ENDORSEMENTS

Pierre Dillenbourg: Academic Director of the EPFL Center for Digital Education and head of the CHILI Lab: "Computer-Human Interaction for Learning and Instruction," Lausanne, Switzerland

The EDC adventure started many years before tablets and tabletops were known in the public. The urban planning application was the first example I encountered that illustrated how this technology may actually re-shape social interactions. In this case, it also created new forms of participation in societal decisions. The story and results reported in this book will inspire developers who aim to have an impact.

Morten Fjeld, Ph.D.: Professor, Director of the t2i Lab, Chalmers University of Technology, Sweden

This is a timely and interesting book and one that is rewarding to read. Offering a substantial contribution to Human-Centered Informatics, this book is well suited for computer science graduate students with an interest Human-Computer Interaction, Interaction Design, and CSCW. Students of urban planning and digital architecture are also likely to benefit. The book is well written and well illustrated and is a treasure for anyone wishing to better understand how emerging interactive technologies will affect the practice of collaborative planning. Drawing on the Envisionment and Discovery Collaboratory (EDC) project, the book presents more than 20 years of pioneering research into collaboration technology. This research has brought about revolutionizing tech innovations such as touch-based user interfaces, interactive tabletops, and large visualization walls. Such products and prototypes have later instigated radical shifts in certain professions, such as energy management, urban planning, and crisis management.

Gerry Stahl: Editor-in-Chief, *International Journal of Computer-Supported Collaborative Learning* and Professor Emeritus, College of Computing and Informatics, Drexel University, Philadelphia, PA, U.S.

The powerful idea driving this book is that judiciously integrated systems of software components for design and communication can be developed to facilitate challenging problem solving by communities of stakeholders. This pushes the use of technology far beyond the automation of well-understood tasks or the augmentation of individuals' skills. These new environments must effectively support the tight collaboration of group reflection, design, and construction, as well as provide timely and informative feedback and visualizations. The EDC featured here, and the DODEs preceding it, pioneered this approach. The book reflects on the considerable theoretical, technical, and experimental effort that was required to move from vision to functional success. It reveals the details in which the devil of software design for collaboration hides. Leading-edge efforts today at building environments that integrate construction of visual, table-top, virtual-reality, or tangible

artifacts with group discourse and system feedback must build on the heritage meticulously documented in this volume to make further progress.

Emily Talen, Ph.D.: Professor, School of Geographical Sciences and Urban Planning at the Arizona State University, Fellow of the American Institute of Certified Planners, and Co-editor of the *Journal of Urbanism*

There is a lot of talk today about "bottom-up" planning, but without the right tools for effective exchange, local knowledge is hard to tap into. Excellent communication, in other words, is the key to successful planning. This book on EDC technology shows how this communication relies on good visual tools—that we need more than verbal transaction to keep the lines of communication flowing and productive. It shows that professionals need the input of clients just as much as clients need the input of professionals. However, more importantly, it provides practical understanding of how to successfully engage, with insight about the methods for mutual learning and active consensus-building—not passive "stakeholder" meetings. This is crucial for tapping local knowledge and, ultimately, making better cities.

Richard Byyny: Former Chancellor, University of Colorado, Boulder, U.S.

As a lifelong learner, educator, practitioner, problem solver, and leader I found this book compelling on account of the authors' new ideas, revelations, and advanced methodologies to support creativity, learning, and design. The authors describe interdisciplinary team-based problem solving combined with table-top computing environments to support participation in the action design and planning. They successfully integrate technical systems with computational simulation and social systems for more effective individual and collaborative design and decision making by helping people work together in creativity and problem solving. Their methodologies also greatly enhance experiential learning. This is an important read for those in many fields working on creativity, design, problem solving, and learning.

Paul Tabolt: Former Vice Chancellor for Administration, University of Colorado, Boulder, U.S.

I didn't know what to expect when I was initially exposed to concepts espoused in the Envisionment and Discovery Collaboratory more than 15 years ago. I was accustomed to observing the tension and conflict often found in practical urban planning conversations. During years' worth of experiences with the Collaboratory platform I observed exciting breakthroughs as technology coupled with social engagement enabled a refinement of problem analysis and understanding at multiple levels in a community. I had the unique opportunity to participate and observe dramatic shifts in the tone of normally hard-lined conversations as urban planning and technologically driven simulation models and table-top exercises encouraged, fostered, and stimulated dialog. The application and lessons learned from research and tools outlined in this book can lead to more productive, informed, and enlightened conversation as well as better decision making in many different fields and endeavors.

The Envisionment and Discovery Collaboratory (EDC)

Explorations in Human-Centered Informatics with Tabletop Computing Environments

Synthesis Lectures on Human-Centered Informatics

Editor

John M. Carroll, *Penn State University*

Human-Centered Informatics (HCI) is the intersection of the cultural, the social, the cognitive, and the aesthetic with computing and information technology. It encompasses a huge range of issues, theories, technologies, designs, tools, environments, and human experiences in knowledge work, recreation and leisure activity, teaching and learning, and the potpourri of everyday life. The series publishes state-of-the-art syntheses, case studies, and tutorials in key areas. It shares the focus of leading international conferences in HCI.

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The Envisionment and Discovery Collaboratory (EDC): Explorations in Human-Centered Informatics with Tabletop Computing Environments
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The Envisionment and Discovery Collaboratory (EDC)

Explorations in Human-Centered Informatics with Tabletop Computing Environments

Ernesto G. Arias
University of Colorado, Boulder and Universidad de Costa Rica
Hal Eden
University of Colorado, Boulder
Gerhard Fischer
University of Colorado, Boulder

SYNTHESIS LECTURES ON HUMAN-CENTERED INFORMATICS #32

ABSTRACT

The *Envisionment and Discovery Collaboratory (EDC)* is a long-term research platform exploring immersive socio-technical environments in which stakeholders can collaboratively frame and solve problems and discuss and make decisions in a variety of application domains and different disciplines.

The knowledge to understand, frame, and solve these problems does not already exist, but is constructed and evolves in ongoing interactions and collaborations among stakeholders coming from different disciplines providing a unique and challenging environment to study, foster, and support *human-centered informatics*, *design*, *creativity*, and *learning*.

At the *social level*, the EDC is focused on the collaborative construction of artifacts rather than the sharing of individually constructed items. It brings individuals together in face-to-face meetings, encouraging and supporting them to engage, individually and collectively, in action and reflection. At the *technological level*, the EDC integrates tabletop computing environments, tangible objects, sketching support, geographic information systems, visualization software, and an envisioned virtual implementation.

This book is based on 20 years of research and development activities that brought together interdisciplinary teams of researchers, educators, designers, and practitioners from different backgrounds. The EDC originated with the merging of two research paradigms from disparate disciplines to build on the strengths, approaches, and perspectives of each. This book describes the artifacts and scenarios that were developed, with the goal of providing *inspiration* for human-centered informatics not focused on technologies in search of a purpose but on the development of systems supporting stakeholders to explore personally meaningful problems.

These developments have inspired numerous research and teaching activities. The challenges, prototypical systems, and lessons learned represent important milestones in the development and evolution of the EDC that are relevant for future research activities and practices in human-centered informatics.

KEYWORDS

human-centered informatics, tabletop computing environments, design, creativity, learning, collaboration, participatory design, design environments, urban planning, ill-defined problems, problem solving, decision-making, emergency management, energy sustainability, physical games and simulations, inspirational prototypes

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Foreword

It's rare for a research team to stay together, productively, for over 20 years. The unifying bond in the joint work of Ernesto Arias, Hal Eden, and Gerhard Fischer is their common desire to move "away from the computer as the focal point toward an understanding of the human, social, and cultural system that creates the context for use."

They are not the first to go beyond the computer or its user interface to the user experience and its cultural context. This shift reframes research to deal with the distinctly human experiences of learning, creativity, collaboration, and community. The authors dig deeply into these contemporary concerns providing numerous stories from diverse projects that contribute to conveying how technology-mediated human experiences work in realistic situations. Of course, breakdowns in the human experiences of learning, creativity, collaboration, and community are also part of their study, and often key to understanding what leads to success and failure.

The book's core consists of the rich insights from the authors' 20+ years of collaboration at the leading edge of human, social, and cultural system innovation. They build on the grand dreams of the socio-technical systems thinkers of the 1960s, carrying those themes to realizations by way of advanced tabletop technologies, yet persistently focused on the human, social, and cultural systems that surround them and their users.

Arias, Eden, and Fischer give us a language for talking about technology-mediated human experiences. Their language grows out of the pioneering work of influential thinkers such as Herb Simon, Donald Schön, Horst Rittel, and Christopher Alexander, who provide terminology for many key concepts such as satisficing, reflection-in-action, wicked problems, and cultures of design, respectively. The authors also enthusiastically draw from other research leaders to describe concepts such as participatory design, tacit knowledge, and boundary objects.

In addition, the authors build on these concepts by identifying new ones such as meta-design, Renaissance communities, and the Seeding, Evolutionary Growth, and Reseeding (SER) Model. As in any boisterous new language community, there are many colorful phrases, overlapping concepts, and variant uses. All of this swirl of new ideas can be thrilling for readers whose minds are tickled by these gusty and gutsy concepts.

The authors' capacity to see what others have missed, and interpret it for us, is what makes this book so valuable. They do more than understand and teach us about what they have seen; at their best they elevate what they have learned into actionable guidance for future researchers, system designers, organizational change agents, and visionary thinkers.

There are many themes, but I encourage readers to pay special attention to the following.

- **Motivation:** Arias, Eden, and Fischer tell their readers that "it is one of the most important forces determining human behavior." This is the big message for the next 100 years. Never before have technologies provided such immensely powerful and exquisitely focused tools for raising human motivation (or squelching it) to improve health behaviors (diet, exercise, smoking cessation, etc.), conflict resolution, financial decisions, or learning opportunities. Triggering a cascade of motivational energy could change civilization even more vigorously than a nuclear chain reaction.

- **Participation:** Getting individuals, families, teams, organizations, communities, and cultures to become more engaged so as to give generously to others, engage in civic systems, contribute to community safety, etc., is now more possible than ever. Yet, our theories of participation and how to catalyze it are weak, incomplete, and sometimes misguided. This book moves our thinking forward in how to redesign systems to dramatically increase participation.

- **Reflection:** Arias, Eden, and Fischer are men of action, but they are also profoundly men of reflection. I think they would like to be remembered for promoting deep reflection by more people, more of the time. I think the kinds of reflection they seek are far deeper than casual reconsideration of past actions, but more in the spirit of how can my past experiences change our communal future? Reflection can have its quiet meditative moments, but I think the authors are after the adrenalin-induced intensity that leads to innovation and new possibilities.

- **Responsibility:** I was pleased to see how well the writing recognizes the importance of individuals stepping forward to take more responsibility for their own performance and for the success of their teams. I think design to clarify, encourage, and reward responsibility for success (and accountability for failures) will become a major theme for the coming decades.

Finally, even though the authors never use these terms, every page seems to be about trust and empathy. These vital human features are what make human, social, and cultural systems succeed. In recent decades, cybersecurity and privacy advocates have discussed design to improve trust in systems by users, but empathy has as much power to shape learning, creativity, collaboration, and community. Design discussions about raising trust and empathy seem to be just becoming possible now.

The additional happy news about this book is that it is infused with human values and ethical considerations. Reading the stories of diverse projects conveys a great deal about the human values

that they seek to foster and the ethical practices that are part of their research as well as their offerings to readers. The collection of stories offers powerful lessons for many researchers.

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August 2015
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Preface

The *Envisionment and Discovery Collaboratory (EDC)* is a socio-technical environment serving as a long-term research platform to explore *conceptual frameworks* for *design*, *creativity*, and *learning*.

Over the last two decades, we have published numerous articles documenting specific aspects of the EDC—but no coherent document exists to describe the numerous different facets of our research effort. Even without such a document, the EDC has generated over time interest in different communities. Other researchers have emphasized the importance of the EDC, for example Dillenbourg and Evans (2011) remarked the following about the EDC in a special issue of the CSCL journal *Tabletop Interfaces for CSCL* by stating: "A primary contribution of this work <the EDC> was to lay a foundation for much work cited in this article and continuing to this day."

AUDIENCES FOR THE BOOK

The frameworks and developments described in the book are relevant for several different disciplines (and specific results have been reported in the journals and conferences of these research communities)—the major ones being as follows.

- *Human-Computer Interaction (HCI)* with a publication (Arias et al., 2001) demonstrating that the EDC shifts developments away from the computer as the focal point toward an understanding of the social and cultural systems creating the context in which the system is embedded. This shift facilitates to explore key conceptual principles such as establishing shared understanding among various stakeholders, contextualizing information to the task at hand, and creating objects-to-think-with in collaborative design activities.

- *Computer-Supported Collaborative Learning (CSCL)* with a publication (Fischer and Sugimoto, 2006) arguing (1) for the importance of self-directed learning taking place among heterogeneous groups of people and (2) the need supporting communities, mindsets, and cultures that embrace lifelong learning.

- *Design of Interactive Systems (DIS)* with a publication describing our efforts to develop integrated design environments linking physical and computational dimensions to attain the complementary synergies that these two worlds offer.

- *Creativity and Cognition (C&C)* with a publication (Fischer et al., 2005) illustrating how individual and social creativity can be integrated, how the creation of shareable externalizations and boundary objects can be enhanced, and how new design competencies are emerging.

- *Participatory Design (PD)* with a publication (Fischer et al., 2002) discussing the Seeding, Evolutionary Growth, and Reseeding (SER) model that broadens the historical focus of participatory design beyond the initial design of a system.

- *End-User Development (EUD)* with a publication (Fischer and Giaccardi, 2006) arguing that the challenge of design is not a matter of getting rid of the emergent, but rather of including it and making it an opportunity for more creative and more adequate solutions to problems and introducing meta-design as a conceptual framework aimed at defining and creating social and technical infrastructures in which new forms of collaborative design can take place.

- *Computer-Supported Cooperative Work (CSCW)* with a publication (Fischer and Ostwald, 2005) differentiating communities of practice and communities of interest by analyzing the challenges of collaborative design that involve stakeholders from different practices and backgrounds requiring constructive interactions among multiple knowledge systems.

- *Conflict Resolution, Informed Participation, and Decision Analysis (CR&IP)* with publications (Arias, 1996; and Arias et al., 2001) introducing the use of decision-support games and simulations to enhance informed participation in community planning, urban planning and design.

For researchers and practitioners in different application domains, the book describes in urban planning (Chapter 2), campus planning (Section 5.1), emergency management (Section 5.2), energy sustainability (Section 5.3), student projects in different domains (Sections 7.1.2 and 7.1.3), and EDC inspired projects by two of our scientific collaborators (Sections 7.2.1 and 7.2.2).

While some themes pursued in the context of the EDC are more connected to one of the specific research and practice activities mentioned, the most important contribution of the EDC is that it has facilitated an interdisciplinary dialogue between these different disciplines.

Acknowledgments

The three authors formed the core design and development team for the EDC. But the research activities described in this book would not have been possible without the extensive involvement of numerous other participants contributing their expertise and generously giving their time over the last two decades. We are especially grateful to the support and contributions of:

- *Ph.D. students* (specifically Eric Scharff and Jonathan Ostwald);
- *Undergraduate Research Apprentices* (specifically Kyle Bygott, Jack Elston, and Anuradha Kumar);
- *Students* in our courses in the Computer Science department and the Research Methods courses in the College of Architecture and Planning;
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  - the Regents of the University of Colorado and the Members of the Boulder City Council (as pictured in Figure 5.2 during a joint planning session);
  - representatives from the transportation and the emergency department of the City of Boulder; and
  - Robert Harriss from the National Center for Atmospheric Research (NCAR), Boulder.

Finally, we owe a big "thank you" to different directorates and program directors at the National Science Foundation (NSF) that have generously supported our research over many years, specifically through the programs in *Human-Centered Computing*, *Science of Design*, and *Creativity and IT*.

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