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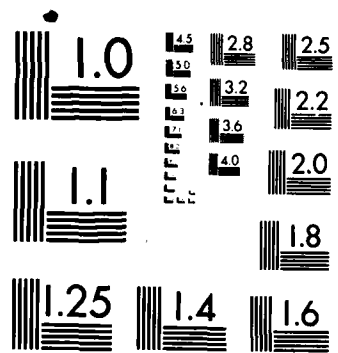
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Software Sizing and Cost Estimation Study

by

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Software Sizing and Cost Estimation Study

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This study investigated techniques that would assist Navy programs in more accurately estimating software size in new weapon system developments. The study was exploratory in nature, and presents a description of existing software sizing and estimation methods and an evaluation of their strengths and weaknesses, in addition to a description and tabulation of a sizing data base collected and the estimating relationships developed. This presentation summarizes the results of the investigation, which was conducted between 19 Mar 1985 and 19 July 1985.

The investigative research performed in this study focused on Navy programs. We assembled and analyzed a sizing data base of current Navy projects involving software. In the course of the analysis, we capitalized on recent data collection techniques developed by the Air Force and NASA and expanded upon these techniques by developing functional sizing relationships from the Navy data.

We identified and cataloged methods for assessing software size in Navy programs. We reviewed a number of methodologies used by Navy program offices and software developers in industry, and conducted a survey of recent

technical literature to ascertain the current state of the art in software size-estimation methods. Consequently, four types of sizing methods were identified as being representative of the general methods used in DOD application. These four methods are presented in Table I, and are described in Appendix A of ARINC Research Publication TR-3675.

To investigate and develop functional sizing relationships, we established a sizing data base of software collected from current Navy projects. Our effort focused on avionics and sonar systems for which current data were available. We examined existing software data collection packages and techniques for Navy application and conducted interviews, visits, and surveys to collect the necessary data elements. The presentation will focus on the data collected, reduced, and grouped by similar software functions for the analyst to assess existing relationships between function and size.

TABLE I
SOFTWARE SIZING METHODS

Method	Approach	Form of Estimating Relationship
PERT Sizing	Delphi Polling	$Size = \dfrac{a + 4m + b}{6}$ $= \dfrac{b - a}{6}$
Qualitative Functional Relationships	Analogy	Size = 5 to 10K lines for functions sonar track processing + 10 to 15K lines for function data management
Quantitative Functional Relationships	Analytical SERs	$Size = \sum_i (\text{number modules}_i)$ $\times (\text{average module size}_i)$ $\times (\text{attributes}_i)$
Measurement	Protoptyping	Size = Extrapolation from size of rapid prototyping of critical function(s)

We analyzed the data collected and investigated the development of functional size-estimating relationships. The following results emerged:

- Qualitative functional relationships have been developed to functionally characterize avionics and sonar software and to assess existing relationships between software function and size. These relationships require engineering judgment to estimate software size for functions in new development by analogy to similar functions in existing programs. The relationships are very provisional, having been developed from the analysis of limited data sets and sizing characteristics collected in the study.

- A preliminary framework for quantitative functional relationships for software sizing has been developed, and quantitative functional size-estimating relationships (SERs) have been derived for those functions that have sufficient data available. No attribute factors have been found to be statistically significant for sizing adjustments, except language.

- No final, statistically significant quantitative functional relationships for software sizing can be recommended at this stage of the study.

Much progress has been made in investigating techniques to assist Navy programs in more accurately estimating the size of the software in new weapon system developments. This progress includes the development of a Navy sizing data base of nearly 450 software functions, the analysis of the data providing

provisional qualitative functional relationships to support software size
estimating by analogy, the development of a framework equation for SER gen-
eration, and the evaluation of first-cut SERs generated from the data collect-
ed. However, a great deal remains to be done. The following recommendations
are presented to expand upon the results of the study in the following areas:

- Automated data base - An automated data base should be developed to
  update and maintain the detail sizing and cost data collected for Navy
  programs, as well as for similar programs from existing Air Force
  software data bases. The data base would provide a more rapid reference
  tool for Navy analysts to easily identify, sort, or search pertinent
  software characteristics from the data records.

- Qualitative functional relationships - A concerted effort should be
  directed toward collecting detail sizing data from Navy field
  engineering activities and software developers, as well as system-level
  data from program offices. This effort should complete the data
  collection for systems in the current sizing data base and add new data
  sets for other mission areas such as Navy C^3 equipment and space
  projects.

- Quantitative functional relationships - Research should continue to
  investigate statistical relationships to estimate the size for specific
  software functions. This research requires a homogeneous data base
  consisting of many statistically reliable data points for each specific
  software function.

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