Towards Unified Principles of Interaction

Michel Beaudouin-Lafon

Towards Unified Principles of Interaction

Michel Beaudouin-Lafon
LRI, Université Paris-Sud, CNRS, Inria
Université Paris-Saclay
Orsay, France
mbl@lri.fr

ABSTRACT

Even though today's computers are used for many different types of tasks, they still rely on user interfaces designed for office workers in the 1980s. HCI researchers have produced a slew of innovative interaction styles, from gestural interaction to mixed reality and tangible interfaces, but they have not replaced traditional GUIs. I argue that we must devise fundamental principles of interaction that unify, rather than separate, interaction styles in order to support the diversity of uses and users. I describe ongoing work on my ERC advanced grant, ONE, which explores how the concepts of information substrates and interaction instruments create digital environments that users can appropriate and (re)combine at will.

CCS CONCEPTS

• **Human-centered computing → Interaction paradigms**;

KEYWORDS

Interaction Principles, Conceptual Model, Instrumental Interaction, Information Substrates

ACM Reference Format:
Michel Beaudouin-Lafon. 2017. Towards Unified Principles of Interaction. In *Proceedings of CHItaly '17, Cagliari, Italy, September 18–20, 2017,* 2 pages. https://doi.org/10.1145/3125571.3125602

1 INTRODUCTION

Today's computers come in many forms and are used for a wide range of tasks by a wide variety of users, yet their interfaces are trapped in the same, 35 year-old model: each application is designed for a single user, on a single device, with pre-defined tools to accomplish predefined tasks, such as editing a single document or posting a comment to a single social network. Clearly, *one is not enough!*

One user is not enough: Most applications, particularly for authoring content, do not support multiple, simultaneous users, yet most activities are collaborative. Therefore we need to support *ubiquitous sharing*: Users should easily understand and manage shared content; the infrastructure, not individual applications, should support real-time sharing of digital content.

CHItaly '17, September 18–20, 2017, Cagliari, Italy

ACM ISBN 978-1-4503-5237-6/17/09…$15.00
https://doi.org/10.1145/3125571.3125602

One device is not enough: We juggle many devices, but they are largely ignorant of each other. Distributed interfaces, for example when a smartphone controls a slide presentation on a laptop, are limited and complex. Therefore we need to support *distributed interaction*: Users should be able to easily migrate and distribute data, interfaces and functions across personal and public devices.

One document is not enough: Documents are trapped in applications, files systems and cloud-based services that insulate them from each other, creating walled gardens and information silos. Yet we constantly use inter-related digital artifacts that must be kept together. Therefore we need to support *owned content*: Users must be able to choose among different organizational principles to manage their digital content; applications and cloud services should not own users' data.

One application is not enough: Most applications are dedicated to a small set of tasks and a single type of content and they are not extensible. But the real world has no "applications": we fluidly design and redesign our workspaces to adapt to the activity at hand. Therefore we need to support *interactions as first-class objects*: Users should be able to easily select, fine-tune and appropriate their tools; open environments should replace closed applications.

The goal of project ONE[1] is to fundamentally re-think the conceptual model and basic principles of interactive systems to empower users by letting them appropriate their digital environment. Sharing documents in real time, distributing content and tools across devices and flexibly managing one's digital environment must become an integral part of the fabric of the digital world. This requires a paradigm shift in the way we think of interaction.

2 A NEW CONCEPTUAL MODEL

HCI research has explored a number of interaction paradigms and interaction styles, from gestural interfaces to mixed reality and tangible interaction. Yet graphical user interfaces (GUIs) are still the dominant paradigm. However the goal should not be to replace one style by another, but instead to let users decide which style is more appropriate for the situation at hand. To support a diversity of interaction styles, we need *unifying principles* so that the various styles can build upon shared concepts and representations.

I propose the concept of *information substrate* as the basis for this unified conceptual model. A substrate is a digital computational medium that holds digital information, possibly created by another substrate, applies constraints and transformations to it, reacts to changes in both the information and the substrate, and generates information consumable by other substrates. Substrates are extensible, composable with other substrates, and they can be shared. They provide the fabric of the digital world.

[1] http://erc.one

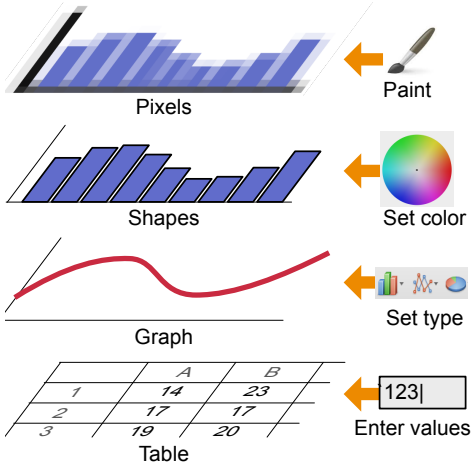

Figure 1: A rich substrate and associated instruments

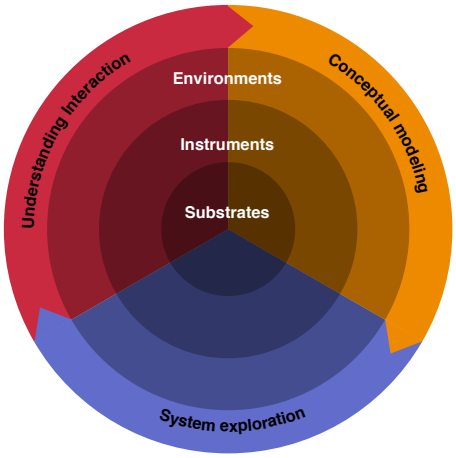

Figure 2: The structure of project ONE.

To interact with substrates, we build on Instrumental Interaction [1]: *Instruments* are substrates that can operate on other substrates, even with very little knowledge about their properties and structure. By unifying instruments and substrates, the model is both simple and powerful. A substrate can become an instrument, similar to the real world when we appropriate an object as a tool.

Finally, substrates provide a unified answer to organizing the digital environment: file systems, window managers and applications are indeed substrates that impose a specific organization on their content. I call these substrates *environments*. New environments can be created for particular tasks and contexts of use, such as project-centric, activity-centric, or data-centric environments.

2.1 Example

Figure 1 shows a rich substrate. The data table is a substrate with column headings and an entry per row of the table. The data may come from a sensor, adding a new entry for each new reading. The table provides this information to a graphing substrate to plot it. The graph turns its input data into a set of graphical shapes. These shapes constitute yet another substrate, which a renderer substrate turns into a set of pixels displayed on the screen.

The graph that the user sees is therefore made of four substrates, each with its own properties, capabilities, and affordances. Different instruments (on the right) can operate at each level to add data to the table, change the type of graph, set the color of the bars, or edit the pixels to draw annotations. The color tool, for example, can also be used with other substrates, such as text or a paint brush.

2.2 Ongoing work

Our current work combines three strands (Fig. 2): We study how expert users deal with current physical and digital tools [5]; We refine the conceptual model, building on design principles from instrumental interaction [2] as well as on a number of theories, including affordances, enaction, technical reasoning, co-adaptation and distributed cognition; And we create systems to explore specific aspects of the model, such as universal sharing [4] and layering [3], and test them in real settings.

Next, we plan to create a significant collection of substrates and show that users indeed perceive the affordances of the stack that constitutes a digital object and of the tools that can be used with it. We also want to show that instruments and substrates can scale to an entire digital environment, and that instruments can work with substrates even if they were not designed for each other.

3 CONCLUSION

I believe that users should have better control over their digital tools. They should be free to use a GUI when sitting at a desk, a voice interface while driving, and a command-line interface when automating repetitive tasks. The goal of ONE is to provide a unified foundation based on substrates, instruments and environments, to create a more humane and more flexible digital world.

ACKNOWLEDGMENTS

This work is funded by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 695464).

REFERENCES

[1] Michel Beaudouin-Lafon. 2000. Instrumental Interaction: An Interaction Model for Designing post-WIMP User Interfaces. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '00)*. ACM, New York, NY, USA, 446–453. https://doi.org/10.1145/332040.332473

[2] Michel Beaudouin-Lafon and Wendy E. Mackay. 2000. Reification, Polymorphism and Reuse: Three Principles for Designing Visual Interfaces. In *Proceedings of the Working Conference on Advanced Visual Interfaces (AVI '00)*. ACM, New York, NY, USA, 102–109. https://doi.org/10.1145/345513.345267

[3] Jérémie Garcia, Theophanis Tsandilas, Carlos Agon, and Wendy Mackay. 2012. Interactive Paper Substrates to Support Musical Creation. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '12)*. ACM, New York, NY, USA, 1825–1828. https://doi.org/10.1145/2207676.2208316

[4] Clemens N. Klokmose, James R. Eagan, Siemen Baader, Wendy Mackay, and Michel Beaudouin-Lafon. 2015. Webstrates: Shareable Dynamic Media. In *Proceedings of the 28th Annual ACM Symposium on User Interface Software & Technology (UIST '15)*. ACM, New York, NY, USA, 280–290. https://doi.org/10.1145/2807442.2807446

[5] 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 (CHI '17)*. ACM, New York, NY, USA, 5053–5064. https://doi.org/10.1145/3025453.3025718