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THE ECONOMICS OF TEXT-EDITING FUNCTIONS:
COST-EFFECTIVENESS ANALYSIS OF NLS AND OTHER SYSTEMS.

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A method for estimating the cost-effectiveness of a text editor under normal office operating conditions is described. Use of the tool is fully documented so that the analysis can be extended to any text-editor for which a measure of cost-effectiveness is desired.

This document presents the results obtained when this "test-kit" was applied to an analysis of text-editing functions in terms of comparative costs to the user. The scope was not restricted to NLS but included an examination of two commercially-available systems. An extension of the analysis to other systems is proposed.

1. THE APPROACH.

The approach taken was the following:

1. We started from externally-specified "tasks", each task being a typical activity that could present itself in everyday office or workshop situations. A "Task" consisted in the entry, proofing, text-editing and structure-editing of a certain document.
2. We decided to test the method on two readily-available systems, namely TNLS and WYLBUR, and to gradually extend it to others, such as the MTST, DNLS and later TECO (TECO is not included in the present study). It is assumed that an analysis of these five systems will give us a good indication of the overall picture.
3. At each facility we explained the conditions of the experiment to trained operators who were very familiar with the tool that was analyzed.
4. All costs reported here include machine-measurable charges only, to the exclusion of personnel salary and overhead; system crashes were not tabulated, as they would have to be in a true business-oriented survey of the field.

2. SELECTION OF TASKS.

Text-editors are not universal tools. They are typically matched to certain office functions, and while some may be excellent for text-entry they fail as table-manipulators or as structure-handlers. Therefore there exists a SPECTRUM of tasks that need to be explored.

In the typical environment we are studying we expect to handle information in three main categories: there will continue to be medium or large bodies of English text such as memos, reports, user guides. These typically have little structure and contain few tables. In a second category we may find the "accounting" report, where text coefficients ~~and~~ apply to NLS in general.

alternates with columns of figures. In a third category, which exhibits deep structure, we have program procedures such as we handle everyday in NLS development.

Accordingly the following three documents were selected:

T1: The source code for the QUERY program. It contains 282 lines of L10 code with deep structure. (5 typewritten pages, 5250 characters).

T2: Paul's measurement report of Jan.30th, containing 304 lines of text detailing the CPU time required for TNLS and DNLS commands. This is presented in the form of several tables. (8 typewritten pages, 5620 characters).

T3: An article containing 404 lines of English text. The title of this article is "JUPITER IN AQUARIUS: YOUR LUCKY BREAK?" and it appeared in "Astrology" for February 1973. (7 printed pages, 23530 characters).

3. DEFINITION OF THE "FUNCTIONS".

The various functions to be analyzed are the following:

F1: TEXT ENTRY. In this phase the operator is given the text of the document and is told to enter it into his computer using any command, tool or "trick" that he is familiar with, without going back to edit typing errors. He is also to provide a listing for proofreading.

F2: PROOFING. It is a fact of common experience that a given text-editor encourages a specific type of error. The DNLS keyboard, for instance, forces typing errors that are impossible using the IBM 2741. The syntax is also an important factor since a mis-placed "d" in TNLS can throw the entire text down one level, a possibility that would not exist under TECO or on the MTST, and so on. Therefore it is important to measure not only the cost of initial entry but the cost of bringing all the documents to the same level of perfection.

F3: TEXT-EDITING. A specific study is needed of the text-editing function, i.e. the replacement of certain words by others, the replacement of strings of text by others, and the systematic substitution of one word or string for another in the entire body of text. Our instructions to the operators in this respect were standardized and are given in the appendix. In this phase we also measure the cost of moving groups of statements up or down, of transposing branches, of deeply altering the entire structure of the given text.

F4: TEXT VIEWING. Displaying the text to a remotely-located user is a basic function whose cost depends greatly on the type of device supported by the program.

4. FACILITIES INCLUDED IN THE SURVEY.

At ARC we have analyzed TNLS and DNLS. At the Stanford Computing Center, Campus Facility, we have used the WYLBUR system, and at the

Stanford Graduate School of Business We have tested the MIST machine. A short description of these four systems is given below:

TNLS is the teletype version of the NLS system. It is a statement-oriented, rather than line-oriented editor, where operators must remain aware of the pointer positions.

DNLS, the display version of the same system, makes the pointer position graphically visible through use of a movable arrow on the screen. It automatically refreshes the text to reflect view changes.

WYLBUR is an interactive editor and remote-job-entry system for IBM/360 that was developed at the Stanford Computing Center between 1967-68 and has been made available on many configurations around the country.

The MTST (Magnetic tape selectric typewriter) is an office machine supplied by IBM that is NOT connected to a computer. The machine generates a magnetic tape and has an editing capability. It is widely used in office environments where installing a general-purpose computer is too expensive or unnecessary.

The rates for the MTST utilization were taken as charged by the Stanford Graduate School of Business.

All operators were familiar with the process being analyzed and were good typists at the professional level. In the case of TECO, however, Kirk Kelley was not thoroughly trained in the use of the system and the figures must be taken as upper bounds.

Standard instructions were given to the operators at each facility. It was explained to them that this was not a test of their service itself but a test of the FUNCTIONS performed by the text-editor they offered. Need to keep an accurate record of all time intervals was stressed. All console sheets were to be saved and given to us. A clean listing was to be generated in each phase, and the cost of producing it included in the survey.

The salary of operators (as stated above) was not included in the results. With this in mind, the figures given below can be placed in the perspective of secretarial services, that typically charge \$2.50 per page for letter-type documents. Assuming 50 lines per page the cost would be 5 cents per line. (PES)

5. TNLS RESULTS.

For all PDP-10 costs we have assumed current BBN rates, namely \$1/hour of connect time and \$8/minute of CPU time.

This gives NLS costs of 13.33 cents/cpu second, 6.66 cents/terminal minute. ('cost.1' column). However analysis of our own internal costs leads to a figure of either \$6.25 per cpu minute (10.42 cents per cpu sec, cost.2 column) or \$10 per terminal hour (16.66 cents per terminal min, cost.3 column). These figures have been tabulated for comparison.

	Function	cpu-time (sec)	connect (min)	cost.1 (\$)	cost.2 (\$)	cost.3 (\$)
T1	F1.Text Entry	56.5	58	11.39	5.89	9.66
	F2.Proofing					
	F3.Editing	114.0	87	20.99	11.66	14.49
	F4.Viewing	34.0	15	5.53	3.54	2.50
	TOTAL	204.5	160	37.91	21.31	26.65

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T2	F1.Text Entry	54.1	111	14.60	5.63	18.49
	F2.Proofing	46.0	31	8.20	4.79	5.16
	F3.Editing	75.0*	101*	16.67*	7.81*	16.83*
	F4.Viewing	21.0	10	3.37	2.19	1.67
	TOTAL	196.1	253	42.84	20.42	42.15

T3	F1.Text Entry	89.4	125	20.24	9.32	20.83
	F2.Proofing	30.0	25	5.66	3.13	4.17
	F3.Editing	38.2	9	5.69	3.98	1.50
	F4.Viewing	48.0	23	7.93	5.00	3.83
	TOTAL	205.6	182	39.52	21.43	30.33

TNLS TOTAL 606.2 595 120.27 63.16 99.13
(PES)

It must be noted that the results for T2 are only given as a lower bound of the cost of editing this type of document under TNLS: We had to stop the experiment because both the cpu time and the terminal time involved were obviously unreasonable. Approximately one fourth of the changes requested in the test had been entered when the experiment was stopped. The person doing the task had given up trying to perform the work with TNLS editing functions and was simply re-typing those portions of the text affected by the changes. When this was observed it was decided to interrupt the process.

6. WYLBUR RESULTS.

WYLBUR is commercially available in the Peninsula at rates lower than those charged by Stanford. However we have used the Stanford environment as an upper limit of WYLBUR costs because it was more typical of the anticipated "workshop". These rates are \$3.50/hour of connect time and \$9/minute of CPU time. It will be noted that although the 360/67 at Stanford is considerably more powerful than our PDP-10 the typical WYLBUR user has to share it with about 50 to 60 other users. All WYLBUR experiments were done during normal work hours.

WYLBUR charges were 15.00 cents/cpu second, 5.73 cents/terminal minute.

Function	cpu-time (sec)	connect (min)	cost (\$)
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T1	F1.Text Entry	1.1	78	4.63	
	F2.Proofing				
	F3.Editing	4.6	84	5.50	
	F4.Viewing	0.6	19	1.18	
	TOTAL	6.3	181	11.31	TOTAL 11.31

T2	F1.Text Entry	1.7	71	4.32	
	F2.Proofing	0.5	3	0.25	
	F3.Editing	4.0	95	6.04	
	F4.Viewing	0.7	29	1.77	
	TOTAL	6.9	198	12.38	TOTAL 12.38

T3	F1.Text Entry	2.2	116	7.03	
	F2.Proofing	2.0	24	4.27	
	F3.Editing	5.8	10	1.54	
	F4.Viewing	1.0	46	2.79	
	TOTAL	11.0	196	12.89	TOTAL 12.89

WYLSUR	TOTAL	24.2	575	36.58	TOTAL 36.58 (PES/)

7. MTST RESULTS.

The MTST used at the Stanford Graduate School of Business was charged at the rate of \$7.50 per hour for recording mode (text entry and edits) and \$10 per hour for playback (viewing).

In these tests it had been decided not to include operator time in any of the statistics. From the above figures we therefore subtracted the standard rate charged for MTST operators, namely \$4.50 per hour. The figures below were obtained using a rate of \$3/hr for recording and \$5.50/hr in playback mode.

After the text entry phase it was found that i) the text produced was perfect and no need existed for a "proofing" phase. and ii) The edits required would be so complex on this machine that the operator would more efficiently re-type the entire document. Therefore we took the cost of text entry as the cost of editing.

Function cpu-time connect cost					
(sec) (min) (\$)					

T1	F1.Text Entry	N/A	120	6.00	
	F2.Proofing				
	F3.Editing	N/A	120	6.00	
	F4.Viewing	N/A	25	2.30	
	TOTAL	N/A	265	14.30	TOTAL 14.30

T2	F1.Text Entry	N/A	150	7.50	
	F2.Proofing				
	F3.Editing	N/A	150	7.50	
	F4.Viewing	N/A	25	2.30	
	TOTAL	N/A	325	16.30	TOTAL 16.30

T3	F1.Text Entry	N/A	300	15.00		
	F2.Proofing					
	F3.Editing	N/A	300	15.00		
	F4.Viewing	N/A	70	6.40		
	TOTAL	N/A	670	36.40	TOTAL	36.40
MTST	TOTAL	N/A	1165	67.00	TOTAL	67.00 (PES)

8. DNLS RESULTS.

As in the case of TNLs we have assumed current BBN rates, namely \$4/hour of connect time and \$8/minute of CPU time. This gives DNLS costs of 13.33 cents/cpu second, 6.66 cents/terminal minute. ('cost.1' column). However analysis of our own internal costs leads to a figure of either \$6.25 per cpu minute (10.42 cents per cpu sec, cost.2 column) or \$10 per terminal hour (16.66 cents per terminal min, cost.3 column). These figures have been tabulated for comparison as was done in section 5 above.

	Function	cpu-time (sec)	connect (min)	cost.1 (\$)	cost.2 (\$)	cost.3 (\$)
T1	F1.Text Entry	418	50	59.00	43.56	8.33
	F2.Proofing					
	F3.Editing	140	29	20.59	14.59	4.83
	F4.Viewing	12	1	1.67	1.25	0.17
	TOTAL	570	80	81.26	59.39	13.33
T2	F1.Text Entry	507	52	71.04	52.83	8.67
	F2.Proofing					
	F3.Editing	240	38	35.19	25.00	6.33
	F4.Viewing	22	4	3.20	2.29	0.67
	TOTAL	769	94	109.43	80.12	15.67
T3	F1.Text Entry	492	87	71.37	51.27	14.49
	F2.Proofing	30	8	4.53	3.12	1.33
	F3.Editing	36	6	5.20	3.75	1.00
	F4.Viewing	26	6	3.87	2.71	1.00
	TOTAL	584	107	84.97	60.85	17.82
DNLS TOTAL		1923	281	275.66	200.36	46.82

CONCLUSION: A logical next step in the application of this tool would be to obtain similar cost-effectiveness measures for such systems as TECO and ATS. A definite statement ranking the systems we have studied in terms of their cost-effectiveness would be premature for two main reasons: i) The TNLs figures do not reflect true costs because the tests had to be truncated and ii) we do not know enough about the cost