50 Years of Human Engineering

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50 YEARS OF HUMAN ENGINEERING

History and Cumulative Bibliography of the Fitts Human Engineering Division

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Armstrong Laboratory
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FOREWORD

Engineers have been aware of the desirability of designing equipment to meet the requirements of the human operator, but in most cases have lacked the scientific data necessary for accomplishing this aim.

— P.M. Fitts

What is now the Fitts Human Engineering Division began with a directive for establishment of the Psychology Branch in the Aero Medical Laboratory at Wright Field in the closing days of World War II (May 1945). The mission of the Psychology Branch, under the leadership of Lt Col Paul M. Fitts, was the scientific study of human capabilities and characteristics that could be applied to the design of equipment, operations, and work environments. This was a significant event, the first organizational commitment to human engineering research and development undertaken within the United States military.

Successful military performance is dependent on the effective integration of human and systems technologies. Human-centered systems promote mission success through superior operability, maintainability, and survivability. The ultimate advantages of technological advances in controls, displays, and information handling, remain inextricably linked to human factors such as the pilot's sensory, perceptual, cognitive, and motor capabilities; strength and anthropometrics; motivation; experience; and skills. The mission of the Fitts Human Engineering Division is to ensure this linkage by anticipating future needs, developing human engineering technologies, and providing human-system integration design criteria to exploit the fullest potential of the Air Force warfighting team, irrespective of gender, mission, or environment.

Dr. Fitts' legacy of scientific excellence and relevance to military needs is embodied in five productive decades of research by the organization he founded. On this occasion — the fiftieth anniversary of the Fitts Human Engineering Division — we are proud to offer this volume which depicts the Division's research and development efforts spanning the past half-century.

JAMES W. BRINKLEY, SES
Director, Crew Systems

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PREFACE

The data, models, guidance, technology demonstrations, and evaluations produced under laboratory research and development efforts are typically archived as technical reports, journal articles, or other professional communications. Ultimately, the scientific and technical documentation is the enduring product of research and development. In the normal course of events, however, collections of these technical information products accumulate and all too often languish in libraries, databases, and proprietary archives. Under these conditions, the value of research and development accomplishments and investments may either be diminished or never attained. Given that the value of information can only be realized through its use, it is therefore vital that responsible research and development managers make every effort to reduce the high costs of "rediscovery" of their research products by potential users.

The mission of the Armstrong Laboratory, Fitts Human Engineering Division involves the definition and documentation of capabilities and limitations of operators through scientific study of human behavior, physical characteristics, physiology, strength, performance, and tolerance of physical and mental stresses to aid the design of technologically superior human-systems. In developing this cumulative bibliographic reference, it was our intent to aid and promote the accessibility of relevant Human Engineering Division research information. Additionally, this commemorative volume is a celebration of five decades of human engineering research and development.

This volume is organized around a reference bibliography comprising the cumulative technical reports, journal publications, conference proceedings, books and book chapters documenting the research and development program of the Fitts Human Engineering Division from August 1945 through December 1994. The bibliography is divided into five sections or decades of activity and is organized alphabetically by author within each of these decades. The bibliography is itself generously illustrated with photos, illustrations, data functions, quotes, biographic notes, and period anecdotes which exemplify the people and events which have shaped the history and character of the division. The introduction includes several narrative histories and an optimistic nod towards the Human Engineering Division's future.

We sincerely hope that you enjoy this historic document. If you have further interest in the mission or products of the Fitts Human Engineering Division, please do not hesitate to contact me at:

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Kenneth R. Boff, PhD
Chief, Human Engineering Division

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ACKNOWLEDGMENTS

No task of this magnitude is accomplished without the contributions of a large and diverse group of people. This project is certainly no exception. It is incumbent upon us, the editors of this document, to see that proper credit is given to the many dedicated and talented people whose efforts brought this project to a successful conclusion.

The inspiration for this document originated with the planned celebration of the 50-year anniversary of what is now called the Human Engineering Division. Located under the Crew Systems Directorate of the Armstrong Laboratory, the Human Engineering Division (AL/CFH) traces its roots to 1945 and the establishment of the Psychology Branch, Aero Medical Laboratory. The concept of producing a bibliography of all research published over 50 years by researchers in the Human Engineering Division and its predecessors is a natural one and is attributable to Dr. Kenneth R. Boff, currently Chief of the Human Engineering Division. Evolution of that concept into the broader, historically enhanced bibliography you see printed here can also be traced to Dr. Boff. It is safe to say that Dr. Boff was the creative and driving force behind this project. He gave us lofty goals to meet, high standards to guide us along the way, and the resources needed to succeed. To the extent that this document conveys the sense that Air Force human engineering for half a century has been both productive and fascinating, the credit goes to Dr. Boff.

Getting from decades-old partial bibliographies captured in various forms and formats to a cohesive 50-year bibliography was a triumph of both automation and brute force. Key to the success of this project was the technical and clerical support of employees of our engineering support services contractor, Logicon Technical Services, Inc. Leading the way was Susan Pfaadt, Software Department Manager. Susan waged a successful year-long campaign to develop a flexible database in which to store the 2,500-plus citations that represent the 50-year research throughput of the Human Engineering Division. She converted bibliographic inputs from WORDSTAR and other arcane bibliographic databases, managed the hand entry of citations when necessary, identified spurious data entries, and "ported" the finished data to a desktop publishing computer program. Susan went on to become a full member of the project team, and the editors wish to express their deep appreciation for her countless valuable suggestions regarding all aspects of the project.

Not the least of her contributions was Susan's hiring of a subcontractor to build the electronic copy of the bibliography in PAGEMAKER, a desktop publishing computer program. The young lady, Kimberly Kayler Izenson, proved to be another "hero" of this project. With a work ethic that left us in awe, Kimberly pulled together pieces from dozens of contributors and, in less time than we could imagine, laid out a tasteful, visually appealing, accurate document. It is important to note, also, that Kimberly was a frequent, valuable contributor of ideas for making improvements to this document. She was an emergent leader taking responsibility for facets of this project, such as scanning illustrations into the computer and single-handedly building an author index, for which she was not originally responsible. Her flexibility and enthusiasm were both welcome and fortuitous. Recognition is also due David Spangler of LTSI for a summer-long dedicated effort at keystroking citations into the computer database.

A project of this scope demands leadership to succeed. In each stage of this effort, leadership was passed to the project team member with the necessary skills to see that stage successfully through to completion. Special thanks, however, go to Walt Summers, Chief of the Ergonomics Analysis Branch, for his central role, largely during the late stages of the project, in pulling together parallel activities and focusing them toward completion. He skillfully walked the fine line between realizing the best product possible and getting the project done in a timely fashion. His quiet, understated manner was instrumental in facilitating the process of emergent leadership.

Many other major contributions to the success of the project came from members of the Ergonomics Analysis Branch of the Human Engineering Division. Renee Kaffenbarger, for example, stood as a skilled and willing typist and proofreader. Time and again, she keystroked valuable and historical documents into her word processor for inclusion in the bibliography. While the documents were often long, Renee's responses were always rapid, skillful, and congenial—she is a truly remarkable individual and a treasured resource. Early in this project, SSgt Wiley Wells, also of AL/CFHA, got us started in the graphics portion of the project by digitally scanning all the graphics selected for the book up to that time.

The gifted interviewing techniques of Dr. Reuben Hann were enlisted as part of this project to capture the recollections of key figures in the division's history. Lew's interviews with the likes of Dr. Melvin Warrick, Steve Heckart, Dr. Robert O'Donnell, Dr. Don Topmiller, and Charlie Clauser, add a warm, human touch to this work. Lew also extracted quotes from material gathered earlier in interviews with Earl Sharp and Phil Kulwicki. We thank him and the seven interviewees for their prompt and valuable participation. Dr. Ken Kennedy, whose interview was regrettably lost due to a recording difficulty, also deserves our thanks. In addition, our grateful acknowledgment is extended to Steve Heckart and Jean Ring for their generosity in contributing valuable early technical reports and articles from their personal collections.

Another contributor deserving of special recognition is Wayne Martin. A long-time member of the Human Engineering Division, who moved on to assignments elsewhere in the Crew Systems Directorate, Wayne generously contributed two anecdotes which give the reader valuable insight into life in the Human Engineering Division some decades back. Dean Kocian and Dr. Joe McDaniel of the Human Engineering Division deserve similar praise for their fascinating historical timelines of two key human engineering technologies. Dean's history of helmet-mounted device technology forcefully illustrates the central role played by the division in the development of the entire helmet-mounted sight, helmet-mounted display, night vision goggle, and virtual reality fields. Similarly, Joe McDaniel's history of workplace accommodation traces for the reader the long and rich history of yet another central facet of human engineering technology. Our grateful thanks go out to each of these authors for taking time during a particularly hectic time of year to provide these valued documents.

Help from outside the Human Engineering Division family should also be recognized. Mike Gallagher of the Defense Printing Service Detachment Office was particularly patient, participating in long meetings and taking numerous phone inquiries, all in the name of educating us in the complexities of printing a document of this nature. That he succeeded, in large measure, is credit to his skill and determination. Thanks are also extended to Klein Associates for sharing with us the results of interviews conducted with Earl Sharp and Phil Kulwicki. Though conducted for another purpose, the interviews provide delightful insights into long-standing and special relationships between the division and some of its "customers."

Valuable support was provided by administrators at several levels. Within the division, Randy Yates, of the Design Technology Branch, was a valuable source of information and help in setting up and using the computer hardware and software facilities required to do this job. Randy's support is particularly noteworthy given that the timing of our requests for support coincided exactly with the busiest time of year for Randy's other support commitments. Patricia M. Lewandowski, the Crew Systems Directorate STINFO (Science and Technology Information Officer), was also a source of crucial support to us in getting clearance of this document for public release, advice on publication procedures, and assistance in recovering bibliographic information from directorate files.

Proofreading, however painful, is pivotal in a project of this type. We had the good fortune on this effort of having some of the best proofreaders around on our team. Besides Kimberly Izenson herself, our proofreading corps included Elizabeth Combs and Anita Cochran. Betsy Combs, the current division secretary, suffered from work overload even without this proofreading assignment. But, that never stopped her before and it didn't this time either. The thoroughness and accuracy of Betsy's proofreading were incredible. One of the few proofreaders in Betsy's league is Anita Cochran. Anita is retired from the University of Dayton Research Institute and was available to us as a consultant through the Crew System Ergonomics Information Analysis Center, or CSERIAC. She performed the final edit on all parts of this document, including all citations, the list of illustrations, and the author index, always patiently waiting on us for material and then responding magnificently to our need for quick turnaround. Her comments and corrections were absolutely essential. She is amazing. An additional note of thanks goes out to countless contributors of ideas, photographs, text, corrections, etc., who cannot, for reasons of practicality, be cited individually here—your generosity is nonetheless noted and appreciated.

This brings us to our final acknowledgment. The editors wish to acknowledge the magnificent skill, knowledge, energy, enthusiasm, and dedication of the men and women of the Human Engineering Division, both past and present. The experience of compiling and editing this book drove home in unmistakable terms the staggering accomplishments of this merry band of human engineers. We have drawn freely from their lore in putting this document together. Exemplary of that group is Dr. Melvin Warrick, former Associate Division Chief of the Human Engineering Division. Mel was with the Human Engineering Division, then the Psychology Branch, in 1946, and he is still with us, as a volunteer, today. An invaluable resource for this project in terms of identifying people, facilities and programs from old-time documents, and verifying the historical accuracy of our entries, Mel represents the embodiment of the collective human engineering spirit—a proud, industrious, intellectual, and obviously well published scientific family.

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