

# Foreword

Computers provide the most plastic medium for representation, communication, and interaction we have ever known. The computational medium is plastic in the sense that we can employ it to:

- mimic other media (e.g., books, newspapers, magazines, photographs, audio recordings, and films), devices, and mechanisms of interaction,
- create models that represent, with ever increasing fidelity, the physical world, spanning from models of atoms and molecules to those used to forecast weather or to guide spacecraft to destinations far from earth,
- provide virtual worlds that range from the simple metaphorical desktop of the graphical user interface to the amazing digital effects and virtual characters of current films, or
- combine the real and the virtual (e.g., in robotic surgery the tremors of a surgeon's hands are removed as he or she interacts with a computer interface remote from the patient).

This plasticity and the myriad ways computers are now enmeshed in our personal and professional lives and in the infrastructure of science and society present enormous opportunities and challenges. Computationally-based forms of communication and interaction are changing the world in which we live and the ways we interact within it.

With each new technology we seem characteristically drawn to focus almost exclusively on the new opportunities it presents and how it might replace older technologies, frequently forgetting, or at least not adequately appreciating, that new technologies must exist and evolve in ecologies comprised of older technologies as well as webs of established cognitive and cultural practices. Understanding how a new technology meshes and interacts with existing ecologies and practices is as fundamental and important a component of design as the new opportunities it creates.

From the beginnings of the modern computer at Xerox Parc in the early '70s one consistent refrain has been that new computational devices would replace paper and the future would be increasingly paperless. As every office and home continues

to bear witness, and as is well documented in Sellen and Harper's seminal book, *The Myth of the Paperless Office*, we are far from becoming paperless, continuing to exploit both digital and paper media. Following Wellner's early digital desk explorations there have been a series of innovative investigators exploring not how to replace paper with digital tools but rather how to combine the two. Stellar examples of this approach are Guimbretière's *Paper Augmented Digital Documents*, Yeh's *Butterflynet*, Liao's *PapierCraft*, Tabard's hybrid notebook, and Signer's and Weibel's work to support interaction across the paper-digital divide. The most recent advance in this line of research is the excellent thesis work of Jürgen Steimle that is the basis of the present book. Steimle confronts the complex and crucially important issue of how to bridge and combine digital and paper worlds so as to facilitate access to the best of each.

In this book Steimle addresses the question of how to design interfaces that integrate traditional pen-and-paper-based practices with digital media. He begins with a comprehensive survey of pen-and-paper computing in which he covers the technologies involved, existing toolkits and applications, and characterizes an underlying model of generic core interactions as a basis for developing principles and guidelines. Based on this model he describes CoScribe, a novel modular framework to support collaborative paper-based work. CoScribe provides an integrated environment that supports multiperson collaboration with multiple documents. It is unique in addressing the complex challenges involved in supporting asynchronous shared handwritten annotations and hyperlinking between printed and digital documents. The exposition using scenarios, detailed descriptions of the technologies, and careful empirical evaluations is compelling and advances both the science and technology of interface design. While the focus of the book is on pen-and-paper interfaces, everyone interested in how to design for real-world activity will profit from reading this book.

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The mass deployment of Smart Phones, Netbooks, and Web tablets has made computing essentially pervasive and ubiquitous – yet to date, there is only one truly ubiquitous information processing technology: pen and paper. Imagine the wealth of paper variants that may populate the venue of a creative and information-centered workshop: little Post-it notes and snippets, sturdy colored cards, numerous piles of memos and notes, groupings of bound or stapled documents, annotated leaflets and brochures, journals and magazines along with ready-made, commented laser copies of relevant contents, binders and folders full of classified information, flipcharts and wall-covering series of charts and other drawings, not to mention waste baskets, full to the brim with torn and crumpled sheets, . . . the list is endless. And it is still a long way to go until we can use and afford computers in the same quantity and variety, and with such simplicity and carelessness.

On the other hand, computers can handle information in a way that paper will never be able to: store and archive in ‘infinite’ quantity with an ever smaller footprint, search and analyze, transmit, copy, and share at virtually no cost at lightning speed, edit and interconnect, . . . again, the list is endless. Given these considerations about the uniqueness and ubiquity of both paper and computers, the present book is long since overdue: a thorough, concise, and well-organized compendium of marriages between paper based and electronic documents.

This book, a revised and extended version of Jürgen Steimle’s award-winning computer science dissertation, provides the reader with a broad and extensive overview of the field. The state of the art is covered in a most up to date, complete, and systematic way, so as to provide the full picture of pen-and-paper computing like no other reference before.

The contributions made with regard to modeling the interaction with pen-and-paper interfaces provide an unprecedented theoretical foundation and organization of the subject matter, helping to structure and order the problem and design spaces in a rather unique way. The book proposes information ecologies as the appropriate theoretical perspective for designing pen-and-paper interfaces. This involves taking a broad view and looking at all the ingredients that largely influence the interplay of humans and machines in the context of information handling: current and related

documents, cognitive and social networks, past actions and future-oriented intentions. The author presents an elegant ‘building set’ of core interactions helpful in designing solutions that address the diversity of such ecologies.

Retaining the holistic approach of the book, the third part presents an integrated set of interaction techniques for the most relevant human document processing activities: collaboratively annotating, combining (linking), and classifying (tagging) documents. Here, the aforementioned systematic theoretical framework forms the basis for the cleanest and most flexible approach known in comparison to related work. Regarding cross-media annotation, the presented approach provides an impressive proof of the huge potential that lies in joining the individual strengths of the two technologies, paper and computing. As to combination i.e. hyperlinks, a rather small advancement in hardware is provided as a basis: the enabling of Anoto technology for use with both computer screens and traditional paper. This small technical contribution enables a huge effect with respect to eliminating seams and hurdles between the two technologies. Finally, concerning classification (tagging), the author provides smart and elegant means for tagging documents with predefined classes, but also with arbitrary tags that are defined on-the-fly. Here and in the aforementioned contributions, the author proves to be quite resourceful when it comes to leveraging the strengths of paper as a technology, such as the flexible interplay of many paper sheets, but also when it comes to coping with its limitations, such as the lack of inverse operations for writing or cutting.

In short, the present book promises to be an exciting source of information for IT professionals (trying to understand the cutting-edge field of pen-and-paper computing), researchers (interested in an overview of prior research and in the substantial original academic contributions presented in this book), and HCI experts (seeking insights into the comparatively young field of pen-and-paper computing as well as on the advancement of their field in general).

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