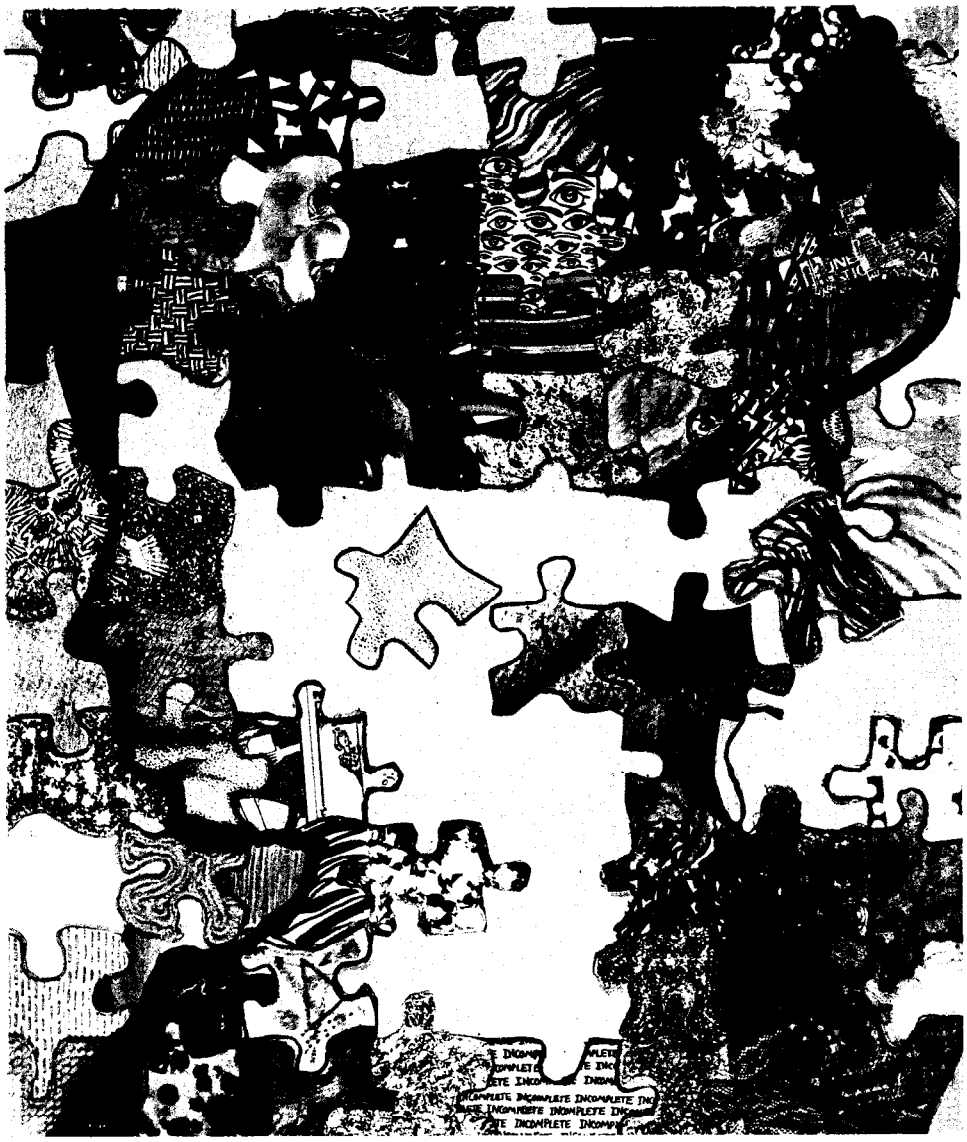
NATIONAL SCIENCE FOUNDATION
1992
ENGINEERING SENIOR DESIGN PROJECTS TO AID THE DISABLED



Edited By
John D. Enderle

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FOREWORD

Welcome to the fourth issue of the National Science Foundation Engineering Senior Design Projects to Aid the Disabled. Started in 1988, the National Science Foundation (NSF) began a program to provide funds for student engineers at universities throughout the United States to construct custom designed devices and software for disabled individuals. Through the Bioengineering and Research to Aid the Disabled (BRAD) program of the Emerging Engineering Technologies Division of NSF[1], funds were awarded competitively to sixteen universities to cover supplies, equipment and fabrication costs for the design projects. A book entitled, "NSF 1989 Engineering Senior Design Projects to Aid the Disabled," was published that reported on the projects funded during the first year of this effort.

In 1989, the BRAD program of the Emerging Engineering Technologies Division of NSF increased the number of universities funded to twenty-two. Following completion of the design projects funded under this initiative during the academic year 1989-90, a second book was published describing these projects, entitled, "NSF 1990 Engineering Senior Design Projects to Aid the Disabled."

In 1991, a third issue of the National Science Foundation Engineering Senior Design Projects to Aid the Disabled was published by NDSU Press. This book described the almost 150 projects carried out by students at twenty universities across the United States.

This manuscript, funded by the NSF, describes and documents the NSF supported senior design projects during the fourth year of this effort during the academic year 1991-92.

As before, the purpose of this manuscript is to report on the engineering senior design projects developed and implemented through participating schools in the BRAD program. Each chapter describes the activity at a single university and, except for the introduction, was written by the principal investigator(s) at that university. Individuals wishing more information on a particular design should contact the designated supervising principal investigator. Additionally, an index is provided so that projects may be easily identified by topic.

It is hoped that this manuscript will enhance the overall quality of future senior design projects directed toward the disabled by providing examples of previous projects, and by motivating other universities to participate because of the potential benefits to the student, school, and community. Moreover, the new technologies used in these projects will provide examples in a broad range of applications for new engineers. The ultimate goal of both this publication and all the projects that were built under this initiative is to assist disabled individuals in reaching toward their maximum potential for enjoyable and productive life.

It should be evident from reviewing this manuscript that the BRAD program has brought together individuals with widely varied backgrounds. Through the richness of these interests, a wide variety of projects were completed, and are in use. A number of different technologies were incorporated in the design projects, so as to maximize the impact of the device on the individual.

For the most part, a two-page project description format is used in this text. Each project is described with a nontechnical description, followed by a summary of impact that illustrates the effect of the project on the disabled person's life. A detailed technical description then follows. Photographs of the devices and other important components are incorporated throughout the manuscript. Some of the projects are described with a much more extensive description covering many pages; these projects are typically the first project in each chapter.

It should be noted that none of the students or faculty received financial remuneration for building devices or writing software for the disabled in this program. Each participating university has made a

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[1] In March of 1989 the Directorate for Engineering (ENG) was restructured. This program is now in the Division of Biological and Critical Systems.

commitment to the program for a minimal five-year period. A yearly review publication is planned, and it is anticipated that additional universities will choose to participate in the future, so that an even greater impact on the lives of the disabled may be achieved.

Sincere thanks are extended to Dr. Allen Zelman, Program Director of the NSF BRAD program, for being the prime mover behind this initiative. Additionally, thanks are extended to Drs. Peter G. Katona and Karen M. Mudry, former and current NSF Program Directors of the Biomedical Engineering and Aiding the Disabled, who have continued to support and expand the program. I wish to acknowledge and thank Ms. Shari Valenta for the cover illustration and the artwork throughout the book, drawn from her observations at the Children's Hospital Accessibility Resource Center in Denver, Colorado. I also wish to acknowledge and thank Ms. Barbara Mykleseth and Ms. Kathy Sjostrom for their administrative assistance during the preparation of this publication. Additionally, I wish to acknowledge and thank Joyce Mayo for drawing the technical illustrations shown throughout the book.

 The projects presented here have been implemented in the fourth year of this initiative; they have a wide range of depth and usefulness. Faculty members using the book as a guide thus should exercise good judgment when advising students.

For more information on this program contact Dr. Karen M. Mudry, Program Director, Biomedical Engineering and Aiding the Disabled, National Science Foundation, Washington DC 20550; telephone number: (202) 357-7955.

It is hoped that this book serves as a catalyst and a source of information for future design work. The editor welcomes any suggestions as to how this review may be made more useful for subsequent yearly issues.

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CHAPTER 1
INTRODUCTION

Devices and software to aid persons with disabilities often need custom modification, are prohibitively expensive, or nonexistent. Much of the disabled community does not have access to custom modification of available devices and other benefits of current technology. Moreover, when available, engineering and support salaries make the cost of any custom modifications beyond the reach of the disabled.

In 1988, the National Science Foundation (NSF) provided a mechanism, through the Bioengineering and Research to Aid the Disabled (BRAD) program of the Emerging Engineering Technologies Division of NSF, whereby student engineers at universities throughout the United States designed and built devices for persons with disabilities. This NSF program enhanced the educational opportunities for students and improved the quality of life for disabled individuals. Students and university faculty provided, through their normal ABET accredited senior design class, engineering time to design and build the device or software, and the NSF provided funds, competitively awarded to twenty-two universities, for supplies, equipment and fabrication costs for the design projects.

As part of the accreditation process for university engineering programs, students are required to complete a minimum number of design credits in their course of study, typically at the senior level. Design is a course that brings together concepts and principles learned in other courses. In the past, students were typically involved in design projects that enabled the student to improve the quality of their life, for instance, by designing and constructing a stereo receiver. Under this new BRAD program, engineering students at the universities participating in this initiative are involved with designs that result in an original device or a custom modification of a device that improves the quality of life for a person with disabilities. The engineering design students are provided an opportunity for practical and creative problem solving to address a well-defined need, and the handicapped individual receives the product of that process. There is no financial cost incurred by disabled persons participating in the BRAD program and upon completion, the finished project becomes the property of the individual for whom it was designed.

Under faculty supervision, students developed specific projects through their senior design classes to address the identified needs of particular disabled individuals. Local school districts and hospitals participated in the effort by referring interested individuals to the program. Each project is specifically designed for a disabled individual or a group of disabled individuals with a similar need by a single student or a team of students.

The emphasis of the program is to:

- Provide disabled children and adults, student-engineered devices or software to improve their quality of life and provide greater self-sufficient capability.
- Enhance the education of student engineers by designing and building a device or software that meets a real need.
- Allow the university an opportunity for unique service to the local community.

Some of the projects described here are custom modifications of existing devices, modifications that would be prohibitively expensive to the disabled individual were it not for the student engineer and the BRAD program. Other projects are unique one-of-a kind devices wholly designed and constructed

by the student for the disabled individual. The students participating in this project have been singularly rewarded through their activity with the disabled, and justly have experienced a unique sense of purpose and pride in their accomplishment.

After the introduction, twenty-one chapters follow, with each chapter devoted to one participating school. The chapters begin by completely identifying the school and the principal investigator(s). Following the chapter introduction for the school, each senior design project description is written using the following format. On page one, the individuals involved with the project are completely identified, including the student(s), the professor(s) who supervised the project, and the many professionals involved in the daily lives and education of the disabled individual. A brief nontechnical description of the project follows with a summary of the impact on how the project has improved the quality of life of the disabled person. A photograph of the device or the device modification is usually included. Following this, a technical description of the device or device modification is given, with parts specified only if they are of, such a special nature that the project could not be fabricated without knowing the exact identity of the part. An approximate cost of the project is provided, excluding personnel costs.

Most projects are described in two pages. However, the first project in each chapter is usually significantly longer and contains more analytic content. Individuals wishing more information on a particular design should contact the designated supervising principal investigator.

The purpose of this publication is two-fold. One obvious purpose is to serve as a reference or handbook for future senior design projects. If this goal is achieved, the quality of senior design projects will improve and an even greater project impact will be felt by persons with disabilities. Additionally, students will be exposed to this unique body of applied information on current technology, thus providing an even broader education, especially in the area of rehabilitation design. Secondly, it is hoped that this publication serves to motivate both student and graduate engineers, and others, to work more actively in rehabilitation, leading to an increased technology and knowledge base to effectively address the needs of the disabled.