E-24-616

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

FINAL PROJECT REPORT
NSF FORM 98A

PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING

PART I—PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
Georgia Tech Research Corporation Atlanta, GA 30332		IST-8217440
	4. Award Period From 1/15/83 To 6/30/86	5. Cumulative Award Amount $74,506

6. Project Title

"Models of Human Performance Using Text Editors (Information Science)"

PART II—SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

The results of this research increase our understanding of human-computer interaction and of experimentation with human subjects who are doing complex tasks. The human-computer interaction results include first, observations on the use of a text editor that kept the user in continuous control of the positioning process and second, experiments and models of user selection of search string keys during editor positioning. The results on experimentation include a study of the power of statistical tests from experiments on computer programming and a way of testing the significance of production rule models of human problem solving.

PART III—TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM	
				Check (✓)	Approx. Date
a. Abstracts of Theses		X			
b. Publication Citations		X			
c. Data on Scientific Collaborators	X				
d. Information on Inventions	X				
e. Technical Description of Project and Results		X			
f. Other *(specify)*					

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
John M. Hammer		1-15-88

NSF Form 98A (1-87) Supersedes All Previous Editions

Form Approved OMB No. 3145-0058

PART IV - SUMMARY DATA ON PROJECT PERSONNEL

NSF Division _____

The data requested below will be used to develop a statistical profile on the personnel supported through NSF grants. The information on this part is solicited under the authority of the National Science Foundation Act of 1950, as amended. All information provided will be treated as confidential and will be safeguarded in accordance with the provisions of the Privacy Act of 1974. NSF requires that a single copy of this part be submitted with each Final Project Report (NSF Form 98A); however, submission of the requested information is not mandatory and is not a precondition of future awards. If you do not wish to submit this information, please check this box ☐

Please enter the numbers of individuals supported under this NSF grant.
Do not enter information for individuals working less than 40 hours in any calendar year.

*U.S. Citizens/ Permanent Visa	PI's/PD's		Post-doctorals		Graduate Students		Under-graduates		Precollege Teachers		Others	
	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.
American Indian or Alaskan Native												
Asian or Pacific Islander												
Black, Not of Hispanic Origin												
Hispanic												
White, Not of Hispanic Origin	1				1			1				
Total U.S. Citizens	1				1			1				
Non U.S. Citizens												
Total U.S. & Non-U.S. ..	1				1			1				
Number of individuals who have a handicap that limits a major life activity.												

*Use the category that best describes person's ethnic/racial status. (If more than one category applies, use the one category that most closely reflects the person's recognition in the community.)

AMERICAN INDIAN OR ALASKAN NATIVE: A person having origins in any of the original peoples of North America, and who maintains cultural identification through tribal affiliation or community recognition.

ASIAN OR PACIFIC ISLANDER: A person having origins in any of the original peoples of the Far East, Southeast Asia, the Indian subcontinent, or the Pacific Islands. This area includes, for example, China, India, Japan, Korea, the Philippine Islands and Samoa.

BLACK, NOT OF HISPANIC ORIGIN: A person having origins in any of the black racial groups of Africa.

HISPANIC: A person of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish culture or origin, regardless of race.

WHITE, NOT OF HISPANIC ORIGIN: A person having origins in any of the original peoples of Europe, North Africa or the Middle East.

THIS PART WILL BE PHYSICALLY SEPARATED FROM THE FINAL PROJECT REPORT AND USED AS A COMPUTER SOURCE DOCUMENT. DO NOT DUPLICATE IT ON THE REVERSE OF ANY OTHER PART OF THE FINAL REPORT.

FINAL REPORT

NSF GRANT IST-82-17440

John M. Hammer

Principal Investigator

November 1987

This section of the final report is an overview of the four articles included as the substance of the report. These articles are:

Hammer, J.M., A display editor with random access and continuous control, International Journal of Man-Machine Studies, Vol. 21, 1984a.

Hammer, J.M., Statistical methodology in the literature on human factors in computer programming, in Human-Computer Interaction, G. Salvendy and M. Oshima, eds., Elsevier Publishing Co., 1984b.

Lewis, C.M. and Hammer, J.M., Significance testing of rules in rule-based models of human problem solving, IEEE Transactions on Systems, Man, and Cybernetics, 16(1), 1986.

Andes, R.C., Jr., An Information-Theoretic Model of Human Search String Selection in Text Editing, M.S. Thesis, Center for Man-Machine Systems Research, School of Industrial and Systems Engineering, Georgia Institute of Technology, Atlanta, Georgia, 1987.

[Hammer 1984a] is a report on an editor designed to keep the user in continuous control of the positioning process. This work was begun out of frustration with a primitive display editor which could produce so much display output that it could lag the user's commands by a second or more, even at then high baud rates. While the description of this editor may make it at first appear similar to many others of its era, it did in fact take

advantage of or make allowances for many aspects of human performance that many display editors still do not accommodate today.

[Hammer 1984b] is the result of an experimental failure, which lead to an exploration of how experiments should be conducted with human subjects. One uncertainty in this new field was the degree of variability in human subjects. Since there were a number of articles on human performance in computer programming, this field was selected for an examination of successful and unsuccessful practices. Many researchers in this field had claimed that programming ability differed widely between individuals. The statistical results in the literature at that time do not support that claim. Instead, most of the results were found to be as large (in terms of variance explained) as were found in the "harder" areas of psychology (such as traditional experimental psychology and human factors psychology).

[Lewis and Hammer 1986] describes several methods for statistical significance testing of rule-based models. A typical evaluation of a production rule model of human problem solving was to point out the percentage agreement between model and subject actions. This article describes three methods (ANOVA, chi-square, and randomization tests) that can evaluate the significance of each rule. The conclusion of the article describes a problem which remains an research interest of both authors: identification of a rule-based model of cognition from

data. Significance testing, even as described in the article, does not guarantee identification. The article describes a paradigm through which this question could be studied.

[Andes 1987], a thesis directed by the principal investigator, describes a model of how the human chooses a search string to move an editor to a desired location. The model posits two processes. First, the human must estimate the number of bits of information in the text between the current and desired editor position. Second, the human must choose a search string with at least this many bits. The model was able to predict human success and failure with at least 90% accuracy.