doi:10.1093/iwc/iws001

Special Issue: Organic User Interfaces

Audrey Girouard[1,*], Roel Vertegaal[2] and Ivan Poupyrev[3]

[1]*Carleton University, Canada*
[2]*Human Media Lab, Queen's University, Canada*
[3]*Disney Research, USA*
**Corresponding author: audrey_girouard@carleton.ca*

Until recently, the ways in which we interacted with computers were limited by the flat, rigid and rectangular form factors of cathode-ray tubes and liquid crystal displays. Technical limitations forced user interfaces into boxes, limiting interactions to 2D pointing and keyboard input. With technological advances in flexible sensor and display technologies, we are experiencing a new revolution in human–computer interaction (HCI): one in which user interfaces can be worn on the body as if they were cloth, used in the office as if they were paper and used in architecture as if they were wallpapers (Co and Pashenkov, 2008; Buechley and Mellis, 2010; Lahey *et al.*, 2011). Rather than being rigid and static, the user interfaces of tomorrow will be able to have a shape that accommodates the user's context and fits the data on display. For instance, if a user wants to explore geographic information, they can use a spherical display that does not require distortion of the earth projection (Stevenson, 2010). When reading an interactive map, users can extend their mobile's screen real estate by unfolding their pocket-size flexible e-paper display.

We call such novel user interfaces as organic user interfaces (OUI): interfaces with non-flat multi-touch displays that can exist in both rigid or flexible form factors (Holman and Vertegaal, 2008; Vertegaal and Poupyrev, 2008). OUIs can have any shape that everyday products can have, and can potentially change shape: this flexibility can be driven by either user manipulation or actuators inside the display. OUIs are an interplay of computation and form through a renewed focus on computational materiality. OUIs are opening up unprecedented opportunities for innovation over the next decade of HCI that require us to re-examine and re-evaluate some of the most basic user interface design principles.

Following the significant interest resulting from the publication of the special issue of Communication of ACM on OUIs (Vertegaal and Poupyrev, 2008), the first workshop on OUIs and transitive materials at CHI 2009 (Coelho *et al.*, 2009) and the second workshop on OUIs at TEI 2011 (Girouard *et al.*, 2011), this special issue seeks to debate and develop further the concepts behind the OUI vision and stimulate research in related areas, such as in tangible, embedded and embodied interfaces. We invited researchers from a broad spectrum of disciplines to explore emerging materials, prototype next-generation interfaces, create tools to design OUIs and discuss the concept and future of this new interface paradigm.

With anthropomorphic resonances, Bongers (2013) presents a historical context of OUIs in art, architecture and design. Through a journey of his own work supplemented by broader discussion, Bongers examines the evolution of organic musical interfaces, liquid architecture and video-based projects. Bongers links human centred design—including human-shaped or anthropomorphic design—to the customized design for individuals. He observes that new techniques in design and 3D printing will allow for mass customization of products that meet individual needs.

Holman *et al.* (2013) outline the need for new methods of non-planar interactive design, which includes technologies for rapid hardware prototyping. The authors present SketchSpace, a system for sketching OUIs without hardware components to provide functional interactive behaviours to passive 3D objects. SketchSpace uses depth sensing and projection to provide a board range of sensors and interactions to common objects. Holman *et al.* concludes by discussing the concept of hyper-contextualized design, in which computational objects will have minimal, specialized interactive content pertaining to one particular task.

Zhu *et al.* (2013) offers a tool to support OUIs as well as a taxonomy of papercraft manipulation. They present two novel methods to provide multi-channel wireless power transfer in papercraft devices, through selective inductive power transmission. Their oscillation prototype can provide enough power to activate shape memory alloys and Nichrome wire, while their amplifier prototype can light up LEDs and heat thermochromic ink. This novel technology can wirelessly actuate folds in a paper substrate, to create wireless self-folding origami.

Through the exploration of MoleBot, a robotic tabletop creature, Lee *et al.* (2013) focus their research on the physical transformability of object surfaces. MoleBot suggests the presence of a mole that lives and moves under an interactive table surface, creating a molehill along its path. Located under a transformable surface made of thousands of vertical hexagonal pins, MoleBot offers to kinetically enhance a tabletop by providing information about the location of the mole. Through this organic deformation of the surface, MoleBot presents an example of a one-shape actuated surface. MoleBot combines OUIs with a ludic user experience.

AmbiKraft Byobu offers an ambient animation of the painted surface of a Japanese room divider, through changes in the temperature of thermochromic ink. With this non-emissive slow-colour changing fabric technology, Peris *et al.* (2013) illustrate the OUI principle of having *the input device be the output device*, as the fabric *is* the interactive display surface. AmbiKraft explores how to merge the boundaries between the physical and virtual, the static and dynamic and the material and immaterial.

Finally, Read *et al.* (2013) offer a first account of the integration of OUI in the design process. The authors discuss participatory design sessions with teenagers that aimed to create energy-aware OUIs. Through the exploration of methods for introducing OUI concepts, combined with sets of materials selected to foster organic designs, the authors paint an interesting portrait of the task of conveying OUI to the world. While their main criticism is the lack of a clear definition of OUI, impacting both how to convey the idea of OUI and how to interpret it, their results show that a majority of users added some element of an OUI to their designs. The article provides some of the groundwork for OUI-themed design studies.

ACKNOWLEDGEMENTS

We would also like to express our appreciation for the time and effort invested by the following reviewers: *Peter Bennett, Leo Bonanni, Angela Chang, Lois Frankel, Matthew Gardiner, Garth Griffin, Mona Leigh Guha, David Holman, Ali Israr, Yvonne Janssen, Sergio Jordan, Johan Kildal, Artur Lugmayr, Simon Olberding, Kas Oosterhuis, Anne Roudaut, Munehiko Sato, Jay Silver, Erin Solovey, Anna Vallgarda, Akira Wakita, Karl Willis*.

REFERENCES

Bongers, B. (2013) Anthropomorphic resonances: On the Relationship between Computer Interfaces and the Human Form and Motion. Interact. Comput. 25, 117–132.

Buechley, L. and Mellis, D. (2010) Living Wall: Programmable Wallpaper for Interactive Spaces. In *Proc. ACM Multimedia*, New York: ACM Press, pp. 1401–1402.

Co, E. and Pashenkov, N. (2008) Emerging Display Technologies for Organic User Interfaces. Commun. ACM, 51, 45.

Coelho, M., Poupyrev, I., Sadi, S., Vertegaal, R., Berzowska, J., Buechley, L., Maes, P. and Oxman, N. (2009) Programming Reality: from Transitive Materials to Organic User Interfaces. In *Proc. 27th Int. Conf. Extended Abstracts Hum. Factors Comput. Syst*. ACM Press, pp. 4759–4762.

Girouard, A., Vertegaal, R. and Poupyrev, I. (2011) Second International Workshop on Organic User Interfaces. In *Proc. 5th Int. Conf. Tangible Embedded Embodied Interact.*, ACM Press, pp. 381–384.

Holman, D., Girouard, A., Benko, H. and Vertegaal, R. (2013) The Design of Organic User Interfaces: Shape, Sketching and Hypercontext. Interact. Comput. 25, 133–142.

Holman, D. and Vertegaal, R. (2008) Organic user interfaces: designing computers in any way, shape, or form. Commun. ACM, 51, 48–55.

Lahey, B., Girouard, A., Burleson, W. and Vertegaal, R. (2011) PaperPhone: Understanding the Use of Bend Gestures in Mobile Devices with Flexible Electronic Paper Displays. In *Proc. SIGCHI Conf. on Human Factors in Computing Systems (CHI '11)*. ACM, New York, NY, USA, pp. 1303–1312. DOI=10.1145/1978942.1979136.

Lee, W., Lee, N., Kim, J.-W., Shin, M. and Lee, J. (2013) 'MoleBot': An Organic Usert-Interface-Based Robot That Provides Users with Richer Kinetic Interactions. Interact. Comput. 25, 154–172.

Peiris, R.L., Koh, J.T.K.V., Tharakan, M.J., Fernando, O.N.N. and Cheok, A.D. (2013) AmbiKraf Byobu: Merging Technology with Traditional Craft. Interact. Comput. 25, 173–182.

Read, J.C., Horton, M. and Fitton, D. (2013) Theatre, PlayDoh and Comic Strips: Designing Organic User Interfaces with Young Adolescent and Teenage Participants. Interact. Comput. 25, 183–198.

Stevenson, A., Perez, C. and Vertegaal, R. (2010) An inflatable hemispherical multi-touch display. In *Proc. 5th Int. Conf. Tangible Embedded Embodied Interact.*, ACM, New York, NY, USA, pp. 289–292.

Vertegaal, R. and Poupyrev, I. (2008) Organic user interfaces. Commun. ACM, 51, 48–55.

Zhu, K., Nii, H., Fernando, O.N.N., Koh, J.T.K.V., Aue, K. and Cheok, A.D. (2013) Designing Interactive Paper-Craft Systems with Selective Inductive Power Transmission. Interact. Comput. 25, 143–155.