Hand Tools: A Study of the Perception of Domestic Users and Woodwork Professionals

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ABSTRACT

The use of some hand tools, utilized within the process of manufacturing wood products, is already popular in the activities of maintenance and setup in domestic environments, which creates groups of users with distinct repertoires, as well as differentiated frequency and kinds of use, with equal mastery of judgment and shopping decision. In the moment of the decision process leading to acquisition, the visual sensorial modality is the most important one. And, sometimes, information about such tools is acquired in catalogs, virtual shops and packages that provide interaction exclusively at the visual level. In order to know the perception of users about some hand tools, parting from visual interaction with them, subjective opinions were collected through: inquisition about the process and criteria on selecting tools, semantic differential tests and evaluation of the perception of comfort through the pair comparison method. Among the results obtained we can highlight that: the aspect “safety” is considered by both user groups as the most important in the moment of selecting the tool; and some users, both domestic and woodwork professionals, relate tool handling with difficulty of use and discomfort.

Keywords: visual perception, semantic differential, importance ordination, hand tools.

INTRODUCTION

Hand tools are mediation instruments of constructive and productive human activity, whose physical structure is supported by the operator’s handhold during the course of the activity. Constructive activities are those that help construction of greater knowledge about the human action, for which we have, for instance, measure tools. And, productive activities are those that involve the conformation and material assembling (FOLCHER & RABARDEL, 2007), for which tools like hammers, drills, screwdrivers, etc are used. Hand tools can also be characterized by their driving power which can be human (non-energized tools) or pneumatic and electric (energized tools).

The conceptual model to analyze hand tools proposed by Martin et al. (1996) reveals that human overcharge factors suffer specific variations for each hand tool according to the task and subject; which means besides the application of basic ergonomics concepts, the context of use, as well as the group of individuals who will use it, are also important to obtain references for the selection and project of tools.

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The aspects valued by the consumer are called quality dimensions. For a product (ZEITHAML,1990; GARVIN,1987 *apud* CARVALHO,2008) the main quality dimensions are: performance (operational aspects), characteristics (secondary characteristics), reliability (fallibility of a product), conformity (degree in which the product is up to pre-established standards), durability (economical according to its life cycle), service (services associated to the product), aesthetic (appearance), observed/perceived quality (consumer's inference based on perception).

The decision process leading to selection is a cognitive process, which involves judgment and decision making, with the end of selecting options and evaluate opportunities (STERNBERG, 2008). The moment of choice is the consumer's first contact with the hand tool. In this stage of interaction with the product, the visual sensorial modality is the most important one in the decision process leading to acquisition (FENKO et al., 2010).

The highlight for vision as the main sensorial receiver in the moment of selection leading to acquisition reinforces that the product's apparent congruence with design sensorial aspects is important (SMETS and OVERBEEKE, 1995). The initial judgment about a product starts at the first perception the user has about it, with driven attention to desirable traits, and sometimes a comparative evaluation between available products.

Desirable traits in certain products can be described by adjectives, which build a profile of ideal qualities for a given product. The technique called semantic differential, which has been widely applied in marketing and design studies, was developed by Charles Osgood, and generates a semantic profile of the products from a subjective analysis of the products through pairs of descriptors with opposing meanings, which form scales of bipolar evaluation. (VAN DER LINDEN, 2007).

Considering one of the most common forms of daily evaluation of products through comparison, the area of psychophysics has the method of evaluation by pairs, which structures a comparative analysis between pair of objects, generating a ranking between compared objects.

Hand tools are present in work and domestic environments, being, many times, categorized by the commercialization system, respectively, as wither professional or domestic tool. However, in the city of Manaus (in the state of Amazonas, Brazil) it is possible to observe the use of hand tools of similar brands and models in distinct environments by different users: in domestic environments, by people who handle them sporadically for maintenance and domestic Setups; and by professionals in small woodwork companies for production activities. Among the most used hand tools in both environments are the drill and the hammer – which were selected for this study.

Given the increasing need to orient conception and adequate selection of hand tools to distinct groups of users and end activities (production, maintenance, Setup), this study seeks to comprehend whether typical users, of different repertoires, have similar perceptions about hand tools from visual interaction with them – which corresponds to the most important sensorial modality in the moment of the decision process leading to acquisition.

MATERIALS AND METHODS

In order to verify the perception of typical users about some hand tools, a protocol was applied to extract subjective opinions about: aspects considered when choosing a tool, products semantic profiles, evaluation of perceptual differences on comfort by comparing products by pairs. Four hammers and 4 drills were chosen for the study and the subjects were twelve individuals belonging to three groups of users.

Objects of Study

The tools chosen as objects of study were drill and hammer. The interest for these tools is especially because the verification of their use, in similar brands and models, by different user profiles, and employed in distinct environments: in domestic ones, by people who handle them sporadically, and in small companies in Manaus (in the state of Amazonas, Brazil), by professionals of woodwork. In the domestic environment these tools are used for maintenance of products, residential spaces and Setup of consumption products. In joinery workshops these tools make up the resources utilized for manufacture.

For every kind of tool (drill and hammer) 4 (four) models were selected, whose selection criterion was formal differentiation between models, especially their handle and drive systems.

For the drills group 4 (four) pistol-type handhold tools were selected, with differences on their handle possibilities, such as: one handle (A), two front-rear handles (B), two front-side handles (C), and two close fisted front-rear handles (D) (Figure 1).

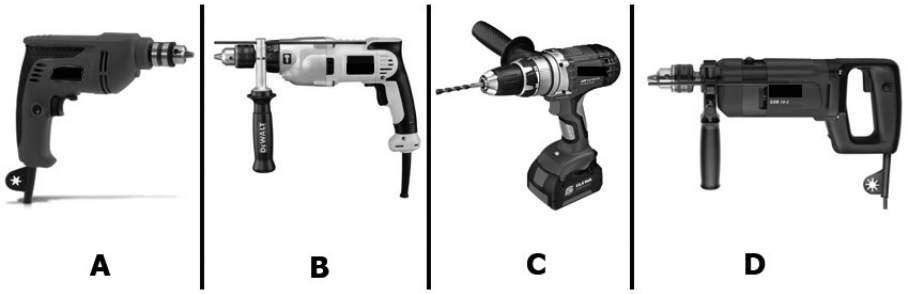

Figure 1 – Drills: four models studied.

For the hammers group 4 tools with formal diferences were selected, especially their handles (handle area) (Figure 2).

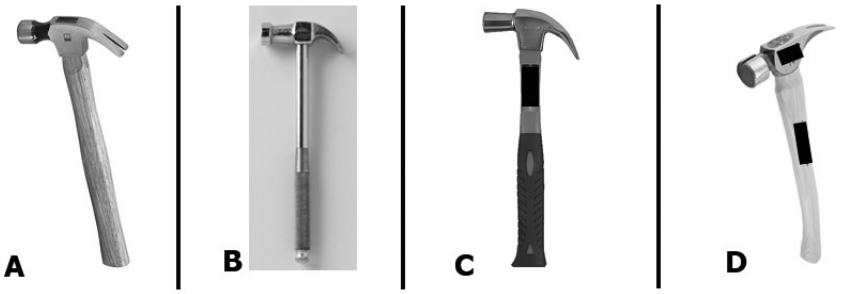

Figure 2 – Hammer: Four models studied.

Subjects

12 volunteer subjects participated in this study, out of which 4 are woodwork professional, 4 are domestic users whose profession (either of project or repairing consumption products) grants them familiarity with certain hand tools, and 4 are common domestic users, whose professions do not grant them contact with these types of tools. We have called these groups of users, respectively: woodwork professionals, semiprofessional users and domestic users. Table 1 summarizes the characteristics of these subjects.

Table 1 – Main characteristics of the 12 volunteer subjects

	Woodwork Professionals	Semiprofissional Users	Domestic Users
Age: average (standard deviation)	44 (15, 3)	40 (7,9)	44 (8,9)
Gender: male/female	4/0	3/1	4/0

Laterality: right-handed/left-handed/ ambidextrous	4/0/0	3/0/1	3/1/0
Education: Elementary/ High School/ Graduation/ Post Graduation	1/3/0/0	1/0/0/3	2/1/1/0
Professional Activity:	4 woodwork professionals	1 clockworker 3 Design Professors	1 Butcher 1 Counter Assistant 1 Postman 1 Public Officer

Procedures

The volunteers' subjective opinions were collected through: questionnaire, Form with bipolar evaluation for semantic differential accompanied by individual file with illustrations of every tool, and pair comparison evaluation form. The questionnaire comprises use, choice and purchase of tools.

Definition of Descriptor Semantic Pairs

With the objective of identifying the expectation and perception of users on the tools, the Semantic Differential technique was applied, to outline a profile of the ideal tool and evaluate the real value of the tools analyzed when compared to the ideal value, according to the subjects. The opposing descriptor pairs were applied in a bipolar scale of five levels, with zero as the center between values 1 and 2, in opposite directins, so as to avoid induction and reflect the scale's bipolarity. Each tool (four hammers and four drills) was presented to the subjects in files, with an individual picture followed by the scales with opposing descriptors (Table 2).

Table 2 – Bipolar Scale with five levels and eleven pairs of opposing descriptors

	2	1	0	1	2	
Beautiful						Ugly
Complex						Simple
Large						Small
Safe						Dangerous
Cheap						Expensive
Resistent						Fragile
Heavy						Light
Efficient						Inefficient
Flashy color						Discrete color
Easy to store						Difficult to store
Rugged handle						Smooth handle

The eleven pairs of opposing descriptors were generated through brainwriting among the members of the research team (Table 3), having as a reference the adjectives and expressions used in product description, applyable to hand tools, and the groups of value factors of a product (BACK, 1983): aesthetic (refering to the emotional relationship between person and product), economical (which result in the product's total cost for the consumer), ergononomic (refering to the relation between the settings of the product's parts and the anatomical parts of man, as well as the comunicational aspects of the product so that the information may be received and interpreted the best way by people) and technical (refering to performance aspects).

Table 3 – Categories of Value factors and opposing descriptors

Factor Categories	Examples of Value Factors	Listed Opposing Descriptors
Aesthetic	Design, shape, color, texture, taste, smell.	Beautiful/Ugly Flashy Color/Discrete Color
Economical	Cost per unit, consumption, maintenance cost, economical life.	Cheap/Expensive
Ergonomic	Dimension, shape, texture, trigger types (pedals, switches, buttons), comunication	Complex/Simple Large/Small

	devices.	Safe/Dangerous Heavy/Light Easy to store/difficult to store Rugged handle/smooth handle
Technical	Material's resistance, precision, speed.	Resistant/Fragile Efficient/Inefficient

The importance between groups of value factors vary according to the type of product – consumption goods or capital goods (BACK, 1983). Specifically hand tools, as capital goods, have technical and economic factors more valued than ergonomic and aesthetic ones, as the first ones bear a lot more weight at the moment of choice.

Pair Comparison

In order to collect opinions about the perception of comfort similar to daily judgments that people make indirectly when they see a product's catalog or package, the method of Pair Comparison was applied, which allows comparative evaluation of perceptual differences between many products.

For this study, two groups of products were selected: a group of four hammers and another of four drills. Considering the presentation of objects in pairs, in all possible combinations, for comparison, with 4 being the number of products, it's possible to obtain the even number of combinations through the formula ((4)(4-1))/2, which equals 6 pairs of hammers and 6 pairs of drills for comparative evaluation.

Each subject was presented files with images of products in pairs, with the question below: "Which hand tool is more comfortable?"

RESULTS AND DISCUSSION

Use, choice and purchase of hand tools

Among the tools and equipment most used for work by woodwork professionals, the 3 most mentioned were: hammer, drill and chisel.

The main maintenance and Setup activities done by semiprofessional and domestic users in a domestic environment are: setup and maintenance of furniture (shelves, armoires, TV stands; with a highlight for shelves, the most mentioned) and repairs in domestic environments (doors and locks; sockets, light bulbs and wires; sink valves). The activities of setup and maintenance for decoration objects, accessories and appliances were seldom mentioned. When asked about hand tools they used for such domestic maintenance and setup activities, users pointed out 12 tools, out of which the most mentioned were, respectively: drill, hammer, screwdriver and pliers.

They were asked whether there was any difficulty in using the tools. Out of the 12 subjects asked, 5 mentioned difficulties (2 woodwork professionals; 3 semiprofessional users). Woodwork professionals pointed out difficulty in using: hand tools for demanding a lot of physical effort, auxiliary tool accessories, hammers with iron cylindrical handle. Semiprofessional users pointed out difficulty in using the drill, and the lack of comfort due to handle shape.

In the moment of choosing the tool, some visual aspects give out indicatives of the tool's traits, along with that some previous knowledge or data found in the product's package can also be used in the process of decision leading to acquisition. In order to identify the characteristics considered in the moment when users choose the tools, a list with 11 aspects was presented: weight, size, handle type, trigger type, handling accessories, number of auxiliary items, previous knowledge, indication, quality, price, ease of performing purchase. The subjects were asked to number the aspects presented in the list in order of importance. The item most mentioned as one of the three most important considered in the moment of choice was quality, followed by previous knowledge of the tool and weight; handle type, price and handling accessories.

All users go to stores to purchase tools, and one of the woodwork professionals informed he also acquires tools through orders from catalogs, but none of the users asked uses the internet to perform this type of purchase. Two of the woodwork professionals said purchasing hand tools is done only by the joinery's owner.

Semantic Profile of hand tools: the ideal and the real

In order to help determine the semantic profile of an ideal hand tool, the median of the answers of all 12 subjects in the opposing descriptors bipolar scale was adopted. (Table 4).

Table 4 – Semantic Profile of the ideal tool.

	2	1	0	1	2	
Beautiful		■■■	■			Ugly
Complex		■		■■■		Simple
Large			■■■■			Small
Safe	■■■■					Dangerous
Cheap		■		■■■		Expensive
Resistent	■■■■					Fragile
Heavy		■			■■■	Light
Efficient	■■■■					Inefficient
Flashy color			■	■■■		Discrete color
Easy to store	■■■■					Difficult to store
Rugged handle	■■■	■				Smooth handle

■ ideal semantic profile out of all subjects' answers
■ ideal semantic profile out of domestic users' answers
■ ideal semantic profile out of semiprofessionals' answers
■ ideal semantic profile out of professionals' answers

Upon evaluating the 4 (four) models of drills (Tables 5 and 6), the trait "beautiful" for drills C and B have more indications and drill D is clearly assessed as "ugly"; the aspect "simplicity" was clearly indicated for model A; model B was characterized as "big" and D as "very big", model C was considered "small" and A leaned towards median size. All drills were characterized as safe. As for monetary value, only drill A was assessed "cheap". All models were considered "resistant", with some of the indications of "very resistant" for models B and D, which were also considered "heavier" and "very efficient". Models A and C were considered "efficient"

Table 5 – Semantic Profiles of Drill A and Drill B

	Drill A					**Drill B**					
	2	1	0	1	2	2	1	0	1	2	
Beautiful		■■	■■			■	■■		■		Ugly
Complex				■■■	■	■	■	■	■		Simple
Large		■	■■■				■■■ ■				Small
Safe		■■■ ■				■■■	■				Dangerous
Cheap		■■■	■						■■■	■	Expensive
Resistent		■■■ ■				■■	■■				Fragile
Heavy		■	■■■			■	■■■				Light
Efficient	■	■■■				■■■ ■					Inefficient
Flashy color	■	■■■				■■	■■				Discrete color
Easy to store	■	■■		■		■	■■			■	Difficult to store
Rugged handle		■■	■	■		■	■■■				Smooth handle

■ semantic profiles of drills A and B out of all users'answers
■ semantic profiles of drills A and B out of domestic users' answers
■ semantic profiles of drills A and B out of semiprofessionals' answers
■ semantic profiles of drills A and B out of professionals' answers

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Only dark blue model D was characterized as having a discrete color; the other red, yellow and light blue models (A, B, C) were assessed as having "flashy colors", yellow model B having the most indications of highly flashy color. Drill A leaned towards "being difficult to store". Only drill A leaned towards having a "smooth handle", by the semiprofessionals' group. Among the assessed drills, model D is the one that presents some aspects which are different from the ideal semantic profile, they are: lack of "beauty" and being "difficult to store".

Table 6 – Semantic Profiles of Drill C and Drill D

	Drill C					**Drill D**					
	2	1	0	1	2	2	1	0	1	2	
Beautiful	■	■■	■						■■■ ■		Ugly
Complex	■		■■	■				■	■■■		Simple
Large			■	■■■		■■■ ■					Small
Safe	■■■	■		■		■■■ ■					Dangerous
Cheap			■	■■■					■■■ ■		Expensive
Resistent		■■■ ■				■■■	■				Fragile
Heavy			■■■	■		■■■	■				Light
Efficient	■	■■■				■■■ ■					Inefficient
Flashy color	■	■■		■					■■	■■	Discrete color
Easy to store	■	■■	■				■		■■	■	Difficult to store
Rugged handle	■	■■■				■■	■■				Smooth handle

■ semantic profiles of drills C and D out of all users' answers
■ semantic profiles of drills C and D out of domestic users' answers
■ semantic profiles of drills C and D out of semiprofessionals' answers
■ semantic profiles of drills C and D out of professionals' answers

Upon evaluating the 4 (four) hammer models (Tables 7 and 8), models B and C were assessed as "beautiful", and model D only leaned towards "beautiful" in semiprofessionals' judgment, and model A didn't lean towards any of the opposing descriptors – beautiful/ugly. All models were considered either "simple" or "very simple", and model A was considered "very simple" by all asked user groups. As for size, the only hammer considered large by professionals and semiprofessionals was model C. And the only model considered dangerous was hammer A.

Table 7 – Semantic Profiles of Hammer A and Hammer B.

	Hammer A					**Hammer B**					
	2	1	0	1	2	2	1	0	1	2	
Beautiful			■■ ■				■■ ■				Ugly
Complex					■■■				■■■		Simple

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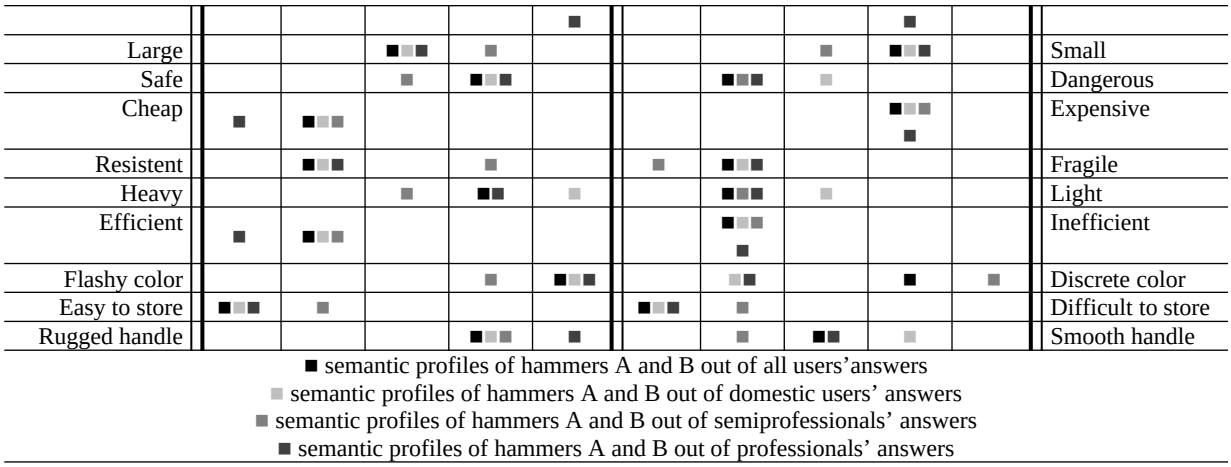
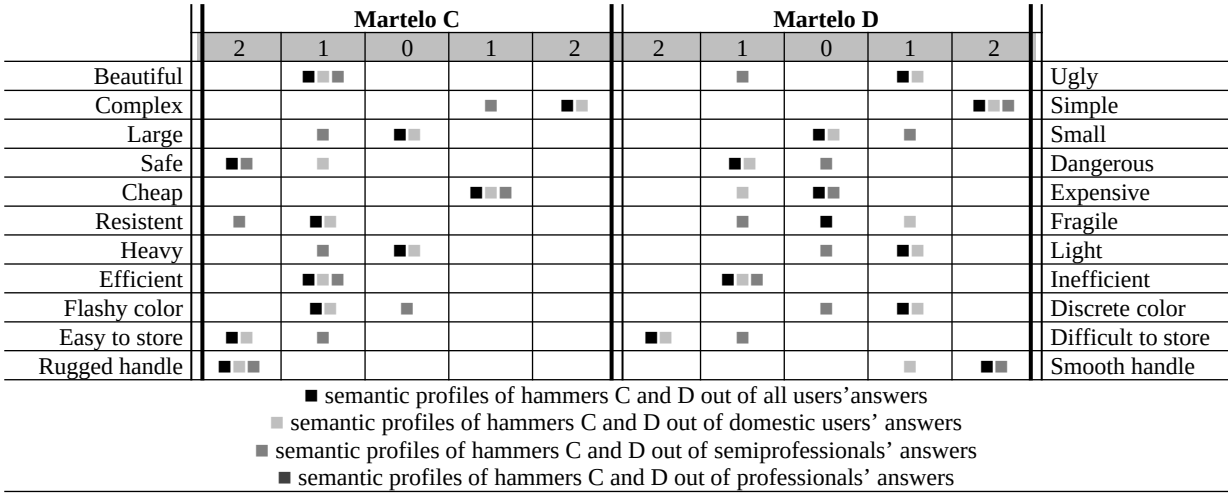


Table 8 – Semantic Profiles of Hammer C and Hammer D.



All subject groups considered models B and C "expensive". Semiprofessionals considered hammer A "fragile" and professionals and domestic users considered model D "fragile". Model B leaned towards being considered "heavy". All models were considered "easy to store". All groups assessed hammer C as a "rugged handle" type of model; hammers A and D were assessed as having "smooth" and "very smooth" handles, and model B didn't lean clearly to any opposing extreme descriptors (rugged/smooth). Out of the assessed hammers, models D and A show some aspects which are different from the ideal semantic profile; model D turned away from the ideal tool in the aspects lack of beauty, average resistance and smooth handle; model A, in turn, because of the aspects little safety and smooth handle.

Comparative Analysis on comfort perception

By the Number of indications each drill received, being considered more comfortable than the other models it was compared to (Table 9), we have the following ranking of most comfortable drill: models B, C, D, A.

Table 9 – Pair Comparison of Drills A, B, C and D.

All Subjects – Comfort Comparison of Drills					**Domestic Users** – Comfort Comparison of Drills				
Pairs of Drills	Frequency		Percentage		Pairs of Drills	Frequency		Percentage	
	1st of the pair	2nd of the pair	1st of the pair	2nd of the pair		1st of the pair	2nd of the pair	1st of the pair	2nd of the pair
AB	5	7	42%	58%	AB	2	2	50%	50%
AC	5	7	42%	58%	AC	2	2	50%	50%

AD	6	6	50%	50%	AD	2	2	50%	50%
BC	8	4	67%	33%	BC	3	1	75%	25%
BD	6	6	50%	50%	BD	2	2	50%	50%
CD	7	5	58%	42%	CD	2	2	50%	50%

Semiprofessionals – Comfort Comparison of Drills					**Professionals** – Comfort Comparison of Drills				
Pairs of Drills	Frequency		Percentage		Pairs of Drills	Frequency		Percentage	
	1st of the pair	2nd of the pair	1st of the pair	2nd of the pair		1st of the pair	2nd of the pair	1st of the pair	2nd of the pair
AB	1	3	25%	75%	AB	2	2	50%	50%
AC	2	2	50%	50%	AC	1	3	25%	75%
AD	2	2	50%	50%	AD	2	2	50%	50%
BC	4	0	100%	0%	BC	1	3	25%	75%
BD	2	2	50%	50%	BD	2	2	50%	50%
CD	2	2	50%	50%	CD	3	1	75%	25%

Table 10 – Pair Comparison of Hammers A, B, C e D.

All Subjects – Comfort Comparison of Hammers					**Domestic Users** – Comfort Comparison of Hammers				
Pairs of Hammers	Frequency		Percentage		Pairs of Hammers	Frequency		Percentage	
	1st of the pair	2nd of the pair	1st of the pair	2nd of the pair		1st of the pair	2nd of the pair	1st of the pair	2nd of the pair
AB	9	3	75%	25%	AB	2	2	50%	50%
AC	2	10	17%	83%	AC	0	4	0%	100%
AD	9	3	75%	25%	AD	4	0	100%	0%
BC	1	11	8%	92%	BC	0	4	0%	100%
BD	5	7	42%	58%	BD	3	1	75%	25%
CD	11	1	92%	8%	CD	3	1	75%	25%

Semiprofessionals – Comfort Comparison of Hammers					**Professionals** – Comfort Comparison of Hammers				
Pairs of Hammers	Frequency		Percentage		Pairs of Hammers	Frequency		Percentage	
	1st of the pair	2nd of the pair	1st of the pair	2nd of the pair		1st of the pair	2nd of the pair	1st of the pair	2nd of the pair
AB	3	1	75%	25%	AB	4	0	100%	0%
AC	0	4	0%	100%	AC	2	2	50%	50%
AD	1	3	25%	75%	AD	4	0	100%	0%
BC	1	3	25%	75%	BC	0	4	0%	100%
BD	1	3	25%	75%	BD	1	3	25%	75%
CD	4	0	100%	0%	CD	4	0	100%	0%

By the Number of indications each hammer received, being considered more comfortable than the other models it was compared to (Table 10), we have the following ranking of most comfortable hammer: models C, A, D, B.

The two drills considered most comfortable by the method of pair comparison, models B and C, have the presence of two handle areas in common which grant them better support at performing tasks. The shape of handles and auxiliary handling systems were some of the aspects mentioned as the most important at the moment of purchase. These two models were assessed by subjects as drills with “rugged” handles, trait which is part of the ideal tool’s profile as described by the answers in the research. Other traits pointed out as ideal, which were identified in drill models B and C were: “safe”, “resistant” and “efficient”.

The two hammers indicated as most comfortable by the method of pair comparison, models C and A, were those whose shapes are the easiest to find in the market. Model C, considered the most comfortable among all other models is the one which fulfills every characteristic for an ideal tool described by subjects, whereas model A (second best), doesn’t express some of the characteristics expected by subjects, such as: “beautiful”, “safe” and having a “rugged handle”.

FINAL CONSIDERATIONS

All three user groups (professional, semiprofessionals and domestic users) value, in hand tools, traits related to

technical factors (resistance, efficiency), ergonomic (rugged handles, storing ease, safety).

The models of hammer and drill considered most comfortable have in common greater compliance to the traits described by subjects in the profile of the ideal tool. Among these traits, the ones which are directly related to the tool's morphology are size, weight and handle. In the description about difficulties in using tools, subjects who had some sort of difficulty related that to the characteristics of handle shape.

The results of this exploratory study confirm the importance given to technical factors for products which are capital goods, and reveals that ergonomic factors are also being valued, especially for hand tools. Among the traits related to ergonomic factors, handle morphology deserves in-depth studies to describe its characteristics and relations with perception of comfort.

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