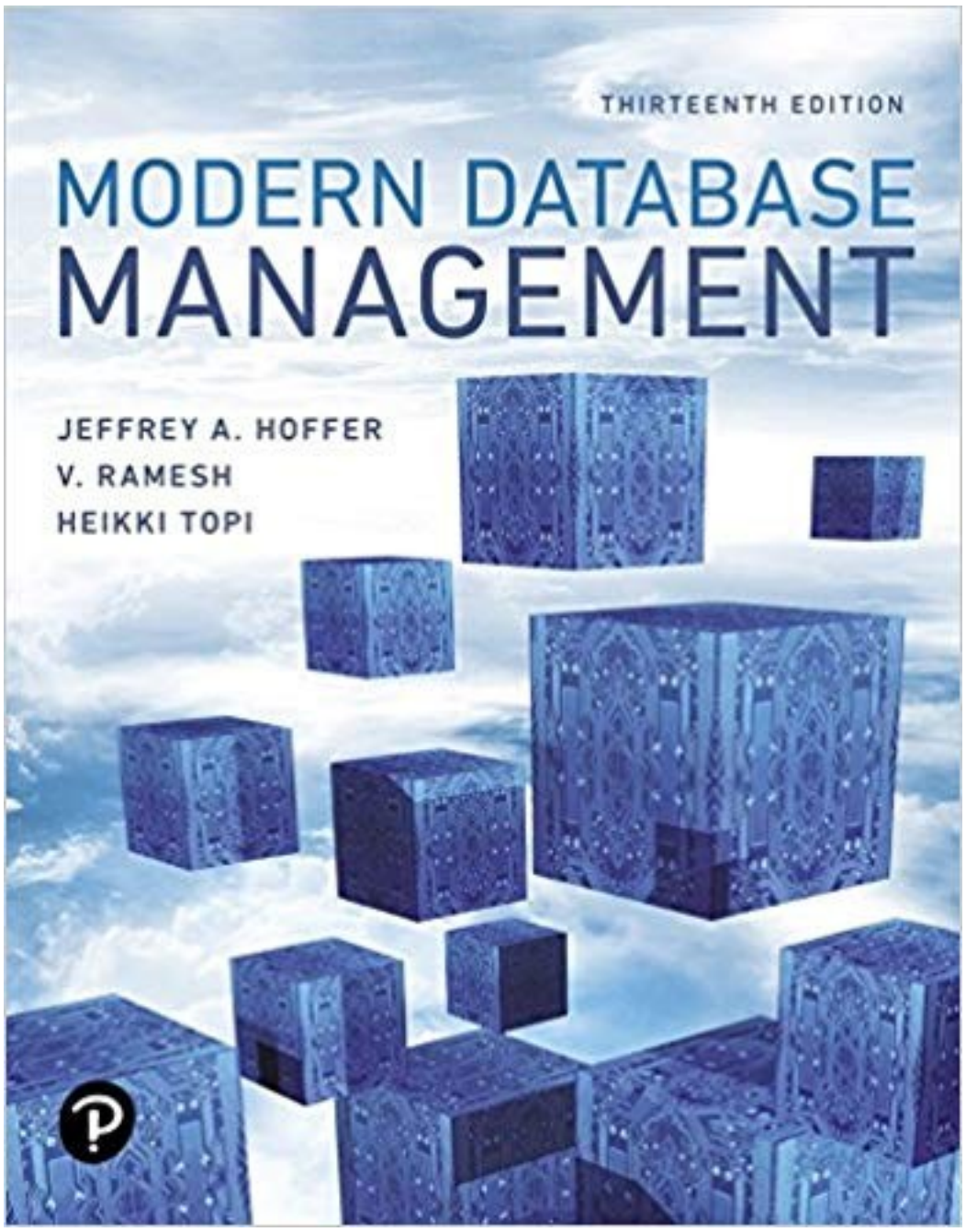
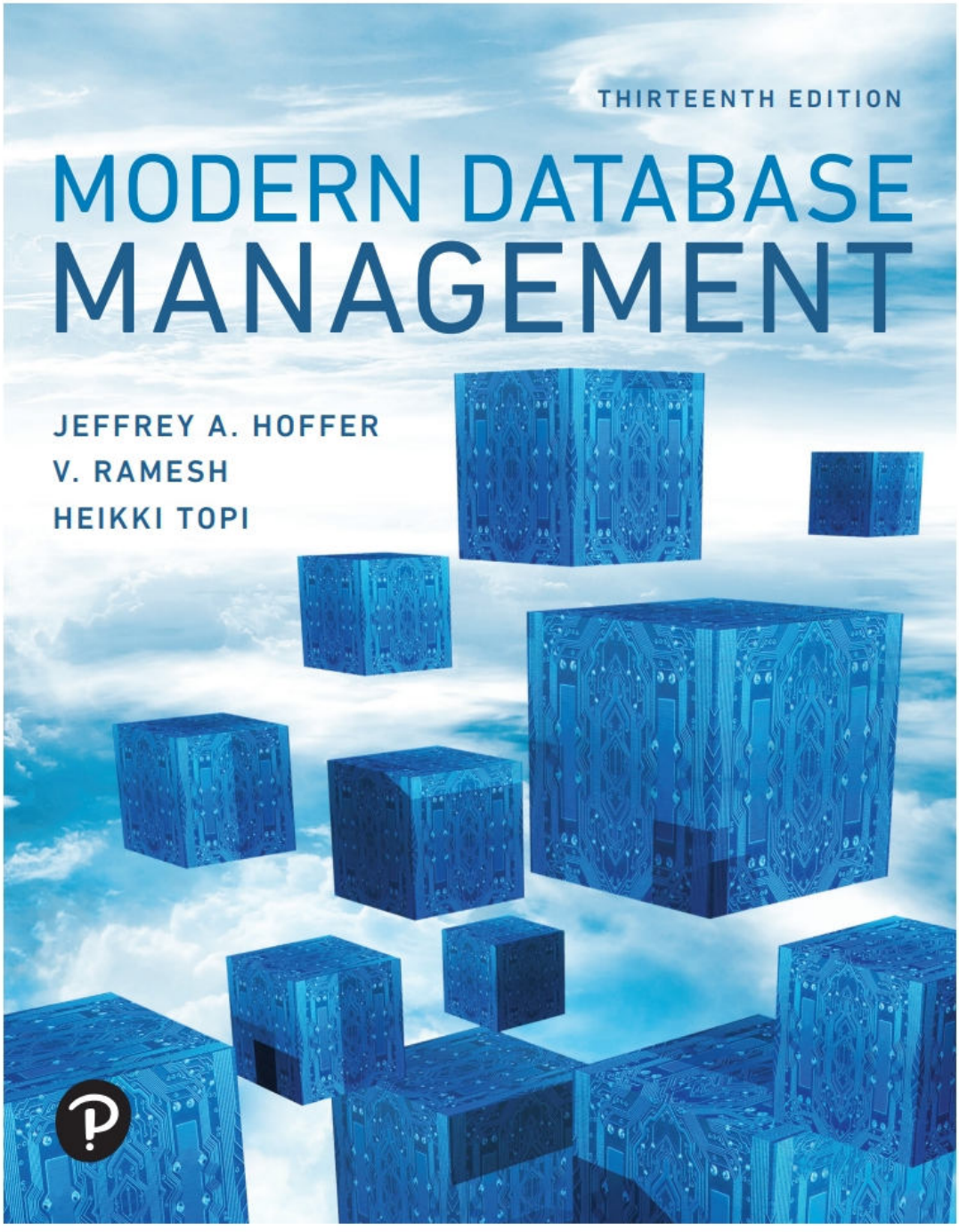
# (eBook PDF) Modern Database Management 13th Edition by Jeff Hoffer







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*To Patty, for her sacrifices, encouragement, and support for more than 35 years of being a textbook author widow. To my students and colleagues, for being receptive and critical and for challenging me to be a better teacher.*

*—J.A.H.*

*To Gayathri, for her sacrifices and patience these past 25 years. To my parents, for letting me make the journey abroad, and to my cat, Raju, who was a part of our family for more than 20 years.*

*—V.R.*

*To Anne-Louise, for her loving support, encouragement, and patience. To Leila and Saara, whose laughter and joy of life continue to teach me about what is truly important. To my teachers, colleagues, and students, from whom I continue to learn every day.*

*—H.T.*

# BRIEF CONTENTS

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## ONLINE CHAPTERS

# PREFACE

This text is designed for introductory courses in database management. Such a course is usually required as part of an information systems curriculum in business schools, computer technology programs, and applied computer science departments. The Association for Information Systems (AIS), the Association for Computing Machinery (ACM), and the International Federation of Information Processing Societies (IFIPS) curriculum guidelines (e.g., IS 2010 and MSIS 2016) all outline this type of database management course or the competencies a student completing the course is expected to have. Previous editions of this text have been used successfully for more than 35 years at both the undergraduate and graduate levels as well as in management and professional development programs.

## WHAT'S NEW IN THIS EDITION?

This 13th edition of *Modern Database Management* updates and expands materials in areas undergoing rapid change as a result of improved managerial practices, database design tools and methodologies, and database technology. Later, we detail changes to each chapter. The themes of this 13th edition reflect the major trends in the information systems field and the skills required of modern information systems graduates. The most important changes are as follows:

- The book has been restructured in several important ways. Chapter 7 on databases in applications now also includes segments on transaction integrity, designing multi-user solutions, and application level security, bringing these important perspectives together with their context. The revised chapter on physical database design and database infrastructure (new Chapter 8) includes also coverage of database security, backup and recovery, cloud-based database solutions, and other essential database infrastructure topics. This new comprehensive structure on physical design and infrastructure is now placed after the SQL chapters. The new version of Chapter 9 integrates material on data warehousing and data integrity in a conceptually natural pairing. Recognizing the way in which analytics capabilities rely on all types of data management solutions, Chapter 11, on analytics and implications, is now separate from Chapter 10, on big data. Finally, Chapter 12 brings together data and database administration with data quality, emphasizing the essential connections between the three.
- The part structure of the book has been redesigned to be fully aligned with the new chapter structure.
- We have introduced a new overarching framework (Figure 1-5), which gives our readers a clearer overview of structure of the book and its core topic areas. The framework communicates clearly the increasing importance of informational systems (divided into Analytics–Data Warehousing and Analytics–Big Data) in addition to this book's traditional strength of transactional systems.
- Given the continued and still increasing interest in big data and analytics, we have continued to expand content in this area. The book has now separate chapters on big data technologies (Chapter 10) and analytics (Chapter 11). In addition to general coverage of NoSQL and Hadoop technologies, Chapter 10 provides also detailed examples of MongoDB, Pig, and Hive. Chapter 11 includes extended coverage of R, Python, and Apache Spark—all essential technologies for analytics professionals that allow a link between analytics and data management architectures.
- We emphasize the increasing importance of cloud-based database solutions, mobile technologies, and agile development throughout the book.
- Chapter 1 now better recognizes the broad range of enterprise level applications data management solutions enable and support, including enterprise systems, data warehouses, and data lakes.

- Chapter 7 on databases in applications now includes an extensive example demonstrating the use of Python in the context of database-driven applications.
- The instructor's manual will have more material to support the case Forondo Artist Management Excellence that was introduced in the 12th edition.

In addition to the new topics covered, specific improvements to the textbook have been made in the following areas:

- Every chapter went through significant edits to streamline coverage to ensure relevance with current technologies and eliminate redundancies.
- The entire book has been edited so that its language clearly reflects its focus on the readers as learners instead of authors as teachers
- End-of-chapter material (review questions, problems and exercises, and/or field exercises) in every chapter has been revised with new and modified questions and exercises.
- We continued to update the figures in several chapters to reflect the changing landscape of technologies that are being used in modern organizations.
- The Web Resources section in each chapter was updated to ensure that students have information on the latest database trends and expanded background details on important topics covered in the text.
- The book continues to be available through VitalSource, an innovative e-book delivery system, and as an electronic book in the Kindle format.

Also, we continue to provide on the student Companion Web site several custom-developed short videos that address key concepts and skills from different sections of the book. These videos, produced by the textbook authors, help students learn difficult material by using both the printed text and a mini-lecture or tutorial. Videos have been developed to support Chapters 1 (introduction to database), 2 and 3 (conceptual data modeling), 4 (normalization), and 6 and 7 (SQL). Look for special icons on the opening page of these chapters to call attention to these videos, and go to **www.pearsonhighered.com/hoffer** to find these videos.

## FOR THOSE NEW TO *MODERN DATABASE MANAGEMENT*

*Modern Database Management* has been a leading text since its first edition in 1983. In spite of this market leadership position, some instructors have used other good database management texts. Why might you want to switch at this time? There are several good reasons:

- One of our goals, in every edition, has been to lead other books in coverage of the latest principles, concepts, and technologies. See what we have added for the 13th edition in "What's New in This Edition?" In the past, we have led in coverage of object-oriented data modeling and UML, Internet databases, data warehousing, and the use of CASE tools in support of data modeling. For the 13th edition, we continue this tradition by continuing to expand and improve coverage of big data and analytics, focusing on what every database student needs to understand about these topics.
- While remaining current, this text focuses on what leading practitioners say is most important for database developers. We work with many practitioners, including the professionals of the Data Management Association (DAMA) and The Data Warehousing Institute (TDWI), leading consultants, technology leaders, and authors of articles in the most widely read professional publications. We draw on these experts to ensure that what the book includes is important and covers not only important entry-level knowledge and skills but also those fundamentals and mind-sets that lead to long-term career success.
- In the 13th edition of this highly successful book, material is presented in a way that has been viewed as very accessible to students. Our methods have been refined through continuous market feedback for more than 35 years as well as through our own teaching. Overall, the pedagogy of the book is sound, and we believe that the new framework that we introduced in Chapter 1 will further strengthen our students'

understanding of the big picture of data management. We use many illustrations that help make important concepts and techniques clear. We use the most modern notations. The organization of the book is flexible, so you can use chapters in whatever sequence makes sense for your students. We supplement the book with data sets to facilitate hands-on, practical learning and with new media resources to make some of the more challenging topics more engaging.

- Our text can accommodate structural flexibility. For example, you may have particular interest in introducing SQL early in your course. Our text makes this possible. First, we cover SQL in depth, devoting two full chapters to this core technology of the database field. Second, we include many SQL examples in early chapters. Third, many instructors have successfully used the two SQL chapters early in their course. Although logically appearing in the life cycle of systems development as Chapters 5 and 6, part of the implementation section of the text, many instructors have used these chapters immediately after Chapter 1 or in parallel with other early chapters. Finally, we use SQL throughout the book, for example, to illustrate Web application connections to relational databases in Chapter 7 and online analytical processing in Chapter 11.
- We have the latest in supplements and Web site support for the text. See the supplement package for details on all the resources available to you and your students.
- This text is written to be part of a modern information systems curriculum with a strong business systems development focus. Topics are included and addressed so as to reinforce principles from other typical courses, such as systems analysis and design, networking, Web site design and development, MIS principles, and application development. Emphasis is on the development of the database component of modern information systems and on the management of the data resource. Thus, the text is practical, supports projects and other hands-on class activities, and encourages linking database concepts to concepts being learned throughout the curriculum the student is taking.

## SUMMARY OF ENHANCEMENTS TO EACH CHAPTER

The following sections present a chapter-by-chapter description of the major changes in this edition. Each chapter description presents a statement of the purpose of that chapter, followed by a description of the changes and revisions that have been made for the 13th edition. Each paragraph concludes with a description of the strengths that have been retained from prior editions.

## PART I: THE CONTEXT OF DATABASE MANAGEMENT

### Chapter 1: The Database Environment and Development Process

This chapter discusses the role of databases in organizations and previews the major topics in the remainder of the text. The primary change to this chapter has been the introduction of a new integrated data management framework (Figure 1-5) and supporting text accompanying it. This framework recognizes the increasing importance of the *informational* systems in addition to the traditional focus of this book on *transactional* systems. After presenting a brief introduction to the basic terminology associated with storing and retrieving data, the chapter presents a well-organized comparison of traditional file processing systems and modern database technology. The chapter then introduces the core components of a database environment. It then goes on to explain the process of database development in the context of structured life cycle, prototyping, and agile methodologies. The chapter also discusses important issues in database development, including management of the diverse group of people involved in database development and frameworks for understanding database architectures and technologies (e.g., the three-schema architecture). Reviewers frequently note the compatibility of this chapter with what students learn in systems analysis and design classes. A brief history of the evolution of database technology, from pre-database files to modern object-relational technologies, is presented. The chapter also provides

an overview of the range of database applications that are currently in use within organizations—personal, multi-tier, and enterprise applications. The explanation of enterprise databases includes databases that are part of enterprise resource planning systems and data warehouses. The chapter concludes with a description of the process of developing a database in a fictitious company, Pine Valley Furniture. This description closely mirrors the steps in database development described earlier in the chapter. The first chapter provides an introduction to the FAME case, which then continues through the book until Chapter 8.

## PART II: DATABASE ANALYSIS AND LOGICAL DESIGN

### Chapter 2: Modeling Data in the Organization

This chapter presents a thorough introduction to conceptual data modeling with the entity-relationship (E-R) model. The chapter title emphasizes the reason for the E-R model: to unambiguously document the rules of the business that influence database design. Specific subsections explain in detail how to name and define elements of a data model, which are essential in developing an unambiguous E-R diagram. The chapter continues to proceed from simple to more complex examples, and it concludes with a comprehensive E-R diagram for the Pine Valley Furniture Company. In the 13th edition, we have provided six new problems and exercises; these new exercises present some more modern situations, such as Internet of Things applications for databases. A variety of other problems and exercises as well as review questions have been changed to emphasize important topics of the chapter. Appendix A provides information on different data modeling tools and notations.

### Chapter 3: The Enhanced E-R Model

This chapter presents a discussion of several advanced E-R data model constructs, primarily supertype/subtype relationships. As in Chapter 2, problems and exercises have been revised, with three new exercises and several building on or extending the new exercises from Chapter 2. The third part of the new FAME case is presented in this chapter. The chapter continues to present thorough coverage of supertype/subtype relationships and includes a comprehensive example of an extended E-R data model for the Pine Valley Furniture Company.

### Chapter 4: Logical Database Design and the Relational Model

This chapter describes the process of converting a conceptual data model to the relational data model, as well as how to merge new relations into an existing normalized database. It provides a conceptually sound and practically relevant introduction to normalization, emphasizing the importance of the use of functional dependencies and determinants as the basis for normalization. Concepts of normalization and normal forms are extended in Appendix B. The chapter features a discussion of the characteristics of foreign keys and introduces the important concept of a nonintelligent enterprise key. Enterprise keys (also called surrogate keys for data warehouses) are emphasized as some concepts of object-orientation have migrated into the relational technology world. New problems and exercises are included that draw upon the new problems and exercises from Chapters 2 and 3 for relational modeling and normalization. The chapter continues to emphasize the basic concepts of the relational data model and the role of the database designer in the logical design process.

## PART III: DATABASE IMPLEMENTATION AND USE

### Chapter 5: Introduction to SQL

This chapter (Chapter 6 in 12th edition) presents a thorough introduction to the SQL used by most DBMSs (SQL:1999) and introduces the changes that are included in the latest standards (SQL: 2011 and SQL:2016). This edition adds coverage of the new features of SQL:2016, including row pattern recognition, JSON support, and extended analytical

capabilities. The new edition also clarifies coverage of SQL data types and, overall, makes it easier to move from relational design in Chapter 4 directly to database implementation without the material on physical database design (now in Chapter 8). The coverage of SQL is extensive and divided between this chapter and Chapter 6. This chapter includes examples of SQL code, using mostly SQL:1999 and SQL:2016 syntax, as well as some Oracle 12c and Microsoft SQL Server syntax. Some unique features of MySQL are mentioned. In this edition, coverage of views has been moved to Chapter 6. Chapter 5 explains the SQL commands needed to create and maintain a database and to program single-table queries. Five review questions and 13 problems and exercises have been added to the chapter or modified extensively. The chapter continues to use the Pine Valley Furniture Company case to illustrate a wide variety of practical queries and query results.

### Chapter 6: Advanced SQL

This chapter (Chapter 7 in 12th edition) continues the description of SQL, with a careful explanation of multiple-table queries, transaction integrity, data dictionaries, dynamic and materialized views, triggers and stored procedures (the differences between them are now more clearly explained), and embedding SQL in other programming language programs. All forms of the OUTER JOIN command are covered. Standard SQL (with an updated focus on SQL:2016) is also used. The revised version of the chapter includes now thorough coverage of views and the purposes for which they are used, including their role in enabling security and privacy solutions. This chapter illustrates how to store the results of a query in a derived table, the CAST command to convert data between different data types, and the CASE command for doing conditional processing in SQL. Emphasis continues on the set-processing style of SQL compared with the record processing of programming languages with which the student may be familiar. The section on routines has been revised to provide clarified, expanded, and more current coverage of this topic. The material of transaction integrity, has, however been moved to Chapter 7, where it most naturally belongs. The chapter continues to contain a clear explanation of subqueries and correlated subqueries, two of the most complex and powerful constructs in SQL. At the end, the chapter discusses material that is new to this chapter: data dictionary facilities (in practice, using SQL to understand the structure of the database) and recent extensions and enhancements to SQL. Chapter review material has been updated with 13 new problems and exercises and three new review questions.

### Chapter 7: Databases in Applications

This chapter (Chapter 8 in 12th edition) provides a modern discussion of the concepts of client/server architecture and applications, middleware, and database access in contemporary database environments. The chapter has been structurally significantly modified to provide additional clarity, including the integration of material on a two-tiered architecture into the section on three-tiered architecture. In addition to a revised example of writing a Java web application, there is an entire new section—including an extensive and detailed example—on writing Web applications with Python, a widely used general purpose programming language that has become very popular in analytics. Sections on transaction integrity, concurrent access, and application level data security have been revised and moved to this chapter to provide additional conceptual clarity. Material on cloud computing has been moved to Chapter 8 on database infrastructure. Review questions and problems and exercises have been updated.

### Chapter 8: Physical Database Design and Database Infrastructure

This chapter (Chapter 5 in the 12th edition) describes the steps that are essential in achieving an efficient database design, with a strong focus on those aspects of database design and implementation that are typically within the control of a database professional in a modern database environment. In addition, several new topics on database infrastructure have been integrated into this chapter to improve the structural clarity of the book, including data dictionaries and repositories, general database software security features, and database backup and recovery. A revised and extended section on cloud-based database infrastructure completes the chapter. Overall, the chapter emphasizes ways to

improve database performance, with references to specific techniques available in Oracle and other DBMSs to achieve this goal. The discussion of indexes includes descriptions of the types of indexes that are widely available in database technologies as techniques to improve query processing speed. Appendix C provides excellent background on fundamental data structures for programs of study that need coverage of this topic. The chapter continues to emphasize the physical design process and the goals of that process. Review questions and problems and exercises have been updated and extended based on the new structure and content of the chapter.

## PART IV: ADVANCED DATABASE TOPICS

### Chapter 9: Data Warehousing and Data Integration

This chapter describes the basic concepts of data warehousing, the reasons data warehousing is regarded as critical to competitive advantage in many organizations, and the database design activities and structures unique to data warehousing. The most important change of this chapter is the integration of material on data integration (formerly in Chapter 10 in the 12th edition) into it. This change strengthens the readers' ability to understand the essential role of data integration in data warehousing (particularly in ETL and other aspects of data preparation), and it clarifies the structure of the book. Topics covered in this chapter include alternative data warehouse architectures and the dimensional data model (or star schema) for data warehouses. In this edition, additional attention is given to cloud-based implementation of data warehouses. Throughout the chapter, several details have been updated to ensure technical correctness. Operational data store and independent, dependent, and logical data marts are defined. The chapter includes multiple new and revised review questions and problems and exercises.

### Chapter 10: Big Data Technologies

This chapter incorporates big data infrastructure material from Chapter 11 in the 12th edition, significantly expanding it and making it more directly applicable with substantial detailed descriptive examples of MongoDB (the most popular NoSQL database) and Pig (scripting language and task automation environment for Hadoop) and Hive (an SQL-like declarative language for querying data stored in Hadoop). This new version of the material gives the students a much more practical, hands-on sense of the purposes for which these well-known tools can be used and how they can serve the goals of big data management. The chapter also includes several new problems and exercises based on these environments. Overall, the chapter helps the readers understand how big data technologies have expanded the possibilities for analytics-driven innovation through advanced informational systems that are pushing boundaries further in terms of volume, velocity, and variety of data while paying continuous attention to value and veracity of big data.

### Chapter 11: Analytics and its Implications

Chapter 11 offers integrated coverage of analytics, including descriptive, predictive, and prescriptive analytics. It is based on material on analytics in the big data and analytics chapter in the 12th edition, expanding it with comprehensive new sections on R, Python, and Apache Spark and bringing in material on analytical functions in SQL. The discussion on analytics is linked not only to the coverage of big data but also the material on data warehousing in Chapter 9 and the general discussion on data management in Chapter 1 (as indicated in the new framework in Chapter 1). The chapter also covers approaches and technologies used by analytics professionals, such as on-line analytical processing, data visualization, business performance management and dashboards, data mining, and text mining. Finally, the chapter integrates the coverage of big data and analytics technologies to the individual, organizational, and societal implications of these capabilities. Review questions on the new material have been added.

### Chapter 12: Data and Database Administration with Focus on Data Quality

This chapter presents a thorough discussion of the importance and roles of data and database administration and describes a number of the key issues that arise when these functions are performed. This chapter emphasizes the changing roles and approaches of data and database administration, with a renewed and strengthened emphasis on data quality. The chapter both discusses essential characteristics of high-quality data and the mechanisms that organizations need to put in place to enable data quality improvement. Data governance, data availability, and master data management are also covered. The chapter continues to emphasize the critical importance of data and database management in managing data as a corporate asset.

### Chapter 13: Distributed Databases

This chapter—available on the book's Web site—reviews the role, technologies, and unique database design opportunities of distributed databases. The objectives and trade-offs for distributed databases, data replication alternatives, factors in selecting a data distribution strategy, and distributed database vendors and products are covered. This chapter provides thorough coverage of database concurrency access controls. Many reviewers have indicated that they are seldom able to cover this chapter in an introductory course, but having the material available is critical for advanced students or special topics.

### Chapter 14: Object-Oriented Data Modeling

This chapter presents an introduction to object-oriented modeling using Object Management Group's Unified Modeling Language (UML). This chapter has been carefully reviewed to ensure consistency with the latest UML notation and best industry practices. UML provides an industry-standard notation for representing classes and objects. The chapter continues to emphasize basic object-oriented concepts, such as inheritance, encapsulation, composition, and polymorphism. As with Chapter 13, Chapter 14 is available on the textbook's Web site.

## APPENDICES

In the 13th edition three appendices are available on the book's Web site and are intended for those who wish to explore certain topics in greater depth.

### Appendix A: Data Modeling Tools and Notation

This appendix addresses a need raised by many readers—how to translate the E-R notation in the text into the form used by the CASE tool or the DBMS used in class. Specifically, this appendix compares the notations of CA ERwin Data Modeler r9.7, Oracle SQL Data Modeler 4.2, SAP Sybase PowerDesigner 16.6, and Microsoft Visio Professional 2016. Tables and illustrations show the notations used for the same constructs in each of these popular software packages.

### Appendix B: Advanced Normal Forms

This appendix presents a description (with examples) of Boyce-Codd and fourth normal forms, including an example of BCNF to show how to handle overlapping candidate keys. Other normal forms are briefly introduced. The Web Resources section includes a reference for information on many advanced normal form topics.

### Appendix C: Data Structures

This appendix describes several data structures that often underlie database implementations. Topics include the use of pointers, stacks, queues, sorted lists, inverted lists, and trees.

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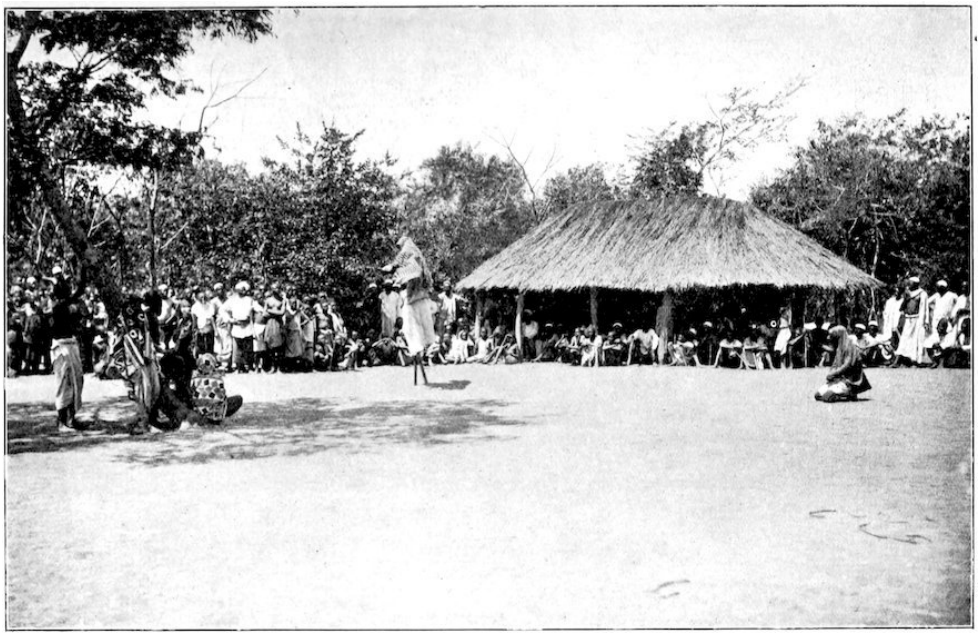
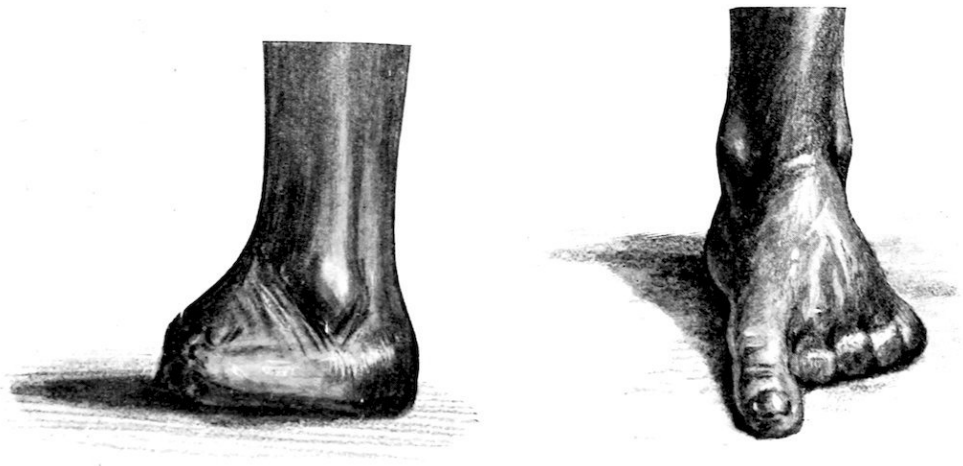


DANCE ON STILTS AT THE GIRLS' UNYAGO, NIUCHI

Newala, too, suffers from the distance of its water-supply—at least the Newala of to-day does; there was once another Newala in a lovely valley at the foot of the plateau. I visited it and found scarcely a trace of houses, only a Christian cemetery, with the graves of several missionaries and their converts, remaining as a monument of its former glories. But the surroundings are wonderfully beautiful. A thick grove of splendid mango-trees closes in the weather-worn crosses and headstones; behind them, combining the useful and the agreeable, is a whole plantation of lemon-trees covered with ripe fruit; not the small African kind, but a much larger and also juicier imported variety, which drops into the hands of the passing traveller, without calling for any exertion on his part. Old Newala is now under the jurisdiction of the native pastor, Daudi, at Chingulungulu, who, as I am on very friendly terms with him, allows me, as a matter of course, the use of this lemon-grove during my stay at Newala.



FEET MUTILATED BY THE RAVAGES OF THE "JIGGER"
(*Sarcopsylla penetrans*)

The water-supply of New Newala is in the bottom of the valley, some 1,600 feet lower down. The way is not only long and fatiguing, but the water, when we get it, is thoroughly bad. We are suffering not only from this, but from the fact that the arrangements at Newala are nothing short of luxurious. We have a separate kitchen—a hut built against the *boma* palisade on the right of the *baraza*, the interior of which is not visible from our usual position. Our two cooks were not long in finding this out, and they consequently do—or rather neglect to do—what they please. In any case they do not seem to be very particular about the boiling of our drinking-water—at least I can attribute to no other cause certain attacks of a dysenteric nature, from which both Knudsen and I have suffered for some time. If a man like Omari has to be left unwatched for a moment, he is capable of anything. Besides this complaint, we are inconvenienced by the state of our nails, which have become as hard as glass, and crack on the slightest provocation, and I have the additional infliction of pimples all over me. As if all this were not enough, we have also, for the last week been waging war against the jigger, who has found his Eldorado in the hot sand of the Makonde plateau. Our men are seen all day long—whenever their chronic colds and the dysentery likewise raging among them permit—occupied in removing this scourge of Africa from their feet and trying to prevent the disastrous consequences of its presence. It is quite common to see natives of this place with one or two toes missing; many have lost all their toes,

or even the whole front part of the foot, so that a well-formed leg ends in a shapeless stump. These ravages are caused by the female of *Sarcopsylla penetrans*, which bores its way under the skin and there develops an egg-sac the size of a pea. In all books on the subject, it is stated that one's attention is called to the presence of this parasite by an intolerable itching. This agrees very well with my experience, so far as the softer parts of the sole, the spaces between and under the toes, and the side of the foot are concerned, but if the creature penetrates through the harder parts of the heel or ball of the foot, it may escape even the most careful search till it has reached maturity. Then there is no time to be lost, if the horrible ulceration, of which we see cases by the dozen every day, is to be prevented. It is much easier, by the way, to discover the insect on the white skin of a European than on that of a native, on which the dark speck scarcely shows. The four or five jiggers which, in spite of the fact that I constantly wore high laced boots, chose my feet to settle in, were taken out for me by the all-accomplished Knudsen, after which I thought it advisable to wash out the cavities with corrosive sublimate. The natives have a different sort of disinfectant—they fill the hole with scraped roots. In a tiny Makua village on the slope of the plateau south of Newala, we saw an old woman who had filled all the spaces under her toe-nails with powdered roots by way of prophylactic treatment. What will be the result, if any, who can say?

The rest of the many trifling ills which trouble our existence are really more comic than serious. In the absence of anything else to smoke, Knudsen and I at last opened a box of cigars procured from the Indian store-keeper at Lindi, and tried them, with the most distressing results. Whether they contain opium or some other narcotic, neither of us can say, but after the tenth puff we were both "off," three-quarters stupefied and unspeakably wretched. Slowly we recovered—and what happened next? Half-an-hour later we were once more smoking these poisonous concoctions—so insatiable is the craving for tobacco in the tropics.

Even my present attacks of fever scarcely deserve to be taken seriously. I have had no less than three here at Newala, all of which have run their course in an incredibly short time. In the early afternoon, I am busy with my old natives, asking questions and making notes. The strong midday coffee has stimulated my spirits to

an extraordinary degree, the brain is active and vigorous, and work progresses rapidly, while a pleasant warmth pervades the whole body. Suddenly this gives place to a violent chill, forcing me to put on my overcoat, though it is only half-past three and the afternoon sun is at its hottest. Now the brain no longer works with such acuteness and logical precision; more especially does it fail me in trying to establish the syntax of the difficult Makua language on which I have ventured, as if I had not enough to do without it. Under the circumstances it seems advisable to take my temperature, and I do so, to save trouble, without leaving my seat, and while going on with my work. On examination, I find it to be 101·48°. My tutors are abruptly dismissed and my bed set up in the *baraza*; a few minutes later I am in it and treating myself internally with hot water and lemon-juice.

Three hours later, the thermometer marks nearly 104°, and I make them carry me back into the tent, bed and all, as I am now perspiring heavily, and exposure to the cold wind just beginning to blow might mean a fatal chill. I lie still for a little while, and then find, to my great relief, that the temperature is not rising, but rather falling. This is about 7.30 p.m. At 8 p.m. I find, to my unbounded astonishment, that it has fallen below 98·6°, and I feel perfectly well. I read for an hour or two, and could very well enjoy a smoke, if I had the wherewithal—Indian cigars being out of the question.

Having no medical training, I am at a loss to account for this state of things. It is impossible that these transitory attacks of high fever should be malarial; it seems more probable that they are due to a kind of sunstroke. On consulting my note-book, I become more and more inclined to think this is the case, for these attacks regularly follow extreme fatigue and long exposure to strong sunshine. They at least have the advantage of being only short interruptions to my work, as on the following morning I am always quite fresh and fit. My treasure of a cook is suffering from an enormous hydrocele which makes it difficult for him to get up, and Moritz is obliged to keep in the dark on account of his inflamed eyes. Knudsen's cook, a raw boy from somewhere in the bush, knows still less of cooking than Omari; consequently Nils Knudsen himself has been promoted to the vacant post. Finding that we had come to the end of our supplies, he began by sending to Chingulungulu for the four sucking-pigs which we had

bought from Matola and temporarily left in his charge; and when they came up, neatly packed in a large crate, he callously slaughtered the biggest of them. The first joint we were thoughtless enough to entrust for roasting to Knudsen's *mshenzi* cook, and it was consequently uneatable; but we made the rest of the animal into a jelly which we ate with great relish after weeks of underfeeding, consuming incredible helpings of it at both midday and evening meals. The only drawback is a certain want of variety in the tinned vegetables. Dr. Jäger, to whom the Geographical Commission entrusted the provisioning of the expeditions—mine as well as his own—because he had more time on his hands than the rest of us, seems to have laid in a huge stock of Teltow turnips,[46] an article of food which is all very well for occasional use, but which quickly palls when set before one every day; and we seem to have no other tins left. There is no help for it—we must put up with the turnips; but I am certain that, once I am home again, I shall not touch them for ten years to come.

Amid all these minor evils, which, after all, go to make up the genuine flavour of Africa, there is at least one cheering touch: Knudsen has, with the dexterity of a skilled mechanic, repaired my 9 × 12 cm. camera, at least so far that I can use it with a little care. How, in the absence of finger-nails, he was able to accomplish such a ticklish piece of work, having no tool but a clumsy screw-driver for taking to pieces and putting together again the complicated mechanism of the instantaneous shutter, is still a mystery to me; but he did it successfully. The loss of his finger-nails shows him in a light contrasting curiously enough with the intelligence evinced by the above operation; though, after all, it is scarcely surprising after his ten years' residence in the bush. One day, at Lindi, he had occasion to wash a dog, which must have been in need of very thorough cleansing, for the bottle handed to our friend for the purpose had an extremely strong smell. Having performed his task in the most conscientious manner, he perceived with some surprise that the dog did not appear much the better for it, and was further surprised by finding his own nails ulcerating away in the course of the next few days. "How was I to know that carbolic acid has to be diluted?" he mutters indignantly, from time to time, with a troubled gaze at his mutilated finger-tips.

Since we came to Newala we have been making excursions in all directions through the surrounding country, in accordance with old habit, and also because the *akida* Sefu did not get together the tribal elders from whom I wanted information so speedily as he had promised. There is, however, no harm done, as, even if seen only from the outside, the country and people are interesting enough.

The Makonde plateau is like a large rectangular table rounded off at the corners. Measured from the Indian Ocean to Newala, it is about seventy-five miles long, and between the Rovuma and the Lukuledi it averages fifty miles in breadth, so that its superficial area is about two-thirds of that of the kingdom of Saxony. The surface, however, is not level, but uniformly inclined from its south-western edge to the ocean. From the upper edge, on which Newala lies, the eye ranges for many miles east and north-east, without encountering any obstacle, over the Makonde bush. It is a green sea, from which here and there thick clouds of smoke rise, to show that it, too, is inhabited by men who carry on their tillage like so many other primitive peoples, by cutting down and burning the bush, and manuring with the ashes. Even in the radiant light of a tropical day such a fire is a grand sight.

Much less effective is the impression produced just now by the great western plain as seen from the edge of the plateau. As often as time permits, I stroll along this edge, sometimes in one direction, sometimes in another, in the hope of finding the air clear enough to let me enjoy the view; but I have always been disappointed. Wherever one looks, clouds of smoke rise from the burning bush, and the air is full of smoke and vapour. It is a pity, for under more favourable circumstances the panorama of the whole country up to the distant Majeje hills must be truly magnificent. It is of little use taking photographs now, and an outline sketch gives a very poor idea of the scenery. In one of these excursions I went out of my way to make a personal attempt on the Makonde bush. The present edge of the plateau is the result of a far-reaching process of destruction through erosion and denudation. The Makonde strata are everywhere cut into by ravines, which, though short, are hundreds of yards in depth. In consequence of the loose stratification of these beds, not only are the walls of these ravines nearly vertical, but their upper end is closed by an equally steep escarpment, so that the

western edge of the Makonde plateau is hemmed in by a series of deep, basin-like valleys. In order to get from one side of such a ravine to the other, I cut my way through the bush with a dozen of my men. It was a very open part, with more grass than scrub, but even so the short stretch of less than two hundred yards was very hard work; at the end of it the men's calicoes were in rags and they themselves bleeding from hundreds of scratches, while even our strong khaki suits had not escaped scatheless.

NATIVE PATH THROUGH THE MAKONDE BUSH, NEAR MAHUTA

I see increasing reason to believe that the view formed some time back as to the origin of the Makonde bush is the correct one. I have no doubt that it is not a natural product, but the result of human occupation. Those parts of the high country where man—as a very slight amount of practice enables the eye to perceive at once—has not yet penetrated with axe and hoe, are still occupied by a splendid timber forest quite able to sustain a comparison with our mixed forests in Germany. But wherever man has once built his hut or tilled his field, this horrible bush springs up. Every phase of this process

may be seen in the course of a couple of hours' walk along the main road. From the bush to right or left, one hears the sound of the axe—not from one spot only, but from several directions at once. A few steps further on, we can see what is taking place. The brush has been cut down and piled up in heaps to the height of a yard or more, between which the trunks of the large trees stand up like the last pillars of a magnificent ruined building. These, too, present a melancholy spectacle: the destructive Makonde have ringed them—cut a broad strip of bark all round to ensure their dying off—and also piled up pyramids of brush round them. Father and son, mother and son-in-law, are chopping away perseveringly in the background—too busy, almost, to look round at the white stranger, who usually excites so much interest. If you pass by the same place a week later, the piles of brushwood have disappeared and a thick layer of ashes has taken the place of the green forest. The large trees stretch their smouldering trunks and branches in dumb accusation to heaven—if they have not already fallen and been more or less reduced to ashes, perhaps only showing as a white stripe on the dark ground.

This work of destruction is carried out by the Makonde alike on the virgin forest and on the bush which has sprung up on sites already cultivated and deserted. In the second case they are saved the trouble of burning the large trees, these being entirely absent in the secondary bush.

After burning this piece of forest ground and loosening it with the hoe, the native sows his corn and plants his vegetables. All over the country, he goes in for bed-culture, which requires, and, in fact, receives, the most careful attention. Weeds are nowhere tolerated in the south of German East Africa. The crops may fail on the plains, where droughts are frequent, but never on the plateau with its abundant rains and heavy dews. Its fortunate inhabitants even have the satisfaction of seeing the proud Wayao and Wamakua working for them as labourers, driven by hunger to serve where they were accustomed to rule.

But the light, sandy soil is soon exhausted, and would yield no harvest the second year if cultivated twice running. This fact has been familiar to the native for ages; consequently he provides in time, and, while his crop is growing, prepares the next plot with axe and firebrand. Next year he plants this with his various crops and

lets the first piece lie fallow. For a short time it remains waste and desolate; then nature steps in to repair the destruction wrought by man; a thousand new growths spring out of the exhausted soil, and even the old stumps put forth fresh shoots. Next year the new growth is up to one's knees, and in a few years more it is that terrible, impenetrable bush, which maintains its position till the black occupier of the land has made the round of all the available sites and come back to his starting point.

The Makonde are, body and soul, so to speak, one with this bush. According to my Yao informants, indeed, their name means nothing else but "bush people." Their own tradition says that they have been settled up here for a very long time, but to my surprise they laid great stress on an original immigration. Their old homes were in the south-east, near Mikindani and the mouth of the Rovuma, whence their peaceful forefathers were driven by the continual raids of the Sakalavas from Madagascar and the warlike Shirazis[47] of the coast, to take refuge on the almost inaccessible plateau. I have studied African ethnology for twenty years, but the fact that changes of population in this apparently quiet and peaceable corner of the earth could have been occasioned by outside enterprises taking place on the high seas, was completely new to me. It is, no doubt, however, correct.

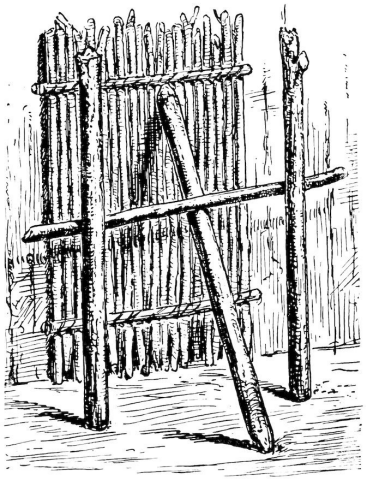
The charming tribal legend of the Makonde—besides informing us of other interesting matters—explains why they have to live in the thickest of the bush and a long way from the edge of the plateau, instead of making their permanent homes beside the purling brooks and springs of the low country.

"The place where the tribe originated is Mahuta, on the southern side of the plateau towards the Rovuma, where of old time there was nothing but thick bush. Out of this bush came a man who never washed himself or shaved his head, and who ate and drank but little. He went out and made a human figure from the wood of a tree growing in the open country, which he took home to his abode in the bush and there set it upright. In the night this image came to life and was a woman. The man and woman went down together to the Rovuma to wash themselves. Here the woman gave birth to a still-born child. They left that place and passed over the high land into the valley of the Mbemkuru, where the woman had another child, which

was also born dead. Then they returned to the high bush country of Mahuta, where the third child was born, which lived and grew up. In course of time, the couple had many more children, and called themselves Wamatanda. These were the ancestral stock of the Makonde, also called Wamakonde,[48] *i.e.*, aborigines. Their forefather, the man from the bush, gave his children the command to bury their dead upright, in memory of the mother of their race who was cut out of wood and awoke to life when standing upright. He also warned them against settling in the valleys and near large streams, for sickness and death dwelt there. They were to make it a rule to have their huts at least an hour's walk from the nearest watering-place; then their children would thrive and escape illness."

The explanation of the name Makonde given by my informants is somewhat different from that contained in the above legend, which I extract from a little book (small, but packed with information), by Pater Adams, entitled *Lindi und sein Hinterland*. Otherwise, my results agree exactly with the statements of the legend. Washing? *Hapana*—there is no such thing. Why should they do so? As it is, the supply of water scarcely suffices for cooking and drinking; other people do not wash, so why should the Makonde distinguish himself by such needless eccentricity? As for shaving the head, the short, woolly crop scarcely needs it,[49] so the second ancestral precept is likewise easy enough to follow. Beyond this, however, there is nothing ridiculous in the ancestor's advice. I have obtained from various local artists a fairly large number of figures carved in wood, ranging from fifteen to twenty-three inches in height, and representing women belonging to the great group of the Mavia, Makonde, and Matambwe tribes. The carving is remarkably well done and renders the female type with great accuracy, especially the keloid ornamentation, to be described later on. As to the object and meaning of their works the sculptors either could or (more probably) would tell me nothing, and I was forced to content myself with the scanty information vouchsafed by one man, who said that the figures were merely intended to represent the *nembo*—the artificial deformations of *pelele*, ear-discs, and keloids. The legend recorded by Pater Adams places these figures in a new light. They must surely be more than mere dolls; and we may even venture to assume that they are—though the majority of present-day Makonde are probably unaware of the fact—representations of the tribal ancestress.

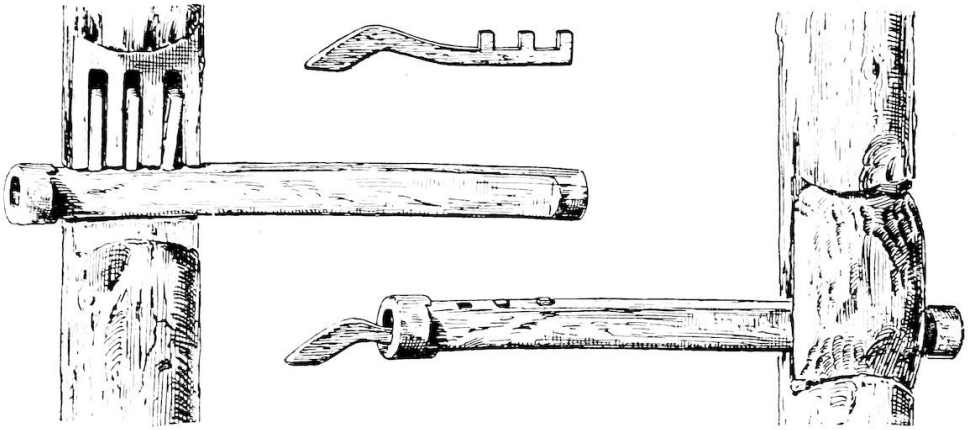
The references in the legend to the descent from Mahuta to the Rovuma, and to a journey across the highlands into the Mbekuru valley, undoubtedly indicate the previous history of the tribe, the travels of the ancestral pair typifying the migrations of their descendants. The descent to the neighbouring Rovuma valley, with its extraordinary fertility and great abundance of game, is intelligible at a glance—but the crossing of the Lukuledi depression, the ascent to the Rondo Plateau and the descent to the Mbemkuru, also lie within the bounds of probability, for all these districts have exactly the same character as the extreme south. Now, however, comes a point of especial interest for our bacteriological age. The primitive Makonde did not enjoy their lives in the marshy river-valleys. Disease raged among them, and many died. It was only after they had returned to their original home near Mahuta, that the health conditions of these people improved. We are very apt to think of the African as a stupid person whose ignorance of nature is only equalled by his fear of it, and who looks on all mishaps as caused by evil spirits and malignant natural powers. It is much more correct to assume in this case that the people very early learnt to distinguish districts infested with malaria from those where it is absent.



USUAL METHOD OF CLOSING HUT-DOOR

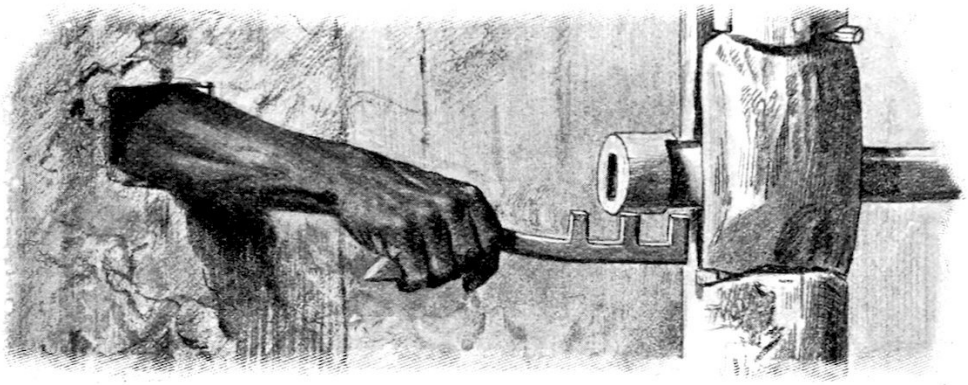
This knowledge is crystallized in the ancestral warning against settling in the valleys and near the great waters, the dwelling-places of disease and death. At the same time, for security against the hostile Mavia south of the Rovuma, it was enacted that every settlement must be not less than a certain distance from the southern edge of the plateau. Such in fact is their mode of life at the present day. It is not such a bad one, and certainly they are both safer and more comfortable than the Makua, the recent intruders from the south, who have made good their footing on the western edge of the plateau, extending over a fairly wide belt of country. Neither Makua nor Makonde show in their dwellings anything of the size and comeliness of the Yao houses in the plain, especially at Masasi, Chingulungulu and Zuza's. Jumbe Chauro, a Makonde hamlet not far from Newala, on the road to Mahuta, is the

most important settlement of the tribe I have yet seen, and has fairly spacious huts. But how slovenly is their construction compared with the palatial residences of the elephant-hunters living in the plain. The roofs are still more untidy than in the general run of huts during the dry season, the walls show here and there the scanty beginnings or the lamentable remains of the mud plastering, and the interior is a veritable dog-kennel; dirt, dust and disorder everywhere. A few huts only show any attempt at division into rooms, and this consists merely of very roughly-made bamboo partitions. In one point alone have I noticed any indication of progress—in the method of fastening the door. Houses all over the south are secured in a simple but ingenious manner. The door consists of a set of stout pieces of wood or bamboo, tied with bark-string to two cross-pieces, and moving in two grooves round one of the door-posts, so as to open inwards. If the owner wishes to leave home, he takes two logs as thick as a man's upper arm and about a yard long. One of these is placed obliquely against the middle of the door from the inside, so as to form an angle of from 60° to 75° with the ground. He then places the second piece horizontally across the first, pressing it downward with all his might. It is kept in place by two strong posts planted in the ground a few inches inside the door. This fastening is absolutely safe, but of course cannot be applied to both doors at once, otherwise how could the owner leave or enter his house? I have not yet succeeded in finding out how the back door is fastened.



MAKONDE LOCK AND KEY AT JUMBE CHAURO

This is the general way of closing a house. The Makonde at Jumbe Chauro, however, have a much more complicated, solid and original one. Here, too, the door is as already described, except that there is only one post on the inside, standing by itself about six inches from one side of the doorway. Opposite this post is a hole in the wall just large enough to admit a man's arm. The door is closed inside by a large wooden bolt passing through a hole in this post and pressing with its free end against the door. The other end has three holes into which fit three pegs running in vertical grooves inside the post. The door is opened with a wooden key about a foot long, somewhat curved and sloped off at the butt; the other end has three pegs corresponding to the holes, in the bolt, so that, when it is thrust through the hole in the wall and inserted into the rectangular opening in the post, the pegs can be lifted and the bolt drawn out.[50]

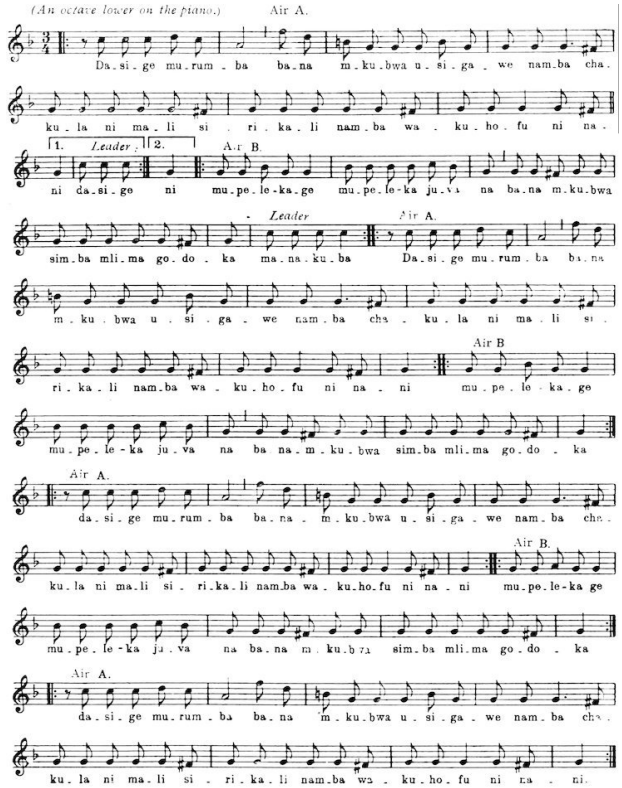


MODE OF INSERTING THE KEY

With no small pride first one householder and then a second showed me on the spot the action of this greatest invention of the Makonde Highlands. To both with an admiring exclamation of "*Vizuri sana!*" ("Very fine!"). I expressed the wish to take back these marvels with me to Ulaya, to show the Wazungu what clever fellows the Makonde are. Scarcely five minutes after my return to camp at Newala, the two men came up sweating under the weight of two heavy logs which they laid down at my feet, handing over at the same time the keys of the fallen fortress. Arguing, logically enough, that if the key was wanted, the lock would be wanted with it, they had taken their axes and chopped down the posts—as it never occurred to them to dig them out of the ground and so bring them intact. Thus I have

two badly damaged specimens, and the owners, instead of praise, come in for a blowing-up.

The Makua huts in the environs of Newala are especially miserable; their more than slovenly construction reminds one of the temporary erections of the Makua at Hatia's, though the people here have not been concerned in a war. It must therefore be due to congenital idleness, or else to the absence of a powerful chief. Even the *baraza* at Mlipa's, a short hour's walk south-east of Newala, shares in this general neglect. While public buildings in this country are usually looked after more or less carefully, this is in evident danger of being blown over by the first strong easterly gale. The only attractive object in this whole district is the grave of the late chief Mlipa. I visited it in the morning, while the sun was still trying with partial success to break through the rolling mists, and the circular grove of tall euphorbias, which, with a broken pot, is all that marks the old king's resting-place, impressed one with a touch of pathos. Even my very materially-minded carriers seemed to feel something of the sort, for instead of their usual ribald songs, they chanted solemnly, as we marched on through the dense green of the Makonde bush:—

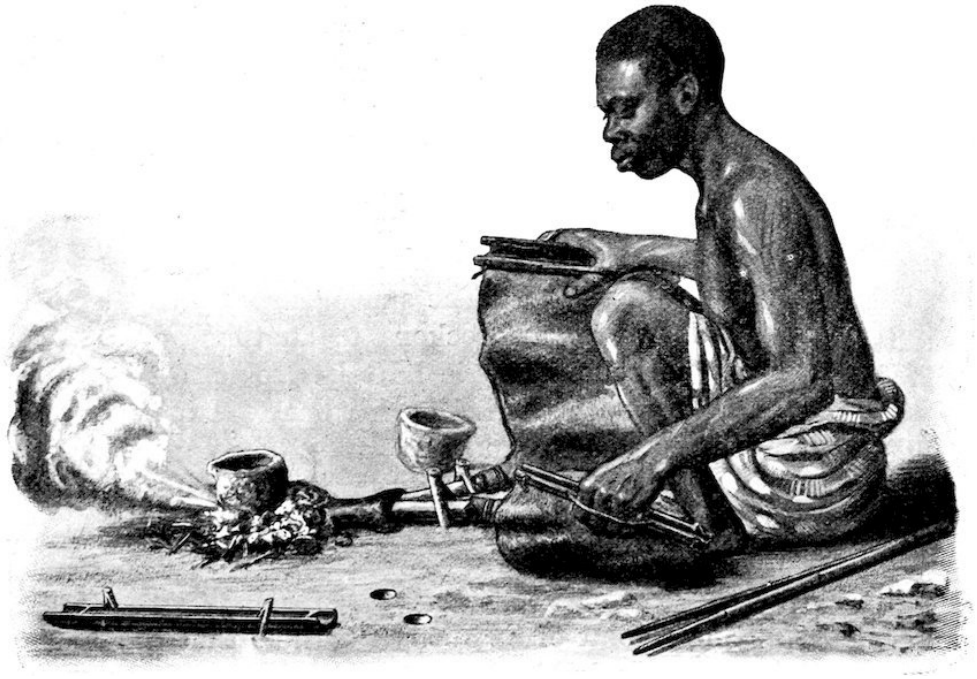



“We shall arrive with the great master; we stand in a row and have no fear about getting our food and our money from the Serkali (the Government). We are not afraid; we are going along with the great master, the lion; we are going down to the coast and back.”

With regard to the characteristic features of the various tribes here on the western edge of the plateau, I can arrive at no other conclusion than the one already come to in the plain, viz., that it is impossible for anyone but a trained anthropologist to assign any given individual at once to his proper tribe. In fact, I think that even an anthropological specialist, after the most careful examination, might find it a difficult task to decide. The whole congeries of peoples collected in the region bounded on the west by the great Central African rift, Tanganyika and Nyasa, and on the east by the Indian Ocean, are closely related to each other—some of their languages are only distinguished from one another as dialects of the same speech, and no doubt all the tribes present the same shape of skull and structure of skeleton. Thus, surely, there can be no very striking differences in outward appearance.

THE ANCESTRESS OF THE MAKONDE

Even did such exist, I should have no time to concern myself with them, for day after day, I have to see or hear, as the case may be—in any case to grasp and record—an extraordinary number of ethnographic phenomena. I am almost disposed to think it fortunate that some departments of inquiry, at least, are barred by external circumstances. Chief among these is the subject of iron-working. We are apt to think of Africa as a country where iron ore is everywhere, so to speak, to be picked up by the roadside, and where it would be quite surprising if the inhabitants had not learnt to smelt the material ready to their hand. In fact, the knowledge of this art ranges all over the continent, from the Kabyles in the north to the Kafirs in the south. Here between the Rovuma and the Lukuledi the conditions are not so favourable. According to the statements of the Makonde, neither ironstone nor any other form of iron ore is known to them. They have not therefore advanced to the art of smelting the metal, but have hitherto bought all their iron implements from neighbouring tribes. Even in the plain the inhabitants are not much better off. Only one man now living is said to understand the art of smelting iron. This old *fundi* lives close to Huwe, that isolated, steep-sided block of granite which rises out of the green solitude between Masasi and Chingulungulu, and whose jagged and splintered top meets the traveller's eye everywhere. While still at Masasi I wished to see this man at work, but was told that, frightened by the rising, he had retired across the Rovuma, though he would soon return. All subsequent inquiries as to whether the *fundi* had come back met with the genuine African answer, "*Bado*" ("Not yet").

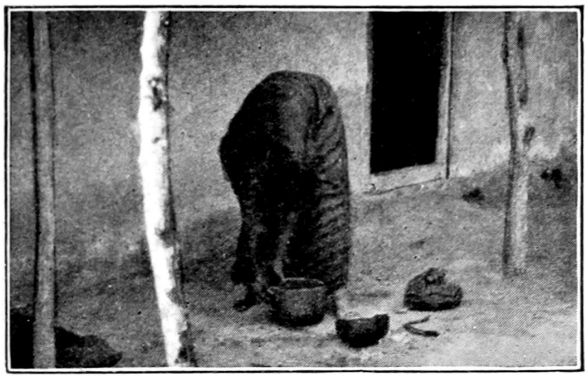


BRAZIER

Some consolation was afforded me by a brassfounder, whom I came across in the bush near Akundonde's. This man is the favourite of women, and therefore no doubt of the gods; he welds the glittering brass rods purchased at the coast into those massive, heavy rings which, on the wrists and ankles of the local fair ones, continually give me fresh food for admiration. Like every decent master-craftsman he had all his tools with him, consisting of a pair of bellows, three crucibles and a hammer—nothing more, apparently. He was quite willing to show his skill, and in a twinkling had fixed his bellows on the ground. They are simply two goat-skins, taken off whole, the four legs being closed by knots, while the upper opening, intended to admit the air, is kept stretched by two pieces of wood. At the lower end of the skin a smaller opening is left into which a wooden tube is stuck. The *fundi* has quickly borrowed a heap of wood-embers from the nearest hut; he then fixes the free ends of the two tubes into an earthen pipe, and clamps them to the ground by means of a bent piece of wood. Now he fills one of his small clay crucibles, the dross on which shows that they have been long in use, with the yellow material, places it in the midst of the embers, which, at present are only faintly glimmering, and begins his work. In quick alternation

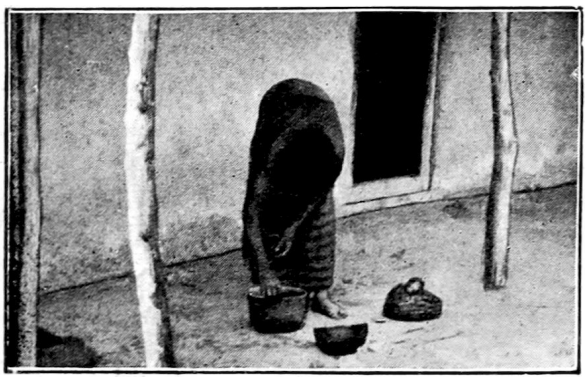
the smith's two hands move up and down with the open ends of the bellows; as he raises his hand he holds the slit wide open, so as to let the air enter the skin bag unhindered. In pressing it down he closes the bag, and the air puffs through the bamboo tube and clay pipe into the fire, which quickly burns up. The smith, however, does not keep on with this work, but beckons to another man, who relieves him at the bellows, while he takes some more tools out of a large skin pouch carried on his back. I look on in wonder as, with a smooth round stick about the thickness of a finger, he bores a few vertical holes into the clean sand of the soil. This should not be difficult, yet the man seems to be taking great pains over it. Then he fastens down to the ground, with a couple of wooden clamps, a neat little trough made by splitting a joint of bamboo in half, so that the ends are closed by the two knots. At last the yellow metal has attained the right consistency, and the *fundi* lifts the crucible from the fire by means of two sticks split at the end to serve as tongs. A short swift turn to the left—a tilting of the crucible—and the molten brass, hissing and giving forth clouds of smoke, flows first into the bamboo mould and then into the holes in the ground.

The technique of this backwoods craftsman may not be very far advanced, but it cannot be denied that he knows how to obtain an adequate result by the simplest means. The ladies of highest rank in this country—that is to say, those who can afford it, wear two kinds of these massive brass rings, one cylindrical, the other semicircular in section. The latter are cast in the most ingenious way in the bamboo mould, the former in the circular hole in the sand. It is quite a simple matter for the *fundi* to fit these bars to the limbs of his fair customers; with a few light strokes of his hammer he bends the pliable brass round arm or ankle without further inconvenience to the wearer.

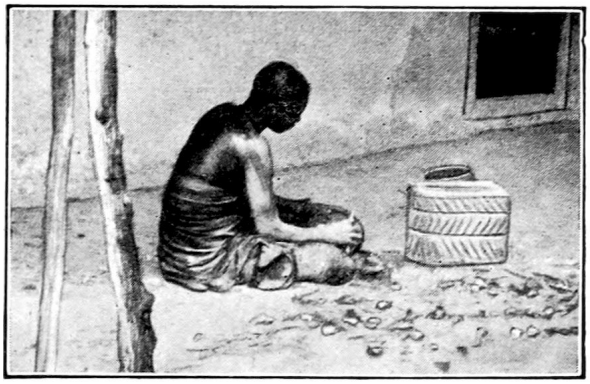


SHAPING THE POT

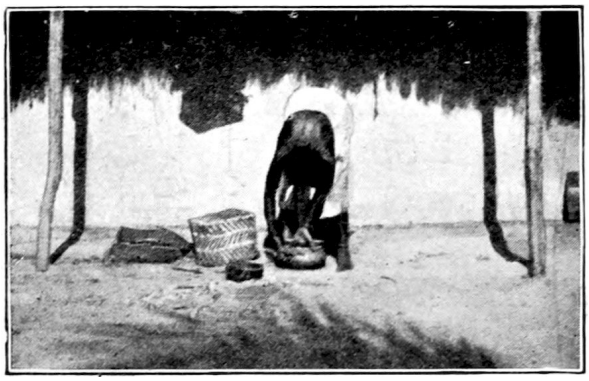
SMOOTHING WITH MAIZE-COB



CUTTING THE EDGE



FINISHING THE BOTTOM



LAST SMOOTHING BEFORE
BURNING

FIRING THE BRUSH-PILE

LIGHTING THE FARTHER SIDE OF THE PILE

TURNING THE RED-HOT VESSEL

NYASA WOMAN MAKING POTS AT MASASI

Pottery is an art which must always and everywhere excite the interest of the student, just because it is so intimately connected with the development of human culture, and because its relics are one of the principal factors in the reconstruction of our own condition in prehistoric times. I shall always remember with pleasure the two or three afternoons at Masasi when Salim Matola's mother, a slightly-built, graceful, pleasant-looking woman, explained to me with touching patience, by means of concrete illustrations, the ceramic art of her people. The only implements for this primitive process were a lump of clay in her left hand, and in the right a calabash containing the following valuables: the fragment of a maize-cob stripped of all its grains, a smooth, oval pebble, about the size of a pigeon's egg, a few chips of gourd-shell, a bamboo splinter about the length of one's hand, a small shell, and a bunch of some herb resembling spinach.

MAKUA WOMAN MAKING A POT. SHOWS THE BEGINNINGS OF THE POTTER'S WHEEL

Nothing more. The woman scraped with the shell a round, shallow hole in the soft, fine sand of the soil, and, when an active young girl had filled the calabash with water for her, she began to knead the clay. As if by magic it gradually assumed the shape of a rough but already well-shaped vessel, which only wanted a little touching up with the instruments before mentioned. I looked out with the closest attention for any indication of the use of the potter's wheel, in however rudimentary a form, but no—*hapana* (there is none). The embryo pot stood firmly in its little depression, and the woman walked round it in a stooping posture, whether she was removing small stones or similar foreign bodies with the maize-cob, smoothing the inner or outer surface with the splinter of bamboo, or later, after letting it dry for a day, pricking in the ornamentation with a pointed bit of gourd-shell, or working out the bottom, or cutting the edge with a sharp bamboo knife, or giving the last touches to the finished vessel. This occupation of the women is infinitely toilsome, but it is without doubt an accurate reproduction of the process in use among our ancestors of the Neolithic and Bronze ages.

There is no doubt that the invention of pottery, an item in human progress whose importance cannot be over-estimated, is due to women. Rough, coarse and unfeeling, the men of the horde range over the countryside. When the united cunning of the hunters has succeeded in killing the game; not one of them thinks of carrying home the spoil. A bright fire, kindled by a vigorous wielding of the drill, is crackling beside them; the animal has been cleaned and cut up *secundum artem*, and, after a slight singeing, will soon disappear under their sharp teeth; no one all this time giving a single thought to wife or child.

To what shifts, on the other hand, the primitive wife, and still more the primitive mother, was put! Not even prehistoric stomachs could endure an unvarying diet of raw food. Something or other suggested the beneficial effect of hot water on the majority of approved but indigestible dishes. Perhaps a neighbour had tried holding the hard

roots or tubers over the fire in a calabash filled with water—or maybe an ostrich-egg-shell, or a hastily improvised vessel of bark. They became much softer and more palatable than they had previously been; but, unfortunately, the vessel could not stand the fire and got charred on the outside. That can be remedied, thought our ancestress, and plastered a layer of wet clay round a similar vessel. This is an improvement; the cooking utensil remains uninjured, but the heat of the fire has shrunk it, so that it is loose in its shell. The next step is to detach it, so, with a firm grip and a jerk, shell and kernel are separated, and pottery is invented. Perhaps, however, the discovery which led to an intelligent use of the burnt-clay shell, was made in a slightly different way. Ostrich-eggs and calabashes are not to be found in every part of the world, but everywhere mankind has arrived at the art of making baskets out of pliant materials, such as bark, bast, strips of palm-leaf, supple twigs, etc. Our inventor has no water-tight vessel provided by nature. "Never mind, let us line the basket with clay." This answers the purpose, but alas! the basket gets burnt over the blazing fire, the woman watches the process of cooking with increasing uneasiness, fearing a leak, but no leak appears. The food, done to a turn, is eaten with peculiar relish; and the cooking-vessel is examined, half in curiosity, half in satisfaction at the result. The plastic clay is now hard as stone, and at the same time looks exceedingly well, for the neat plaiting of the burnt basket is traced all over it in a pretty pattern. Thus, simultaneously with pottery, its ornamentation was invented.

Primitive woman has another claim to respect. It was the man, roving abroad, who invented the art of producing fire at will, but the woman, unable to imitate him in this, has been a Vestal from the earliest times. Nothing gives so much trouble as the keeping alight of the smouldering brand, and, above all, when all the men are absent from the camp. Heavy rain-clouds gather, already the first large drops are falling, the first gusts of the storm rage over the plain. The little flame, a greater anxiety to the woman than her own children, flickers unsteadily in the blast. What is to be done? A sudden thought occurs to her, and in an instant she has constructed a primitive hut out of strips of bark, to protect the flame against rain and wind.

This, or something very like it, was the way in which the principle of the house was discovered; and even the most hardened misogynist

cannot fairly refuse a woman the credit of it. The protection of the hearth-fire from the weather is the germ from which the human dwelling was evolved. Men had little, if any share, in this forward step, and that only at a late stage. Even at the present day, the plastering of the housewall with clay and the manufacture of pottery are exclusively the women's business. These are two very significant survivals. Our European kitchen-garden, too, is originally a woman's invention, and the hoe, the primitive instrument of agriculture, is, characteristically enough, still used in this department. But the noblest achievement which we owe to the other sex is unquestionably the art of cookery. Roasting alone—the oldest process—is one for which men took the hint (a very obvious one) from nature. It must have been suggested by the scorched carcase of some animal overtaken by the destructive forest-fires. But boiling—the process of improving organic substances by the help of water heated to boiling-point—is a much later discovery. It is so recent that it has not even yet penetrated to all parts of the world. The Polynesians understand how to steam food, that is, to cook it, neatly wrapped in leaves, in a hole in the earth between hot stones, the air being excluded, and (sometimes) a few drops of water sprinkled on the stones; but they do not understand boiling.

To come back from this digression, we find that the slender Nyasa woman has, after once more carefully examining the finished pot, put it aside in the shade to dry. On the following day she sends me word by her son, Salim Matola, who is always on hand, that she is going to do the burning, and, on coming out of my house, I find her already hard at work. She has spread on the ground a layer of very dry sticks, about as thick as one's thumb, has laid the pot (now of a yellowish-grey colour) on them, and is piling brushwood round it. My faithful Pesa mbili, the *mnyampara*, who has been standing by, most obligingly, with a lighted stick, now hands it to her. Both of them, blowing steadily, light the pile on the lee side, and, when the flame begins to catch, on the weather side also. Soon the whole is in a blaze, but the dry fuel is quickly consumed and the fire dies down, so that we see the red-hot vessel rising from the ashes. The woman turns it continually with a long stick, sometimes one way and sometimes another, so that it may be evenly heated all over. In twenty minutes she rolls it out of the ash-heap, takes up the bundle of spinach, which has been lying for two days in a jar of water, and

sprinkles the red-hot clay with it. The places where the drops fall are marked by black spots on the uniform reddish-brown surface. With a sigh of relief, and with visible satisfaction, the woman rises to an erect position; she is standing just in a line between me and the fire, from which a cloud of smoke is just rising: I press the ball of my camera, the shutter clicks—the apotheosis is achieved! Like a priestess, representative of her inventive sex, the graceful woman stands: at her feet the hearth-fire she has given us beside her the invention she has devised for us, in the background the home she has built for us.

At Newala, also, I have had the manufacture of pottery carried on in my presence. Technically the process is better than that already described, for here we find the beginnings of the potter's wheel, which does not seem to exist in the plains; at least I have seen nothing of the sort. The artist, a frightfully stupid Makua woman, did not make a depression in the ground to receive the pot she was about to shape, but used instead a large potsherd. Otherwise, she went to work in much the same way as Salim's mother, except that she saved herself the trouble of walking round and round her work by squatting at her ease and letting the pot and potsherd rotate round her; this is surely the first step towards a machine. But it does not follow that the pot was improved by the process. It is true that it was beautifully rounded and presented a very creditable appearance when finished, but the numerous large and small vessels which I have seen, and, in part, collected, in the "less advanced" districts, are no less so. We moderns imagine that instruments of precision are necessary to produce excellent results. Go to the prehistoric collections of our museums and look at the pots, urns and bowls of our ancestors in the dim ages of the past, and you will at once perceive your error.

MAKING LONGITUDINAL CUT IN BARK

DRAWING THE BARK OFF THE LOG

REMOVING THE OUTER BARK

BEATING THE BARK

WORKING THE BARK-CLOTH AFTER BEATING, TO MAKE IT SOFT

## MANUFACTURE OF BARK-CLOTH AT NEWALA

To-day, nearly the whole population of German East Africa is clothed in imported calico. This was not always the case; even now in some parts of the north dressed skins are still the prevailing wear, and in the north-western districts—east and north of Lake Tanganyika—lies a zone where bark-cloth has not yet been superseded. Probably not many generations have passed since such bark fabrics and kilts of skins were the only clothing even in the south. Even to-day, large quantities of this bright-red or drab material are still to be found; but if we wish to see it, we must look in the granaries and on the drying stages inside the native huts, where

it serves less ambitious uses as wrappings for those seeds and fruits which require to be packed with special care. The salt produced at Masasi, too, is packed for transport to a distance in large sheets of bark-cloth. Wherever I found it in any degree possible, I studied the process of making this cloth. The native requisitioned for the purpose arrived, carrying a log between two and three yards long and as thick as his thigh, and nothing else except a curiously-shaped mallet and the usual long, sharp and pointed knife which all men and boys wear in a belt at their backs without a sheath—*horribile dictu!* [51] Silently he squats down before me, and with two rapid cuts has drawn a couple of circles round the log some two yards apart, and slits the bark lengthwise between them with the point of his knife. With evident care, he then scrapes off the outer rind all round the log, so that in a quarter of an hour the inner red layer of the bark shows up brightly-coloured between the two untouched ends. With some trouble and much caution, he now loosens the bark at one end, and opens the cylinder. He then stands up, takes hold of the free edge with both hands, and turning it inside out, slowly but steadily pulls it off in one piece. Now comes the troublesome work of scraping all superfluous particles of outer bark from the outside of the long, narrow piece of material, while the inner side is carefully scrutinised for defective spots. At last it is ready for beating. Having signalled to a friend, who immediately places a bowl of water beside him, the artificer damps his sheet of bark all over, seizes his mallet, lays one end of the stuff on the smoothest spot of the log, and hammers away slowly but continuously. “Very simple!” I think to myself. “Why, I could do that, too!”—but I am forced to change my opinions a little later on; for the beating is quite an art, if the fabric is not to be beaten to pieces. To prevent the breaking of the fibres, the stuff is several times folded across, so as to interpose several thicknesses between the mallet and the block. At last the required state is reached, and the *fundi* seizes the sheet, still folded, by both ends, and wrings it out, or calls an assistant to take one end while he holds the other. The cloth produced in this way is not nearly so fine and uniform in texture as the famous Uganda bark-cloth, but it is quite soft, and, above all, cheap.

Now, too, I examine the mallet. My craftsman has been using the simpler but better form of this implement, a conical block of some hard wood, its base—the striking surface—being scored across and

across with more or less deeply-cut grooves, and the handle stuck into a hole in the middle. The other and earlier form of mallet is shaped in the same way, but the head is fastened by an ingenious network of bark strips into the split bamboo serving as a handle. The observation so often made, that ancient customs persist longest in connection with religious ceremonies and in the life of children, here finds confirmation. As we shall soon see, bark-cloth is still worn during the *unyago*,[52] having been prepared with special solemn ceremonies; and many a mother, if she has no other garment handy, will still put her little one into a kilt of bark-cloth, which, after all, looks better, besides being more in keeping with its African surroundings, than the ridiculous bit of print from Ulaya.

MAKUA WOMEN