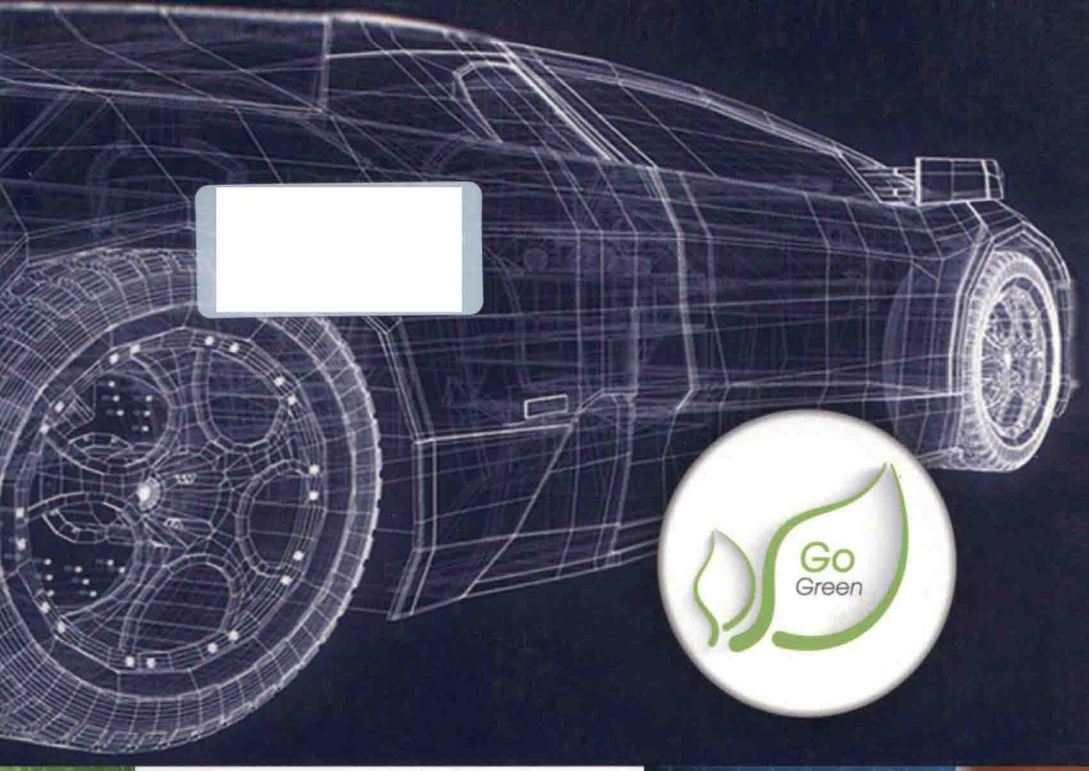

ROADMAP TO GREENER COMPUTING

RAOUL-ABELIN CHOUMIN NGUEMALEU
LIONEL MONTHEU

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A CHAPMAN & HALL BOOK

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Preface

THIS PROJECT BEGAN IN 2009, after an international engineering conference at Stanford University, California. On the flight back home to Germany, we were reflecting on what lessons we had learned and what we could take away from this inspiring experience. We asked ourselves what we as an engineer and a computer scientist could do to positively impact our community and the world.

Today, computers (our domains of expertise are software specialist, and hardware specialist/ product lifecycle management specialist, respectively) belong to the world heritage and are used by the most influential CEOs on Wall Street as well as the poor orphan child in India or in Central Africa.

Originating from sub-Saharan Africa, we experienced firsthand the negative impacts of global warming on agriculture, health, and the environment during childhood such as frequent floods and empty granaries in the north region of Cameroon. Thus, to us, this book is a contribution toward fighting the plague that afflicts our environment and humanity. This book is a concise and simplified introduction to greener computing, which can be easily accessed. It addresses how computer science, computer infrastructure, and the computer as product affect the environment, and presents the main challenges involved in making computing more environmentally friendly.

When we started writing the book, we were thinking of a one-theme book with different related chapters to avoid repetition. After some discussions, we finally decided that the book should be divided into independent chapters, such that each author should, beside his expertise, have a free hand in introducing more general information in the project because it is not only meant for specialists.

Before we started writing, we made an online survey of the question, "What is a difficult book for you?" Based on the results of this survey, we pointed out that people have encountered chapters or books that they

just cannot get into. There are lots of reasons for this: sometimes they are required to read about a topic that is just plain boring; sometimes they try to read material that is written way above their current intellectual level; and sometimes they find that the writer is not good at clearly explaining things. Our intention is that this book should be readable for a large audience, for kids in schools, teenagers in high school, college and university students, teachers, professors, homemakers, football players, computer specialists, taxi drivers, etc.

Lionel, who is a software engineer with wide field experience, focused on the computer infrastructure and software while Raoul, who has more than 12 years of field experience in software deployment and product lifecycle management, handled the part on the computer as a tool and as a product. As such, the book is divided into six independently written chapters to provide the reader with profound insights on each topic addressed.

CHAPTER 1: ON THE WAY TO ECO-FRIENDLY COMPUTER INFRASTRUCTURE

Here, the reader is informed about the impact of the computer infrastructure lifecycle on the environment and learns some solutions for greener IT. Ecological friendliness is gaining more and more importance nowadays. As the environment and natural milieus are negatively affected by human actions, science and engineering are increasingly conceiving and developing ideas that can make the world greener. The goal of this chapter is to present how computer science and more especially computer infrastructure affect the environment, what major challenges exist in this regard, and how they can be overcome or prevented. After a short introduction in Section 1.1, the problem of toxins in today's computers, their negative health and environmental effects, as well as some options for the manufacturing of ecologically (green) friendly computers are presented in Section 1.2. In Section 1.3, we analyze how making the right choices, while considering several criteria, can help in the purchase of green IT. Section 1.4 addresses power consumption and problems related to cooling when using computers in private or corporate settings. Section 1.5 covers challenges regarding the disposal of old computers or their components, and finally, in Section 1.6, some examples of how Information and Technology (IT) can positively influence the environment are described.

CHAPTER 2: GREEN SOFTWARE SCIENCE

Here, methodologies, designs, frameworks, and software development tools that can be used to compute energy efficiently are presented. According to the Green World Network, two of the world's biggest problems today are environmental damage caused by enormous greenhouse gas emissions and energy shortage, against the backdrop of the fact that the world's energy reserves are not unlimited. The Green World Network estimates that the Earth's supply of natural resources will be able to sustain only 2 billion humans for 100 years from 2000.* Thus, a reduction in energy consumption in all activities will greatly defuse these problems. In this work, methodologies, designs, frameworks, and software development tools that can be used in computer science to reduce energy consumption or compute energy efficiently are analyzed.

CHAPTER 3: COMPUTER AIDED SUSTAINABLE DESIGN

Designer and CAD applications that can reduce damage to products and the environment are discussed in this chapter.

Producing and consuming more and at the lowest possible price have characterized our society for several decades. This tendency has led to the overexploitation of natural resources, the intensification of air and water pollution, the disappearing of plant and animal species, and a dramatic increase in waste. In order to break this chain, urgent action must be undertaken such that more can be produced with less. Several corporations have embraced this new "produce more with less" approach and have started including sustainable development in their business strategies.

What can design engineers and CAD applications do to support the new "produce more with less" business approach and conserve the environment? In this chapter we analyze different approaches and propose answers to this question.

General information on design and the environment, access to literature, field experience, and concrete day-to-day business scenarios are discussed with the aim of getting a clear balance between theory and practice.

We also explain the Eco-Design concept and the impact of CAD on the environment as well as potential areas for improvement in the future.

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* Reproduced by permission of the Australian Broadcasting Corporation (c) (2000) ABC. All rights reserved. http://www.abc.net.au/civics/environment/02_p1problems.htm (accessed January 21, 2013).

CHAPTER 4: COMPUTING NOISE POLLUTION

Here the reader is given an introduction to noise pollution. Together with light and heat, noise pollution is a form of energy pollution. Its contaminants are not physical; it is therefore sometimes difficult to be fully aware of this "silent" destructor, which has become a plague to an increasing proportion of the population. Noise generated by PC fans or air cooling systems has always been an issue for people working intensively with computers (stress engineer, computer gamers, data center administrator, etc.). This chapter discusses noise pollution caused by computers and computer users, its effects on their daily lives, and solutions that can be employed to counteract it.

The first section of this chapter focuses on the definition of sound in general, its various sources, and mechanisms for its perception by humans, that is, via sound sensors in the ear and the brain. In addition, the effects of sound (as noise) on the mind and body are discussed. The second section examines computer noise and standards, techniques, tips, and tricks that can be employed to counteract it. Some practical examples are also included in this section.

CHAPTER 5: END-OF-LIFE OPPORTUNITIES FOR COMPUTER AND COMPUTER PARTS

In this chapter, we discuss basic ways of handling a computer when it begins to become obsolete for the end user. We propose a flow diagram representing the different given options, when a computer no longer fulfills its purpose.

It goes without saying that having a well-established computer or series of computers on the market is the main reason why computer companies develop and improve their products. Producers therefore tend to ensure the supply of successful products for as long as possible. The more computers are produced, the more effort must be invested to take them out of life in an environmentally friendly way. At the end of their lives, many computers are deposited in landfills while many more are upgraded or recycled as markets for used computers and electronic devices expand. Yet many are retained, despite the disadvantages of storage.

CHAPTER 6: CLOUD COMPUTING

In this chapter, the reader is introduced to cloud computing by way of definition and an overview of its green capabilities. Nowadays, it is quite

hard not to have heard of cloud computing, even as a layperson. It is even likely that you use cloud-computing services without knowing it.

The overall demand for new, state-of-the-art IT services has increased and in order to continuously offer innovative services and at the same time fulfill financial requirements, it is relevant to ask whether we should rely on cloud computing or standard IT infrastructure. We first describe how computing was carried out before the cloud came and then go ahead to explain what cloud computing means. We describe the characteristics and specific capabilities of clouds and take a deeper look into existing services and applicable deployment models. We also discuss several use cases of cloud computing, its benefits, and potential risks. Finally, we look into if cloud computing can be green.

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We also wish to express our profound gratitude to our proofreader, Dr. Wendy Awa, for her helpful discussions, comments, and corrections, and useful suggestions, which have enabled us to complete the project on time. We would also like to express our gratitude to our families for their kind cooperation and encouragement throughout this project.

Note: The tests and experiments mentioned in this book were conducted by a team of professionals. If you wish to reproduce any of these tests and experiments by yourself, please seek professional assistance.

About the Authors

Raoul-Abelin Choumin Nguemaleu was born and raised in Cameroon (Central Africa). After earning his Baccalauréat (high school diploma) in Cameroon, he went to Germany for university studies. Raoul is graduated in mechanical engineering from Hamburg University of Applied Sciences in Germany.

He started his professional career as a CAD/PLM consultant working for the world's two leading aircraft manufacturers. His assignment focused on the development of appropriate, accurate, and valuable CAD/PLM training, processes, and methods. He has also worked in many companies as a consultant for software testing and implementation. In this function, he was a member of the CAD/PDM/Configuration management team for many projects in Germany, UK, France, and the United States.

For the last five years, he has worked as a global service consultant at one of the largest software companies in the world and the leading provider of product development solutions. Today, he works as CAE Coordinator for a global leader in aerospace, defense, and related services. He is a member of several environmental organizations.

Lionel Montheu was born and raised in Cameroon (Central Africa). He visited the school there and decided to come to Germany after earning his Baccalauréat (high school diploma). Lionel is graduated in computer science from University of Ulm (South Germany).

While working on his diploma thesis, he was involved with the optimization of monitoring software in an embedded system used in satellite ground stations. He started his professional career as an IT solution designer, and developed software solutions and tools used by different departments in a universal and international trading bank in Germany. Due to his position, he was involved in different phases of the software development process (requirements engineering, conception, design, implementation, test, and maintenance).

Today he works as a software developer for a company that has proprietary software specialized in business service monitoring. He is also a member of several environmental organizations.

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