

## Preface

Since it emerged in the mid-80s through the protagonism of pioneer organized movements, the notion of freely shareable, collaboratively developed technology has steadily established itself in the following decades to enter the 21st century as a leading industrial paradigm.

Today, nearly 40 years after the concept of *free and open source* (FOSS) was introduced, and despite the initial skepticism that has gradually been dissipated by positive empiric evidence, some questions still baffle newcomers and even experienced practitioners.

*How have many large community-run open-source ventures evolved from experimental undertakings into long-standing, economically sustainable projects?*

*Why are major commercial enterprises increasingly engaging in developing open-source systems, and how do such decisions meet their business goals?*

*How to design an economically-effective business model and a sustainable development strategy for an open-source product or service in a given industry segment?*

By shedding light on those issues, this book aims at offering a starting point both for individual entrepreneurs venturing into innovative undertakings and for already established organizations willing to consider the open, collaborative paradigm for a new product or service.

More than “*why use open-source,*” the book is about “*why create open-source.*” It is inspired by the observation that while, on the one hand, it is not difficult to enumerate advantages of FOSS from the users’ standpoint — whether related to cost, socio-technological inclusion, flexibility, dependability, or transparency — on the other hand, understanding the driving interests of individuals and organizations that invest massively in FOSS development is not so straightforward. Why would anyone commit resources — money, labor, time — in producing intellectual creations, only

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to deliberately relinquish the exclusive profiting prerogatives endowed by intellectual-property enforcement? True, it is plausible to look for clues in initiatives conceived on ethical grounds, like GNU, and intellectual enjoyment, like Linux — as well as portfolio building, like the ever-growing collection of personal projects hosted in source-code management platforms. However, while such hints may point to valid origins of many community-driven projects, they do not address how those endeavors matured into lasting, sustainable enterprises. Moreover, arguably, neither hobby nor philanthropy is to be accounted for as the only goal of the large corporations that have decided to embrace the open-source development model.

Against this background, while successful experiences of FOSS have been around for over three decades, more often than not, when considering the option of delivering a given innovation product under an open-source license, a preeminent question that arises for both new entrepreneurs and industry veterans is how to figure out a suitable business strategy that is economically sustainable in the long-term.

The present book dwells on those questions. In exploring study cases, the investigation aims at understanding the rationales and strategies underlying some companies' decisions to produce and release open-source products. By addressing the topic from varying perspectives, the book's chapters examine which business models have succeeded, and which ones might apply to leverage the open-source industry in areas where world-class FOSS solutions have not flourished yet.

From a contemporary perspective, the book embraces the realization that the principles of collaborative construction of publicly accessible knowledge grounding the open-source paradigm have been extended beyond the software industry's original ambit, coming to encompass any intellectual artifact made available under non-exclusive rights of utilization, adaptation, and distribution. From this standpoint, the study assumes a comprehensive view of *free and open-source* systems that applies to all technological, educational, artistic, or other creations, including computer programs, hardware design, artwork, scientific data, and other intellectual artifacts.

The contents of this volume cover relevant topics such as the foundations of the free and open-source paradigm, scientific and technological innovation, business models, industry cases, community fostering, decision-making, licensing, project governance, community ethics, challenges to the FOSS industry, and the dynamics of collaborative ecosystems.

By calling forth the knowledge of experienced authors, the material is expected to offer a state-of-the-art reference for researchers and practitioners involved in developing or managing open-source projects, and for decision-makers considering the appropriate strategy to design open-source business models for their products and services.

To give a glimpse of what is in the book, we can briefly refer to some of the original ideas discussed by the authors.

For instance, it is fair to say that the FOSS debut was less of a timid rookie attempt than of a rebel call to action, and its success was not initially received without a good deal of surprise. In the chapter “Open Source and Economic Models in an Evolutionary Approach,” Dr. Marco Berlinguer lays a comprehensive review of the trajectory of FOSS along its history, and the different interpretations that have been tried to explain its seemingly paradoxical success in the context of the traditional innovation industry. In his analysis, the author criticizes the premature bid to co-opt FOSS into the conventional logic of the capitalist market, as well as the naive trivialization of FOSS as yet another more-of-the-same hype — as those narratives fail to account for the transformations FOSS has been yielding in the mainstream digital production standards. Berlinguer discusses the varying phases through which FOSS has evolved, from the self-organizing volunteer communities to widespread market adoption, and highlights the new phase we are entering now, when public policies and significant geopolitical unfoldings are expected to call forth a more organic involvement of the government sphere in the trajectory of FOSS. By assuming an evolutionary-economic perspective, the chapter frames FOSS as a digital commons and dissertates on how the success of FOSS may be evidence of a broader role of this concept in the emerging digital economy. Anyone venturing into the FOSS-based enterprise domain would benefit from glancing at what is to come.

That is especially true for individuals and organizations considering an open-source strategy for a new enterprise, as devising an appropriate business is crucial for the project’s economic viability. Many different approaches have been developed for commercial open-source products over the years. The chapter “A Business Model Framework for Open Source Software Companies,” by Dr. Karl-Michael Popp, analyzes varying such models through a unified framework. The author distinguishes between community and commercial open-source projects, and looks at various alternatives based either entirely or partially on open-source licenses. Pop breaks down the several examples into basic building blocks, and explores the possible combinations of main business models to reveal different hybrid instances capable of delivering differentiated value. The chapter overviews how commercial open-source companies foster contributor communities for their enterprises, and look further into the future of on-demand and software-as-a-service deployments.

Opportunely, while certainly the canonical example, the software case is not the only representative of the open-source concept under the industry’s attention, as the influential success of that segment has also impacted other fields where the concept of free open collaboration has been felt. Among those new extents lies the emergence of the open-source hardware (OSH) technology. Elaborating on that new compelling topic, the chapter “Building Open Source Hardware Business Models” by Dr. Laetitia Marie Thomas, Prof. Karine Evrard-Samuel, and Prof. Peter Troxler reviews the state-of-the-art of OHS communities. The authors build

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on the Commons theory to shed length on how OSH initiatives have developed economically effective and sustainable business models. Thomas, Evrard-Samuel, and Troxler develop the ideas grounded on empirical evidence collected through nearly 30 study cases which they followed over an extended period. Their findings propose a framework for helping OHS practitioners design viable business models, enumerating actionable, strategic steps for this purpose, and raising the potential of the open-source approach to meet the sought-after equilibrium between our social demands and the environmental capacity of the planet.

At this point, it is worth remembering that when examining the digital economy, the scope of the discussion is no longer confined to how people use laptops and smartphones. Modern electronic equipment is increasingly being designed as a collection of peripherals around embedded computer hardware: smart TVs, internet routers, smartwatches, vehicular control units, and a myriad of wearable internet-enabled gadgets are, essentially, computers. Today FOSS runs in those computers to such an extent that open-source technology has become pervasive in our daily lives, even when we are not typing on a keyboard or swapping a touch screen. In the chapter “Open Source and Free Software Licenses for Embedded Systems,” Dr. René de Souza Pinto discusses the effect of FOSS in the embedded system industry and analyzes how open-source licensing impacts the consumer electronics market. The author evokes one of the best examples, the Linux kernel, which is present in millions of embedded devices. René discusses Linux’s copyleft license, which enforces any derivative work to be released under the same terms as the original license. Embedded device manufacturers should be aware of such clauses and understand how to handle the distribution of their open-source systems. The chapter covers relevant aspects of different open-source licenses and common issues of interest for the business model design.

Still concerning Linux, the chapter “Trusting Critical Open Source Components: The Linux Case Study” by Marcelo Schmitt and Dr. Paulo Meirelles raises the question of dependability in FOSS systems. Exploring Linux device drivers as a study case, the authors invite us to ask how much we can trust the FOSS infrastructure that sustains so much of the software and online systems we rely upon for our business and lives. Schmit and Meirelles conduct an extensive analysis of the software testing methodologies employed by the Linux project to evaluate the quality of device drivers. From their discussion, it is interesting to ponder on the transparency allowed by the FOSS model, as it is not equally feasible to inspect the inner workings of many of the proprietary products that power mission-critical systems. Linux is a long-lasting project whose outcome grounds much of today’s modern computational infrastructure — and it is fortunate that the community has been able to devise successful strategies to justify the system’s positive reputation. That has been possible thanks to innovative business models that connect individuals

and organizations with varying perspectives, allowing them to take advantage of the shared resources, while being encouraged to give back to the community through investment and technological contributions.

In the same vein as free and open-source hardware extended the original idea of free and open-source software, related concepts have gradually emerged in the context of other kinds of intellectual creations, including open-source educational content, scientific communication, commercial artwork, and research data, to name only a few examples. In the chapter “Coherent Synergy: Fostering Innovation in Open Source Ecosystems,” Dr. Francisco José Monaco abstracts the fundamental principles shared by those varying instances into the unified notion of open-source innovation, referring to any kind of intellectual creation, irrespective of its nature, whether technological, artistic, scientific or other. The author addressed the question of how an innovation-based business that deliberately renounces the exclusive prerogatives endowed by intellectual property can foster continuous innovation. Against this background, Monaco approaches the open-source model as a new paradigm of innovation fostering that does not rely on the IP-enforcement model, bringing up a comprehensive conceptual framework to understand different kinds of open-source business models in a unified and systematic way. The study formulates the notion of coherent synergy: a property that determines the roles of intellectual creation and the essence of value delivery in open-source innovation ecosystems. The chapter examines some fundamental criteria when designing open-source business models concerning their adequacy to sustain a consistent, continuous innovation process.

The concept of FOSS ecosystem, in turn, can not be separated from that of Community, as it is through the latter that the cooperative feedback flows. The long-term sustainability of an open-source project, either a commercial enterprise or a community-driven effort, inherently depends on an engaged and enthusiastic community. Fostering a FOSS community around a project is a key concern for the long-term sustainability of the project. This aspect comprises the theme of the chapter “Fostering FOSS Communities: A Guide for Newcomers” by Hillary Nyakundi and Cesar Henrique De Souza. The authors conduct an extensive literature review addressing the technical and social barriers that cause newcomers to cease their contribution to a FOSS project, and complement the discussion with best practices to build a productive and long-lasting community.

Still on FOSS communities, the chapter “Building Teams and Developing a Career in the FOSS Industry” by Dr. Renê de Souza Pinto discusses aspects of FOSS as a professional path, highlighting the possibilities open for both individuals and organizations. The chapter approaches the potential frictions that may emerge from conflicts between the company’s exclusive commercial goals and the community’s collective interests, pointing to ways such dynamics can be addressed. The author

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elaborates on why companies should invest in building FOSS teams, and the opportunities open for entrepreneurs and young professionals.

The concept of open source embodies the idea of shared knowledge, which lies at the core of the FOSS model. Therefore, it is only natural that open-source technology plays a crucial role in the development of inclusive educational tools. This is the topic approached in the chapter “The Open Source Perspective in the Education Technology: A Digital Kon-Tiki Journey” by Martin Dow and Dr. David Preston. The authors highlight how the benefits of the FOSS paradigm extend beyond cost-effectiveness. In addition to the flexibility enabled by unrestricted access to source code, the chapter discuss how FOSS also promotes public sovereignty by empowering communities to regain control over the technology they rely on. In the context of education, this becomes particularly significant as it directly influences our ability to implement educational programs without being constrained by technical, economic, or ideological biases imposed by corporate giants in the tech industry. This chapter delves into this subject, exploring a compelling case study based on the OSLAP (Open-Source Learning Academy Protocol) initiative. Similar to other domains that require sustainable FOSS business models, open-source educational technology emerges as a realm where innovative ideas and strategies for long-term project financing are in high demand.

Finally, the chapter “The Red Hat Enterprise Linux Business Model” by Cesar Henrique De Souza addresses one of the most iconic practical illustrations of open-source-based enterprise, the case of Red Hat Inc. The author introduces the business model behind Red Hat’s Linux development, highlighting its contribution to the Linux kernel. Faracco describes the main aspects of Red Hat Enterprise Linux, undoubtedly one of the most successful commercial Linux distributions, and the company’s experience in using other open-source distributions such as Fedora and CentOS. The chapter brings a brief historical overview of each distribution and their communities, and comments on how their histories impacted the enterprise’s products.

Through an in-depth discussion of these and related topics, the authors gather valuable information and critical analysis to help the interested audience understand the open-source development’s rationales. The studies explore novel referential frameworks upon which individuals and organizations can devise strategies and design appropriate business models for a particular product or service.

We hope this book serves as a valuable resource to researchers, students, and practitioners investigating the foundations of the open-source model and its economic, social, technological, and ethical implications.

## **A Word About the Authors**

This volume was brought about by many hands. It gathers the thoughts shared by academics and practitioners in response to the open call for contributions distributed through professional mailing lists, special interest groups, scientific forums, and other public channels.

We are enormously glad that we could count on the contribution of the acknowledged authors who helped write this book.

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