

## Thesis Overview:

### Sketching Enactive Interactions

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The growing trend to integrate the physical form and the digital process affects all the disciplines involved in the design of interactive systems. From a computing perspective, it means creating both embodied and contextual interfaces (which use physical objects to control digital information and depend on the signals available in the environment and situation). Designing has been considered central to HCI with different turns from a focus on the design of software to the current family of user-centered design processes. Theories of Cognition that understand it as an embodied, situated, and enactive phenomenon have expanded notably and opened new research programs in HCI. In recent decades there was a shift towards embodiment with the intention of understanding the interaction with the social and physical environment and the design of supporting interactive systems.

The focus of this thesis is constituted in the intersection of three topics of current interest for HCI: a) the designing of interactive systems, with an emphasis on the creation of interaction mechanisms that combine one foot in the digital and one in the physical: how to cope in practice with the challenge of integrating physical form with digital software?; b) the available support of new theories of embodied and enactive cognition: how to approximate the design of interactive systems taking into account explicitly that the cognition that users have of them is embodied and enactive?; c) the creative process supported by sketching, a tool par excellence for the design of interactions: what are the similarities and differences between freehand sketching and enactive interaction sketches? How should the supporting tools be?

This thesis is divided in six Chapters and one Appendix

- Chapter 1 introduces the main themes of the thesis, the context and research questions, the triangulation methodology used and the contributions of the work. The publications made and the general organization of the thesis are detailed.
- Chapter 2 reviews the state of the art related to the cognitive concepts that support the thesis: embodied and enactive cognition from three different points of view: as computing and distributed representation, as Situated Social Practice and as Sensory-Motor Coupling. Contributions and effects in the design of interactive systems are reviewed.
- Chapter 3 completes the line of theoretical study with a bibliographic review of works related to this thesis: first, a detailed approach to the role that sketching plays in the process of creating design ideas as a central tool of the designer's thinking; then a review of the tools that have been proposed to support this sketching process, particularly for the design of interactive systems with tangible interfaces.
- Chapter 4 reports a series of workshops for the generation of ideas of active interaction on which observations and ethnomethodological analysis were made, with the aim of characterizing the practice of sketching. Four workshops were carried out in which a total of 69 professionals of different nationalities and disciplines participated. With the slogans "See with the ears", "See with the skin" and "Feel the physical/digital environment in the body", designers were asked to generate ideas of enactive interfaces based on sensory substitution, a design strategy that requires an embodied cognition approach. The process analyzed with a protocol based on the People-Activities-Time-Space model. The analysis shed light on the conceptions of embodied cognition used by designers and on the processes and tools they use to sketch design ideas.
- Chapter 5 presents the contributions proposed by this thesis to support the design of interactions with an embodied and enactive perspective of cognition. They consist of a framework to conceptually organize the sketching of enactive interactions and two versions of tools to include the composition sketch with software and hardware in that process. The contributions are of two types, a theoretical contribution and an artifactual one. A framework is proposed to give structure and conceptual organization to the sketching of enactive interactions that clarifies the three functions of sketching in this ideation process and organizes the production of outsourcing. In addition, a tool is proposed for

sketching with a creative composition approach that facilitates the production of sketches at different levels of embodiment, allows an integration between various forms of the sketch that is manageable by the designer, facilitates the definition and design of the interactivity through the use of interaction vocabulary, keeps the threshold of access to technology as low as possible and allows the filling of the process with expressive traces that are re-visited. Initial validation of these tools has been presented by informal case studies and demonstration of the achievable design space.

- Chapter 6 discusses the results obtained and presents the conclusions of this work. Finally, future lines of action are proposed.
- Appendix 1 includes the report of the four Workshops presented in Chapter 4

The main scientific publications contributing to this thesis were:

- Rodríguez, González, and Rossi. (2014). Sketching for Designing Enactive Interactions. XV International Conference on Human Computer Interaction, ACM, 39:1–39:2 <http://doi.acm.org/10.1145/2662253.2662292>
- Rodríguez. (2014). Extending OpenUP to Conform with the ISO Usability Maturity Model. In Human-Centered Software Engineering. 5th IFIP WG 13.2 International Conference, Stefan Sauer, Cristian Bogdan, Peter Forbrig, Regina Bernhaupt and Marco Winckler (eds.). Springer, 90–107. [https://doi.org/10.1007/978-3-662-44811-3\\_6](https://doi.org/10.1007/978-3-662-44811-3_6)
- Rodríguez, González and Rossi. (2015). Enactive Sketches for Designing Enactive Interactions. Proceedings of the Latin American Conference on Human Computer Interaction, ACM, 15:1–15:4. <https://doi.org/10.1145/2824893.2824908>
- Rodríguez, González, and Rossi. (2015). Marco de Trabajo para el Bocetado de Interacciones Enactivas. Revista Colombiana de Computación 16, 1: 48–74 <https://doi.org/10.29375/25392115.2493>
- Rodríguez, Fernández, and Hormazábal. (2018). Beyond the GUI in agriculture: a bibliographic review, challenges and opportunities. Proceedings of the XIX International Conference on Human Computer Interaction, Interacción 2018, Palma, Spain, September 12-14, 2018, ACM, 35:1–35:8. <https://doi.org/10.1145/3233824.3233844>
- Grigera, Gardey, Rodríguez, Garrido, and Rossi. (2019). One Metric for All: Calculating Interaction Effort of Individual Widgets. In Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems (CHI EA '19). ACM, New York, NY, USA, Paper LBW0278, 6 pages. <https://doi.org/10.1145/3290607.3312902>

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