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The minimal manual: is less really more?

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Carroll, Smith-Kerker, Ford and Mazur-Rimetz (The minimal manual, *Human–Computer Interaction*, **3**, 123–153, 1987) have introduced the minimal manual as an alternative to standard self-instruction manuals. While their research indicates strong gains, only a few attempts have been made to validate their findings. This study attempts to replicate and extend the original study of Carroll *et al.* Sixty-four first-year Dutch university students were randomly assigned to a minimal manual or a standard self-instruction manual for introducing the use of a word processor. During training, all students read the manual and worked training tasks on the computer. Learning outcomes were assessed with a performance test and a motivation questionnaire. The results closely resembled those of the original study: minimalist users learned faster and better. The students' computer experience affected performance as well. Experienced subjects performed better on retention and transfer items than subjects with little or no computer experience. Manual type did not interact with prior computer experience. The minimal manual is therefore considered an effective and efficient means for teaching people with divergent computer experience the basics of word processing. Expansions of the minimalist approach are proposed.

Introduction

Computers have gradually become ubiquitous over the past ten years. Initially, computer users were highly trained experts. Now the majority of users are interested lay people with little or no computer knowledge. This new audience has different documentation needs, which companies began to take seriously after finding out that a good manual could clinch a sale (e.g. O'Malley, Smolensky, Bannon, Conway, Graham, Sokolov & Monty, 1983; Paxton & Turner, 1984; Jensen & Osguthorpe, 1985; Foss, Smith-Kerker & Rosson, 1987). One of the ways in which companies have been able to adapt and upgrade their documentation is through extensive analyses of the behavior of the novice user.

These studies have indicated that first-time computer users have relatively simple training needs. They want to get to know how to operate a computer program, and they want to get to know it fast (Scharer, 1983; Carroll, 1990*b*). They are not interested in detailed information on how the computer or software works. Rather, they want to "read to learn to do" (Redish, 1988).

First-time users also frequently depart from the prescribed paths in their manuals. That is, they often explore the functions of the program on their own. Mistakes abound during these explorations and users expect the manual to help with these problems (Cuff, 1980).

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Standard self-instruction manuals do not subscribe to these needs. This may explain why some research has indicated that only 14% of the users actually read the manual (Penrose & Seiford, 1988). Prompted by this misfit, Carroll and his associates have put forth a radically new approach to documentation (Carroll, 1990*a,b*; Carroll, Smith-Kerker, Ford & Mazur-Rimetz, 1987). Their observations of the behaviour of first-time users led to the development of a minimal manual (MM) for teaching novices how to use a computer program.

Research on minimal manuals has only recently started to emerge (e.g. Wendel & Frese, 1987; Frese, Albrecht, Altmann, Lang, von Papstein, Peyerl, Prümper, Schulte-Gücking, Wankmüller & Wendel, 1988; Olfman & Bostrom, 1988; Raban, 1988; Vanderlinden, Cocklin & McKita, 1988; Gong & Elkerton, 1990; Ramsay & Oatley, 1992). All of these studies suggest that an MM is better than a standard self-instruction manual (SS). It is difficult to draw a clear conclusion from these studies, however. They often do not give an explicit account of the principles used to design the MM and the experimental design of some of these studies calls for a little caution.

The main objective of this study is to find additional evidence for the minimalist approach to first-time user documentation. Before presenting the study, it is important to detail the various ways in which it has examined the claims of minimalism and how it seeks to broaden the original experiment of Carroll *et al.* (1987).

Firstly, an important critique of minimalism is that Carroll and his colleagues have not given enough examples and explicit design rules for creating an MM (Tripp, 1990; Nickerson, 1991; Hallgren, 1992, Horn, 1992). We found this criticism to be only partially just. Whereas the major points of departure have been well described in various papers and in Carroll's book *The Nürnberg Funnel* (1991), we also felt a need for more detailed, design-oriented guidelines. Therefore, we studied Carroll's original MM in order to discover the various design rules that are subsumed under the four major principles. In this and other papers we have outlined these design rules (Lazonder & Van der Meij, 1992; Van der Meij, 1992; Van der Meij & Lazonder, 1992; see also Section 2).

Secondly, another point of criticism against Carroll has been the lack of a fair comparison between manuals. One critic has raised the question of whether the control manual is a good example of its kind (Nickerson, 1991). In the present study, both the MM and the control manual were created especially for the experiment in order to have a well-controlled manipulation. The two manuals shared the same basic content and menu-oriented approach to the software, but they obviously differed in their design principles. In addition, both manuals were pilot tested and revised on the basis of the test findings and comments of experts. In short, both manuals are probably good representatives of their approaches to documentation.

Thirdly, the study examines whether computer experience contributes to the effects of the MM. Until now, almost no other study on minimalism has examined this contribution. As more and more people develop computer knowledge and skill, it becomes more important to discover whether minimalism works for people with divergent computer experience (cf. Oatley, Meldrum & Draper, 1989).

Fourthly, the initial development of an MM was stimulated by the bad press for conventional manuals. Carroll *et al.* (1987) wanted to create a manual that would adapt as much as possible to the users' preferences and processing of paper documentation. As a result, the MM is supposed to be better suited to what users want from a manual. It should, therefore, lead to a more positive motivation than a conventional manual. This effect on motivation has not yet been studied.

Fifthly, it is interesting to find out whether minimalism also works in a context that differs in many ways from Carroll's original study. This study does so. We used different materials, a different software system, different kinds of subjects from a different country with a different language. Perhaps the most vital question of these is whether the procedural approach of minimalism, as opposed to a conceptual one, works for other than American cultures. There is, for example, some indication that the Japanese are unlikely to benefit from an MM (Aizu & Amemiya, 1985; Mackin, 1989; Stevensen, 1992). The manual's direct action statements might contrast with their notion of politeness. In addition, the procedural approach of the MM contrasts with their conceptual orientation towards learning. Likewise, some people have expressed doubts whether it fits the Europeans (Brockmann, pers. comm.). In short, it is important to find out whether the minimalist approach works for European subjects (cf. Wendel & Frese, 1987; Ramsay & Oatley, 1992).

The present study thus attempts to validate and expand the work of Carroll *et al.* (1987) in many ways. The study examined the effect of manual type and computer experience on two classes of dependent measures: procedural skill and motivation. Procedural skill was operationally defined by the same measures (e.g. shorter learning time, better test performances) used in the original study of Carroll *et al.* (1987). For motivation, the study measured attention, relevance, confidence, and satisfaction (Keller, 1983, 1987).

In line with Carroll *et al.*'s findings, the MM was predicted to yield higher procedural skill than the SS. In addition, the MM-subjects were expected to end up with higher motivation regarding word processing than SS-subjects because the MM is designed to meet the users' learning preferences, styles and informational needs better. Effects of computer experience are studied in an exploratory fashion.

The minimalist approach to tutorial documentation

Over time, Carroll and others have accorded slightly different characteristics to the MM. But, in general, an MM is based on the following *minimalist principles*: (a) task orientation, (b) adequate use of text, (c) provision of information to detect and correct errors, and (d) modularity (Carroll, 1990*b*; Hallgren, 1992; Horn, 1992; Lazonder & Van der Meij, 1992; Van der Meij, 1992).

The *task-oriented* nature of the MM means that the manual focuses on the basic goals that the program can satisfy. Thus, the MM allows users to get started fast and hardly supports any secondary actions (e.g. installation, advanced tasks) or details concepts (e.g. what menus do). In our MM for a word processor, the chapters therefore deal with tasks that users are familiar with, such as typing an invitation, changing the lay-out of a letter to a telephone company and revising the minutes of a member's meeting. The task-oriented nature of the manual also transpires in the headings. Chapter headings denote overall goals users may want to attain (e.g. "Rearranging text", "Changing characters, words and lines") and section headings refer to subgoals (e.g. "Copying text", "Changing the fontsize"). As in the original MM, "Do it yourself" sections were included to stimulate users to discover new goals that the program could satisfy.

There are two basic rules behind the principle that *text should be adequate.* Firstly, there should be as little text as possible. Like the original, our MM lacks a preface, advance organizers, an index, and summaries at the end of each chapter. There is also little conceptual information in the manual, nearly all information refers to "doing things". Not even all procedures are fully specified. For example, some information that users can find on the screen, or that they can easily infer, was left out intentionally (e.g. "Look at the screen. WordPerfect explains how you actually remove these lines."). This was done to force users into discovering parts of the program by studying the screen, inferencing and reflecting.

Secondly, the text should be simple and without jargon where possible. For this reason, the text was presented in short sentences of about 14 words, in a subject-predicate order. Embedded sentences, like this one, were not used. In addition, most of the jargon and technical expressions were substituted by more common terms. Some potentially confusing words were, however, not removed because they belong to the word processor's menu choices or system messages (e.g. intermittent use of the words "document" and "file"), or because they belong to the basic computer lingo (in English) that any user should get to know (e.g. "printer", "diskette" or "cursor").

Learning how to use a complex program such as a word processor inevitably causes users to make mistakes. Our MM therefore contains lots of information to *detect and correct errors.* General exits out of the program and general recovery strategies in the program are introduced early—namely, in the first chapter—and they reappear later on where appropriate. In subsequent chapters specific recovery information is presented (e.g. "If you have made the wrong choice, press the F1 key again to return to the menu"). To prevent users from making mistakes in the first place, the manual frequently directs their attention to the screen to check whether they are still on the right track. Illustrations were used to clarify operations on the hardware (e.g. turning the power on, inserting a diskette) and to help users identify special keys (e.g. F1, BACKSPACE) the first time they were to be used.

There is not a complete *modularity* of all of the chapters in our MM. The first chapter deals with starting and ending the program and is therefore basic to the rest. The remaining chapters can be worked through independently from one another, however, and there is no cross-referencing. Each chapter is thus self-contained, which is exemplified in the numbering of the pages. Each chapter starts afresh with page 1, and the page number is preceded by the chapter number (e.g. instead of page 18, users see page 3.2, meaning the second page of Chapter 3).

The MM was developed for WordPerfect 5.1 and it copied Carroll's manual as much as possible (for a detailed description of this construction, see Van der Meij & Lazonder, 1992). The manual is not just a replica because of variations in hardware (IBM vs. Sirex), software (Display Writer vs. WordPerfect 5.1) and language (English vs. Dutch).

Every effort was made to make the MM different from the SS *only* with regard to the minimalist principles. Thus, both manuals covered exactly the same basic tasks, and the same command names and approach to the program (menu-oriented rather than by using the function keys of WordPerfect). Moreover, the lay-out was identical. The SS was adapted from a sample of currently used WordPerfect manuals. These manuals start from the belief that the acquisition of declarative information is a necessary condition for the acquisition of procedural information (e.g. Anderson, 1985). In addition to the procedural information that it shared with the MM, the SS therefore gave ample conceptual information. Thus, the SS contained regular sections such as a welcome word, an introduction, an index, and summaries. Moreover, explanations accompanied most of the procedures (i.e. the manual explains what the computer "does" when a command is executed). All procedures to attain a certain goal were explicated as opposed to the occasional inferencing in the MM. The SS also explained jargon and technical terms in detail, many of which were introduced before the users had turned the computer on. Like most standard self-instruction manuals, the SS gave little error-recovery information and there were no "Do it yourself" sections that invited users to explore additional options of the program. As a result, the SS was almost twice as thick as the MM and it had three times as many words as the MM. Exemplary pages of both manuals are shown in Appendix 1.

Method

SUBJECTS

Sixty-four first-year Dutch university students participated in this study. There were 15 males and 49 females with a mean age of 19·1 (S.D. = 2·2). The subjects received course credits for participation. They were classified as *novice, beginner* or *intermediate* user (Chin, 1986; Brockmann, 1990) and randomly assigned to one of the two experimental conditions (MM or SS). The allocation of subjects to conditions is shown in Table 1.

Subjects were considered novices when they had less than 50 hours experience with computers and no background with word processors. Beginners had either less than 50 hours experience with computers and experience with word processors, or had more than 50 hours computer experience, but no experience in working with WordPerfect. Intermediate users had some experience with WordPerfect.

The drop-out rate was low. Only one (SS) subject did not attend the second session. Due to a computer break-down, there were incomplete data for seven subjects during the learning phase (2 MM; 5 SS) and for five subjects during the test

TABLE 1
Number of subjects per condition

User	Condition		Row total
	MM†	SS‡	
Novice	13	18	31
Beginner	7	7	14
Intermediate	10	9	19
Column total	30	34	64

† Minimal manual.
‡ Standard self-instruction manual.

(2 MM; 3 SS). The data for these subjects were excluded on an analysis-by-analysis basis, causing variable group sizes in some of the analyses.

Experimental checks on the random allocation to conditions revealed no significant differences between the groups for intelligence, educational background, sex, initial motivation or typing skill. As Table 1 shows, computer experience was evenly distributed between experimental groups.

MATERIALS

Experimental setting and word processor

All sessions took place in a computer class equipped with a network of 19 Sirex 386-SX personal computers and a laser printer. The word processor (WordPerfect 5.1) was downloaded from a network, thereby assuring an identical setup for all subjects. Given the fact of relatively inexperienced users, WordPerfect's menu (instead of its infamous function keys) was used to execute commands (see Cuff, 1980).

During the hands-on part of the training sessions and during the test phase, a registration program stored the subjects' actions in a logfile. Every time a subject struck a key, time and keypress were recorded.

Instructional materials

During training, all subjects received a manual (MM or SS) and a diskette containing all documents to be used in training. Both manuals were developed iteratively. A concept version of each manual was reviewed by three experts (an instructional technologist, a technical writer with detailed knowledge of the software and a graphical designer). In addition, pilot tests were run with a number of novice students. On the basis of these findings, both manuals were revised.

Questionnaires and tests

The participants filled in a background questionnaire, containing questions about sex, age, previous schooling, native language, typing skill and prior experience with computers. Intelligence was assessed with a standardized Dutch verbal analogies test. Motivation was assessed by two questionnaires. One questionnaire determined the subjects' initial motivation; another measured their motivation after training. Both questionnaires consisted of 45 behavioral descriptions (fillers included) that were drawn from existing instruments (Lemos, 1978; Reece & Gable, 1982; Popovich, Hyde, Zakrajsek & Blumer, 1987; Temple & Lips, 1989). The subjects judged each description (positively and negatively stated) on a 5 point agree–disagree scale. (See Appendix 2 for the relevant items and their reliability coefficients (Cronbach's alpha).)

A performance test was administered to assess learning outcomes. This test included basic-managerial, retention and transfer items. The six basic-managerial items addressed tasks like document retrieval and file saving. Since these tasks were practiced more frequently than the other tasks in the MM (or in the SS), they will be analysed as a distinct category. The nine retention items dealt with simple word processing tasks rehearsed during practice (e.g. copying and moving text, restyling words, paragraphs and pages). Four transfer items addressed topics that went beyond the scope of the manuals (e.g. changing the position of the page number, altering a footnote). Task documents were offered on a separate diskette.

PROCEDURE

The experiment was run in five groups of 7–16 subjects. All subjects attended two sessions of four hours each. The time between sessions was one week exactly for each group. In all, the experiment took two weeks. All procedures were identical for the various groups and the same two experimenters conducted all sessions. Subjects in the same session were given the same manual.

At the start of the first session, subjects received the paper and pencil tests, a manual and a diskette and were seated at their computer. After a brief introduction, they filled in the background and initial motivation questionnaire. Subsequently, they were given exactly 20 min to complete the verbal analogies test.

After the test, more detailed instructions for working with WordPerfect were provided. As in the original experiment, subjects were instructed to work individually, in their own way and at their own pace. They were to consult the experimenter only when a mechanical error had occurred, or when they were stuck for more than 15 min. The students were asked not to use WordPerfect between sessions.

The second session started with another 2·5 hours of hands-on experience during which all participants managed to complete their training. After a short break, all subjects filled in the final motivation questionnaire. Next, they were given 60 min for the performance test. During the test the subjects were allowed to consult their manual.

Coding and scoring

The coding resembled that of the original study as much as possible. Dependent variables were: time to complete training, time to complete the performance test, number of errors in the test, recoveries from errors in the test, quality of test performance, and motivation. These measures were calculated for completed tasks only.

As in Carroll *et al.*'s (1987) original study, these data also led to the following performance measures: (a) performance success, (b) performance efficiency, (c) recovery effectiveness, and (d) recovery efficiency. Performance success was defined as the number of successfully completed items, which was assessed by examining the task documents stored on diskette and the logfiles of each subject. Performance efficiency was the ratio of the relative number of successfully completed items to the time to complete these items. Error corrections and recovery time were combined into a measure of recovery efficiency: the number of successful recoveries divided by the total recovery time for a given item. Effectiveness of recovery was defined as the number of correct revisions divided by the total number of revisions for a given item (for further details, see Carroll *et al.*, 1987).

The initial motivation questionnaire measured five constructs: (a) curiosity, (b) relevance, (c) confidence, (d) reference group, and (e) persistence. The final motivation questionnaire measured: (a) attention, (b) relevance, (c) confidence, and (d) satisfaction (Keller, 1987). Both questionnaires employed a 5-point Likert-type scale with options bearing simple weights of 5, 4, 3, 2, or 1 for positive items, and the reverse for negative items. Scores on all items were added for each subject and compared between groups. High scores represent a high motivation; low scores indicate a low motivation.

Data analyses

The study was set up as a quasi-experimental design with manual type and computer experience as the two main factors. Manual has two levels (MM and SS). Experience has three levels (novice, beginner, intermediate), leading to a 2 × 3 design.

All data were analysed by means of analyses of variance. Where appropriate, multivariate MANOVA analyses preceded univariate ANOVA and post-hoc Scheffé analyses (alpha was set at 0·05). All outcomes were corrected for initial motivation by inserting the five initial motivation scores into the analyses as covariates. Since no interactions were found between manual type and computer experience, these data will not be reported.

Results

TIME

Table 2 presents the mean time (in minutes) subjects required to complete training. Overall, MM-subjects needed over 25% less time to learn to use the word processor. This difference was statistically significant ($F(1, 46) = 16{\cdot}46$, $p < 0{\cdot}01$).

Computer experience had no effect on overall learning time ($F(3, 46) = 1{\cdot}85$). Novices, beginners and intermediate users all needed about the same time to complete training.

One of the design objectives of the MM is to allow users to get started fast. Table 2 lists the mean time it took subjects to reach some getting-started benchmark tasks. MM-users did indeed get to these tasks sooner than SS-users ($F(3, 43) = 20{\cdot}96$, $p < 0{\cdot}01$). As the table shows, they started the system about 6 min earlier ($F(1, 45) = 45{\cdot}19$, $p < 0{\cdot}01$) and were faster with printing their first document ($F(1, 45) = 12{\cdot}45$, $p < 0{\cdot}01$). There was no effect of computer experience on these benchmark tasks.

The mean time subjects required to complete the various test items is shown in

TABLE 2
Mean time to reach getting started benchmarks

Manual	Complete training	Start system	Start WP	Print
MM†	144·5 (38·7)	2·7 (2·0)	1·3 (0·9)	29·9 (10·1)
SS‡	195·0 (45·6)	9·2 (4·5)	2·1 (1·9)	82·7 (70·9)

Time in min, S.D. in parentheses.
† Minimal manual.
‡ Standard self-instruction manual.

TABLE 3
Mean solution time on test items

	Item type		
	Basic	Retention	Transfer
Manual			
MM†	0·5 (0·3)	3·0 (1·0)	7·7 (4·2)
SS‡	1·1 (0·9)	4·0 (2·1)	6·5 (3·4)
Computer experience			
Novice	0·9 (0·8)	4·2 (2·0)	7·7 (4·8)
Beginner	0·6 (0·5)	2·8 (1·1)	6·3 (3·4)
Intermediate	0·7 (0·5)	2·7 (0·7)	7·1 (2·9)

Time in min, S.D. in parentheses.

Since not all subjects completed the performance test (10 SS-subjects did not get to the transfer items), the ratio of time to the number of completed items was compared between experimental groups. Given the fact of speed-test, "faster" automatically implies "having completed more items".

† Minimal manual.

‡ Standard self-instruction manual.

Table 3. Manual again produced an effect. MM-subjects required significantly less time to complete basic-managerial items ($F(1, 48) = 8{\cdot}46$, $p < 0{\cdot}01$) and retention items ($F(1, 48) = 5{\cdot}37$, $p < 0{\cdot}05$). No effect of manual was found for transfer items ($F(1, 38) = 0{\cdot}43$).

Computer experience affected the time to complete retention items ($F(2, 48) = 4{\cdot}78$, $p < 0{\cdot}05$). Post-hoc Scheffé analyses indicated that novice users needed significantly more time to complete retention items than beginners or intermediates.

ERRORS AND RECOVERIES

With errors, the ratio of errors to the number of items completed was compared for basic-managerial, retention, and transfer tasks. Descriptive statistics are presented in Table 4.

There was a significant multivariate effect of manual ($F(3, 39) = 5{\cdot}19$, $p < 0{\cdot}01$).

TABLE 4
Mean number of errors on test items

	Item type		
Manual	Basic	Retention	Transfer
MM†	0·13 (0·24)	0·55 (0·24)	5·82 (6·37)
SS‡	0·32 (0·17)	0·55 (0·24)	6·65 (6·07)

S.D. in parentheses.

† Minimal manual.

‡ Standard self-instruction manual.

TABLE 5
Percentage of successful recoveries on test items

	Item type		
	Basic	Retention	Transfer
Manual			
MM†	80·5 (33·2)	45·3 (38·8)	18·8 (21·9)
SS‡	50·5 (42·6)	37·2 (36·4)	15·7 (25·8)
Computer experience			
Novice	54·2 (39·5)	41·1 (46·5)	7·7 (8·4)
Beginner	75·0 (41·8)	42·6 (24·3)	29·3 (32·9)
Intermediate	59·1 (49·1)	39·4 (26·3)	21·5 (24·6)

S.D. in parentheses.
† Minimal manual.
‡ Standard self-instruction manual.

Overall, MM-users made fewer errors, but a significant univariate effect was found only for basic-managerial items ($F(1, 41) = 10{\cdot}56$, $p < 0{\cdot}01$).

Computer experience did not affect the number of errors ($F(6, 76) = 1{\cdot}77$).

Since the MM aims to support the detection and correction of errors, MM-users were expected to correct more errors. Table 5 shows the percentage of corrected errors per item type, as a function of manual type and computer experience. As the mean scores indicate, there was no overall effect of manual. Whereas MM-subjects did make more successful recoveries on basic-managerial items, this difference was not significant ($F(1, 31) = 2{\cdot}97$, $p < 0{\cdot}10$) due to the extreme high variability of scores.

There was a significant effect of computer experience on recoveries on transfer items ($F(2, 39) = 4{\cdot}65$, $p < 0{\cdot}05$). Scheffé analyses revealed that more experienced users were significantly more successful in recovering from errors on transfer items than novices.

QUALITY OF PERFORMANCE

As in the original experiment, this study assessed the effect of the main factors on performance success, performance efficiency, recovery effectiveness and recovery efficiency.

Table 6 shows the mean performance success scores. Overall, MM-subjects successfully completed a significant 9% more items than did SS-subjects ($F(3, 48) = 4{\cdot}23$, $p < 0{\cdot}05$). Manual type had a significant univariate effect only on performance success on basic-managerial items ($F(1, 50) = 11{\cdot}55$, $p < 0{\cdot}01$). For retention and transfer items the difference between MM-subjects and SS-subjects was not significant.

Computer experience also significantly affected these scores ($F(6, 94) = 3{\cdot}94$, $p < 0{\cdot}01$). There were univariate effects on performance success on retention and transfer items ($F(2, 50) = 5{\cdot}58$, $p < 0{\cdot}01$ and $F(2, 50) = 10{\cdot}14$, $p < 0{\cdot}01$ respectively). Scheffé analyses showed that novice users were less successful on these items than beginners or intermediates (see Table 6).

TABLE 6
Mean performance success scores

	Item type		
	Basic	Retention	Transfer
Manual			
MM†	5·7 (0·5)	5·3 (1·4)	1·3 (0·8)
SS‡	4·6 (1·4)	5·1 (2·0)	1·0 (1·2)
Computer experience			
Novice	4·7 (1·4)	4·4 (1·6)	0·7 (0·7)
Beginner	5·6 (0·7)	5·9 (1·7)	2·0 (1·1)
Intermediate	5·3 (1·2)	5·9 (1·5)	1·4 (1·0)

S.D. in parentheses.
Performance success = number of items successfully completed.
† Minimal manual.
‡ Standard self-instruction manual.

Table 7 shows the performance efficiency data. Manual had a significant multivariate effect ($F(3, 36) = 5{\cdot}57$, $p < 0{\cdot}01$). In general, the performance of MM-users was more efficient than that of SS-users. Manual type had a significant univariate effect on performance efficiency only on basic-managerial items ($F(1, 38) = 11{\cdot}71$, $p < 0{\cdot}01$). Contrary to expectations, SS-subjects showed a higher performance efficiency score on retention and transfer items. This difference was not significant, however.

Computer experience also significantly affected performance efficiency ($F(6, 74) = 3{\cdot}28$, $p < 0{\cdot}01$). A univariate effect on retention items was found ($F(2, 38) = 7{\cdot}32$, $p < 0{\cdot}01$). Scheffé analyses again showed that novice users were less efficient than beginners or intermediates.

TABLE 7
Mean performance efficiency scores

	Item type		
	Basic	Retention	Transfer
Manual			
MM†	40·0 (16·6)	2·6 (0·9)	2·7 (1·9)
SS‡	25·2 (16·0)	3·0 (1·5)	3·8 (4·6)
Computer experience			
Novice	30·6 (13·3)	2·1 (0·7)	2·4 (2·0)
Beginner	39·9 (22·8)	3·2 (1·6)	4·1 (4·2)
Intermediate	31·5 (18·3)	3·3 (0·9)	3·5 (4·2)

S.D. in parentheses.
Performance efficiency = % of items successfully completed per time × 100.
† Minimal manual.
‡ Standard self-instruction manual.

TABLE 8
Efficiency and effectiveness of recovery behavior

	Item type		
	Basic	Retention	Transfer
Efficiency			
Manual			
MM†	334·9 (380·9)	48·5 (50·7)	31·4 (47·6)
SS‡	126·2 (169·3)	41·4 (44·4)	72·4 (164·7)
Effectiveness			
Manual			
MM†	100·0 (0·0)	96·2 (10·4)	93·7 (22·7)
SS‡	80·5 (38·2)	85·0 (25·9)	85·0 (35·1)
Computer experience			
Novice	92·5 (24·5)	85·5 (26·4)	91·7 (26·2)
Beginner	75·0 (41·8)	95·1 (11·5)	90·9 (30·2)
Intermediate	77·8 (44·1)	95·5 (11·1)	86·7 (32·2)

S.D. in parentheses.
Recovery efficiency = number of recoveries per time × 100; recovery effectiveness = number of successful recoveries to the number of attempted recoveries × 100.
† Minimal manual.
‡ Standard self-instruction manual.

Table 8 presents the main findings for the effectiveness and efficiency of recovery. Recovery-effectiveness differed in favor of the MM-group on all three item-types, but a statistically significant outcome was found only for basic-managerial items ($t(35) = 2{\cdot}62$, $p < 0{\cdot}05$). A similar finding was obtained for recovery-efficiency for these items ($F(1, 30)$ 4·32, $p < 0{\cdot}05$).

Experience with computers had no effect on these measures.

MOTIVATION

Two of the subjects' initial motivation scores affected the outcomes. Curiosity had a significant effect on the time to print a document ($t(45) = -2{\cdot}29$, $p > 0{\cdot}05$). As one might expect, time and curiosity were negatively correlated. Curious subjects printed their document earlier. In addition, persistence significantly affected the time subjects needed to complete basic-managerial items ($F(1, 48) = 4{\cdot}43$, $p < 0{\cdot}05$). More persistent subjects were faster in completing these items. Persistence also significantly affected the outcomes ($F(1, 39) = 4{\cdot}28$, $p < 0{\cdot}05$). High persistent subjects made more successful recoveries from errors on transfer items.

The MM is designed to meet users' learning preferences as much as possible. Therefore, it was expected that the MM would increase the subjects' motivation more than the SS would.

Comparison between the subjects' final motivation scores (i.e. a between-subjects effect) were made with Mann-Whitney U-tests. These tests showed no effect whatsoever of manual on any of the four motivational constructs. Apparently, MM-users came out of their training as motivated as did SS-users.

Computer experience did, however, affect the users' confidence and relevance scores after training. Surprisingly, the novices ended with a higher self-confidence than beginners ($U(42) = 101{\cdot}0$, $p < 0{\cdot}05$) or intermediates ($U(46) = 127{\cdot}0$, $p < 0{\cdot}01$). Novices and beginners ended with lower scores for relevance than intermediates ($U(48) = 95{\cdot}5$, $p < 0{\cdot}01$ and $U(30) = 46{\cdot}5$, $p < 0{\cdot}01$ respectively).

Conclusions

The main objective of this study was to find additional evidence in favor of the minimalist approach to computer documentation. As in Carroll's experiment, the MM was hypothesized to lead to higher procedural skill than the SS. In addition, MM-users were expected to increase their motivation (e.g. confidence, satisfaction) more than control subjects. Effects of computer experience were studied in an exploratory fashion.

The first hypothesis is clearly supported by the results. The MM-subjects were superior to the SS-subjects during practice and on the performance test. The MM helped users to get started faster and MM-users needed less time to complete the training. MM-users also had higher performance scores: they completed more test items successfully and required less time to do so than SS-users. Moreover, MM-users made fewer errors and successfully recovered from errors more frequently. No conclusion can be drawn with regard to the performance on the transfer items since 10 SS-subjects did not process these items (cf. the original experiment of Carroll *et al.*, 1987).

Our findings thus confirm *all* of the results of Carroll *et al.* (1987), supporting the strengths of the minimalist approach. In addition, they also justify the conclusion that our "translation" of Carroll's minimalist principles into more detailed design-oriented guidelines (see also Van der Meij, 1992; Van der Meij & Lazonder, 1992) lead to the construction of a true MM.

Surprisingly, the results do not support the second hypothesis. The MM did not increase the subjects' motivation more than the SS did. This may have to do with the overwhelming nature of the subjects' first experience with a word processor. To novice users, WordPerfect may seem a wonderful tool for creating, editing and formatting text. Casual observations during the experiment support this stance: subjects were thrilled by the (graphical) options of WordPerfect and by their laser-printed texts. Another explanation is that MM-users liked some, but not all, minimalist design characteristics. For example, they may think positively of error-recovery information, but, at the same time, dislike the "learning by doing" approach prompted in the "Do it yourself" sections.

The most important finding with regard to computer experience is that it did *not* interact with manual type. Apparently, the MM has a similar positive effect on novices, beginners and intermediates. In view of the general increase of computer experience, this is an important additional sign of the strength of the minimalist approach.

Computer experience did affect the speed and quality with which the subjects learned to use the word processor. For example, novices needed significantly more time, and they were less successful and less efficient for retention items than beginners or intermediates. In addition, they were less capable of recovering from errors and had lower efficiency scores for transfer items.

Somewhat surprisingly, the novices showed the highest gains in self-confidence. This speaks favorably of the quality of the program and the two manuals, but it is unclear why this is so. Do the novices not yet see the more complex problems that lie ahead? Likewise, it is unclear why intermediates had significantly higher relevance gains than novices or beginners.

Discussion

Whereas this study confirms the functionality of the minimalist approach, little is yet known about how the minimalist principles work. Future research should therefore aim to study minimalism in depth and in breadth.

IN-DEPTH EXPANSIONS

With two exceptions, research has concentrated on how *all* minimalist principles affect performance. Gong and Elkerton (1990) studied the effect of including error-recovery information in two types of manuals (an MM and an SS). They found that the error-recovery information helped to prevent errors. In addition, it speeded up the time subjects needed to complete the transfer tasks. Black, Carroll and McGuigan (1987), who compared four manuals to examine the effect of adequate use of text, found that the amount of text correlated positively to learning time and test time. Subjects who had less to read completed their training and test faster. Both studies thus showed facilitative effects of a single minimalist principle. In future, such work should be continued in order to increase our understanding of the operation of distinct minimalist principles, and to give insights into *how* these principles help people learn from (minimalist) documentation. Knowing how people use a manual (and how they learn from that) is fundamental to knowing how manuals may meet users' learning styles and preferences.

In-depth extensions might also start from a rational perspective. The minimalist philosophy was originally derived from observations of first-time computer users. Due to this empirical approach, some relevant user-characteristics may have been overlooked. By contrasting the minimalist approach with theories of learning and instruction, principles possibly omitted by the original observations can be uncovered. For example, behavioristic learning theories, and the literature on guided discovery learning and human–computer interaction, give insight into how users deal with errors. This knowledge might point to new directions for designing error-recovery information.

IN-BREADTH EXPANSIONS

It is important to expand the suitability of the minimalist approach to different levels of expertise and user groups. Research has traditionally focused on initial skill learning, the area for which the MM was originally designed. It is not self-evident that MM-subjects are better equipped to learn the more advanced word processing procedures than subjects trained with a conventional manual. Some authors have even argued that such a transfer is hampered when too much emphasis is put (too early) on the development of procedural skills (e.g. Jelsma, Van Merriënboer & Bijlstra, 1990). Would this also be the case for MM-subjects? Research has yet to address this important issue.

The present study shows that computer experience has a significant effect on learning and test performance. What it does *not* tell is how this experience affects the processing of an MM. More experienced users are likely to activate other (computer) prior knowledge and thus have different learning needs (Schriver, Hayes & Langston, 1986). Since the MM capitalizes on exploiting the subjects' prior knowledge and needs, the effects on novice and more experienced users are bound to differ.

The MM is not one of the most attractive manuals that we have come across. Although Carroll and his co-workers have addressed some issues of lay-out and typography, their attention to it has been minimal. This is unfortunate because it tends to lead to a separation of content and presentation. By linking the two, other ways to operationalize the minimalist principles come into view. For example, attempts are being made to construct a manual that "slashes the verbiage" by substituting nearly all text by illustrations. In this, and other ways, the operationalizations of good design principles are a continuous challenge for research on documentation in the nineties.

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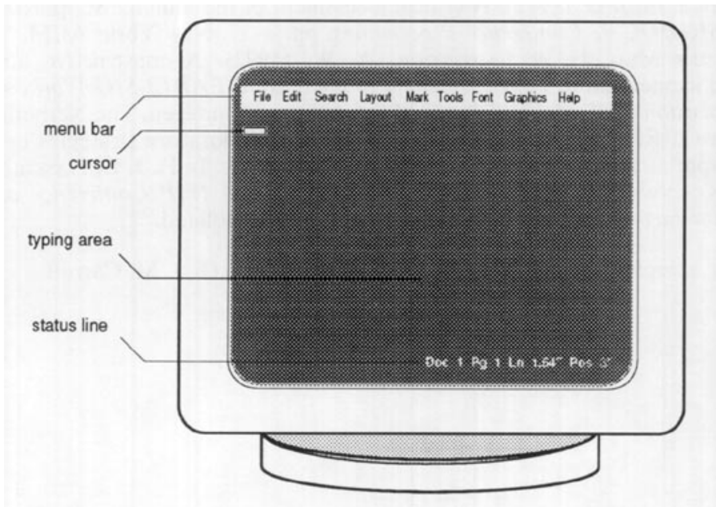
Appendix 1: exemplary pages of the experimental manuals

THE MINIMAL MANUAL

2. *Typing*

The typing area

You type your documents in the typing area.



The short line that is brightened on the screen is called the cursor. It marks where the next letter you type will appear. If you type the cursor moves to the right. The cursor tells you 'where you are'.

Typing a text

- Type the text below. Do *not* press the ENTER key and try *not* to correct typos. See what happens.

> Saturday September the 14th the basketball club "'Dunk'68" will be collecting old paper. The profits of this action will be used to buy new shirts for our junior members. We hope that you cooperate. Could you please put the old paper on your doorstep before 9 a.m.? We thank you for your help!

Saving a text

If you end WordPerfect now your text will be lost forever. To prevent this, you must save your text so that you may use it later.

- Go to the menu bar by pressing the ALT key.
- Press the ↓ key.
- Press the ↓ key until you reach the command SAVE.
- Press the ENTER key.

If you have chosen a wrong command **and** *you have pressed the ENTER key, then you can correct this by pressing the F7 key.*

You must give your file (your text) a name. Under that name you can always find the text. To prevent confusion you should give each file a separate name.

Check if the following message appears on the screen: **Document to be saved:**

- Type the name DUNK68.WP

It does not matter whether you use capitals or small print.

Typos can be corrected by pressing the BACKSPACE key. Then type the correct text.

- Press the ENTER key.

The lamp near the diskette brightens and you will hear a humming sound. WordPerfect saves the file.

See if the text **A:\DUNK68.WP** appears on the screen. WordPerfect then has saved the file.

THE STANDARD SELF-INSTRUCTION MANUAL

2.4 Creating a document

You can now start to type and save a simple text. In principle, any text will do, but it may be advantageous for first-time users to type the letter below and to follow the steps in making this letter.

Some advice in advance: you can correct typos with [BACKSPACE] (located on the upper right of the typing area of the keyboard). This will move the cursor backwards one position and delete the last letter.

The letter that you are about to type will closely resemble this figure .

J. Roberts
1a Rubidoux Ave
Riverside, CA 92506

September 2, 1991

Dear mister Roberts,

I am at the end of my wits. My whole family has adviced me to buy a computer and type my letters with a textprocessor. It would save me lots of time. Unfortunately, this is not the case. In fact I have never had so little sleep in my whole life. I want to learn how to use my textprocessor but I don't understand anything. I press the wrong keys and sometimes I wipe out what I have been typing in the evening.
To be frank, I'd rather go back to my good old typewriter, but I cannot stand not understanding. I am getting impatient, almost to the point of throwing the computer out of my window. My wife complaints about my bad temper. What I am to do? Please help!

E. Tyler

Figure 2.1 Sample Letter

If you have started the program and the screen is empty you may start to type the letter. You begin with typing the letterhead. Each line of text must be closed with [ENTER]

1 Type **J.Roberts** followed by [ENTER]
2 Type **1a Rubidoux Ave** followed by [ENTER]
3 Type **Riverside, CA 92506** followed by [ENTER]

You should now make some white lines. Trying to moving the cursor down with the [↓] key will not work.The reason is that the cursor can reach only places with 'text'.

4 Press three times on [ENTER]

What happens now is that you create *hard returns* that are codes for 'go to the next line'. After the letterhead you start typing the date and opening.

1 Type **September 2, 1991**
2 Press several times on [ENTER]
3 Type **Dear mister Roberts**, followed by [ENTER]

Again press several times on [ENTER] and then type the first paragraph of the letter. Finish typing the entire paragraph and then press [ENTER] again. The program takes care of the line transport within paragraphs. At the end of each line it automatically places a *soft return*. Soft means that it has been put there by the program. The nice thing about these soft returns is that they are automatically adapted or removed when necessary.

You should use [ENTER] only in the following cases:

- to end a line of text that you don't want to be filled completely;
- to insert a new white line;
- to close a paragraph.

You may now finish typing the letter. Type the second paragraph and ending as indicated in Figure 2.1.

2.5 Saving a file

The text on your screen is in what is called the working memory of the computer. If you were to shut down the computer now your text would be lost. What you have to do, therefore, is to copy the text from the working memory of the computer to your diskette. In WordPerfect this is called saving.

The following terms are important when saving a file:

File

This is the general name for everything that you save on a diskette or a hard disc: programs, macros, games and so on. Instead of the word file WordPerfect also uses the word document occasionally.

Directory

A directory is the storage place for files. It can be a section of the hard disk or diskette that has its own name. In paragraph 2.3 you already saw that all WordPerfect files are stored in the directory A:\ .

To save your file take the following steps:

1 Press [ALT].
2 Press [↓], until you reach the command SAVE.
3 Press [ENTER].

On the status line you will see the following instruction: **Document to be saved:**

You should fill in the name of your file here. This name is the index with which you can find your text back later on.

Please Note: There are important rules for naming a file. The most elementary ones are the following:

Appendix 2: motivational questionnaires

INITIAL MOTIVATION

Relevance ($\alpha = 0{\cdot}77$)

1. I type my letters, memos, reports and the like.
2. I pay attention to the lay-out of letters, memos, reports and the like.
3. I type or write official letters.
4. Having one's own computer is useful.
5. I find it important that my letters, memos, reports and the like look fine.
6. There is no need to type letters, memos, reports and the like.
7. I write official letters.
8. I would buy a computer if I had the money.
9. I will need to do a lot of typing this year.
10. At the utmost I will be preparing two reports this year.

Curiosity ($\alpha = 0{\cdot}84$)

1. I read about computers.
2. I am fascinated by modern technology.
3. I want to know how technical apparatuses work.
4. I pay attention to technology.
5. Technical developments fascinate me.
6. I am absolutely not interested in how technical apparatuses work.
7. I am interested in computers.
8. I find it important to keep in touch with technological developments.

Reference group ($\alpha = 0{\cdot}70$)

1. I know many people who own a computer.
2. My relatives, friends and acquaintances are interested in computers.
3. The people that I know are fascinated with computers.
4. My relatives, friends and acquaintances own a computer.

Confidence/prior knowledge ($\alpha = 0{\cdot}91$)

1. I find it difficult to learn how to operate a technical apparatus.
2. I know almost nothing about technical apparatuses.
3. I quickly understand how technical apparatuses work.
4. I can easily handle technical apparatuses.
5. My friends are better at handling technical equipment than me.
6. Compared with the people that I know I am handy with technical apparatuses.
7. I quickly know how a technical apparatus works.
8. It takes me a long time before I understand how to use a technical apparatus.
9. I cannot handle technical apparatuses very well.

Persistence ($\alpha = 0{\cdot}77$)

1. When I am having a problem, I keep working on it until it is solved.
2. I finish what I start.
3. If I cannot solve a problem quickly, I will leave it be.
4. If I start something it does not mean that I will also finish it.

MOTIVATION AFTER TRAINING

Satisfaction ($\alpha = 0{\cdot}81$)

1. I like textprocessing.
2. I find working with WordPerfect stimulating.
3. Textprocessing is boring.
4. It didn't come easy today.
5. It took me longer to learn WordPerfect than I expected.
6. My knowledge of WordPerfect is very useful.
7. I get annoyed from textprocessing.
8. Textprocessing is unpleasant.
9. Textprocessing is frustrating.
10. Textprocessing is scary.

Confidence ($\alpha = 0{\cdot}85$)

1. Now I know how to use a textprocessor.
2. WordPerfect is difficult.
3. I find it scary to work with the computer.
4. I find textprocessing scary.
5. Now I can do my textprocessing without help.
6. I feel that I can work well with WordPerfect.
7. Textprocessing is simple.
8. I am confident with regard to textprocessing.

Relevance ($\alpha = 0{\cdot}78$)

1. Textprocessors are handy.
2. My knowledge of WordPerfect comes in handy for my study, work or hobby.
3. I would rather type my letters, memos, reports and the like on a typewriter than with a textprocessor.
4. I don't think that I will be using WordPerfect shortly.
5. I would like to use WordPerfect as quickly as possible.

Attention ($\alpha = 0{\cdot}73$)

1. The manual directs your attention to important things.
2. The manual gives good cues.
3. The manual gave good suggestions what to look for.