

Beyond Comprehension: A Usability Study on User Instruction Manual for Stove with Steam Function

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Abstract. This paper presents a study on the redesign of a user manual and pocket guide of a stove with steam function produced in Brazil. The redesigned material was validated through heuristics evaluation, usability and readability tests. The results in graphic presentation were satisfactory. However, the instructions provided were not sufficient to a successful use of some functions, due to ergonomic drawbacks in the product design and in its digital touch panel. This may led to users' cognitive overload in task performance, which could not be prevented, but only minimized by the manual. The possible contributions to the field and the need of a user-centered approach to the design of instructional material by product manufacturers are highlighted.

1 Introduction

Using a product is not only an interaction between product+user, but also a communication activity. In this sense, users' instructional material plays a chief part, since the level of accuracy and completeness of information content may lead to success or failure in using a product [1] [2] [3] [4]. Ganier [5] [6] considered the reading of instructions an inferential activity, in which users will fill in the information gaps based upon their prior acquaintance with the task/similar tasks and/or product. This regards the action plan produced by users when reading product instructions, which are mental images of the procedures to be undertaken. If the action plan is not accurate, users may made misleading inferences, which will lead to errors in task performance/product usage.

The representation of information in instructional material through words and images, as well as their graphic presentation in the document, are influencing aspects on users' cognitive and metacognitive processes [7] [8] [9]. The former is related to content comprehension and is an unconscious activity. According to Paivio [10] in his Duo Coding Theory (DCT), human cognition occurs in two systems: verbal and non-verbal. The former processes the linguistic information (*logogen*) whereas the latter, the non-linguistic information (*imagen*). The systems act in an independent manner, but in cooperation to promote understanding. In order to avoid information overload in one of the systems, the joint use of text and image is encouraged. For that reason, pictorial and textual representations should be employed to convey instructions, facilitating users' cognitive process.

Regarding the metacognitive process in instructional documents, it is related to interpretation of their visual structure, i.e., how instructions are visually organized. It is a conscious activity that aids problem solving and decision making in task performance [7] [8]. Thus instructional material is a communication artifact that supports user-product interaction. Furthermore, the graphic presentation on instructions (text, images, page layout) can be considered a metainstruction. In this sense, providing readers with a well-structured graphic instruction would ease task performance allied to content completeness. Although this latter depends upon users' information needs to undertake a task, empirical and theoretical studies claim that the provision of introductory information on the task and product are relevant to instruction comprehension and task performance [11] [12]. Such information could be a heading, an inventorial image/text showing the product components and features, and /or a contextual image depicting the task outcome, which aid the construction of action plan. Besides, typographic resources (e.g., bold, font size, color, table of contents) may ease information searching/finding and document navigation in instructional material, functioning as visual cues.

Other important information in instructional material is warning. It prevents hazards and risks related to users and/or products by providing information on the recognition of hazard/risk (signal word); description of the hazard and its consequences; and how to avoid it [13] [14]. In this sense, attention is a chief element in warning communication, since warnings should be promptly noticed to make people aware of possible hazards/risks.

Considering these aspects and the need of improvement in the communication effectiveness of instructional material for users, this paper presents a study on the redesign of user instructional material for a stove with steam function produced in Brazil. It consisted of a product full manual and its short version as a pocket guide with basic information to users on how to install, use and clean the stove. The redesign was commissioned by the stove manufacturer¹ due to problems in comprehension of its actual material by users. Initially an evaluation of the graphic presentation of the actual stove manual and user's pocket guide was undertaken to provide the support for the redesign proposal. Then, the redesign was validated with manufacturer experts and potential users, as explained next.

2 Evaluating the Content and the Graphic Presentation

The stove user manual and the pocket user guide were printed in color on white paper. The main colors were black (text) and blue (headings) in alignment with the manufacturer branding, and red color was employed for emphasis, mainly in arrows to indicate the steps/movement.

The evaluation of the manual and the pocket user's guide considered their graphic presentation and information content. In the latter, drawbacks were found in information sequencing, information grouping, consistency and adequacy of terms throughout the text. Moreover, the text whether provided excessive and/or unnecessary informa-

¹ The manufacturer's name is not mentioned here due to confidentiality of the design consulting contract.

tion to users (e.g., technical details), or lacked relevant information on the stove components and usage (e.g., the electric oven). The former would jeopardize information comprehension, whereas the latter could lead users to misconceptions based upon their inferences on how to use the product. In both situations, users' action plans to use the stove could be compromised. It was also found that audible feedbacks of certain steps were not accounted for in both instructional materials, and neither were the visual feedbacks of the touch panel (lighting/blinking functions). These feedbacks are important part of the user interaction with the product as an outcome of steps [15]. Thus, their omission in the instructional material may cause confusion, and/or lead to uncertainty during task performance.

The graphic presentation of the manual and pocket guide also presented deficiencies. They regard visual hierarchy of information, graphic consistency, pictorial depiction, text-image relation and typographic articulation. These latter will be highlighted here as they directly affect users' information searching and comprehension. The inventorial image of the stove had its component names as a word list displayed apart, using numbers as elements of visual correspondence between image and words. Such cross-reference approach could lead to unnecessary cognitive demand by users, as they should first find the stove component in the numbered word list, and then look for the corresponding number within the image. This could be prevented through the employment of linked labels on the stove image, facilitating users' cognitive load and information processing. Other drawback regards the misleading pictorial representation of actions/steps through labels and arrows over the image, which seems part of the object depicted, as shown in Figure 1. The images attempt to represent 'Turn the grill on' and 'Turn the oven on'. Users may assume that the labels and arrows surrounding the bottoms are elements of the stove panel. Although this may not strongly affect task performance (users would probably realize the distinction when interacting with the actual bottoms), it is a misuse of graphic resources to represent steps in instructional material.

Concerning typographic articulation, drawbacks were mainly found in warning information on the conditions and restrictions for installation, use and cleaning of the stove to prevent damage to the product and/or users. They regard lack of typographic resources (e.g., upper case, bold) to differentiate warnings from other information in the text, whether allied or not to graphic elements, such as outlined/full boxes. Warnings had the same typographic presentation of headings and/or steps. As a result, the

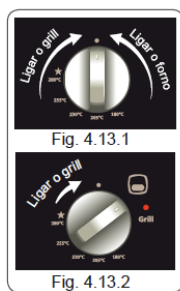


Fig. 1. Misuse of arrows and labels in images

prompt perception of warning information in the instructional materials was jeopardized since there was no element to call users' attention, which is a key element for warning communication success [13]. Furthermore, some warnings were not in line with the recommendations mentioned herein (e.g., use of signal words).

2.1 Redesigning the Instructional Material

Based upon the outcomes of the instructional material assessment allied to recommendations from theoretical and empirical research on the fields of information ergonomics and information design, redesigned versions of the manual and pocket guide were produced. The content was grouped into levels of headings with typographic distinction; boxes, signal words and exclamation marks were employed to call attention to warnings; onomatopoeic words were added in the text to represent the audible feedbacks, and the visual feedbacks were represented in the images of the stove touch panel; word labels were added to the inventorial image; and arrows were clearly used to represent movement in the images. Afterwards, the redesigned material was validated with users and assessed by the manufacturer expert team, as briefly described next.

3 Consulting Users and Manufacturer Expert Team

The proposed instructional materials were validated with 12 members of the manufacturer expert team. They assessed aspects of information design/graphic presentation and content through a protocol with 47 items for the pocket guide and 53 items for the manual (five items were added regarding content navigation in the manual) presented as heuristics. The results were analyzed qualitatively.

In general, the experts' views on the graphic presentation of the redesigned manual and pocket guide were positive, ratifying the decisions made on the visual layout of the material. However, the experts disagreed on the content of the instructional materials. Some considerations were even conflicting, as in the use of onomatopoeic words for audible feedbacks, and in the amount of information provided to users. Since the information content was generated by the experts themselves, their non-agreement in this matter may indicate weakness in the content management for instructional material for users by the manufacturer expert team. This led to drawbacks in the design process for the materials, since the definition of information content took longer than expected. With the adjustments made in the redesigned manual and in its pocket version, they were then validated with users, as explained next.

4 Validating with Users: Usability and Readability

The validation of the instructional materials occurred through a usability test of the pocket user guide, and a readability test of the manual. This research approach was based upon the premise that to learn how to use the stove, users would first interact with the pocketed guide (as it would be taken as a straightforward document), and in case of doubts or for further information, users would consult the full manual (as it would be taken as a more comprehensive document).

4.1 The Usability Test of the Pocket User Guide

The usability test of the redesigned pocket guide was conducted with 12 participants in laboratorial condition, i.e., at the manufacturer premises. It aimed to verify the effectiveness of the material as a support to the product use; and participants' understanding of and satisfaction with the proposed redesign. Data was collected through observation and task verbalization, followed by semi-structured interview. The variables considered were content and graphic presentation of the pocket guide (independent variables - X); task performance, satisfaction and content understanding by participants (dependent variables - Y). The testing material consisted of a prototype of the pocket guide, the stove, a testing protocol and an interview protocol with 19 questions. The procedures were explained to participants, who carried out the tasks individually and separately. They were asked to use the stove according to the information provided in the pocket guide, verbalizing their actions during task performance. When necessary, the researcher encouraged verbalization by asking questions. After completion of the tasks, a semi-structured interview was conducted on the pocket guide readability, legibility, graphic presentation, as well as participants' satisfaction with the material. The test was video recorded and the results were analyzed in a qualitative manner, however numbers were used to indicate trends. Task performance was analyzed to identify errors based on Barber and Stanton [16] and Rasmussen [17] human errors taxonomies. For the purpose of this study the categories considered were: Information Processing errors (related to understanding the information provided) and Action errors (related to undertaking the steps).

The results showed that all participants made mistakes when carrying out the tasks with the aid of the pocket guide. The information processing errors were mainly on the use of steam function and clock setting. These were due to: (a) omission of steps and sub-steps of the tasks, (b) misleading or lack of information sequencing; and (c) lack of clarity in some of the instructional pictures (steam oven). The use of steam function also produced action errors by all participants. Most of them (N = 11) also failed to empty the hot water reservoir, what would probably lead to burns in real situations. Five out of 12 participants (N = 5) also had difficulties in using the bowl for cooking with steam, and expressed their worries regarding burn risks. Moreover, action errors occurred in the use of digital touch panel due to participants' difficulties in associating several functions to a single key as required in some tasks.

In the interviews, participants gave satisfactory answers to the understanding of warnings, stove installation and cleaning, as well as to the care with the ovens, grill, and steam functions. However, there is a conflict between the outcomes of task performance and the answers of the interviews. Although participants seemed to understand the information provided in the pocket guide when asked about them, they failed in performing certain steps, particularly those related to the steam function. This was considered by the participants the most difficult function to be used, whether due to its complexity (involving several steps) or participants' lack of familiarity with this kind of stove. These results indicate a gap between comprehension and task performance in the scope of product usage + instructional material. This may also be due to drawbacks in individuals' action plan for using the product, caused by a lack of information in the instructional material that lead to inaccurate inferences in task performance [7] [8] [5] [6]. Thus, users' information needs seem not properly accounted for in the instructional material tested.

Regarding participants' opinions on the graphic presentation of the pocket guide, in general they were positive to most items (typography hierarchy and articulation, page layout, images). Nevertheless, participants criticized the graphic presentation of warnings, of functions of the touch panel and of the bowl for steam cooking. Moreover, participants criticized the product for considering it complex and lacking safety features. Despite possible drawbacks in the product design, such impressions were related to participants' difficulties in using the touch panel and the steam function during task performance based upon the information provided in the pocket guide.

These results reveal that deficiencies in the content (e.g., poor sequencing or omission of information) negatively influenced participants' opinions on the graphic presentation of the pocket guide and on the product. This indicates that the completeness of information content in instructional material affects its aesthetic appreciation by users, and might affect users' empathy with the product. Thus, the usability of instructional material in task performance affects users' judgment of a product.

4.2 Readability Test of the Manual

The readability test of the redesigned manual was conducted with 10 participants and looked at understanding of text and images, participants' information searching/finding strategies, and their opinion on the instructional material. Data was collected through semi-structured interview with information searching tasks. The variables considered were content and graphic presentation of the manual (independent variables - X); content (image and texts) understanding and information searching/finding by participants (dependent variables - Y).

The material consisted of a prototype of the redesigned manual and an interview protocol with 24 questions on comprehension and information searching. To allow comparing responses across tests, 19 questions were the same of the usability test interview, and five were specific questions for the redesigned manual. Participants were interviewed and asked to find information in the manual individually and separately. The interviews were audio recorded and the results were analyzed in a qualitative manner, however numbers were used to indicate trends.

The results of the readability test of the redesigned manual, in general, ratify those of the pocket guide usability test. The explanation on the use of the steam function and the touch panel produced poor responses on comprehension, and they seemed complex to the participants. Moreover, participants complained about technical and unusual terms in the text, and unclear information sequencing, which prevent them to understand/follow the instructions. On the other hand, their responses on warnings, stove installation and cleaning procedures were satisfactory. The majority of participants (N=9) found the manual would be relevant in assisting task performance.

Regarding participants' information searching/finding in the redesigned manual, most results was satisfactory. The table of contents was accessed as a searching source by all participants whether always or sometimes (when the participant could not find the information requested perusing the manual brochure). Headings, highlighted words (bold, and color) and color boxes were also employed to find information on the manual pages. These results ratify the importance of using table of contents and typographic articulation to facilitate information searching/finding and document navigation in the instructional material, as previously mentioned in this paper.

5 Improving the Redesigned Material

Based upon the results of the usability and readability tests, adjustments were made in the redesigned manual and pocket guide to improve their effectiveness in communicating instructions on using the stove. Warnings were emphasized in the text; information

Table 1. Comparison between the existing manual and pocket guide and their redesigned versions

Existing Pocket guide & Manual	Redesigned versions
Drawbacks identified	Solutions proposed [stakeholder feedbacks]
Graphic presentation	
• Poor page layout grid	• Fix grid for page layout
• Graphic inconsistency in pictorial depiction and lack of accuracy	• Definition of picture style and accuracy in depiction
• Cross-reference in inventorial image	• Labels in inventorial images
• Lack of inventorial image of the touch panel and stove accessories	• Inclusion of images
• Lack of/poor typographic hierarchy and consistency	• Inclusion of heading levels and typographic consistency
Information content	
• Omission of information	• Inclusion of steps and detailed explanations
• Lack of/misleading information sequencing	• Inclusion of numbers and space
• Lack of introductory information on the touch panel	• Inclusion of introductory content
• Lack of distinction for warnings, instructions and headings	• Typographic differentiation for warnings, instructions and headings (box, bold, type size)
• Lack of audible feedback	• Inclusion of feedback
• Technical terms	• Use of plain language
• Wording inconsistency	• Use of specific wording according to task (e.g., press, select, turn)
Navigation/information searching	
• Few/lack elements in the table of contents for document navigation and attention	• Inclusion of elements

sequencing and grouping were improved to meet participants' demands; images and content were added to better explain the touch panel functions and the steam function. Table 1 shows a comparison between the existing manual and pocket guide and their redesigned versions based on the feedbacks of stakeholders, presented in this paper.

6 Final Considerations

Based on the results and outcomes of the tests and interviews, it can be concluded that in general the redesigned manual and pocket guide for the stove were satisfactory in their graphic presentation of information to users. However, the instructions provided were not sufficient to a successful use of some functions, due to ergonomic drawbacks in the product design and in its digital touch panel. This might led to users' cognitive overload in task performance, which could not be prevented, but only minimized by the instructional material. In this sense, it is worth mentioning the comment made by one participant during an interview: *'The product is complicated. It has many new features and hidden functions in the panel. The manual is of assistance, but not enough to make the stove easier to use'*. This impression points to the need of more intuitive products in their use, so as to make instructional material unnecessary, what is claimed in the literature [1] [3] [4].

The outcomes of this study corroborate to the need of a user-centered design approach to the design of instructional material. It should no longer be seen as a technical complex product document, hence a difficult-to-read artifact. But it should be considered a communication source, an artifact that mediates the user-product-task relationship. Moreover, instructional material is an adding-value component in the manufacturer-consumer liaison, and therefore it is part of the branding, and as so should be seen by manufacturers.

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