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A Study on Situated Cognition: Product Dissection's Effect on Redesign Activities

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ABSTRACT

Situated cognition theory describes the context of a learning activity's effect on learner's cognition. In this paper, we use situated cognition theory to examine the effect of product dissection on product redesign activities. Two specific research questions are addressed: 1) Does situated cognition, in the form of product dissection, improve product functionality during redesign exercise?, and 2) Does situated cognition, again in the form of product dissection, affect the creativity during product redesign? In this study, three sections of first-year students in two different locations – The Pennsylvania State University (Penn State) and Missouri University of Science and Technology (S&T) – performed product redesign using coffee makers. The redesigned products have been analyzed with respect to both depth (detail level) and creativity. Based on our results, we find that situated cognition, in the form of product dissection, improves product functionality during redesign and positively affects creativity. The implications of these results are also discussed.

Key Words: product dissection, situated cognition theory, product redesign

INTRODUCTION

According to Ferguson [1] and Petroski [2], modern students are less prepared for success in engineering because they spend a significant amount of time using computers and doing less "hands on" activities. Findings by other entities such as the Federal Government, industry and engineering societies also noticed a decline in the quality of undergraduate engineering education [3,4]. Since 1991, collegiate engineering programs have begun to incorporate product dissection [5-7], a technique used by many corporations, into curricula to improve engineering education.

In industry, engineers usually use product dissection as the first step for benchmarking: "a systematic way to identify, understand, and creatively evolve superior, products, services, designs, equipment, processes, and practices to improve [an] organization's real performance" [8]. Competitive benchmarking is a common practice in the automotive industry in manufacturers such as General Motors [9], Chrysler [10], and Ford [10], as well as suppliers such as Lear, Johnson Controls, TRW and Motorola [11-13]. The reasons for the proliferation of this practice are many, but they may be best summed up by auto industry analyst Lindsay Brook, (quoted by Hoffman on the importance of competitive teardowns) "as much as you think you know, nothing beats picking up the parts, feeling them, weighing them, and knowing the processes that made them" [9].

The practice of benchmarking is not solely used to learn from competitors' products; it is often used to improve a company's own products through the internal benchmarking process. The annual Supplier Innovation Challenge, hosted by Whirlpool, is an example of corporate internal benchmarking [14]. The competition encourages suppliers to dissect Whirlpool products to identify potential cost reductions, quality improvements, and innovative ideas. With these types of activities showing measurable improvements for the corporations, savings of $7 million in the Whirlpool case [14], product dissection has caught the eye of many engineering educators.

The premise of integrating product dissection into the engineering curriculum – particularly at the undergraduate level – has been to enable students to apply engineering principles coupled with significant visual feedback [3]. Through its integration into the classroom, product dissection has been found to: 1) increase awareness of the design process [11]; 2) encourage the development of curiosity, proficiency, and manual dexterity [12]; 3) give students early exposure to fully operational and functional products and processes; as well as 4) increase motivation and retention [13]. Furthermore, a related study on students' perception of dissection activities has shown that students have a positive perception toward dissection and that design teams that utilize dissection activities report greater workload sharing, team satisfaction, and team viability [15].

Given that several benefits of product dissection have been documented in both corporate and academic settings it is important that the impact of product dissection on student cognition is measured and understood to continue its suitable integration into undergraduate engineering curricula. To investigate the impact of product dissection on cognition, the classroom activity must be categorized with a cognitive framework. Situated cognition is a theory used to describe the context of a learning activity's effect on learner's cognition [16]. Within the theory of situated cognition there exist cognitive apprenticeships. A cognitive apprenticeship enables learning as a product of the activity or context in which it is developed and used [17]. The product dissection activity can be considered a form of cognitive apprenticeship [18] because students learn about the product and its design features as they are participating in the activity.

By investigating product dissection as a specific type of cognitive apprenticeship, its effect on two types of design cognition, namely, functionality and creativity, can be measured. To undertake this investigation, a study was conducted at the Missouri University of Science and Technology (S&T) and the Pennsylvania State University (Penn State). The results from the study quantitatively demonstrate product dissection's impact on student cognition. Furthermore, when combined with the engineering education framework for disassemble/analyze/assemble activities [19], this study will assist engineering educators in determining the most appropriate place for product dissection activities within the undergraduate engineering curriculum.

The remainder of this paper is organized as follows. In the next section, we discuss the research questions with regards to functionality and creativity that we investigate in this study. Section 3 details the experimental set up that we used. In Section 4, we analyze the results and discuss their implications. Finally, closing remarks and future work are offered in Section 5.

PRODUCT DISSECTION'S EFFECT ON COGNITION: RESEARCH QUESTIONS

Our experimental research study into product dissection's effect on cognition focuses on two main research questions: 1) Does situated cognition, in the form of product dissection, improve product functionality during redesign? and 2) Does situated cognition, again in the form of product dissection, affect creativity during product redesign? Each question has roots in both product design and situated cognition theories. As discussed in the following sections, the investigation of these two questions in a multi-university experimental setup has established quantitative measures of product dissection's impact on engineer's abilities with respect to both depth and creativity of product designs.

Research Question 1: Does Situated Cognition, in the Form of Product Dissection, Improve Product Functionality During Redesign?

Product functionality is a central theme of importance in a significant amount of product design research and education efforts. Therefore, the impact of product dissection on students' understanding and use of functionality as a design tool is important to determine. Prior research suggests that objects, like the ones involved in product dissection, are integral parts of design communication and alter the dynamics in a multi-designer setting [20]. Furthermore, 83% of design actions involve material artifacts [21], and material representations are often used as starting points of design proposals [22]. While research clearly suggests that objects and material representations play a significant role in product design activities, it is necessary to determine if the exposure to material artifacts through product dissection improves students' understanding of product function.

This research question is investigated in this multi-university study by examining the redesign of a consumer product by student design teams. The redesigned products are evaluated with respect to the number of redesigns that include functional changes or alterations rather than just product form changes. Half of the student sample has previously participated in product dissection activities involving the products that they are redesigning while the other half has no experience dissecting the product. In the experimental data evaluation, redesigns will be considered more thorough if they contain changes in both form and function.

Research Question 2 - Does Situated Cognition, in the Form of Product Dissection, Affect the Creativity of Product Redesigns?

Creativity is a key component of good product design and must not be adversely affected by what we teach in the engineering curriculum. Prior work has indicated that product dissection provides a rich source of ideas for both product and process design and redesign [23, 24]. However, product dissection exposes students to single design solutions; therefore, it is important that this learning activity does not cause fixation on the given design, i.e., hinder their creativity. Thus, the design outcomes (here creativity) of students that have performed product dissection learning activities and then redesigned the products must be measured and compared to students' redesigns without this exposure to the product through its dissection.

Previous research has provided various metrics for evaluating creativity during product design [25]. It indicates that for engineering processes it is more prudent to evaluate the outcome of ideas rather than occurrence of specific cognitive processes. We adopt quantity, novelty and variety to evaluate creativity in redesigned products. *Quantity* refers to the total ideas generated; *novelty* is a measure of how unusual an idea is as compared to other ideas; and *variety* is a measure of the explored solution space during idea generation [25]. While we have adopted these measures for our investigation, we only present the *quantity* measure. We also compile the generated designs according to the vantage point of the designers (external or form related vs. internal or function related) to give an indication of the variety of the generated designs.

In relation to the vantage point, we hypothesize that teams that did not do dissection (i.e., did not see the internal components of a design) would focus on designing components/features that are visible without tearing down the product and that these designs would be more form related (implying visible outside alterations), and hence, perhaps yielding a much lower variety in designs. Furthermore, we also hypothesize that if the team has done dissection, because they would see the interior components of the product, perhaps their creativity in terms of functionally relevant design variants would be low.

Overall, we aim to evaluate the product dissection cognitive apprenticeship for its effect on the creativity of product redesign activities. It is important to note that this paper does not seek to answer the question, "Can product dissection be used to teach creativity?" The concept of teaching creativity is discussed by Tornkvist [26] with respect to engineering education. Instead, the work in this paper focuses on the measurement of the adverse effect on creativity (if any) that product dissection activities imbue on engineering students.

The use of outcome-based measures is adopted in this study because observing the cognitive processes with which design ideas are generated is very difficult. This observation requires a protocol study with extensive data coding and analyses requirements. Secondly, even when data are recorded, in general, results cannot be generalized because there is no agreement on how they should be analyzed [27]. Consequently, these measures were developed using two criteria regarding the assessment of the ideation process [28]: (1) how well does the method allow students to *expand* the design space and (2) how well does the method help students *explore* the design space. This assessment of the ideation process provides insight into the students' cognition displayed by their redesign solutions.

The research questions are investigated by examining the redesigns of a consumer product produced by student design teams at two universities and assessing their results. As described in Section 2.1, roughly half of the student sample has previously participated in product dissection activities on the products that they are redesigning while the other half has not dissected the products being redesigned. In the experimental data evaluation, product design experts independently evaluate each redesign for its completeness and variety, and account for it by adjusting the different design concept count. These independent scores are used to establish inter-rater reliability and ensure accurate data analysis.

STUDY SAMPLE AND EXPERIMENTAL DESIGN

A study of product dissection as a cognitive apprenticeship was performed in an attempt to address the two research questions posed in Section 2. In the study, three sections of first-year students at two different locations (MS&T and Penn State) were included. Two of the sections were from Penn State, and they were evenly distributed into eight team sections. One of these sections (eight teams) completed a coffee maker redesign project after dissecting a coffee maker as part of their course, while the teams in the other section redesigned the coffee

Figure 1. Coffee-maker provided to the students.

maker without dissecting it; however, they were each provided with a coffee maker to inspect. All participating MS&T students dissected the coffee maker before redesigning it. A total of 81 students participated in the study across the two universities. The coffee maker used for this activity is shown in Fig. 1.

Data Collection

Subjects were instructed to document their generated ideas using morphological charts [30]. A sample morphological chart is shown in Table 1 as provided by one of the student teams. In these charts, feature-based or functionally decomposed sub-problems and possible solution ideas for each problem are placed in a matrix. The chart's structure lists all the sub-problems or functions in the first row, and proposed solution concepts or means to achieve those functions in successive rows (as shown in Table 1). After collecting the morphological charts from each team, each entry was evaluated and placed into a matrix that listed all of the sub-functions and features along with all of the generated ideas and the ownership of the ideas at the team level. A portion of the resultant table is presented in Appendix 1. Note that a total of 148 distinct ideas were generated by the teams (we only include 28 ideas in the appendix). In the table, form and function relevance and of each idea was rated by design experts.

Data Analysis

Statistical inference in the form of hypothesis testing was used to analyze the data. Specifically, Z tests [28] were used to identify the relationships between the predictors and the outcomes of the research hypotheses. The research hypotheses corresponding to Research Question 1

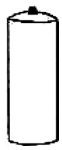
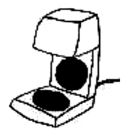
	Function				
Means	Coffee Pots	Heating Mechanism	Display	Materials	Reheating Mechanism
1	 Stainless Steel with insulating interior	 Propane in small canister	An analogue display involvng a clock with hands	Stainless steel with some kind of heat resistant plastic	 Contacts at the top conduct current to pot
2	 Glass with plastic handle	 Pre-boiled water	A digital display powered by LEDs	Black or white plastic/ composite	Heat comes from a place on which the pot is placed
3	 Tall and slim	Conventional coil which heat the water as it runs through the machine	An interactive touchscreen display	Bamboo	 Both side and bottom provide heat
4	 Handle dug out of body		No display On-Off Switch	Teflon (interior)	

Table 1. A sample morphological chart.

are presented first. These hypotheses were derived from Research Question 1 by assuming that redesigns that contained function information improved product functionality. Therefore, it is necessary to determine the amount of form and function content that was presented in the coffee maker redesigns.

Null Hypothesis 1.A for Research Question 1

The teams that did not do dissection focused more on form in their redesigns. Mathematically the hypothesis is shown in Eq. (1) where H_o is the null hypothesis, H_a is the alternate hypothesis, and p_i is the proportion from the experimental data.

$$H_o: pi_{(form,\ no\text{-}dissection)} = pi_{(form,\ dissection)}$$
$$H_a: pi_{(form,\ no\text{-}dissection)} > pi_{(form,\ dissection)} \qquad (1)$$

The test method used for this hypothesis is a one-sample Z test with a significance level of 0.05 as shown in Eq. (2). In this equation, the estimated common population proportion for the two samples combined is represented by Pc.

$$Z = ((p_{11} - p_{21}) - 0)/sqrt(P_c(1 - P_c)((1/n_1) + (1/n_2)) \quad (2)$$

Null Hypothesis 1.B for Research Question 1

The teams that did dissection focused more on function issues. Mathematically the hypothesis is shown in Eq. (3) where Ho is the null hypothesis, and Ha is the alternate hypothesis, and pi is the proportion from the experimental data.

$$H_o: p_{i\ (function,\ no\text{-}dissection)} = p_{i\ (function,\ dissection)}$$
$$H_a: p_{i\ (function,\ no\text{-}dissection)} < p_{i\ (function,\ dissection)} \quad (3)$$

The test method used for this hypothesis is also a one-sample Z test with a significance level of 0.05 as shown in Eq. (2).

The null hypotheses development for Research Question 2 considers the evaluation of the *quantity* and *variety* aspects of creativity defined in Section 2.2. The novelty aspect of creativity was not evaluated in this study. The null Hypothesis 2.A considers the number of ideas generated as an indicator of the level of design universe searched, i.e., the quantity of ideas. The remaining null hypotheses examine the variety of coffee maker redesigns by considering both internal (2.B) and external (2.C) coffee maker changes presented by the students.

Null Hypothesis 2.A for Research Question 2

The level of design space searched by teams that did not do dissection is less than the teams that did. Mathematically the hypothesis is shown in Eq. (4) where H_o is the null hypothesis, and H_a is the alternate hypothesis, and p_i is the proportion from the experimental data.

$$H_o: p_{i\ (form\ \&\ function,\ no\text{-}dissection)} = p_{i\ (form\ \&\ function,\ dissection)}$$
$$Ha: p_{i\ (form\ \&\ function,\ no\text{-}dissection)} < p_{i\ (form\ \&\ function,\ dissection)} \quad (4)$$

The test method used for this hypothesis is also a one-sample Z test with a significance level of 0.05 as shown in Eq. (2).

Null Hypothesis 2.B for Research Question 2

The teams that did dissection focused more external features of the coffee makers. Mathematically the hypothesis is shown in Eq. (5) where Ho is the null hypothesis, and Ha is the alternate hypothesis, and pi is the proportion from the experimental data.

$$H_o: p_{(external,\ no\text{-}dissection)} = p_{(external,\ dissection)}$$
$$H_a: p_{(external,\ no\text{-}dissection)} < p_{(external,\ dissection)} \quad (5)$$

The test method used for this hypothesis is also a one-sample Z test with a significance level of 0.05 as shown in Eq. (2).

Null Hypothesis 2.C for Research Question 2

The teams that did dissection focused more on the internal features of the coffee makers. Mathematically the hypothesis is shown in Eq. (4) where H_o is the null hypothesis, and H_a is the alternate hypothesis, and p_i is the proportion from the experimental data.

$$H_o: p_{i\ (internal,\ no\text{-}dissection)} = p_{i\ (internal,\ dissection)}$$
$$H_a: p_{i\ (internal,\ no\text{-}dissection)} < p_{i\ (internal,\ dissection)} \quad (6)$$

The test method used for this hypothesis is also a one-sample Z test with a significance level of 0.05 as shown in Eq. (2).

For all the hypotheses, if the p-value is less than the significance level (0.05), then the null hypothesis is rejected. The statistical analysis was initialized by dividing the data and calculating the proportions. The features identified in the coffee maker redesign were divided into two categories, namely, form and function, while the teams were divided into no-dissection and dissection to calculate the proportions shown in Table 2. In the table, p_{ij} represents sample proportion of the form/function features used by no-dissection/dissection teams. P_1 and P_2 represent the proportion of the no-dissection and dissection teams, respectively.

RESULTS AND DISCUSSION

The detailed results are discussed in this section. The response to the first research question is sought using the hypotheses 1.A and 1.B. The results from the Z- test of Hypothesis 1.A indicate that

	No-Dissection Teams (1)		Dissection Teams (2)	
Form (1)	p_{11}	**P_1**	p_{12}	**P_2**
Function (2)	p_{21}		p_{22}	

Table 2. Data categories for proportion calculations.

the p-value is less than 0.05; therefore, we reject the null hypothesis, indicating that the no-dissection teams did focus more on form. For Hypothesis 1.B, the p-value is higher than 0.05 (0.742); therefore, the null hypothesis is not rejected, indicating that there is no significant difference between the relative focus on form versus function by the dissection and no-dissection teams. Taken together, these two hypotheses indicate that the students who performed product dissection did indeed produce more redesign alternatives that focused on function. Assuming that higher quantities of functional concepts during redesign will lead to improved product functionality, the answer to the first research question is positive, namely, *situated cognition, in the form of product dissection, improves product functionality during redesign.*

The response to the second research question is sought using the hypotheses 2.A-2.C. The result from the Z-test of hypothesis 2.A is a rejection of the null hypothesis since the p-value is less than 0.5. Thus, the teams that did dissection are more creative with respect to the *quantity* of concepts produced. Hypotheses 2.B and 2.C examine creativity with respect to the *variety* of concepts produced. The results of the Z-test for Hypothesis 2.B also indicate a rejection of the null hypothesis since the p-value was less than 0.05. Therefore, the no-dissection teams focused more on external concepts as we hypothesized. The results of the Z-test for Hypothesis 2.C again reject the null hypothesis because the p-value is less than 0.05. Thus, teams that did dissection focused more on internal concepts. Taken together, the rejection of these three hypotheses indicates that the student teams who performed dissection generated a wider variety of concepts as well as a higher quantity of concepts (internal and external concepts). According to the assumptions made in the study of Research Question 2, the rejection of Hypotheses 2.A-2.C indicates that *yes, situated cognition, in the form of product dissection, positively effects creativity during product redesign.*

While the implications of our specific findings are straightforward, their impact has serious ramifications both in the short- and long-term on engineering education for product design. As pre-college students spend more and more time on computers—and hence less and less time doing "hands on" activities like product dissection—their ability to be successful product designers will be adversely impacted. Ferguson [1] and Petroski [2] warned of this nearly two decades ago, and we continue to see the disparity increase in students' engineering capabilities in our classrooms as a result. Most recently, several freshmen commented in their final course evaluations that they wanted more explanation of how tools worked as part of a dissection activity; this does not bode well for those educating future product designers.

While there are certainly numerous reasons for this, we clearly see from Research Question 2 that students' lack of familiarity with the inner workings of products (e.g., through dissection) adversely impacts their ability to generate creative solutions that will improve product functionality. While both groups are comparable in terms of new concepts for product form, from an engineering perspective, it is the internal functionality that dictates the success (or failure) of many products; therefore, exposing students to product functionality through dissection-type activities will become even more critical in the future. The problem will likely be amplified as these students move into upper-level classes that tend to focus more on theory, and it is clear why product dissection courses such as those listed in Section 1 are becoming more widespread and more popular. When combined with our findings, such courses will become more essential as we prepare engineering students to be creative product designers in the workplace.

CONCLUSIONS

An experiment was performed at two universities to determine the effect of product dissection situated cognition's affect on students' redesigns. Overall, we find that student teams that did not do dissection focused significantly more on form related features, while the teams that completed dissection before the redesign activity were able to focus equally well both on form and function. Further, we also find that teams that completed dissection had a higher creativity level, and they present design concepts to a higher proportion than those of the no-dissection teams. A follow-up study is currently being conducted to analyze the functional genealogy of the collected design concepts to calculate novelty metric values for the designs in addition to quantity and variety metrics. Finally, replicating the study with upper class students will help us better understand the long-term implications of our findings and identify ways to ensure students are adequately prepared to be successful product designers upon graduation.

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APPENDIX 1: SAMPLE EXPERIMENTAL DATA

				No-dissection Teams								Dissection Teams											
Sub-function/Feature	Form/Function	External/Internal	Concept	1	2	3	4	5	6	7	8	9(1)	10(2)	11(3)	12(4)	13(5)	14(6)	15(7)	16(8)	17(9)	18(10)	19(11)	20(12)
Carafe Lid	Form	E	Spring loaded slide						*														
Carafe Lid	Form	E	Screw on		*																		
Carafe Lid	Form	E	Hinge		*				*														
Color of body (shell)	Form	E	Black			*				*				*									
Color of body (shell)	Form	E	Multiple											*									
Color of body (shell)	Form	E	White			*				*				*									
Design of the carafe	Form	E	Circular			*		*		*		*											
Design of the carafe	Function	E	Insulated/thermos		*			*		*						*	*					*	
Design of the carafe	Form	E	Rectangular prism									*									*		
Design of the carafe	Form	E	Concave top																				*
Design of the carafe	Form	E	Triangular prism									*											
Ergonomics of the pot handle	Form	E	Finger grip	*					*														
Ergonomics of the pot handle	Form	E	Rough plastic	*																			
Ergonomics of the pot handle	Form	E	Smooth plastic	*					*	*													
Ergonomics of the pot handle	Form	E	Handle dug out of body							*													
Ergonomics of the pot handle	Form	E	Smooth steel	*																			
Extra Features	Function	E	Hot & cold juice maker									*											
Extra Features	Function	E	Tea maker						*														
Extra Features	Function	E	Frother		*																		
Extra Features	Function	E	Toaster									*											
Filter	Form	E	Convex bottom																				*
Filter	Function	E	French press										*										
Filter	Function	E	Internal						*					*									
Filter	Function	E	None											*									
Filter	Function	E	Paper filters (disposable)		*		*	*					*			*							
Filter	Function	E	Re-usable filters - magnet attached						*														
Filter	Function	E	Re-usable filters		*		*	*	*				*			*							
Filter openning	Form	E	Button swing open			*																	
Filter openning	Form	E	Pull out			*																	
Filter openning	Form	E	Swing out		*	*																	
Filter openning	Form	E	Take off top			*																	
Filtration System	Function	E	Brew select (type of coffee is selected)	*	*																		
Filtration System	Function	E	One type brew	*																			
Grinder	Function	E	No grinder, storage only											*									
Grinder	Function	E	Yes											*									
Heating unit (or system)	Function	E	Bottom heating plate		*					*	*				*	*							
Heating unit (or system)	Function	I	Dual heating (hot) plates								*												
Heating unit (or system)	Function	I	Ceramic bottom heating plate													*			*	*			
Heating unit (or system)	Function	I	Coiling heating element around water tube							*													
Heating unit (or system)	Function	I	Connected to water heater					*		*				*									
Heating unit (or system)	Function	I	Dual heating coils										*										
Heating unit (or system)	Function	I	Heat loop tube - loop of heated water warms plate						*				*			*							
Heating unit (or system)	Function	I	Heater to the back of the carafe							*						*	*			*			
Heating unit (or system)	Function	I	Heater to the bottom of the carafe							*							*						
Heating unit (or system)	Function	I	Heating coil (circular heating element)	*				*			*		*	*				*	*	*			
Heating unit (or system)	Function	I	Heating element encapsulates water tube													*							
Heating unit (or system)	Function	I	Heating element inside the water line					*								*							
Heating unit (or system)	Function	I	Heating on sides of the carafe												*								
Heating unit (or system)	Function	I	Heating source coupled with a temperature sensor	*																			
Heating unit (or system)	Function	I	Infrared heating source															*					
Heating unit (or system)	Function	I	Insulated sides (walls) to fit the carafe (vacuum)											*	*							*	
Heating unit (or system)	Function	I	Microwave heater											*				*					
Heating unit (or system)	Function	I	Stovetop heater													*	*						
Heating unit (or system)	Function	E	Contacts at the top conducting current to the pot							*													
Heating unit (or system)	Function	I	Duct																	*			
Heating unit (or system)	Function	I	Heat sink																				*
Heating unit (or system)	Function	I	U-shaped heating element								*												
Interface	Function	E	Digital screen	*	*					*													
Interface	Form	E	Knob (Dial)	*					*	*	*												
Interface	Function	E	LCD screenwith bluetooth PC/Cell interface											*									
Interface	Function	E	LED screen	*				*		*													
Interface	Function	E	Regular lights					*															
Interface	Function	E	Simple timer/digital								*			*									
Interface	Function	E	Simple timer/analog							*	*												
Interface	Form	E	Buttons		*				*	*	*												
Interface	Form	E	Buttons on the side of the console			*																	
Interface	Form	E	Buttons under the coffee pot			*																	
Interface	Form	E	Buttons on top of the filter			*																	
Interface	Form	E	Slide								*												
Interface	Function	E	Touch screen	*					*	*	*												
Material of the body (shell)	Form	E	All metal - not specified																*	*			
Material of the body (shell)	Form	E	Aluminum											*									
Material of the body (shell)	Form	E	Brass	*																			
Material of the body (shell)	Form	E	Carbon fiber																*	*			
Material of the body (shell)	Form	E	Copper	*																			
Material of the body (shell)	Form	E	Glass	*																			*
Material of the body (shell)	Form	E	Metal and plastic							*									*	*			
Material of the body (shell)	Form	E	Bamboo							*													
Material of the body (shell)	Form	E	Composite							*													
Material of the body (shell)	Form	E	Plastic	*	*	*			*	*				*					*	*			
Material of the body (shell)	Form	E	Stainless Steel	*	*	*			*	*													
Material of the carafe	Function	E	Aluminum														*						
Material of the carafe	Function	E	Clear Plastic	*	*		*																
Material of the carafe	Function	E	Glass	*	*		*		*	*				*			*						*
Material of the carafe	Function	E	Styrofoam				*																
Material of the carafe	Function	E	Stainless Steel	*	*		*			*													
Notification	Function	I	Bluetooth notify PC/Cell (B/T chip)											*									
Notification	Function	I	Sound alarm											*									
Notification	Function	I	iPod adapter+speakers+volume control + LED display																	*			
Notification	Function	I	Sounds alarm + Bluetooth notify PC/Cell (B/T chip)											*									
Overall shape	Form	E	Conic																				
Overall shape	Form	E	Cyclindirical							*									*	*			
Overall shape	Form	E	Rectangular prism																		*		
Overall shape	Form	E	Slimmer, taller		*																		
Overall shape	Form	E	Optional wall-mount		*																		
Overall shape	Form	E	Standard coffee pot shape							*									*	*			
Packaging	Form	E	Foam						*														
Packaging	Form	E	Cardboard						*														
Portability	Form	E	Carrrying handle	*																		*	
Portability	Form	E	Less protruding handle	*																		*	
Portability	Form	E	Smaller base	*																	*	*	
Portability	Form	E	Strap to hold pot in place	*																		*	
Power Source (supply)	Function	I	Batteries	*	*		*	*			*		*	*	*	*	*	*	*	*			
Power Source (supply)	Function	E	Flame	*			*						*			*							
Power Source (supply)	Function	I	Gas				*			*				*									
Power Source (supply)	Function	I	Recharagble batteries	*	*			*															
Power Source (supply)	Function	E	Solar		*			*			*		*	*		*	*	*	*	*			
Power Source (supply)	Function	E	Wall outlet	*	*		*	*			*		*	*	*	*	*	*	*	*			
Power Source (supply)	Function	E	Wall outlet + retractable cord		*						*												
Power Source (supply)	Function	I	Wall outlet + batteries									*			*					*			
Safety	Function	E	Notification of dangerous drinking temperature																			*	
Safety	Function	E	Auto shut off		*									*									
Safety Markings	Form	E	Large bold labels	*																			
Safety Markings	Form	E	Small labels	*																			
Safety Markings	Form	E	Warning light	*																			
serving technique	Form	E	Coffee pot					*										*					
serving technique	Form	E	Large cups				*	*										*					
Spout design (of the carafe)	Form	E	Curved spout			*									*								
Spout design (of the carafe)	Form	E	Cylindrical												*								
Spout design (of the carafe)	Form	E	Half cone												*								
Spout design (of the carafe)	Form	E	Lemonade pitcher												*								
water distribution	Function	I	Regular-drip													*							
water distribution	Function	I	Shower head													*							
water distribution	Function	I	Straw																	*			
water distribution	Function	I	Umbrella top water showerer													*				*			
Water intake (source)	Function	E	Manual tank fill											*						*		*	
Water intake (source)	Form	E	Poptop with removable tank	*																*			
Water intake (source)	Form	E	Poptop with stationary tank	*																*			
Water intake (source)	Form	E	Flip top lid					*															
Water intake (source)	Form	E	Sliding lid	*				*															
Water intake (source)	Function	E	Slits with removable tank	*																*			
Water intake (source)	Function	E	Slits with stationary tank	*																*			
Water intake (source)	Function	E	Water hose connected to water source					*						*									
water movement	Function	I	Drip as in Durabrand															*					
water movement	Function	I	Gravity & pump				*										*					*	
water movement	Function	I	Gravity & steam		*		*										*						
water movement	Function	I	Manual															*					
water movement	Function	I	Osmosis pressure															*					
water movement	Function	I	Pump			*	*				*						*	*				*	
water storage	Form	E	Above pot								*		*			*							
water storage	Form	E	Below pot										*										
water storage	Form	E	Detachable		*				*									*					
water storage	Function	E	Direct from sink with flow regulator										*					*					
water storage	Form	E	Taller, thinner chamber													*							
water storage	Form	E	Water bladder made of flexible material													*							
water storage	Form	E	Water reservoir wrapped around			*										*							
water storage	Form	E	Replaced by percolater																			*	
water storage	Form	E	Water tank as in Durabrand		*				*		*							*					