Assistive Technology for the Hearing-impaired, Deaf and Deafblind

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Marion A. Hersh, Michael A. Johnson (Eds.)

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Assistive Technology for the Hearing-impaired, Deaf and Deafblind

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For my mother and father
Marion A. Hersh

That this book might inspire my two young friends, Holly and Joe
Michael A. Johnson

Preface

Affirmative legislative action in many countries now requires public spaces to be accessible and service providers to change or introduce practices, policies, or procedures that allow equal accessibility by disabled people. Although this is often interpreted as access for wheelchair users, such legislation also covers people with vision or hearing impairments. In these cases it is often the provision of advanced technological devices that enable people with sensory impairments to enjoy the theatre, cinema, a political meeting or a religious meeting to the full. Hearing-impaired and deaf people have been especial beneficiaries of this slow, but growing, technological provision, and this book is about this particular branch of assistive technology.

The field of assistive technology has steadily grown, driven by the desire to provide disabled people with equal access to the facilities and products of society and to provide an enhanced quality of life for this community group. Many different engineering ideas and disciplines have been used to produce the technological solutions required. However, there have been few, if any, systematic attempts to draw together the themes of assistive technology and create a coherent technological and engineering discipline. It is true that organisations like the Rehabilitation Engineering Society of North America (RESNA) and the Association for the Advancement of Assistive Technology in Europe (AAATE) try to present a cohesive programme for assistive technology, but our experience has been that, although many engineers are active in these organisations, assistive technology has not yet become part of mainstream engineering.

Part of the problem is simply the lack of a coherent educational framework for involving *engineers* in the assistive technology field. This is not to say that engineers do not wish to study the subject, since our experience is that young undergraduate and postgraduate engineers relish the idea of trying to solve problems in assistive engineering. Indeed, there are some really challenging technical problems still to be tackled. What is missing are books that demonstrate that it is possible to bring together the themes of human physiology, fundamental engineering principles, design principles, engineering technology, and human end-user issues (such as ethics) to make a coherent course that can contribute to the higher education of electrical and mechanical engineers. This particular collaborative book is an attempt to demonstrate just how this might be accomplished for the assistive technology needed by the hearing impaired and deaf community. The book is envisaged as the first of a series of three texts dealing, in turn, with assistive technologies and devices for people with hearing, vision and mobility impairments.

In parallel with developing this textbook, we have been pioneering the introduction of a course module on Assistive Technology in the Electronic and Electrical Engineering degrees at our respective universities. The experience gained in developing the educational framework has also been fed into the book as it progressed. The consequence has been a strong editorial steer on the various chapters to give the type of information required in degree courses and the strong engineering approach in the book. This particular book is about the application of electrical technology to all aspects of communication and daily living for those people with hearing impairments. The first chapter, on physiological aspects of hearing, sets the background for the various technological areas, namely hearing-aid development, induction and infrared communications for public spaces, and accessibility. The book then continues with facilitating technologies and devices for telephony and daily living. The penultimate chapter takes a look at assistive technology for deafblind people, a really challenging area with a number of unsolved research questions. The final chapter of the book presents a basic introduction to human end-user issues and ethics, as well as the distribution of devices to end users. This is not a long chapter, but it deals with topics that are often omitted from existing engineering courses.

We believe we set ourselves ambitious objectives in writing this book, which could not have been accomplished without the cooperation and enthusiasm of our collaborating authors. We would like to thank them all for their help and patience in seeing the project come to fruition. We have been lucky to meet many of our collaborators at the Conference and Workshop on Assistive Technologies for Vision and Hearing Impairment, which we organise with invaluable European Union support (from the High Level Scientific Conference Programme), and this has given us the opportunity to discuss and debate together many of the engineering ideas and techniques reported in the book. Needless to say, we have made many new friends in the process and gained many useful insights into assistive technology for people with hearing and vision impairments. We hope this book will inspire many new projects, new courses and new ways to assist people with sensory impairments.

Marion Hersh and Michael Johnson
Glasgow, Scotland, UK

Who Should Read This Book

This book is designed to inform a wide range of current and future professionals about basic engineering principles and the way these principles are turned into assistive technology devices, the possible future technology developments, and the human end-user aspects in assistive technology for hearing-impaired and deaf people. As far as we have been able to ascertain, there are no other textbooks for electrical engineering, mechanical engineering and scientific professionals on this technological area at this depth or with this higher educational approach. This is expected to change as legislative pressures drive the need for more engineering and social professionals to become aware of

these technologies. Similarly, we have not been able to find any undergraduate course texts of adequate detail and depth for the discipline of assistive technology. Thus, we hope this book will be well placed to meet this need, as it has been designed to be read by electrical engineering undergraduates as a course book or to supplement existing courses. The authors have been encouraged to see many engineering undergraduates enjoy this type of material, and it is hoped that this enjoyment will fire the ingenuity of engineering students to find new and innovative ways to develop technology to support hearing-impaired and deaf people.

An Overview of the Book

This book provides detailed coverage of the full range of assistive technologies used to support deaf and hearing-impaired people, including state-of-the-art techniques. Division into chapters is based on either the type of technology or the field of application. The following applications are discussed: audiology and assessment of hearing loss, hearing aids, telecommunications, devices for daily living and devices for deafblind people. Systems and devices based on the induction-loop technology and infrared technology are presented. To provide a background to the technologies, particularly the hearing assessment and hearing-aid technologies, the first chapter discusses the physiology of the ear and causes of deafness.

The book is designed so that each chapter is self-contained and can be read on its own, though familiarity with the material in Chapter 1 will be assumed in some of the other chapters. Each chapter is motivated by specific learning objectives and contains an introduction to the subject, such as the basic principles of the underlying technology or the application area. This is usually followed by a full discussion of the applications of the technology to support the hearing impaired. The chapters close with suggestions for projects and reference to further reading sources, books, journal and conference papers and Web sites. There may be many professionals for whom this is a new area and who may not be familiar with the underpinning pedagogical engineering topics covered in the various chapters, so Table 1 is given to provide an outline plan of the book and the disciplines involved.

Editorial Responsibilities

The concept of this book originated with Marion Hersh and Michael Johnson, who were also responsible for the overall task of collating and integrating the various contributions. The book is more a close collaboration between editors and chapter contributors than the usual book of edited chapters and papers. This was necessary to try and obtain the style of a textbook on assistive technology for hearing-impaired and deaf people.

Table 1 An outline plan of book and pedagogical fundamentals.

Chapter		Key fundamentals in the chapter
1	Anatomy and Physiology of Hearing, Hearing Impairment and Treatment	Human physiology (of the ear) Acoustics, speech and sound Hearing-loss categories
2	Audiology: The Measurement of Hearing	Measurement principles Frequency response and decibels Instrumentation – medical Calibration and standards
3	Hearing-aid Principles and Technology	Signal-processing principles Human body as an engineering environment Electronics – analogue and digital
4	Induction-loop Systems	Electromagnetic principles Electrical circuit equivalents Calibration and standards
5	Infrared Communication Systems	Electromagnetic spectrum Basic communication system principles Diodes – LEDs and IREDs System design, construction and standards
6	Telephone Technology	Basic telephony principles Electromagnetic induction Textphone principles Videophone principles Ergonomics
7	Alarm and Alerting Systems for Hearing-impaired and Deaf People	Unifying generic system structures Sensors, transmission modules and actuators Amplifier types and principles Interface design and ergonomics
8	Dual Sensory Impairment: Devices for Deafblind People	Sensory impairment demography and classes Braille principles Sensors and actuators Difficult interface design and ergonomics Information technology
9	The Final Product: Issues in the Design and Distribution of Assistive Technology Devices	Human issues Working with end users Social research methods Ethics for engineers and other professionals

Chapter Contributions

Chapter 1 on, Anatomy and Physiology of Hearing, Hearing Impairment and Treatment, was the work of Jay Lucker with input from Marion Hersh. Marion Hersh and Michael Johnson contributed Chapter 2, on Audiology: The Measurement of Hearing, in which an engineering perspective to the measurement aspect of audiology is taken. Douglas Campbell, who was a Leverhulme Fellow in Hearing Aid Technology, contributed Chapter 3, Hearing-aid Principles and Technology. Bo-Edin is a Swedish company specialising in induction-loop technology, and Conny Andersson drew on his wide applications experience to write Chapter 4 on Induction-loop Systems. Similarly, Erhard Werner used his deep technical expertise garnered from a long career with the Sennheiser

Company to write Chapter 5 on Infrared Communications Systems. British Telecommunications research laboratories, located within BTexact at Adastral Park in Suffolk, have a world renowned reputation in assistive technology for telecommunications. Stephen Furner and his colleagues from BT at Adastral Park wrote Chapter 6 on Telephone Technology for hearing-impaired people. Chapter 7, on Alarm and Alerting Systems for Hearing-impaired and Deaf People, was written by Marion Hersh with input from Jay Lucker. The presentation of a common and generic engineering framework in which to discuss the various devices was an important component of this chapter. John Gill used his long association with the RNIB to write Chapter 8, Dual Sensory Impairment: Devices for Deafblind People; this material was augmented by contributions from Marion Hersh. Finally, Chapter 9, The Final Product: Issues in the Design and Distribution of Assistive Technology Devices, was contributed by Marion Hersh.

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More detailed biographical sketches of the individual contributors can be found at the end of the book.

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