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CUSTOMER SETUP OF THE NCR PC-8 PERSONAL COMPUTER: A CASE STUDY

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Two University of Michigan engineers were videotaped and timed as they collaborated in setting up an NCR PC-8, a personal computer, based on the Intel 80286 processor. Their dialog, a result of the subjects-in-tandem method used here, identified weaknesses in the current setup procedure.

In the first of two sessions, participants unpacked the system unit, then unpacked and installed the keyboard, graphics card, RAM expansion, co-processor, and display. After an hour and a half, they gave up when they were unable to install the 360K floppy drive.

After NCR field engineers spent a day and a half completing installation of the floppy, running the diagnostics, and running the fdisk program, the participants returned. Participants spent another hour and a half unpacking the tilt and swivel mechanism, installing the feet, checking the key lock, running the demonstration program, duplicating a DOS disk, setting up the hard disk, and copying files to it.

Problems were noted in five areas--(1) packaging (unlabeled boxes, no unpacking instructions on boxes, loose parts in easily missed side compartments, no easy way to grasp and remove the cabinet); (2) hardware (no names on parts, no embedded assembly instructions); (3) documentation (not well integrated, confusing use of multiple languages, lack of illustrations, vague text--especially for the disk drive); (4) software (missed opportunities to use batch files); and (5) tools (IC puller and inserter not provided). Many changes are suggested to solve these problems. Once these changes are made, the setup of modified PC-8 should be timed.

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PREFACE

The history of this project shows how gifts to support university research can directly benefit the industrial sponsor. In the fall of 1985 Gary Wagner (NCR Corporate R&D) attended the Human Factors Society Annual Meeting where I presented a paper on the Wizard of Oz rapid prototyper (Green and Wei-Haas, 1985). Discussion of that work led to a visit to the University of Michigan and a gift to the UMTRI Human Factors Division. The gift included research funds, two NCR PC-8 personal computers, and a laser printer. The PC-8's were delivered early in January of 1986, the laser printer arrived about a month later.

The gift was part of an effort to strengthen NCR's ties with universities working on human factors problems and support research on software for evaluating user interfaces. Of particular interest was the Wizard of Oz software.

When the computers arrived, I thought it would be interesting to observe some people setting them up. I had an academic interest in a method often used for that purpose (subjects-in-tandem), though I knew NCR would find the product-specific data useful. I guessed NCR had not done empiric tests of setup and suspected there would be some difficulties. Further, the NCR support had been helpful to us, and we wanted to do something of immediate benefit to NCR in return.

The subjects-in-tandem method used in this experiment involves having two people collaborate to solve a problem. As a natural part of their discussion, participants identify where they are having difficulty and why. Despite its wide use, methodological factors (e.g., two versus three people, the extent of prior collaboration, personality types, etc.) had not been systematically investigated.

As suspected, the PC-8 had setup problems. Shortly after we began setting up the PC-8s, I received a call from Gary Wagner expressing great interest in our little experiment, causing our priorities to shift. The PC-8 had just been reviewed in InfoWorld magazine, and the review was not favorable. The part of the article central to this effort is quoted below. A complete copy of that article (Crabb, 1985) is in Appendix A.

> SETUP: Unpacking the NCR PC8 will test the patience of most users. Our test unit came in five separate boxes, each with enough packing material to protect the contents from any conceivable damage. It took us more than an hour just to open all the boxes and figure out what component was contained in each box.
>
> Setting up the PC8 is even more frustrating. The setup instructions are written in five languages: they are difficult to follow in any of them. Each component comes with separate instructions, making

> them that much easier to replace. NCR attempts to consolidate information about setting up the PC8 in a Getting Started booklet, but the information is far too general to be helpful.
>
> We had to ready the hard disk for use and install the graphics adapter board in our test unit before we could power up the machine. We'd expect those procedures to take 15 minutes; instead, we spent more than an hour. The problem starts when you have to remove the top of the system unit. We practically tore off a finger trying to get the cover off of the box. After you've removed the top, you're faced with the task of locating the necessary jumpers on the main circuit board. The documentation for this search is woefully inadequate. It lacks decent illustrations, and the text doesn't do a satisfactory job of explaining the procedures. After removing the disk controller board, we finally found the jumpers we needed to check and set. After working at this for several hours, we finally had everything connected and configured.
>
> Overall, setup was a frustrating and disappointing experience. If you purchase a PC8, you might want to hire your dealer to do the setup for you, especially if you've purchased a number of options.

After I reviewed the videotapes of us setting up a PC-8, I sent NCR copies of the tapes and accompanying letters describing the difficulties we had (Green, 1986a,b). In response, the Personal Computer Division issued a purchase order for this more formal report. Some of the findings described here were conveyed to NCR at the recent briefing in Clemson (Green, 1986c).

INTRODUCTION

This experiment is an application of the subjects-in-tandem procedure for investigating the efficiency of a process such as setting up a personal computer. Its purpose was to identify problems customers might have with the packaging, hardware, software, or documentation while setting up an NCR PC-8. At both IBM and DEC (and possibly other companies as well), tests of this type are normally carried out during the development of any product installed by customers. These tests were not conducted by NCR, because the original plan called for the PC-8 to be installed by NCR field engineers.

The subjects-in-tandem method involves two or more people collaborating on a project. Their conversation reveals their understanding and misconceptions concerning the hardware, software, and documentation, thus suggesting how the product might be made easier to set up. For example:

1. "What do we do next?"

2. "Well, here in the user's guide manual it says to install this card, but the instruction sheet makes me think we should install these chips. What do you think?"

The method is quite natural. It is non-intrusive and an approach people normally take for solving problems, especially those associated with computers. Further, this method makes the problems that ordinary users experience more apparent, revealing problems that designers miss because they know the product so well.

In one of the first published accounts describing the method, Comstock (1983a) provides detailed recommendations concerning test protocols, based on her experience with prototypes of the Rainbow computer and other products. She advocates the use of videotaping, of using people who have worked together before, and of being sure to record their conversation. Readers interested in additional details should read her paper.

Even better known than her paper is the videotape associated with it ("How to Insert a Diskette into a Diskette Drive," Comstock, 1983b). The tape shows two financial analysts, Candy and Donna, contending with what should be a simple problem. In one sequence, they read an instruction to remove the disk from the envelope. Having already removed it but not realizing they did, they believe the envelope to be the cardboard carrier surrounding the mylar disk, and begin to open it. In a later sequence, they are unable to find the disk drive door, so they insert the disk into a gap between the drive housing and the bezel, losing the disk.

Lewis (1982) also provides some suggestions concerning implementation, based on his work in the IBM Entry Systems (PC) Division, though his paper is not nearly as substantive as that of Comstock. Another well-known example of the method was provided by John Seely Brown in his plenary address at the CHI'83 meeting. Unfortunately, his videotape of people struggling to use a copier is not publicly available.

Subjects-in-tandem is an alternative to the thinking-aloud method (Lewis and Mack, 1981). In thinking aloud, people are tested individually and, as they work, are asked to verbalize what they are doing and why. When they fall silent, they are questioned by an observer. ("Why did you do that?") While thinking aloud provides insight into the participant's thought processes, the intrusions can interfere with what the participant is trying to do and invariably alter task times.

TEST PLAN

Test Participants

Two members of the UMTRI Human Factors Division attempted to assemble a PC-8. Paul, the author of this report, is a 35-year-old scientist in the Division and an assistant professor of industrial engineering. He has a B.S. in mechanical engineering, masters degrees in both industrial engineering and psychology, and a joint Ph.D. in both. He has some knowledge of electronics, having put together a Heathkit H-8 8080-based computer and an H-9 video terminal by himself. He has had an IBM XT in his office and an IBM PC at home for several years. He has installed cards and replaced chips in both computers. Paul has written programs in PL/C, FORTRAN, PDP-1 assembler, and CRASH, and is a skilled BASIC programmer. He does most of his writing on his XT, using Vedit, and is familiar with most of the common software available for the Macintosh (MacWrite, MacPaint, MacDraw, etc.).

Don, who works with Paul, is a 22-year-old graduate student in industrial engineering at the University of Michigan. (His undergraduate work was also in industrial engineering.) Don has some experience with computer software, having written programs in FORTRAN and BASIC, and has used application packages such as Symphony and Vedit, along with most of the general-purpose software available for the Macintosh. Don's interests are in engineering economy and operations research.

Equipment and Materials

Participants assembled a fairly complete NCR PC-8 (an IBM AT clone based on the Intel 80286 processor). Assemblies were shipped in five boxes that contained parts for two PC-8 computers. When fully assembled, each computer had 640K on the motherboard, a 20 megabyte hard disk drive, a 360K floppy drive, a serial/parallel adapter card, a graphic display controller card, a keyboard, and a color display. (See Appendix B for the NCR model numbers.)

Two of the boxes each contained one system unit (with 512K on the motherboard, a CDC Wren model 1 20 megabyte 5-1/4 inch hard disk drive, 1.2 megabyte 5-1/4 inch floppy (flex) drive, and serial-parallel adapter card all installed). Also in each box was a see-through bag containing miscellaneous items (reversible blade screwdriver, disk drive mounting slides, felt feet for the system unit), a box labeled "documentation" containing the Owner's, DOS, and BASIC manuals, a box containing the keyboard, and a power cord.

Two other boxes marked "color display" contained the display hardware. In each was an NCR 14-inch color monitor, an NCR Graphic CRT Controller card, and "kit" instructions ("owner's manuals") for each item. A graphics memory upgrade was installed on the card.

Finally, the fifth box contained numerous miscellaneous parts, each packed in its own box. Included were two tilt and swivel bases for the monitors, two 128K RAM upgrades, two 80287 internal arithmetic co-processors, two 360K 5-1/4 inch floppy (flex) disk drives with headload, two vertical mounts, and two display kits (3-meter video and power cables). Also in this box were at least four sets of RS-232 communications cables, parallel printer cables, and serial cable converters (DB-9 to DB-25). In the test reported here, the vertical mounts and cables were not installed.

Performance was recorded using a 1/2-inch VHS video system. It included a Sony S-100 camera, Panasonic NV-8410 portable recorder, Thalner Electronics Laboratories model TD-426P time and date generator, and Panasonic BT-S700N 9-inch NTSC format color monitor. The date/time generator output (displayed to the nearest 1/10 of a second) was superimposed on the scene being taped and was recorded with it. All video equipment was mounted on a wheeled tripod, and the monitor was facing the participants, so they could see the camera's field of view.

Test Activities and Their Sequence

Participants were videotaped while setting up an NCR PC-8 using the "subjects-in-tandem" method described earlier. All testing was carried out in room 337 at the University of Michigan Transportation Research Institute. A well-lit 15 x 15 foot open area was used for tests, with assembly taking place on a standard 60-inch desk in the center of the work area. On a few occasions where it was unclear what the participants were doing, the camera operator asked them for an explanation.

There were three work periods in this experiment. In the first, the two test participants cooperated in setting up a PC-8, discussing problems as they went. The first and third sessions were recorded on videotape. Activities taking place during the first session included unpacking the system shipping box, removing and installing the keyboard, installing the 128K RAM upgrade and 80287 co-processor, installing the display adapter card, and attempting to install a 360K floppy drive (Green, Ottens, and Reifeis, 1986). The session ended after an hour and a half when the participants were unable to install the disk drive.

In the second work period (for which no data were collected), two NCR field engineers (Norm Cook and Sam Griffith) tried to install the 360K drive. Both spent 1/2 day on it without success. Sam subsequently returned and spent an additional 1/2 day completing installation of the disk drive and installing some of the system software. The field engineers had not received specific training on the PC-8, though they had experience with other similar products. Because the PC-8 was a gift, the NCR procedure to identify training needs for its field engineers had not been triggered.

In the third session, the two subjects installed the display monitor base, put the felt feet on the cabinet, checked the key lock, copied a DOS disk, formatted the hard disk, installed DOS, and copied system and utility files from a floppy disk to the hard disk. That session lasted an hour and a half, and was recorded on videotape (Green, Ottens, and Krusic, 1986).

RESULTS AND DISCUSSION

The results reported here are based upon the videotapes. Readers interested in details beyond those reported here should view the two previously mentioned videotapes.

First Videotape – Hardware Unpacking and Installation

Overall, setup of the PC-8 was a very time-consuming and unpleasant experience. The knowledgeable participants in this experiment were unable to complete it and had to call in NCR field engineers for assistance. In fact, even the NCR engineers had trouble and had to call for help.

As was noted earlier, the first session included all of the tasks associated with setting up a complete system, up to installing a 360K floppy drive. A summary of the session is shown in Table 1. Almost 1/3 of the time (29 minutes) was spent attempting to install a floppy drive, a task which was never completed, and another 18 minutes was spent installing the graphics card. Even installing the co-processor, just one chip, took eight minutes. Much of the hour-and-a-half was spent trying to figure out (unsuccessfully) what to do.

Problems were encountered in virtually every task, as described in the section that follows. For each task, a listing of the activities is provided along with a commentary.

The initial step in setting up the PC-8 was to unpack it. (See Table 2 for the time data.) The first problem faced was deciding which box to unpack. There was no "open me first" label, and for several of the boxes, no labels identifying their contents. The smallest box was opened first because it looked like it might contain manuals and setup instructions. After opening it, removing the manuals, and finding out what they were, the manuals were put back in the box, because they were the wrong ones. About 2-1/2 minutes were wasted doing this.

Since the general assembly instructions couldn't be found, setup proceeded without them. The participants guessed the system unit should be assembled first. Consequently, the heaviest box was opened next, since the system units are usually quite heavy. In fact, the box was so heavy it was best handled by two people, but there were no instructions suggesting that two people should be considered.

At that point there was a delay of 1 minute and 15 seconds in which the participants identified themselves on the tape, something obviously not required during the normal setup procedure, but required for the videotape.

TABLE 1

SESSION 1 SUMMARY

Task	Duration (min:sec)
Unpack the PC-8	13:10
Unpack & Install Keyboard	8:00
Unpack & Install Display	5:50
Install Graphics Card	18:40
Unpack Options	7:00
Unpack & Install Co-processor	8:00
Install 128K RAM Upgrade	8:20
Unpack Floppy & Attempt Installation	29:00
Total (1 hour, 38 minutes)	98:00

Final state: Assembly incomplete, computer not usable, need to call NCR field engineer.

In the absence of any instructions on opening the large shipping box, it was opened where it was taped shut. Language (such as, "this side up") along with the more traditional symbolic arrows (which may be thought of as decoration but are needed for the international market) would have been helpful. Upon opening the box, another box labeled "documentation" was discovered, along with the keyboard box, a spacer, and the power cord. It wasn't obvious how to open the long documentation box. (Again, there were no instructions). Still hoping to find the assembly instructions, the participants opened the documentation box. Inside it were the DOS, BASIC, and Owner's manual. The participants guessed that of those three, the most likely place for the assembly instructions would be in the Owner's manual. (The DOS manual was a second choice.) Ten minutes into the setup process, the first set of instructions was found.

Thus subjects had to go through many steps to find the instructions for getting started: guessing which shipping box they might be in, opening it, emptying it, repacking it when it was realized the wrong box was opened, opening a second unlabeled box, finding a box inside labeled "documentation," assuming that the desired information might be inside,

TABLE 2

UNPACKING THE PC-8

End Time H: M: S	Activity
	Examine documentation box (2 minutes, 30 seconds) ??:??, Introduce selves, look for scissors, show equipment (about 2 minutes, not clocked)
0:00:00	start timer
0:00:40	find scissors
0:01:35	get & open small documentation box
0:02:00	remove manuals from box
0:02:30	put manuals back in box
	unpack big box with PC-8 in it (10:40)
0:02:45	start to get PC-8 box, try to lift
0:03:45	introduce selves (& give PC experience)
0:03:50	pick up big shipping box (with PC-8 in it)
0:04:15	read labels
0:04:50	open box (guessed which side is top)
	"Oh, here's the documentation."
0:05:05	remove the long documentation box, keyboard, & spacer
	how do we get PC-8 out of box? need 2 people to figure out, need lots of work space, no instructions or pictures, toss shipping box aside
0:06:00	tilt box on side, need grips to slide out of big box, check box weight, it's heavy
0:06:30	which side to open PC-8 box?
0:07:25	cut & open box
0:07:40	found & remove – screwdriver, miscellaneous items, cord
0:08:00	found installation report, read and discarded it

TABLE 2 (continued)

End Time H: M: S	Activity
0:08:20	found instruction on box to read "getting started"
0:08:30	found and got long documentation box
	how do you open the long documentation box?
0:09:00	open long documentation box (found DOS, BASIC, owner's manual)
0:09:50	where is getting started? probably in the owner's manual, found it! open shrink wrap
0:10:40	skim "getting started", not useful—too superficial
	how do you turn the box to pull out the PC-8? which side is up? why isn't there a diagram? hard to get fingers in to pull out PC-8
0:11:40	take PC-8 from box: PC-8 fell down—pull from underneath
	which side is up? which is the front?
0:12:00	flip system box (cabinet) over (was upside down)
0:12:50	untape bag
0:13:10	take cabinet out of bag
13:10	Total

Note: The time shown for each activity is the time at which it ended. The start time for each activity is the end time for the previous one. Thus the activity "put manuals back in box" took 30 seconds (2:30 − 2:00).

finding three slip cases inside the "documentation" box containing manuals and, finally, guessing (correctly) which one might contain the desired instructions. Of course, this entire search was based on the assumption there were setup instructions. After all of that effort, the instructions ("Getting Started") found were very superficial.

While it was not as time-consuming, removing the PC-8 cabinet from its shipping box was not easy. The current design of the foam packing does not provide for clearance for the customer to grasp the cabinet. In this experiment the box was tilted and the

participants managed to slide out the cabinet. In the process, the cabinet dropped a few inches on to the desk.

The next task, associated with unpacking and installing the keyboard, took just over seven minutes, of which two minutes were spent checking the non-keyboard-specific documentation. Still, this is far longer than such a simple operation should take. (See Table 3.) Most of the time was spent trying to solve problems (e.g., what the keytips are, which step to do next, which position the switch was in, aligning the keyboard plug, etc.) and not in productive assembly. Labeling the parts and integrating the keyboard kit instructions into the "getting started" manual would sharply reduce this time.

The next task was to unpack the display, a task that took almost four minutes. The subsequent step, attaching the cables to the video display, took just under two minutes. Time data from both steps are shown in Table 4.

Removing the display from its box was quite easy because there was ample room to reach it. It is possible to miss the power cord, because it is packed between the foam and the side of the box. Placing the cord beneath the top flap might be a better choice. To reduce opportunities for error, it would have been wise to label the cable guide and the cable ends.

Installing the graphics card was much more difficult that it should have been. That task took 18 minutes and 40 seconds, but should have taken only 5 minutes. (See Table 5.) As with all phases of setup, there was a problem in determining what to do next. This problem occurred because there were multiple sets of instructions (Getting Started, the Installing Options chapter in the Owner's Manual, and kit instructions) and was never clear which documents one should be reading and in what order. The graphic CRT controller card was referred to in several ways (graphic controller card, monitor controller card, graphics display adapter board), which was confusing. Further, multiple languages, the lack of illustrations, and vague text made the documentation difficult to follow. (See Figure 1.)

Removing the display card from its shipping carton was easy, but determining whether it was properly configured was not. The instructions then called for checking if the card jumpers were open or closed. This took about three minutes, but should have taken no more than 30 seconds. A detailed illustration of the jumpers was not provided, and it was not immediately obvious to the participants what the open or closed positions looked like.

TABLE 3

UNPACKING AND INSTALLING KEYBOARD

Ed Time H: M: S	Activity
0:13:30	read "getting started"
0:13:40	get keyboard
0:14:00	remove keyboard from box put box aside, read "getting started"
0:14:50	get reference chart read "getting started", check if manual is present
0:16:10	found DOS manual, open & check it
0:16:45	put DOS manual aside
0:17:00	check BASIC manual, open, then put manuals aside
0:18:00	keytip char – what are keytips? comment to check out display adapter, where is it? should be comment about installing option in box
0:18:50	trying to decide what's next, decide to install keyboard, have kit documentation, mode switch on keyboard not labeled, how do you slide it? what tool? comment about white mark, back not taken off
0:20:10	plug in keyboard wrong—should not take off back, no info on back to orient keyboard plug (just pins inside)
0:21:10	read instruction & plug in keyboard, keyboard ready
8:00	Total

Installing the display card required opening the cabinet. The participants struggled a bit trying to remove the plastic back panel, because there was no place to grasp it. Removing the top was even more difficult. While an illustration was provided showing which screws to remove, it was still difficult to identify the appropriate ones, because there are so many on the cabinet back. Labeling the cabinet back to indicate which screws to remove would have helped. This would save about two minutes.

TABLE 4

UNPACKING AND INSTALLING DISPLAY

End Time H: M: S	Activity
	Remove Display from the Box (3:50)
0:21:40	get display box
0:22:00	open display box—it's labeled "color display"
0:22:30	found shipper (bill of lading) for this shipment, why wasn't it attached to CPU box?
0:23:00	remove and read bill of lading
0:23:20	found and remove "graphics controller board – 32K"
0:23:30	how do you get the display out?
0:23:50	tilt box
0:24:10	remove display & foam cables and documentation sandwiched between foam and side of box—might have been missed
0:24:40	remove foam from display sides
0:25:00	take plastic off
	Attach Cables (2:00)
0:25:10	found display owner's manual (kit instructions)
0:25:20	cable guide unlabeled– needs one – "What's this thing?"
0:26:00	trying to decipher multilingual instructions, basically ignored them
0:26:20	what's next? cables
0:27:00	plug in cable Don: which is signal cable? label cable ends as "display" and "PC"
5:50	Total

TABLE 5

INSTALLING GRAPHICS CARD

End Time H: M: S	Activity
0:27:30	open graphics card box and remove card
0:27:50	read instructions, what's next?
0:28:50	remove graphics card from box
0:29:00	found kit instructions
0:29:50	read kit instructions where is jumper 1? what is open?
0:31:15	trying to figure out where J1 is on card & if set properly
0:31:30	working on jumper 3—unusual design
0:32:20	show problem with jumper to camera
0:33:40	go to installing options chapter in "getting started," questions about expansion ICs
0:34:30	read installing options – Is it ready to use? no, skim over lots of material in chapter
0:35:20	what's next?
0:36:00	get screwdriver to open cabinet (didn't realize NCR tool was supplied)
0:37:00	read & remove pink sheet over fan (doesn't say to remove) missing screw on back in center, still looking for screwdriver
0:39:00	figure out which back panel screws to remove, they are not labeled
0:39:30	remove screws—where do you put them?
0:40:40	remove top from cabinet, where do you grab back to slide off top? what's attached to what? illustration is needed, graphics card=adapter board—different terms
0:42:40	reading instructions to determine in which slot the graphics card goes (installing options chapter)
0:43:25	found keys, cut cable tie to remove (need bigger tie to fit in scissors) hard to cut

TABLE 5 (continued)

End Time H: M: S	Activity
0:44:30	remove blanking plate (no caution about screw falling on motherboard), blanking plate was bent
0:45:00	insert graphics card
0:45:40	screw in blanking plate for graphics card, board is in
18:40	Total

It also wasn't clear how the top, front, and base were fastened to each other, or which way to push the top to release it. The tight fit of the parts made removal even more difficult. Both an illustration and some place to grasp the bottom would have saved about a minute in this experiment.

There were no problems with insertion of the graphics card other than some confusion about which slot it should go into. A remark about slot choice is provided somewhere in the instructions, but it appears too early to be remembered.

Participants were unsure if the correct card was provided, because it didn't have a name on it. (They were also unsure if the factory-installed daughter board was the serial/parallel adapter. It was.)

The next sequence of steps involved finding and unpacking the options to be installed in the main cabinet. (See Table 6.) A large fraction of the time was spent figuring out what the next step was. Again, this problem resulted from the multiple pieces of documentation being used.

Installing the co-processor, a task that consists of removing a socket cap and installing one chip, took eight minutes (See Table 7). As with the previous tasks, there were problems with understanding the instructions (and which instructions to follow) as well as a lack of illustrations showing where pieces go and how to install them. Also lacking were tools for removing and inserting integrated circuits.

The 128K RAM upgrade took 8 minutes and 20 seconds to install. Here the instructions were reasonably good. However, of that time, about 2-1/2 minutes were wasted removing and then re-installing the graphics display board (See Table 8). The

Graphics Controller
Grafik-Controller
Contrôleur graphique
Governo Grafica
Controlador de Graficos

This board is intended for use with the integrated CRT of the NCR PC 4i, or other compatible CRTs.

Diese Platine ist für den Anschluß des eingebauten Bildschirms des NCR PC 4i und von anderen kompatiblen Bildschirmen vorgesehen.

Cette carte est destinée au PC 4i NCR équipé d'un écran intégré ou d'un autre tube compatible.

Questa piastra viene utilizzata con i video integrati del PC 4i NCR, o altri video compatibili.

Esta tarjeta está destinada para su uso con el tubo de rayos catódicos (TRC) integrado del Ordenador Personal NCR 4i u otros tubos de rayos catódicos compatibles.

1. Review the "Installing Options" chapter of your Owner's Manual to prepare and perform the installation.

   Lesen Sie zur Vorbereitung und Durchführung der Installation im Kapitel "Installation" Ihres Benutzer-Handbuchs nach.

   Pour effectuer cette opération, consultez le chapitre "Mise en place des options" du Manuel de l'Utilisateur.

   Rivedere il capitolo "Installazione delle opzioni" nel Manuale Utente per preparare ed eseguire l'installazione.

   Consulte el capítulo "Instalación de opciones" del Manual del Usuario para preparar y llevar a cabo la instalación.

Figure 1. Sample page from display adapter documentation.

TABLE 6

UNPACKING OPTIONS

End Time H: M: S	Activity
	Decide What to Do Next (2:40)
0:47:30	decide what's next—options? back to getting started? open next box?
0:48:00	check voltage switch
0:48:20	decide what's next. more options to install. skipped over feet.
	Remove Options from Box (4:20)
0:48:35	get another unlabeled box (with options in it)
0:49:05	open box
0:50:50	empty box & see what's inside (cables, drives, RAM, co-processor, accessories). what are accessories?
0:51:25	put extra items for system 2 back in box.
0:51:50	open mystery box & look inside—has parallel cable. Don finds 128K RAM upgrade (looks like pack of matches).
0:52:40	open accessories package & find display cables, not sure what they're for, put aside.
7:00	Total

instructions should have said something about the order in which options should be installed.

Installing the floppy drive was an unsuccessful and frustrating 29-minute experience. Most of the time was spent trying to figure out what to do. (See Table 9.) Unpacking the drive was straightforward. Little else was. It was not clear whether one should rely on the kit instructions, or the installing options chapter in the owner's manual, or both. Consequently, one was constantly switching between them. Questions concerned where the jumpers should have gone, which drive was the last in the chain, which connector was for which drive, and which drive shouldn't have a terminating resistor.

TABLE 7

UNPACKING AND INSTALLING THE CO-PROCESSOR

End Time H: M: S	Activity
0:53:05	remove coprocessor from big box
0:53:40	read coprocessor instructions
0:54:10	find coprocessor socket—no diagram showing where it is
0:55:20	what's next? read instructions. what does it say about the jumper? look for chip puller (look in tool kit, other room)
0:56:10	NCR tools found, including screwdriver (but chip puller not included)
0:57:30	read instructions for co-processor, look at parts in plastic bag. which instructions should be followed? installing options chapter? kit instructions? need IC puller
0:59:00	figure out how to remove socket cap, then use blanking plate to do it
1:00:40	install chip. Don asks question about purpose & orientation of chip
8:00	Total

Even installing the slides for the disk drives was complicated. An instruction to install them was not found, and there was no mention of which package they were in. It was only a matter of luck the participants remembered seeing them earlier, since the instructions on the slides were covered by tape. Securing the screws was most confusing. There were six holes in each slide (fortunately labeled), two holes in the drive frame, but 2 sets of 2 screws (4 total). Only by trial and error was the correct combination found.

After the slides were installed, having spent an hour and a half and still not even installed the disk drive, the participants gave up and called NCR for help.

TABLE 8

INSTALLING THE 128K RAM UPGRADE

End Time H: M: S	Activity
1:03:45	read instructions and put in chips (instructions here are good). where does 128k RAM go? develop strategy. what order should the chips go in? farthest ones first? also examine board
1:04:50	blew it—put display board in first—remove board need more space to grip top and put in plates
1:06:50	install RAM chips (farthest in first)
1:07:15	put graphics card back in
1:08:15	fasten retaining screw (used wrong size screw first time) (and comment—don't let it fall in)
1:09:00	search instructions for information. where is co-processor switch? (configuration switch) decided there wasn't one. any other options?
8:20	Total

Second Videotape – Finishing Hardware Installation, Installing the Software

As was noted previously, no record was kept of the second session when the NCR field engineers installed the 360K drive, ran the diagnostics, and ran the FDISK program. However, in the third session, the two participants from the first one were again videotaped. Shown in Table 10 is a summary of the third session.

The largest fraction of time (almost 25 minutes of the hour-and-22 minute session) was spent copying files from the floppy disks. Other time-consuming tasks included preparing a DOS disk and formatting the hard drive (18 minutes, and 30 minutes, respectively). The duration of these tasks could have been considerably reduced had batch files been provided to carry them out.

Shown in Table 11 are the times associated with the first task of this session, unpacking and installing the tilt and swivel mechanism for the video monitor. This task

TABLE 9

ATTEMPTING TO INSTALL FLOPPY DRIVE

End Time H: M: S	Activity
1:09:30	what's next? put in floppy drive (check shipping list for information)
1:10:40	open big floppy box (not sure about serial card) wasn't sure how it opened
1:11:00	remove foam & inner box
1:11:50	open inner box and conductive foam bag in inner box, what are stickers for?
1:13:45	read kit instructions about floppy, confused about straps. English is together in one section in documentation (languages not mixed)
1:13:55	examine drive. how are drives sequenced?
1:14:45	continue with instructions
1:15:00	flip drive over & examine
1:19:10	continue examining kit instructions, where do jumpers go? which U condition? hopelessly confused. which terminating resistor comes out? indicator condition of what? which drive (no 360K label on front)
1:20:40	look in owner's manual, but where? 360K drive section
1:22:25	where are the guides? found them. remove guides from package, open package. directions covered by tape, hard to open package, use pen
1:25:40	install 1 guide. which screws do you use? (4 screws and 2 holes drive frame, 6 holes in guide). black screws or silver ones? used black in back, silver in front, silver didn't work, remove it and use black one. pick up screw that falls on floor (add label to railing guide—front/back (to orient)). no mention of guides in instructions
1:28:00	install 2nd guide
1:28:25	check fit of drive

TABLE 9 (continued)

End Time H: M: S	Activity
1:29:30	unscrew retaining clips to slide in 360K drive, check fit—it's ok
1:34:00	try to figure out jumpers again—read owner's manual, kit instructions. found comment about jumper and model number, check shipping list, examine jumpers
1:34:15	read instructions about cables in back
1:38:00	read instructions about terminating resistor again, which drive is last in chain? where do we take it out from? how do you take it out? what does a terminating resistor do? STUCK! QUIT! CALL NCR FOR HELP!
29:00	Total

TABLE 10

SESSION 3 SUMMARY

Task	Duration (min:sec)
Unpack & Install Tilt & Swivel	5:05
Install Feet	4:10
Check Key Lock	6:40
Run Demonstration Program	9:15
Prepare DOS Disk	18:20
Set Computer to Boot from Hard Disk	13:40
Copy Files to Hard Drive	24:50
Total (1 hour, 22 minutes)	82:00

took just over five minutes. This is one of the few tasks that proceeded smoothly. The box was well labeled, the parts were easy to remove and assemble, and the instructions were clear.

TABLE 11

UNPACKING AND INSTALLING MONITOR TILT AND SWIVEL

End Time H: M: S	Activity
	comment – NCR installed 360K drive and some software introduce selves again (Paul, Don, and now Ray)
1:38:00	***** start tape again *****
1:38:20	get tilt and swivel box (it's labeled—good!)
1:39:00	open tilt and swivel box (easy to unpack)
1:39:30	skim kit instructions for tilt and swivel base, remove parts and base from box
1:40:00	remove base from plastic bag
1:40:20	read tilt and swivel kit instructions
1:41:10	flip base over, insert bolt clear off part of desk—need room to work
1:41:25	flip monitor over
1:42:05	align hooks in base with monitor lip (easy to do)
1:42:35	fasten base to monitor with bolt
1:42:45	turn monitor right side up
1:43:05	how is the monitor position locked?
5:05	Total

Table 12 contains the data associated with installing the feet on the cabinet. For this brief activity, about half of the time was spent determining what to do next. The rest

of the task was straightforward and aided by the alignment template provided (the paper guide).

TABLE 12

INSTALLING FEET

End Time H: M: S	Activity
1:43:50	what's next? back to the documentation. no holes in the swivel base documentation (for 3 ring binder)
1:44:45	read "getting started." Don: I think we're done.
1:45:00	decide we need feet on cabinet. discovery the front panel comes off. why take the front panel off? can't take the panel off unless you have feet, forgot feet – find them
1:47:15	put feet on cabinet. discover guide for placing feet. guide is clever but paper gets stuck under feet. discovery of mystery labels
4:10	Total

Checking the key lock is a task that should have taken 1 to 2 minutes but instead took 6. (See Table 13.) As with many tasks that were part of the setup procedure, much time was wasted in the beginning of this task trying to figure out what to do next. Once that problem was overcome, there still was the matter of reconciling the conflicting labeling of the switch positions in the manual and on the hardware. Finally, one problem not found here but noted in observing others was difficulty in locating the keys. Early on they were mentioned, but there was no mention of where they were packed.

The next task was to run the demonstration program MCBAT.BAT, which took about nine minutes. (See Table 14.) The program ran smoothly and the keyboard tutorial was well done on the whole. However, comments about using page-up and page-down to move from screen to screen should be repeated on the first few screens. (The message is now only on the first screen. The participants got to the second screen by pressing "return" and then got stuck.) Also, the menu entries on the initial screen should be made more descriptive than "keyboard," "NCR DOS," "typing a letter," and "end."

TABLE 13

CHECKING KEY LOCK

End Time H: M: S	Activity
1:51:15	deal with keyboard lock—back to reading "getting started," positions shown for unlocked in manual and on hardware are different, position of on/off switch—zero is off. check if plugged in
1:52:30	selecting a disk from back manual—which to use, diagnostics or "getting started." Don: which drive does it go in? explain difference between 1.2M & 360K
1:53:55	remove key protector—put key in lock & unlock (found instructions by lock) what is the switch? speaker volume switch
6:40	Total

The main menu entry "DOS" in MCBAT.BAT led the participants to believe they could return to DOS by selecting that entry. Later it lead them to believe it would take care of creating a DOS disk. Participants didn't realize that the disk copied had MCBAT.BAT in the AUTOEXEC.BAT file, which later caused problems. All of the tasks associated with making a duplicate disk should be in a batch file. The file should make a copy of the disk but not include in the autoexec file batch commands, as was the case here. As shown in Table 15, those errors greatly increased the time to make a DOS disk, a rather simple task that should have taken three minutes, not ten.

As with the previous task, running FDISK (not observed here) and formatting the hard disk should have been handled entirely by a batch file. Formatting and related activities took over 13 minutes. (See Table 16). The first 7 minutes and 45 seconds of that time was spent figuring out that it was time to format the hard disk. It was not a matter of understanding the format command syntax, because one of the participants had formatted several hard disks and hundreds of floppy disks before.

The final task in the setup procedure involved copying files to the hard disk. Copying files is a fairly straightforward task that inexperienced users can do, but can be done much faster when using a batch file. This activity took almost 25 minutes, making it

TABLE 14

RUNNING DEMONSTRATION PROGRAM

End Time H: M: S	Activity
1:54:55	turn on equipment. turn display on, documentation says it is already on. must turn on system unit to turn on monitor. Paul: I wonder why documentation says wait a few seconds? turn on system unit
1:55:25	system unit powers up mcbat.bat program
1:55:50	NCR logo appears on screen, get music (company song?)
1:56:25	discussion of screen flicker, adjust brightness and contrast
1:57:05	remove the disk
1:58:50	decide what's next. no explanation about what the software does—check doc. done with "getting started" in documentation, look at "keeping going" section realization that documentation is referring to diagnostics disk.
2:01:40	use keyboard tutorial—choose keyboard from menu (disk wasn't supposed to be removed). tells what keyboard does. Paul: I wonder how you get out of it? try enter to get out. use page-up page-down to navigate the keyboard routine (need reminder on 1st few screens to remember). read several screens exit the routine. tutorial has great graphics!!
2:03:10	try to get back to DOS/exit demo. choose NCR DOS from menu
9:15	Total

TABLE 15

PREPARING DOS DISK

End Time H: M: S	Activity
2:03:20	look for DOS disk
2:04:25	discover we didn't replace back panel. must unplug everything. why did they include the panel? discussion. one more thing to take apart. panel is left off.
2:05:20	check flicker problem. Paul: I wonder why it's flickering so much. turn out the lights. still flickers. adjust monitor controls to stop flicker. no effect
2:06:00	get and insert DOS disk
2:06:40	turn machine off. turn on machine. DOS loads
2:08:40	program to copy disk (mcbat, thought it was DOS). note text on screen now has less flicker, color mode and full graphics mode difference (or maybe reverse video). read documentation on the screen. Paul: I guess you need a quad density disk, doesn't say what kind, only that a disk is needed. 360K drive must be used for target disk. can't use quad, only realize that regular disk is needed
2:09:40	select keyboard, time & date, insert disks (which disk should be the source?)
2:11:25	copy disk (format while copy), time to copy not shown
2:12:30	deal with error. software accepts only upper case for copy another disk prompt (type n for no in lower case). target disk removed from drive B.
2:13:05	don't want to copy another. how to get out? hit esc?
2:13:30	hit escape. starts comparing. why? escape must be some undocumented mode. try shift break to get out of copy another. drive b not ready error as a result of hitting shift-break.
2:14:30	reboot, results in congratulations screen. how does one just get DOS? trying control-break results in copy error message.

TABLE 15 (continued)

End Time H: M: S	Activity
2:16:05	try to get DOS again. turn off machine again. turn on again. what is the purpose of the disk? is there anything in the doc about this disk. congratulations.
2:16:25	try control break. terminate batch job? yes, works. returns to DOS.
2:17:25	use dir command to find out what's on disk
2:19:25	look at autoexec.bat and mcbat files. can't find mcbat. is it a new DOS command? check documentation
2:19:45	rename autoexec file to avoid start-up problem
2:21:30	check if software now works, turn machine off, then turn on. explain to Don why file renamed.
10:20	Total

the most time-consuming of the software-related activities observed. (See Table 17.) Hidden in the task sequence is the considerable time the users spend deciding how the hard drive should be organized and typing in the commands (often erroneously). The documentation gives little advice on directory organization, and it is something new users know little about. Finally, it is assumed that users know about the "prompt" command, which few users do.

TABLE 16

SETTING COMPUTER TO BOOT FROM HARD DRIVE

End Time H: M: S	Activity
2:23:00	boots from the copied disk (A drive) but still asks for date and time. why? must be something in ROM that prompts date and time. date is ok, time isn't
2:24:15	check if boot from hard drive. turn off machine and then turn on machine. error message "no operating system on fixed disk."
2:26:50	find out why it doesn't work. look for instructions for installing operating system on hard disk. check getting started in owner's manual. found installing options (for hard drive.) Paul: "Oh, we have to format the hard drive." what would that be under?
2:27:40	read fdisk and format instructions
2:27:55	beeps if hit keyboard, not sure why.
2:28:55	reboot. still prompting for date & time, why? change to drive C, dir command yields error "Non-DOS disk reading drive C"
2:30:15	run fdisk. several actions. realize that disk already partitioned. hit escape
2:30:45	reboot
2:35:10	format hard disk (format c:/s/v). prompts if want to format. while formatting discussion of lights on system box (should be labeled, light should be on the on/off switch). notice screen is not flickering as it did in the color/graphics mode before. format complete.
13:40	Total

TABLE 17

COPYING FILES TO HARD DRIVE

End Time H: M: S	Activity
2:35:10	what should hard drive be named?
2:44:50	copy files to hard drive from floppy disk—ansi.sys. what does backup do? chkdsk, diskcomp, diskcopy, edlin. Paul: I don't like this backspace, wonder what esc.com is. what is find? format copied. what is freq? can't find explanation for freq—skip it. graftabl, graphics, join. what is all the key stuff? only keyb is documented. what is setup? checking documentation. what's share, subst, try tree, what's vdisk, wtdatim? make dir for the files copied
2:45:50	make directory \util for other files.
2:51:45	fix prompt—didn't install prompt command, documentation doesn't lead one through it very well. make an autoexec file—edlin doesn't work, copy autoexec from disk in a:, rename and try to edlin again. once again bad command or file name. lost in directory, realize that directory doesn't have edlin. change directory with edlin. edlin autoexec file
2:52:50	check if prompt works. turn off machine, then turn on machine. it works! (no date & time request)
2:54:45	create basic directory and copy basic files.
2:58:40	copy remaining utility files to \util (assign, attrib, fdisk, find, join, key*, label, more, remove restore, select, setup, share, sort, subst, tree, wtdatim).
2:59:20	copy A:gwbasic to hard drive
3:00:00	We now have a system!
24:50	Total

RECOMMENDATIONS

It is clear from the previous section that participants had numerous problems with setting up the PC-8. The evidence takes the form of both comments from typical users and an empiric analysis of setup task times. These problems have arisen because the original product concept did not call for customer setup. When human factors/ergonomic considerations are not given priority early in design, it is unlikely the resulting product will be easy to use (or in this case, easy to set up).

It may seem to some that the setup problems reported here can be eliminated by improving the documentation. While that will certainly help, the ultimate solution must include modification of the packaging, hardware, and software as well. Specifically, key suggested changes include:

- making the hardware self-documenting,
- consolidating most of the setup information into one manual,
- eliminating mixed language documentation,
- making much greater use of illustrations,
- adding "open me first," "this side up," and unpacking instructions, and a list of contents on the outside of each shipping box,
- reshaping the foam in the cabinet shipping box to facilitate unpacking it, and
- providing batch files to handle most of the system configuration.

All of these suggestions are expanded upon in the section that follows.

1. As a general principle, hardware should be self-documenting. To achieve this, every part should be labeled with a name, and if possible a number. The name should be engraved in the mold for plastic and cast metal parts, and printed on circuit boards. The name should face the customer when the part is removed from its package and be visible when it is installed. So, for example, with circuit boards, the name should be on the top of the card and also, so one can identify it without opening the cabinet, on the outside of the foot. Because NCR's market is multilingual, it will be a challenge to make the labels legible given the limited space available.

With the present design of the PC-8, the only source of information about setting it up is the written documentation. Ideally, it should be obvious from the hardware how to set it up and the documentation should be a secondary source. Furthermore, the current setup procedure assumes that people go through the documentation step-by-step, never

missing a step, and doing exactly what the author intended, no matter how unclear the instruction. People don't behave that way. They skim instructions. They do things out of order. They don't understand everything they read. They make mistakes, lots of them. It is therefore essential to shift the burden of explanation to the hardware.

2. Based on difficulties in this experiment, there is a clear need to label both the graphics and serial/parallel boards.

3. For the disk drive slides, the name should be added to the body and the tape covering the instructions removed.

4. An extension of the self-documenting principle is to have parts show how they go together. For cards, a label (preferably pictorial) should indicate the slots it can go into. Likewise, the system box or the motherboard should be labeled to indicate the cards each slot will accept.

5. To speed installation of the slides, an outline of the slide should appear on the side of the disk drive.

6. To facilitate opening the cabinet, labels are needed on the cabinet to indicate what the various screws are for, especially those that need to be removed to get the top off. Making them a different color or type (for example, combination slotted or Phillips hex head) would also help but could be more costly.

7. Removal would also be facilitated by providing an illustration showing how. There are some tricks to taking the top off that are difficult to capture in words but easily shown with pictures.

8. The positions of the keyboard switch (PC-4i/PC-6, PC-8) should be labeled.

9. Beyond these specific hardware changes, the design of the color display should be reviewed. While not a setup problem per se, it flickers noticeably when running the initial tutorial (where reverse video is used). The best solution may be to modify the tutorial software rather than the hardware.

10. Some thought should be given to enlarging the backspace key, a commonly used key. As with the display problem, it is not unique to setup, but nonetheless the small backspace key led to many typing errors during setup. This change has been made on the new IBM RT keyboard, which supposedly will be the standard keyboard for all new IBM products. For the PC-8, it may not be a cost-effective change.

11. There were numerous problems with the documentation, and the participants constantly complained about them. The most important change needed is to consolidate

the "getting started" manual and the "installing options" chapter in the "owner's manual." Furthermore, the kit instructions for the keyboard and the display card, which will be used only with NCR products, should be eliminated and the information integrated into that manual.

Many of these changes may already have been made in the proposed new documentation. At Clemson, a draft copy without illustrations was provided, but it has not been examined in detail, because that task was not part of the charge for this project. The proposed revised manual seems to be a vast improvement.

At several points in this experiment, participants did not know which manual they should be looking at. During installation of the disk drive slides, four pieces of documentation were used together—"getting started," the "installing options" chapter in the owner's manual, the disk drive kit documentation, and the instruction sheet for the slides. To make matters worse, inclusion of a fifth document, a checklist, is being considered.

12. To reduce confusion, separate kit instructions for each language should be provided. Where multiple languages are used on each page, the user must repeatedly decide for every step which information to ignore (in a five-language manual, 80% of the text). Where documentation is language-specific, the customer makes just one choice about language. Further, in single language documentation, illustrations appear closer to the text in which they are cited. Multilingual documentation was developed to save paper, but that savings is far less the cost of added hot line calls and user dissatisfaction.

13. Make greater use of illustrations. The IBM philosophy is to minimize the use of words and maximize the use of illustrations, and it has been very successful (Boyer, 1980; Boyle, 1986). Specific illustrations should show the open and closed positions of the jumpers on the graphics card, which slots the graphics card can go in, the jumper configuration for each type disk drive, and the cabling for various disk drive combinations. The illustrations showing how to open the cabinet (to be placed on the back of it) should also be repeated in the manual.

14. The kit documentation of the 360K disk drive is so confusing that it should be re-written from scratch.

15. The kit documentation for the slides should be revised to indicate which screws are used for what.

16. NCR may want to consider developing software that generates a customized short list of installation steps based on the shipping list for each order. This could eliminate much of the time wasted at each step determining what to do next.

17. The labeling for the keyboard switch lock positions shown in the manual should be reversed to agree with the hardware.

The participants in this experiment encountered several difficulties while unpacking the PC-8 and its options. Changes should be considered in the labeling of boxes and in the design of packing materials.

18. Every shipping box should have a name on it describing its contents, just as the color display did, along with a list of contents. (In this experiment the boxes with the cabinet, options, and applications documentation were unlabeled. Perhaps the PC-8 examined was shipped early in the product cycle, before special packaging was ready.) Proper labeling would avoid the need to open every box to determine its contents. In this experiment several minutes were wasted opening, emptying, and then repacking a box with several application package manuals when the "getting started" manual was needed.

19. The graphic indicating the top (parallel arrows) should be reinforced with text ("this side up") to assure that boxes are properly oriented when opened. Unfortunately, many still view these much needed arrows as mere decoration. Also on the top should be a sequence of illustrations (not text) showing how to unpack it, and a list of contents.

20. Boxes containing the system assembly instructions should have a brightly colored "open me first" label on them.

21. Boxes should be packed so that when opened, the item on top is the assembly instructions for the contents. If there are loose parts, they also should be on top. This would eliminate the problem of the "lost" cord experienced when assembling the second PC-8 and reported by others.

22. The foam supporting the system cabinet in its shipping box should be modified so it can be unpacked easily. Right now there is no way to slide it to grasp the cabinet. In the Clemson demonstration, one participant, after struggling with the foam, cut the sides of the box as well as the top. This, of course, is a violation of the "preserve the packaging so I can return the product" principle.

23. Most of the options were all packed in the same size box. While this commonality may reduce packaging costs, it also eliminates the clues that package size

provide about contents and increases search time. This practice needs review. (Should a co-processor chip be in the same size box as a full-size circuit board?)

24. Consideration should be given to placing the key outside the system cabinet when it is shipped, or at least placing a label on the cabinet to state where it is. In the Clemson briefing, the search for the "missing" key took a great deal of time.

Beyond changes in the hardware and documentation, changes in the software should be considered.

25. Use a batch file to handle creating of DOS disks. While the software does this for the most part now, though it also copies over mcbat to the autoexec file on copies.

26. Setting up the hard disk (FDISK, FORMAT, prompts, copying DOS and BASIC, and building the AUTOEXEC file (including the prompt pg command and paths)) should be completely handled by a batch file. A critical part of setting up a hard disk is determining the directory structure, something the average user may not be able to do very well. The batch file should provide the customer with the option to develop his or her own structure. Batch files could reduce setup time by 30 minutes.

27. Modify the format and delete/erase commands to give more information about the consequences of actions. For example, the current format version of FORMAT provides more protection against inadvertent formatting of drive C than version 2.0 did, but it still does not provide enough protection. A more explicit message is needed. "Are you sure you want to re-format drive C (the hard disk)? This command will erase EVERYTHING that is on it (xxx bytes of data, yyy directories, zzz files)". For delete/ erase a similar message is needed when wild cards are used, including a specific message for erasing a directory.

28. Consider providing tools for handling ICs. An IC removal tool is needed to install both the RAM expansion chips and the co-processor. For the co-processor, an IC removal tool is also needed. If the cost of the tools exceeds the benefits of reduced installation time, then the instructions should be modified, suggesting they be obtained.

29. While data were not collected on subsequent installation of a second serial/ parallel card in the PC-8, this proved to be very difficult. This problem should be looked into further.

30. Finally, once some of these changes have been made (especially the revised documentation), testing should continue, using a larger sample. One of the lessons from the work of Gould & Lewis (1985) is that easy-to-use products are the result of repeated

cycling through the design-test steps. This testing should be conducted with a set of goals in mind for user performance (Good, Spine, Whiteside & George, 1986). Even if the evaluation of the PC-8 happens relatively late in its life cycle, the lessons learned will be useful in designing subsequent products.

The PC-8 has proven to be a fast and reliable personal computer. But it is not easy to set up. That is because the original design called for installation by NCR field engineers and setup was never tested. However, if the changes listed here are made and the spirit of the Clemson meeting spreads through the corporation, the PC-8 and its successors could become machines that excel in ease of installation. Emphasis on human factors/ergonomic considerations should turn out to be a competitive advantage for NCR.

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APPENDIX A

INFOWORLD REVIEW

InfoWorld, December 2, 1985, pages 41-42

Solid NCR PC8 Offers Superior AT-Compatible Performance

By Don Crabb
Review Board

Many of you are familiar with the commercials. Comedian Dom DeLuise accosts a group of business executives with a sales pitch for a new computer. When he finishes his spiel, he asks if they're surprised at this recitation of the NCR's fabulous powers. To his amazement (though perhaps not to the television audience's), the executives are not, pointing out that NCR has been in the business-machine field even longer than that other well-known computer maker whose name means business machines. Presumably, NCR knows how to build a personal computer.

Indeed it does. Our review of the NCR PC8, another entry into the burgeoning list of IBM PC AT-compatibles, shows the machine to be a solidly built superior performer; on the down side, setup is difficult and the firm relies entirely on dealers for user support.

FEATURES: The NCR PC8 squeezes extra performance out of its Intel 80286 microprocessor with a clock rate of 8 MHz, compared to the 6 MHz speed of the AT.

The PC8 comes in two versions: the basic system with 256K of random-access memory (RAM) and one 1.2-megabyte floppy disk drive, and the enhanced system, which goes to 512K RAM and adds a 20-megabyte hard disk drive, as well as a serial/parallel interface board. Both systems have eight full-size expansion slots (six are PC AT- and XT-compatible, and two are XT-compatible only). Up to 640K of memory can reside on the main circuit board, and the system can address up to 4 megabytes of RAM on optional memory boards. We tested the enhanced system.

The PC8 system unit is similar in size to the IBM PC AT. The box is a bit over six inches high, 21 inches wide, and 16 inches deep. It weighs about 50 pounds along with the hard disk drive. It can be used horizontally on a desktop, or vertically on the floor on an optional stand.

The separate keyboard is not an IBM clone. It will remind many of you of the keyboard of the DEC Rainbow or the TI Professional. The keyboard includes the usual group of 10 function keys on the left side of the main key grouping, plus 20 function keys arrayed in groups of five across the top of the keyboard. To the immediate right of the main key grouping is the separate cursor keypad and a special grouping of editing function keys. The numeric keypad rests on the far right.

The keyboard connects to the rear of the system unit. The front panel of the system unit displays not only the power switch, disk drive openings, and status lights for power and the hard disk, but also a special swing-down panel, reminiscent of a stereo receiver control panel. Swinging down the panel reveals the system keylock (two keys are provided) and a volume switch for the built-in speaker.

The color monitor we tested has a resolution of 640-by-400 pixels and can produce 16 colors simultaneously. The NCR graphics adapter board supplied with the screen produces both high-resolution text and graphics. A swivel/tilt stand allows you to position the screen for easy viewing. NCR has coated the PC8 screens with an anti-glare substance.

NCR provides the NCR-DOS 3.1 operating system, a functional clone of PC/MS-DOS 3.1, and the command structure is virtually identical. Because of the generous number of expansion slots offered by the PC8 and the use of DOS 3.1 (the network-ready version of DOS that includes the Share command), this machine is a good choice for networking applications.

Software that works with DOS 3.1 should work fine with NCR's clone. NCR also throws in a copy of GW Basic. Version 2.2 when you purchase a PC8, as well as a getting-started disk (very useful for novice users), and a diagnostic disk (useful for testing the machine and determining the source of problems that crop up).

For those requiring Unix compatibility, NCR also offers Xenix 286, the AT&T System V Unix-compatible operating system, at an additional cost of $395.

SETUP: Unpacking the NCR PC8 will test the patience of most users. Our test unit came in five separate boxes, each with enough packing material to protect the contents from any conceivable damage. It took us more than an hour just to open all the boxes and figure out what component was contained in each box.

Setting up the PC8 is even more frustrating. The setup instructions are written in five languages; they are difficult to follow in any of them. Each component comes with separate instructions, making them that much easier to misplace. NCR attempts to consolidate information about setting up the PC8 in a *Getting Started* booklet, but the information is far too general to be helpful.

We had to ready the hard disk for use and install the graphics adapter board in our test unit before we could power up the machine. We'd expect these procedures to take 15 minutes; instead, we spent more than an hour. The problem starts when you have to remove the top of the system unit. We practically tore off a finger trying to get the cover off of the box. After you've removed the top, you're faced with the task of locating the necessary jumpers on the main circuit board. The documentation for this search is woefully inadequate. It lacks decent illustrations, and the text doesn't do a satisfactory job of explaining the procedures. After removing the disk controller board, we finally found the jumpers we needed to check and set. After working at this for several hours, we finally had everything connected and configured.

Overall, setup was a frustrating and disappointing experience. If you purchase a PC8 you might want to hire your dealer to do the setup for you, especially if you've purchased a number of options.

SERVICEABILITY: As may be evident from the protracted setup procedure we went through, the serviceability of the PC8 could be a sore point with users. The procedure of opening up the system unit to make simple modifications is far too cumbersome and poorly documented. The apparent quality of the internal workings of the machine, however, suggest that repairs won't be necessary anytime in the early part of its life.

Quality construction is evident throughout. The main circuit board and the accessory boards are all well-executed. The chassis is rugged and the disk drives are solidly mounted. The oversized power supply should be capable of handling a full complement of mass storage devices (there is space for five) and optional circuit boards. The expansion slots are all easy to access, but our experience at board installation suggests that some users may have trouble forcing them into the proper place.

The keyboard and monitor are also well-made, with quality the norm rather than the exception. NCR built the PC8 ruggedly. The design problems we've mentioned could, however, make it a chore to maintain and expand.

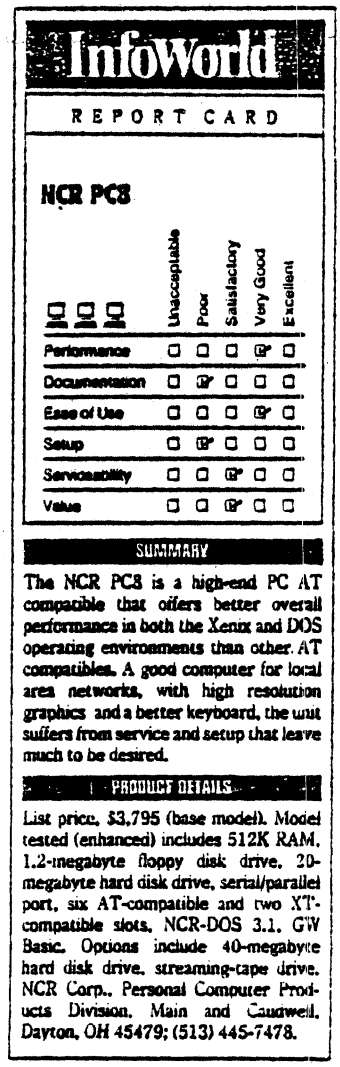
Should you require service for your PC8, we suggest that you find a reliable NCR dealer in your area; our experience in dealing with NCR headquarters in Dayton, Ohio, left us concerned about central support. We made several phone calls to the Dayton office to ask about pricing and to clarify some setup procedures. (The documentation makes no mention of telephone technical support, but we found the number on some NCR promotional literature.)

We hope your experience will be better than ours if you are obliged to call NCR. We were put on indefinite hold twice, transferred to oblivion once, transferred to someone who hadn't even heard of the PC8, and finally we got through to a technical person only once. That person told us that local NCR dealers provide support and that we should contact our dealer. End of conversation. We expect a certain amount of central office service backup, and we think most users will too, at the very least to account for the occasional incompetent dealer.

Since our test unit did not contain any written warranty information about the PC8, we had also hoped to obtain that information when we called the Dayton office. We came up empty on that question as well.

One of the problems with getting any telephone technical support from NCR's Dayton headquarters may be because the unit is not manufactured there. Our test unit came from the NCR Personal Computer Division in Augsburg, West Germany. We didn't try to call Augsburg for technical support.

Although we found the PC8 to be of sturdy construction and well-designed, our



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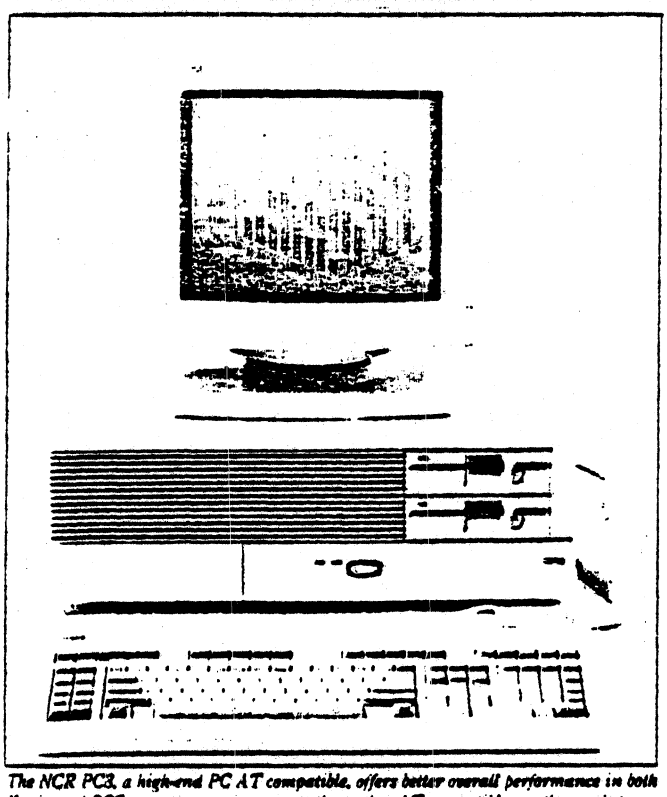

The NCR PC3, a high-end PC AT compatible, offers better overall performance in both Xenix and DOS operating environments than other AT compatibles on the market.

rating for serviceability can't reflect that quality because of the problems getting support.

PERFORMANCE: Once you've gotten the PC8 set up, you'll be rewarded by very good performance. The Intel 80286 microprocessor works at a clock speed of 8 MHz, which accounts for some of the performance improvement over the IBM PC AT. Depending on the software being evaluated, the PC8 was almost always faster at bringing results of a command back to the screen than a similarly configured AT. Operations involving primarily the microprocessor showed the biggest performance improvements, anywhere from 5 percent to 20 percent faster than the AT. The PC8 never performed slower than an AT in our tests.

The hard disk supplied with our test unit was a Control Data Corp. Wren Model 9415. We found it to be a very good performer as well. With a formatted data capacity of 20 megabytes, the Wren uses the new rotary voice-coil head actuator technology typical of AT-type drives.

The hard disk was immune to most of the punishment that we inflicted on it. We tested the drive's capability to resist vibration and shock while reading and writing information. Although we were able to create rotational groans from the drive with our testing, we never lost any data and the drive never failed. The access time for data on the hard disk is comparable to several other high-performance AT-type disks on the market.

Although the keyboard and color monitor of the PC8 are not IBM clones, their performance was fully compatible with the IBM standard. The keyboard works well with software that we've run on the AT, including Multiplan, Lotus' 1-2-3, Dbase III, and Wordmarc. The extra programmable function keys can also be used by some programs.

We had no problems connecting and using both serial and parallel printers with the PC8. A 1200-bit-per-second external modem connected to the RS-232C serial port without incident and worked well. The mode command in NCR-DOS 3.1 allowed us to configure the correct port characteristics for external devices without a hitch.

The color monitor can display the low-, medium-, and high-resolution color graphics that some IBM-compatible software generates, although to take full advantage of the monitor's 16 colors, the software has to be modified. Some packages available from NCR dealers have the enhanced graphics features that support the monitor. The NCR graphics adapter in our test unit is not compatible with the IBM Enhanced or Professional Graphics Adapters, although those IBM boards should work if installed in the PC8.

We found the software compatibility of the PC8 similar to that of the AT. The packages that we've run successfully on an AT (1-2-3, SPSS-PC, and Wordmarc, for example) worked just fine on the PC8. Programs that bypass the ROM-BIOS and make direct calls to memory, or bypass the BIOS when processing keyboard input, will blow up on the PC8 just as they do on the AT. Microsoft's Flight Simulator is a good example. Special versions of IBM PC-compatible programs are also available from NCR; the firm also maintains a list of software that it has tested for the PC8.

DOCUMENTATION: Unfortunately, like a lot of other written information about the PC8, finding this advertised list of compatible software is difficult if not impossible. When we called NCR's Dayton headquarters, they told us that they had never heard of such a list. We did find an NCR dealer in our area, however, who promised to send it to us, though we still haven't received it.

The printed documentation that comes with the PC8 suffers from several problems. Each manual (one each for the PC8, NCR-DOS, and GW Basic) contains solid information, but it's often difficult to digest. You have to plow through page after page of text to find the information that you need. All three manuals suffer from a shortage of illustrations. You don't get any help from the indexes, either. An index for the PC8 user manual doesn't exist, and the index for the NCR-DOS manual is mostly just a listing of DOS commands. Although NCR has made an attempt to section the manuals into easily accessible chapters, the inadequate indexes thwart that effort.

The parts of the documentation that most need to be improved, though, are the installation and setup manuals. These should be completely rewritten, expanded, and then edited into single-language versions. More and better illustrations should be incorporated. Each of the separate installation documents and manual sections should be consolidated into one manual.

NCR does provide a useful pocket guide for NCR-DOS 3.1. We referred to it often while testing the PC8. The system also comes with a getting-started disk that provides a decent introduction to the system for novice users. (The coverage of keyboard basics is good.)

We'd also like to see a detailed technical manual included in the documentation set. This manual should address questions of hardware and software compatibility with the AT in detail.

On the whole, we found the documentation for the PC8 to be poorly conceived and inconvenient to use.

EASE OF USE: The NCR PC8 is as easy to use as any of the AT-compatible machines that we have tested. One definite plus is the keyboard. We found it to be a joy, especially for word processing and spreadsheets. Another plus for novices is the getting-started disk. Overall, we ranked the PC8 as very good in the ease-of-use category.

VALUE: The price of the PC8 enhanced version ($5,505 without a monitor) puts it squarely into the middle of the price range set by IBM and AT-compatible manufacturers. Its features, performance and ease of use make it a desirable machine, but the problems we've mentioned with setup, serviceability, and documentation detract from these advantages.

We put the PC8 squarely in the middle of the value range among its competitors. The PC8 is a good performer and could be a good choice, especially for networking applications, except for the difficulties we encountered.

APPENDIX B

NCR PART NUMBERS OF ITEMS ASSEMBLED (Two NCR PC-8 Systems)

Item	NCR Part Number
U.S. keyboard	3299-K420-V001
14-inch color monitor	3295-0210
graphic CRT controller card	3299-K201-V003
graphics memory upgrade	3299-K202-V001
128K RAM upgrade	3299-K110-V001
80287 arithmetic co-processor	3299-K020-V001
360K 5-1/4 inch flex drive	3299-K711-V001
vertical mount	3299-K801-V001
display kit (cables)	3299-K902-V001
RS-232 communications cable	3299-K912-V001
parallel printer cable	3299-K910-V001
serial cable converter	3299-K915-V001