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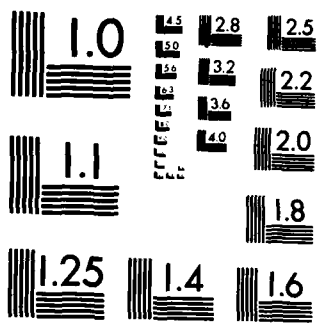
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ON THE STRUCTURE OF INFORMATION IN SOFTWARE

Deborah A. Boehm-Davis

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Software Management Research
Data & Information Systems
General Electric Company
1755 Jefferson Davis Highway
Arlington, Virginia 22202

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DEBORAH A. BOEHM-DAVIS

Software Management Research
Data and Information Systems
General Electric Company
1755 Jefferson Davis Highway
Arlington, Virginia 22202

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report summarizes research designed to evaluate program design methodologies, which claim to enhance the program design process. In this research project, professional programmers were asked to produce pseudo-code solutions to three problems. The time it took them to generate the solution, the completeness of the design solution, and the complexity of the solution were all measured. These data were used to develop profiles of the solutions produced by the different methodologies and to develop comparisons between		

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methodologies. The data suggest that the well-defined methodologies (i.e., Jackson and object-oriented) do provide advantages over the less well-defined methodology of functional decomposition. Original copy.

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INTRODUCTION

During the contract period (15 JUL 83 - 30 SEP 84), we have been examining the role of structuring information in different ways for the production of software. Recent research suggests that errors made early in a software development project and carried on into testing and integration are the most costly type of errors to find and correct. Yet, there is almost a total absence of research examining the impact of tools and methodologies early in the process, such as in program design. This research was designed to address that need by providing theory and quantitative measures of the usefulness of a particular software development tool -- program design methodologies.

One approach to improving the design process has been the use of program design methodologies, which provide strategies to programmers for structuring solutions to computer problems. The basic difference among methodologies is the criterion used to decompose the problem into smaller units. The approaches basically vary along one dimension: the extent to which the decomposition relies upon data structures as an organizing principle for modularization. On one end of the dimension are data structure techniques that rely primarily on the data structures present in the specifications as the basis for modularization, such as the Jackson program design methodology. On the other end of the dimension are techniques that rely primarily on operations as the basis for structuring the problem, such as top-down or functional decomposition. In the former case, modules are organized around data structures, while in the latter, modules are organized around operations. Falling between the two extremes are techniques which rely partially on data structures and partially on

operations as the basis for structuring the programs, such as object-oriented design.

Using this dimension to classify methodologies, it was possible to generate programs decomposed in each of these ways. The effects of these decompositions were then evaluated in terms of the initial coding process, the quality of the resulting code, and the subsequent maintainability of the program. The focus of the research was on a comprehensive evaluation of programs produced by the different classes of methodologies.

RESEARCH

In this research program, we have completed one major experiment. In this experiment (Tech. Rep. 84-B1V-1), professional programmers were provided with the specifications for each of three problems and asked to produce pseudo-code for each specification. Each time the programmers worked on the program, they were asked to complete a summary sheet for the session. The intermediate versions of the programs and these summary sheets were collected for analysis. In addition, the participants were asked to complete a final questionnaire at the end of the project which provided us with information about each programmer's programming background, familiarity with the methodology, and reactions to the problems used in this research.

The measures collected were the time to design and code, percent complete, and complexity, as measured by several metrics. The results suggest that there were differences in time to code, complexity and consistency of the solutions.

CONCLUSIONS

This research has led us to several important observations about the nature of program design methodologies and their role in the production of computer software. The data suggest that the well-defined methodologies (i.e., Jackson and object-oriented) do provide advantages over functional decomposition, which is less well-defined. These advantages would appear to be the result of the structure imposed on the development process by the methodologies.

The research further suggests that we need to be careful in generalizing our results. It would appear from this experiment that the type of problem being solved is also an important consideration in choosing a program design methodology. The results suggested that the data-driven methodologies, such as the Jackson program design methodology, may work better when the system being developed is highly data-oriented. In contrast, the object-oriented methodologies, such as object-oriented design, may work better with embedded systems, where the focus is on the objects within the system.

Overall, it would appear that program design methodologies are effective due to the guidelines they provide to the programmer, not only with regard to the formal structure of the software design process, but also with regard to the organization of the modules in the system itself.

This is in keeping with the psychological literature on problem-solving, which suggests that, at least for certain classes of problems, learning

particular strategies for attempting solutions improves performance. The results suggest that human performance in a software development task may be a function of a person's more general problem-solving abilities. Further, it suggests that principles of learning which improve problem-solving performance should also improve programming performance.

SCIENTIFIC PERSONNEL WHO WORKED ON THE PROGRAM

Deborah Boehm-Davis

Lyle Ross

TECHNICAL REPORTS

Boehm-Davis, D. A. & Ross, L. S. Approaches to structuring the software development process (Tech. Rep. 84-B1V-1). General Electric Co., October 1984.

ARCHIVAL PUBLICATIONS

Boehm-Davis, D. A. On the structure of information in software (Abstract). In Proceedings of the 28th Annual Meeting of the Human Factors Society. Santa Monica, CA: The Human Factors Society, 1984, p. 546.

TECHNICAL REPORTS DISTRIBUTION LIST

OSD

CAPT Paul R. Chatelier
Office of the Deputy Under Secretary
of Defense
OUSDRE (E&LS)
Pentagon, Room 3D129
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Department of the Navy

Engineering Psychology Program
Office of Naval Research
Code 442EP
800 N. Quincy Street
Arlington, VA 22217 (3 cys.)

Manpower, Personnel & Training
Programs
Code 270
Office of Naval Research
800 North Quincy Street
Arlington, VA 22217

Information Sciences Division
Code 433
Office of Naval Research
800 North Quincy Street
Arlington, VA 22217

Special Assistant for Marine
Corps Matters
Code 100M
Office of Naval Research
800 North Quincy Street
Arlington, VA 22217

Director
Naval Research Laboratory
Technical Information Division
Code 2627
Washington, D. C. 20375

Dr. Michael Melich
Communications Sciences Division
Code 7500
Naval Research Laboratory
Washington, D. C. 20375

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NELEX-06T
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Naval Training Equipment Center
Orlando, FL 32813

Human Factors Engineering
Code 8231
Naval Ocean Systems Center
San Diego, CA 92152

Dean of Research Administration
Naval Postgraduate School
Monterey, CA 93940

Dr. A. L. Slafkosky
Scientific Advisor
Commandant of the Marine Corps
Code RD-1
Washington, D. C. 20380

Dr. L. Chmura
Naval Research Laboratory
Code 7592
Computer Sciences & Systems
Washington, D. C. 20375

Professor Douglas E. Hunter
Defense Intelligence College
Washington, D. C. 20374

Department of the Navy cont'd

CDR C. Hutchins
Code 55
Naval Postgraduate School
Monterey, CA 93940

Human Factors Technology Administrator
Office of Naval Technology
Code MAT 0722
800 N. Quincy Street
Arlington, VA 22217

CDR Tom Jones
Naval Air Systems Command
Human Factors Programs
NAVAIR 330J
Washington, D. C. 20361

Commander
Naval Air Systems Command
Crew Station Design
NAVAIR 5313
Washington, D. C. 20361

Mr. Philip Andrews
Naval Sea Systems Command
NAVSEA 61R
Washington, D. C. 20362

Commander
Naval Electronics Systems Command
Human Factors Engineering Branch
Code 81323
Washington, D. C. 20360

Dr. George Moeller
Human Factors Engineering Branch
Submarine Medical Research Lab
Naval Submarine Base
Groton, CT 06340

Dr. Robert Blanchard
Navy Personnel Research and
Development Center
Command and Support Systems
San Diego, CA 92152

Mr. Stephen Merriman
Human Factors Engineering Division
Naval Air Development Center
Warminster, PA 18974

Human Factors Engineering Branch
Code 4023
Pacific Missile Test Center
Point Mugu, CA 93042

Department of the Navy cont'd

Dean of the Academic Departments
U. S. Naval Academy
Annapolis, MD 21402

Department of the Army

Dr. Edgar M. Johnson
Technical Director
U. S. Army Research Institute
5001 Eisenhower Avenue
Alexandria, VA 22333

Technical Director
U. S. Army Human Engineering Labs
Aberdeen Proving Ground, MD 21005

Director, Organizations and
Systems Research Laboratory
U. S. Army Research Institute
5001 Eisenhower Avenue
Alexandria, VA 22333

Mr. J. Barber
HQ, Department of the Army
DAPE-MBR
Washington, D. C. 20310

Department of the Air Force

Dr. Kenneth R. Boff
AF AMRL/HE
Wright-Patterson AFB, OH 45433

U. S. Air Force Office of
Scientific Research
Life Science Directorate, NL
Bolling Air Force Base
Washington, D. C. 20332

AFHRL/LRS TDC
Attn: Susan Ewing
Wright-Patterson AFB, OH 45433

Chief, Systems Engineering Branch
Human Engineering Division
USAF AMRL/HES
Wright-Patterson AFB, OH 45433

Dr. Earl Alluisi
Chief Scientist
AFHRL/CCN
Brooks Air Force Base, TX 78235

Other Government Agencies

Defense Technical Information Center
Cameron Station, Bldg. 5
Alexandria, VA 22314 (12 copies)

Dr. Clinton Kelly
Defense Advanced Research Projects
Agency
1400 Wilson Boulevard
Arlington, VA 22209

Other Organizations

Dr. Jesse Orlansky
Institute for Defense Analyses
1801 N. Beauregard Street
Alexandria, VA 22043

Dr. Paul E. Lehner
PAR Technology Corporation
Seneca Plaza, Route 5
New Hartford, N.Y. 13413

Dr. Stanley Deutsch
NAS-National Research Council (COHF)
2101 Constitution Avenue, N.W.
Washington, D. C. 20418

Mr. Edward M. Connelly
Performance Measurement Associates, Inc.
1909 Hull Road
Vienna, VA 22180

National Security Agency
ATTN: N-32, Marie Goldberg
9800 Savage Road
Ft. Meade, MD 20722

Dr. Marvin Cohen
Decision Science Consortium, Inc.
Suite 721
7700 Leesburg Pike
Falls Church, VA 22043

Dr. Richard Pew
Bolt Beranek & Newman, Inc.
50 Moulton Street
Cambridge, MA 02238

Dr. Douglas Towne
University of Southern California
Behavioral Technology Laboratories
1845 South Elena Avenue, Fourth Floor
Redondo Beach, CA 90277

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