium on User Interface Software and Technology* (Monterey, CA, USA) *(UIST '08)*. ACM, New York, NY, USA, 77–86. https://doi.org/10.1145/1449715.1449729

[4] Paul Coulton, Joseph Galen Lindley, Miriam Sturdee, and Michael Stead. 2017. Design fiction as world building. (2017).

[5] Anthony Dunne and Fiona Raby. 2013. *Speculative Everything: Design, Fiction, and Social Dreaming.* The MIT Press.

[6] Barrett Ens and Pourang Irani. 2017. Spatial Analytic Interfaces: Spatial User Interfaces for In Situ Visual Analytics. *IEEE Comput. Graph. Appl.* 37, 2 (March 2017), 66–79. https://doi.org/10.1109/MCG.2016.38

[7] Daniel A. Epstein, Nicole B. Lee, Jennifer H. Kang, Elena Agapie, Jessica Schroeder, Laura R. Pina, James Fogarty, Julie A. Kientz, and Sean Munson. 2017. Examining Menstrual Tracking to Inform the Design of Personal Informatics Tools. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (Denver, Colorado, USA) *(CHI '17)*. ACM, New York, NY, USA, 6876–6888. https://doi.org/10.1145/3025453.3025635

[8] Aluna Everitt, Faisal Taher, and Jason Alexander. 2016. ShapeCanvas: An Exploration of Shape-Changing Content Generation by Members of the Public. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (San Jose, California, USA) *(CHI '16)*. ACM, New York, NY, USA, 2778–2782. https://doi.org/10.1145/2858036.2858316

[9] Folium. 2019. *Folium Optics.* http://www.foliumoptics.com, last access Sept. 2019.

[10] Christopher Frayling. 1993. Research in Art and Design. *Royal College of Art Research Papers* (1993).

[11] Alexandra Fuchs, Miriam Sturdee, and Johannes Schöning. 2018. Foldwatch: Using Origami-inspired Paper Prototypes to Explore the Extension of Output Space in Smartwatches. In *Proceedings of the 10th Nordic Conference on Human-Computer Interaction* (Oslo, Norway) *(NordiCHI '18)*. ACM, New York, NY, USA, 47–59. https://doi.org/10.1145/3240167.3240173

[12] Alix Goguey, Cameron Steer, Andrés Lucero, Laurence Nigay, Deepak Ranjan Sahoo, Céline Coutrix, Anne Roudaut, Sriram Subramanian, Yutaka Tokuda, Timothy Neate, Jennifer Pearson, Simon Robinson, and Matt Jones. 2019. PickCells: A Physically Reconfigurable Cell-composed Touchscreen. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (Glasgow, Scotland Uk) *(CHI '19)*. ACM, New York, NY, USA, Article 273, 14 pages. https://doi.org/10.1145/3290605.3300503

[13] Juan David Hincapié-Ramos, Sophie Roscher, Wolfgang Büschel, Ulrike Kister, Raimund Dachselt, and Pourang Irani. 2014. cAR: Contact Augmented Reality with Transparent-Display Mobile Devices. In *Proceedings of The International Symposium on Pervasive Displays* (Copenhagen, Denmark) *(PerDis '14)*. ACM, New York, NY, USA, Article 80, 6 pages. https://doi.org/10.1145/2611009.2611014

[14] Ilyena Hirskyj-Douglas and Andrés Lucero. 2019. On the Internet, Nobody Knows You're a Dog... Unless You're Another Dog. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (Glasgow, Scotland Uk) *(CHI '19)*. Association for Computing Machinery, New York, NY, USA, 1–12. https://doi.org/10.1145/3290605.3300347

[15] David Holman and Roel Vertegaal. 2008. Organic User Interfaces: Designing Computers in Any Way, Shape, or Form. *Commun. ACM* 51, 6 (June 2008), 48–55. https://doi.org/10.1145/1349026.1349037

[16] Hideki Koike, Yasushi Matoba, and Yoichi Takahashi. 2013. AquaTop Display: Interactive Water Surface for Viewing and Manipulating Information in a Bathroom. In *Proceedings of the 2013 ACM International Conference on Interactive Tabletops and Surfaces* (St. Andrews, Scotland, United Kingdom) *(ITS '13)*. ACM, New York, NY, USA, 155–164. https://doi.org/10.1145/2512349.2512815

[17] Ilpo Koskinen, John Zimmerman, Thomas Binder, Johan Redstrom, and Stephan Wensveen. 2011. Design Things: Models, Scenarios, Prototypes. In *Design research through practice: From the Lab, Field, and Showroom.* https://doi.org/10.1016/B978-0-12-385502-2.00008-0

[18] Sandjar Kozubaev, Chris Elsden, Noura Howell, Marie Louise Juul Søndergaard, Nick Merrill, Britta Schulte, and Richmond Y. Wong. 2020. Expanding Modes of Reflection in Design Futuring. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (Honolulu, HI, USA) *(CHI '20)*. Association for Computing Machinery, New York, NY, USA, 1–15. https://doi.org/10.1145/3313831.3376526

[19] Matthijs Kwak, Kasper Hornbæk, Panos Markopoulos, and Miguel Bruns Alonso. 2014. The Design Space of Shape-changing Interfaces: A Repertory Grid Study. In *Proceedings of the 2014 Conference on Designing Interactive Systems* (Vancouver, BC, Canada) *(DIS '14)*. ACM, New York, NY, USA, 181–190. https://doi.org/10.1145/2598510.2598573

[20] Byron Lahey, Audrey Girouard, Winslow Burleson, and Roel Vertegaal. 2011. PaperPhone: Understanding the Use of Bend Gestures in Mobile Devices with Flexible Electronic Paper Displays. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Vancouver, BC, Canada) *(CHI '11)*. ACM, New York, NY, USA, 1303–1312. https://doi.org/10.1145/1978942.1979136

[21] Joseph Lindley, Paul Coulton, and Miriam Sturdee. 2017. Implications for Adoption. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (Denver, Colorado, USA) *(CHI '17)*. Association for Computing Machinery, New York, NY, USA, 265–277. https://doi.org/10.1145/3025453.3025742

[22] Andrés Lucero. 2015. Using Affinity Diagrams to Evaluate Interactive Prototypes. In *Human-Computer Interaction – INTERACT 2015*, Julio Abascal, Simone Barbosa, Mirko Fetter, Tom Gross, Philippe Palanque, and Marco Winckler (Eds.). Springer International Publishing, Cham, 231–248. 10.1007/978-3-319-22668-2_19

[23] Andrés Lucero, Kirsikka Vaajakallio, and Peter Dalsgaard. 2012. The dialogue-labs method: process, space and materials as structuring elements to spark dialogue in co-design events. *CoDesign* 8, 1 (2012), 1–23.

[24] Nolwenn Maudet, Ghita Jalal, Philip Tchernavskij, Michel Beaudouin-Lafon, and Wendy E. Mackay. 2017. Beyond Grids: Interactive Graphical Substrates to Structure Digital Layout. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (Denver, Colorado, USA) *(CHI '17)*. ACM, New York, NY, USA, 5053–5064. https://doi.org/10.1145/3025453.3025718

[25] Aziz Niyazov, Nicolas Mellado, Loic Barthe, and Marcos Serrano. 2021. Dynamic Decals: Pervasive Freeform Interfaces Using Constrained Deformable Graphical Elements. *Proc. ACM Hum.-Comput. Interact.* 5, ISS, Article 493 (nov 2021), 27 pages. https://doi.org/10.1145/3488538

[26] Majken Kirkegård Rasmussen and Fabian Hemmert. 2019. Envisioning Future Challenges and Possibilities for Shape-Changing Interfaces through Speculative Scenarios. In *Proceedings of Mensch Und Computer 2019* (Hamburg, Germany) *(MuC'19)*. Association for Computing Machinery, New York, NY, USA, 487–492. https://doi.org/10.1145/3340764.3344444

[27] Majken K. Rasmussen, Esben W. Pedersen, Marianne G. Petersen, and Kasper Hornbæk. 2012. Shape-changing Interfaces: A Review of the Design Space and Open Research Questions. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Austin, Texas, USA) *(CHI '12)*. ACM, New York, NY, USA, 735–744. https://doi.org/10.1145/2207676.2207781

[28] Majken K. Rasmussen, Giovanni M. Troiano, Marianne G. Petersen, Jakob G. Simonsen, and Kasper Hornbæk. 2016. Sketching Shape-changing Interfaces: Exploring Vocabulary, Metaphors Use, and Affordances. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (San Jose, California, USA) *(CHI '16)*. ACM, New York, NY, USA, 2740–2751. https://doi.org/10.1145/2858036.2858183

[29] Anne Roudaut, Abhijit Karnik, Markus Löchtefeld, and Sriram Subramanian. 2013. Morphees: Toward High "Shape Resolution" in Self-actuated Flexible Mobile Devices. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Paris, France) *(CHI '13)*. ACM, New York, NY, USA, 593–602. https://doi.org/10.1145/2470654.2470738

[30] Marcos Serrano, Jolee Finch, Pourang Irani, Andres Lucero, and Anne Roudaut. 2022. Mold-It: Understanding how Physical Shapes affect Interaction with Handheld Freeform Devices. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (New Orleans, LA, USA) *(CHI '22)*. ACM, New York, NY, USA. https://doi.org/10.1145/3491102.3502022

[31] Marcos Serrano, Anne Roudaut, and Pourang Irani. 2016. Investigating Text Legibility on Non-Rectangular Displays. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (San Jose, California, USA) *(CHI '16)*. ACM, New York, NY, USA, 498–508. https://doi.org/10.1145/2858036.2858057

[32] Marcos Serrano, Anne Roudaut, and Pourang Irani. 2017. Visual Composition of Graphical Elements on Non-Rectangular Displays. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (Denver, Colorado, USA) *(CHI '17)*. ACM, New York, NY, USA, 4405–4416. https://doi.org/10.1145/3025453.3025677

[33] Sharp. 2019. *Sharp Free-Form Display*. https://www.sharpsma.com/free-form-display, last access Sept. 2019.

[34] Florine Simon, Anne Roudaut, Pourang Irani, and Marcos Serrano. 2019. Finding Information on Non-Rectangular Interfaces. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (Glasgow, Scotland Uk) *(CHI '19)*. ACM, New York, NY, USA, Article 102, 8 pages. https://doi.org/10.1145/3290605.3300332

[35] Paul Strohmeier, Juan Pablo Carrascal, Bernard Cheng, Margaret Meban, and Roel Vertegaal. 2016. An Evaluation of Shape Changes for Conveying Emotions. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (San Jose, California, USA) *(CHI '16)*. ACM, New York, NY, USA, 3781–3792. https://doi.org/10.1145/2858036.2858537

[36] Miriam Sturdee and Jason Alexander. 2018. Analysis and Classification of Shape-Changing Interfaces for Design and Application-based Research. *ACM Comput. Surv.* 51, 1, Article 2 (Jan. 2018), 32 pages. https://doi.org/10.1145/3143559

[37] Miriam Sturdee, Aluna Everitt, Joseph Lindley, Paul Coulton, and Jason Alexander. 2019. Visual Methods for the Design of Shape-Changing Interfaces. In *Human-Computer Interaction – INTERACT 2019*, David Lamas, Fernando Loizides, Lennart Nacke, Helen Petrie, Marco Winckler, and Panayiotis Zaphiris (Eds.). Springer International Publishing, Cham, 337–358.

[38] Miriam Sturdee, John Hardy, Nick Dunn, and Jason Alexander. 2015. A Public Ideation of Shape-Changing Applications. In *Proceedings of the 2015 International Conference on Interactive Tabletops & Surfaces* (Madeira, Portugal) *(ITS '15)*. ACM, New York, NY, USA, 219–228. https://doi.org/10.1145/2817721.2817734

[39] Richmond Y. Wong, Nick Merrill, and John Chuang. 2018. When BCIs Have APIs: Design Fictions of Everyday Brain-Computer Interface Adoption. In *Proceedings of the 2018 Designing Interactive Systems Conference* (Hong Kong, China) *(DIS '18)*. Association for Computing Machinery, New York, NY, USA, 1359–1371. https://doi.org/10.1145/3196709.3196746

[40] John Zimmerman, Jodi Forlizzi, and Shelley Evenson. 2007. Research through Design as a Method for Interaction Design Research in HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (San Jose, California, USA) *(CHI '07)*. Association for Computing Machinery, New York, NY, USA, 493–502. https://doi.org/10.1145/1240624.1240704